An analysis of policy impact and stream water quality practices on knowledge, attitudes and behaviour toward stream restoration practices in Umlazi Township, KwaZulu Natal, South Africa

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DECLARATION

I, **Ntokozo Amanda Xaba**, do hereby declare that this research report is the result of my investigation and research and that this has not been submitted in part or full for any degree or for any other degree to any other University.

___ _____ ___21/03/2022___

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Approved for Final Submission

02/04/2022

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Professor Mgutshini Date

DEDICATION

I dedicate this thesis to my father Mr Naphtal Mchilizwa Xaba, my pillar and to my mother Thandi Constance Xaba, you are the best parents a child could ever ask for. You believed in me, prayed for me, and supported me, and for this I will forever be grateful. May the Good Lord keep you strong and healthy! I love you

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To God be the glory!

ABSTRACT

Background: Environmental knowledge and environmental policies influence behaviour change towards environmental-policies adherence. Rivers in Umlazi are one of the most polluted rivers in South Africa which results in reports of death resulting from illegal dumping. There is limited understanding of how policy and stream water quality influence people's environmental knowledge, attitude and behavioural practice.

Purpose: The aim of this study was to determine policy impact on knowledge, attitudes and behaviour toward stream restoration practices in Umlazi Township, KwaZulu Natal, South Africa

Methodology: A sequential mixed method design was used in this study. Interviews and focus group discussions were used to collect data from the municipality and community organisations under exploratory design. A survey on community members of Umlazi validates the interview and focus group findings.

Results: Altering physical and natural environment as part of Social Ecological Model (SEM) and improving living conditions of the citizens can be conducted by the government to yield better public health outcomes. Beta coefficients (0.168) for policies findings suggest policy impact has biggest influence in predicting behavioural change towards stream restoration and in decision making than attitude and knowledge. Even though there was lack of proper knowledge on stream water quality testing, poor attitude towards stream restoration practice was highlighted throughout the study. Citizens' behaviour and attitude instead highlighted social disapproval towards clean stream management and 76.3% highlighted concerns of children being more vulnerable to health and safety risks.

Key Contributions Made by the Study: The study proposes a model that suggests that sustainable management of river ecosystems requires a stronger inter-disciplinary approach and reclaiming the 'water sector' from the margins to the centre of policy-making.

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ACROMONY

AMD Acid Mine Drainage

BOD Biochemical Oxygen Demand

CSIR Council for Scientific and Industrial Research

DEAT Department of Environmental Affairs and Tourism

DEA Department of Environmental Affairs

DHP Department of Health Plan

D'MOSS Durban Metropolitan Open Space System

DSW Durban Solid Watse

DWA Department of Water Affairs

DWAF Department of Water Affairs and Forestry

DWS Department of Water and Sanitation

E. coli Escherichia Coli

ESS Ecosystem Services

GIS Geographical Information System

HBM Health Belief Model

HIV Human Immunodeficiency Virus

IWRM Integrated Water Resource Management

NEMA National Environmental Management Act

NFEPA National Freshwater Ecosystem Priority Areas

TB Pulmonary Tuberculosis

RQO Resource Quality Objective

SES Social-Ecological System

SA South Africa

SDGs Sustainable Developmental Goals

UN United Nations

UNICEF United Nations Children's Fund

WWAP United Nations World Water Assessment Programme

WHO World Health Organization's

CHAPTER ONE

BACKGROUND, OUTLINE AND OVERVIEW OF THE STUDY

1.1 INTRODUCTION

Globally, there is growing evidence that a significant proportion of rivers are facing decline in water quality, with over 45 percent of rivers in China (Loucks, van Beek, Stedinger, and Dijkman & Villars 2005) and above one third of rivers in the United States categorized as polluted (Vörösmarty, McIntyre, Gessner, Dudgeon, Prusevich, Green, Glidden, Bunn, Sullivan, and Liermann 2010). Water quality is defined by the physical, chemical and biological characteristics of water (United Nations Educational, Scientific and Cultural Organization/World health Organization/ United Nations Environment Programme (UNESCO/WHO/UNEP) 1996).

The obtainability of water resources is fundamentally connected to water quality, thus contaminated surface water and groundwater may hinder users when there is no pre-treatment available due to it high costs (UNEP 2016). Organic pollution that is calculated by Biochemical Oxygen Demand (BOD) can contribute to inland fish availability, food security and livelihoods, if BOD is high this can ruthlessly affect poor citizens that rely on surface water. This can be caused by unsorted wastewater and all its components which might eventually end up in the marine environment (United Nations World Water Assessment Programme (WWAP) 2017). It has also been observed that some of urban runoff and households' use uncontrolled discharge for irrigation therefore posing a myriad of health risks (WWAP 2017). Fish communities have responded to changes in water quality which has resulted in marked reductions in fish diversity and nursery function (DWA 2013a and DWA 2013 b). Most, if not all the systems in the study area have experienced damage to the estuarine habitat and a loss of the natural buffer on their perimeters and inflowing rivers. The United Nations (UN) (2016) and WWAP (2017) have observed an increased discharge of untreated sewage, joined with farming spill over and deficiently treated wastewater from industry, which has resulted in the degradation of water quality globally. If momentum designs proceed, water quality will keep on getting worse and later influencing dry nations, that for the most part reliant upon surface water, further jeopardizing human wellbeing and environments, adding to water shortage and restricting feasible financial turn of events (UN 2016).

1.2 BACKGROUND TO RESEARCH AREA

The scarcity of safe drinking water presents a global challenge. The World Health Organization's (WHO) and United Nations Children's Fund (UNICEF) programmes that focus on environmental health priorities identify the scarcity and poor water quality as key imperatives (Gorchev & Ozolins 2011; Shortle 2013). Barak and Katz (2015) assert the view that there is widespread agreement that having access to safe drinking water is essential to human health and represents a non-negotiable basic human right. Safe drinking water plays the single most important role in health promotion and health protection (Sandhu 2014).

Developed sanitation services greatly decreases health risks associated with poor water quality, which makes them even more pivotal in contexts like Africa where, one third of all rivers are filled with a multitude of pathogens including the presence of fecal coliforms, which begin from creature and human excreta as is seen from the worldwide water quality observing results (UNEP 2016). Although UNICEF/WHO (2015) maintains that there has been an increase in sanitation coverage and treatment levels in other countries, there are 2.4 billion people who do not have access to better sanitation. South African rivers, particularly the main rivers of Durban, Umlazi township which is situated in the KwaZulu-Natal province, namely the Umlazi river, Isipingo river and Izimbokodo river, are one the most polluted rivers in South Africa (DSW 2018a; Cele 2015). At the time of writing of this research, the implementation of the Resource Directed Measures was still on-going in the Department of Water Affairs (DWA).

In cooperating with National Freshwater Ecosystem Priority Areas (NFEPA) standards and the use of citizen approach, this study sough to examine how to increase commitment of science into policy tp identify the challenges affecting policy implementation (Nel & Driver 2015; McLean, Ground, Boon, Roberts, and Govender & McInnes 2016).These high priority areas were selected based on ecological, socio-cultural and water resource use importance, and are often areas of high ecological importance where water resources are stressed or may be stressed in future, hence describing the status quo of the study area is crucial as the lack of previous data hinders accurate reflection of ecological status trends for most eThekwini rivers and estuaries (McLean *et al*., 2016).

1.2.1 General Overview of Surface Water Susceptibility and Severity Disease Rates

There is a need to address disease risks that are associated with water contamination and gauge the relationship between pollution and diseases at a local level(Alfredo, Prisco, Cosimo, Giulia and Leopoldo 2015). Low-income citizens are left with no choice but to consume water that is filled with many microbial contaminants (Oladipo, Onyenike and Adebiyi, 2009). E Low-income countries have HIV many infected individuals hence are more susceptible to TB surface water contaminated conditions (WHO 2014c; WHO 2014a).

Diseases associated with poor stream management are a major health burden and need to be mitigated otherwise they will result in also being a colossal economic burden for developing countries. There have been reports of traces of tuberculostatic, antifungals, and antimalarials given to HIV positive patients found in contaminated surface water sources (WHO 2014d). In South Africa specifically, an estimated 60% of patients with pulmonary tuberculosis (TB) are HIV-positive (WHO 2008; Abdool Karim, Churchyard, Karim & Lawn 2009; WHO 2011; Naidoo, Theron, Rangaka, Chihota, Vaughan, Brey & Pillay 2017). Hence it is reasonable to expect surface water in KwaZulu-Natal to also be contaminated with these traces of tuberculostic and antimalarials as it has a great number of citizens that are infected. Observational studies from Brust, Lygizos, Chaiyachati, Scott, van der Merwe, Moll, Li, Loveday, Bamber, Lalloo, Friedland, Shah and Gandhi (2011) indicated that South Africa reported worse outcomes for MDR-TB patients co-infected with HIV (WHO 2008; Abdool Karim *et al.* 2009; Naidoo *et al.* 2017). The KwaZulu-Natal Province has the highest TB treatment cost compared to other South African provinces albeit the population is lower than Gauteng province (Sinanovic, Ramma, Vassall, Azevedo, Wilkinson, Ndjeka, McCarthy, Churchyard, and Cox 2015). The relationship between pollution and diseases means low-income citizens consume unsafe water because their water sources are often polluted. Therefore, there exists a need for a comprehensive approach for surface water quality restoration at a catchment level to mitigate disease risks or health susceptibility and severity.

1.2.1.1 TB and Chest Related Diseases on Adults and Children Susceptibility and Severity in Kwazulu-Natal

Contaminated water related diseases can result in a high economic burden due to treatment of these diseases, for example, in South Africa the cost of treating MDR-TB patients in an inpatient setting is more than 40 times that of treating drug-susceptible TB (Schnippel, Rosen, Shearer, Martinson, Long, Sanne and Variava 2013:114). The total population of KwaZulu-Natal is 43.1/56.9 (% urban/rural population); 6 630 (Diagnosed MDR-TB cases n); 51 404 246 (Total cost: fully decentralised model US$); 89 052 967 (Total cost: fully hospitalised model US$); 82 714 173 (Total cost: % urban fully decentralised and % rural fully hospitalised US$) higher than Gauteng Province that has more population yet less cases (Sinanovic et al. 2015). Alderman, Turner, and Tong (2012) also indicated that post-flood mould as the fungal growth indoors can aggravate allergy or asthma symptoms.

1.2.1.2 Cholera Susceptibility and Severity in South Africa

According to WHO (1983), the risk of cholera increases after the heavy rains that contaminate the surface run-off water sources and boreholes. According to Sigudu, Tint, and Archer (2015) cholera susceptibility increases in the developing countries such as South Africa where add up to between December 2008 and March 2009, 6 278 cholera positive cases were reported, with 30 deaths, resulting in a case-fatality rate of 0.48 percent. Sigudu et al. (2015) confirms that cholera regularly happens In large-scale episodes, it causes a high burden of disease and, in a few cases, death. Bwire, Mwesawina, Baluku, Kanyanda and Orach (2016) affirms that the cross-border cholera flare-ups are a major open wellbeing issue in Sub-Saharan Africa contributing to the tall yearly detailed cholera cases and deaths.

1.2.1.3 Sewage Pollution Increasing TB, Cholera and Waste Related Diseases Susceptibility and Severity Changes in Kwazulu-Natal

According to Morii, Miyagatani, Nakamae, Murao and Taniyama (2008), sewer related smell and sewer gases depending on the exposure can cause the health and safety severity. Morii *et al*. (2008) maintains that within 30-60 minutes of exposure to concentrations above 500 ppm, mental state depression and cardiac arrest occur. Inhalation with concentrations greater than 1000 parts per million causes instant death ("knock down") (Morri et al., 2008; Iseki, Ozawa, Seino, Okubo, Yamazaki, Goto & Tase, 2016).

At Umlazi L/M section, 83 percent of the citizens from this overview demonstrated that this stream is rancid with 64 percent that unequivocally concurred Xaba, Chetty and Karodia (2016). However, concurring to Oram (2014) scent of water is the primary clue that shows there's an issue with that water, and this may be caused by chemicals, microscopic organisms and indeed poisons. There are diverse sorts of scent or smell and these incorporate: hydrogen sulfide microscopic organisms that gives smells like rotten-egg and smelly smell; oil defilement that gives sleek scent; natural deterioration that gives phenolic scent and mechanical defilement that gives chemical scent (Oram, 2014).

1.2.1.4 Diarrheal Susceptibility

When Reddy, Patrick and Stephen (2016), investigated Diarrhoeal Disease (DD) treatment from doctors' perspective on whether doctors adhered to standard treatment guidelines when treating children under 5 years of age visiting Edendale Hospital in Pietermaritzburg, KwaZulu-Natal Province, with acute DD. Reddy *et al*. (2016) observed the complains to requesting appropriate examinations was low (12%) for all levels of doctor, frequently due to inadequate investigation.

DD is still a major reason of childhood death in creating nations. The yearly death report discharged by Statistics SA for passing happening in 2013 recorded intestinal irresistible maladies as the driving reason of passing in children beneath 5 a long time

of age (Statistics South Africa (SSA), 2016 b). At EDH, where DD is positioned as the third most visit cause of passing in children beneath 5 a long time, this consider found noteworthy non-adherence to STGs for the administration of DD by specialists in a setting of tall DD predominance. Poor result as high as 60% non- compliance on actions of managing affected was observed, which is reason for worry. Only 38% assistants; 36% for medical officers and as low as 24% for registrars' specialists showed compliance, this, highlighted that the higher the level of professionalism the lower was their commitment on compliance (Reddy *et al*., 2016:217).

1.2.1.5 Umlazi Susceptibility and Severity in Sewage Pollution Increasing TB, Cholera, Diarrhoea and Other Waste Related Diseases

Umlazi being situated in KwaZulu-Natal province where diagnosed MDR-TB cases are the highest than the rest of the country (Sinanovic *et al*.,2015) while observed to have high diarrhoeal infections during high rainfalls (Health Department Province of KwaZulu-Natal, 2015) and contaminated surface water in Umlazi (DWS, 2017; McLean *et al*., 2016; Sethebe *et al*., 2016). According to Department of Health Plan KwaZulu-Natal (2015), uMlazi remains the second populated township in the country with high reports of death levels due diarrhoea outbreak during the rainy season of October to February and the rotavirus season April to August. Umlazi's high diarrhoea outbreak is as a result of water contamination and poor infrastructure and remains a reason for worry in the KwaZulu Natal district (Department of Health Province of KwaZulu-Natal (DHPKZN),2015). DHPKZN (2015) maintains that Umlazi' s high diarrhoea outbreak is as a result of water pollution and poor infrastructure and remains a reason for worry in the KwaZulu-Natal district. DWS (2016) also confirmed that the old and inadequate infrastructure and poor maintenance contribute to poor surface water quality maintenance in peri-urban and rural areas.

1.2.2 Context of the Study

As noted by many including Liu, Liu, and Yang,(2016) water scarcity assessments have previously looked exclusively at water quantity with minimal exploration of the role of water quality as a possible causal factor and likely solution to the widespread water shortages. In South Africa (SA), the importance of ensuring good-quality water is reflected in the initiation of the drinking water quality framework for South Africa. This framework is premised on preventative risk management. Focus meeting interventions suggested the proposed need for better management of stream-water quality. Since suggesting incremental approach to the improvement of water quality, the framework highlights the particular risk caused by urban water sources but notably does not offer or make specific guidelines about the role and involvement of water or consumers within communities (WHO 2014b). Guided the by acknowledgement of the significance of water quality problems in South Africa and globally, the current study aims to address the paucity of related research about water quality management and in so doing will also offer an analysis of the impact of policy and water quality practices on community knowledge, attitudes and behaviour toward stream restoration practices in Umlazi Township, Kwa-Zulu Natal, South Africa.

Many streams in South Africa have been shown to have poor water quality and as such, the water that flows within them is rendered unusable and in many cases disease-causing (Keeler, Polasky, Brauman, Johnson, Finlay, O'Neill, Kovacs, & Dalzell 2012). Recognition of the impact that community action or lack thereof, may have on restorative practices has provided the initial impetus for conducting a study that explores what impact community knowledge, attitudes and behaviours may have on quality enhancing behaviours. The study presents the first known opportunity (in South Africa) for an evaluation of knowledge, attitudes and behaviours in a specific locale and how they influence stream restoration practices. Developing an effective framework for promoting best practices would support the prevention of many water-borne illnesses and offer opportunities for safer water in the streams. Umlazi township is a highly populated township in KwaZulu Natal with over 404, 811 residents and this

study serves as an initial step toward engaging the local community in water restoration (Statistic South Africa (SSA) 2011).

1.2.2.1 Current GIS Layer Used in Determining Changes in River Condition

White, Jimmieson, Obst, Graves, Barnett, Cockshaw, Gee, Haneman, Page, Campbell, Martin, and Paterson (2015) maintains that without the capacity of environments or ecosystem to proceed to supply imperative administrations such as water decontamination, no financial or social advancement will be conceivable. As all human actions are reliant on resources being take out from the natural environment (White *et al*. 2015).

According to Midgley, Pitman, and Middleton (1994), sub-quaternary catchment is a standardised quaternary catchment Geographic Information System (GIS) layer that has an exclusive quaternary catchment identification convention used by the DWA since 1994 to identify river sampling points for monitoring purposes. However, these GIS layers are big units found contained by other various networks such as climate variables that are forever changing. These layers however do not include streams, land use, and dams of smaller regions. One cannot therefore use these layers to determine data for smaller areas such as streams that are within that catchment as the variables used are different, making the data to be inaccurate, therefore requiring a smaller resolution during modelling to preserve the biodiversity of that small area (Nel, Turak, Linke, & Brown 2011; McLean *et al*. 2016, WWAP 2017). According to Dollar, Nicolson, Brown, Turpie, Joubert, Turton, Grobler, Pienaar, Ewart-Smith, and Manyaka (2010), it is important to link citizens' daily activities, even that of surface water activities with these layers. As previously mentioned, the existing sub-quaternary layer used in SA does not however include land use changes, yet, the river conditions change in smaller regions is however determined by variables such as land use.

1.2.2.2 Umlazi Streams Condition Overview

The water quality of streams and rivers in Umlazi is poor because of destitute administration of human exercises and frameworks, which has resulted in faecal pollution which has led high diarrheal disease on children under five years old in the region (DHKZN 2015). Therefore, since river system connection to the land use affects the water quality of that river or stream, continuous monitoring of streams is crucial to minimise health risks associated with poor management of the catchment areas as a whole considering the natural characteristics of the catchment influenced by the physical, chemical and biological characteristics of a river (DEA 2018). The river system goods and services maintaining the habitat for conservation of marine species can be compromised by illegal dumping and must be managed properly (WWAP 2017 and DWS 2017).

Economic expansion and rapid population growth in South Africa has increased the demand on the country's limited water supplies (DWA 2011a). The pathogenic microorganisms from human sewage are discharged into the river catchment because of poor sewage system monitoring (Teklehaimanot 2013). According to Sithebe, Singh, Amoah, and Stenstorm (2016), the sampling point next to the WasteWater Treatment Works (WWTW) of Isipingo River was highly contaminated as well. Amoah, Keraita, Akple, Drechsel, Abaidoo, and Konradsen (2011) confirmed that safe measures are required in WWTW as currently there is insufficient wastewater treatment

Isipingo River is found before the iSipingo WWTW, where the E. coli contamination was around 10 000 000 MPN, main reason for this high count being sewer mismanagement, with a report stating that 60 percent of the sewers were broken (Dicken 2002 and Sithebe 2017). Such conditions from smaller streams affected by unmaintained sewers eventual impact the water quality of the larger rivers such as iSipingo. In these high density urban areas and those subject to inflow from WWTWs, water quality is an issue. Fish kills have occurred in recent years in several estuaries in the eThekwini Municipal area including the Durban Bay (Dicken 2002; Rambally 2013; Sithebe 2017).

In cooperating with the river water quality standards as part of NFEPA standards, the use of the citizen approach for this study aids to examine how to improve commitment of science into policy identification and various problems facing science commitment, as the citizen approach is part of the social ecological systems (SES) perspective is particularly useful to involve all stakeholders in decision making. As uMlazi Township is considered a high priority area based on ecological, socio-cultural and water resource use, the importance where water resources are stressed or may even be stressed in future, hence describing it instream status quo on the study area is crucial using sampling points that are along sewer lines leading to WWTW (South African National Biodiversity Institute (SANBI), 2016).

1.2.2.2.1 The scope of the study area

The catchment is divided into three WWTW sub-area: the northern catchment's wastewater is reticulated to the southern WWTW of uMlazi river; wastewater from the central catchment is treated at the Isipingo WWTW of Isipingo river; and the balance of wastewater generated by the southern catchment is treated at the Amanzimtoti WWTW part of eZimbokodweni river. According to DWA (2003), the boundaries of the catchment to be evaluated and may lead catchment requiring further division into smaller homogeneous management areas as proper water quality assessment requires catchment assessment in order to clearly identify water resource targets.

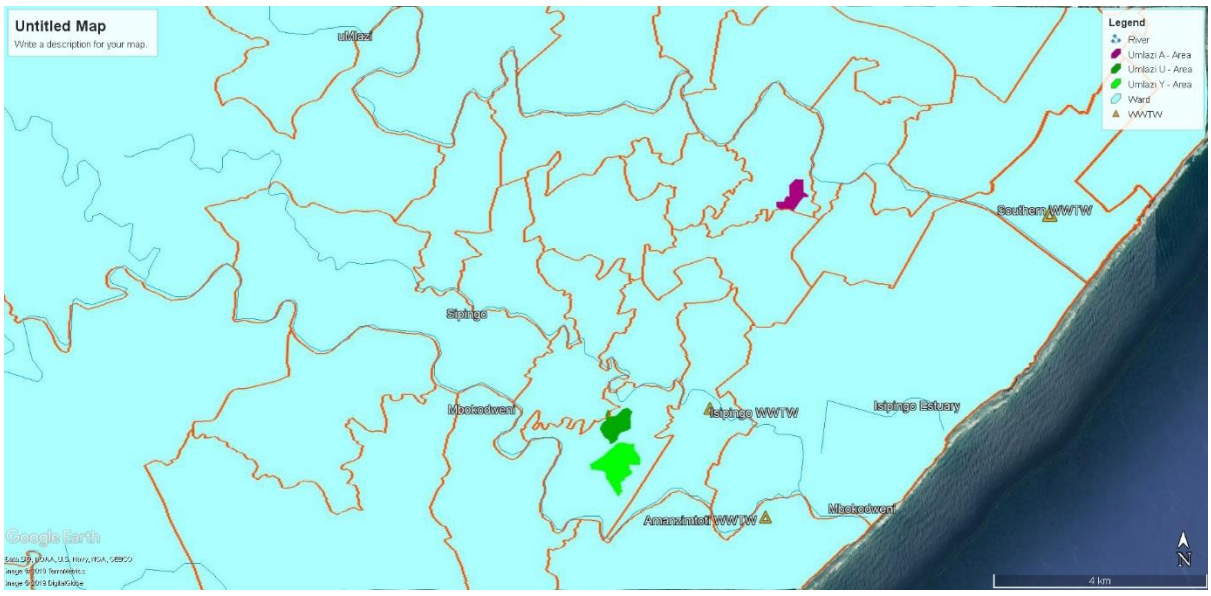

Figure 1. The study area of the entire Umlazi catchment area

As stated earlier,there is a water security issue in South Africa because of water shortage due to drought and surface water contamination. There is therefore a need for comprehensive approach to aid efforts insurface water quality restoration for NFEPA rivers and streams at the catchment level to protect the catchment's endangered ecosystem.

1.2.3 Local NFEPA Rivers and Streams Water Quality Status

Umlazi area consists of two National Freshwater Ecosystem Priority Areas (NFEPA) rivers: the Umlazi River and Izimbokodo River (Council for Scientific and Industrial Research (CSIR)2010; SANBI 2016). However, these rivers are not well monitored and assessed (Xaba *et al*. 2016; McLean 2016). The determination of the instream flow requirement now referred to as ecological reserve and its classification process results to Resource Quality Objectives (RQOs). The RQO process must comply with Integrated Water Resource Management (IWRM) practices that are internationally recognised which requires standardization of water quality (DWAF 2004)

The Department of Water Affairs (DWA) (2017) revealed that the Umlazi and Izimbokodweni river are largely modified hence losing natural habitat while its estuary is extremely modified. The government gazette of the 8th December 2017 indicated that the ecological reserve and it classification process of these rivers is expected to have nutrients indicator of less than 0.075 mg/L, electrical conductivity of less than 85 mS/m; E. coli and coliforms that meet recreational use targets; turbidity should be zero and lastly, toxics ammonia should be within a D category as per DWA (2008) (DWS 2018a).

The aim of this chapter was to conduct a documentary review of the assessed stream water quality in the primary streams within Umlazi Township, KwaZulu Natal, South Africa. This was done by utilizing administration goals or levels for edge of potential concern within the Umlazi catchment area’s rivers. The determination of water quality status is significant when instituting the extent of water quality problems in a river system and determining the impact of downstream water quality. The paper

employments the South African Water Quality Rules (SAWQG) of 1996 as the establishment for the setting the administration goals and thresholds (DWAF 1996).

One of limitations of the existing NFEPA SubQuaternary (SQ) GIS layer is that it excludes the land use variable, therefore lacks current data trends of instream water quality. Yet, in U6 uMlazi: rivers as a tertiary catchment are highly impacted, particularly in the middle and downstream areas of all the river catchments (DWS, 2018a).

High Escherichia coli (*E. coli*) counts and faecal contamination is a challenge in this area due to stormwater contamination, inadequate infrastructure, urban and industrial effluents that alter the conditions of these rivers, especially downstream (DWA 2015). The DPKZN (2015) report confirmed that 2 175 children beneath the age of 5 years were admitted due to diarrhoea disease in the uMlazi and Ngonyameni area in 2011 and this number increased to 2 716 in 2015.

From the site specification data research conducted in this chapter using the DWA website (DWA 2019), no records of microbial monitoring data for 2018 and 2019 for all Water Management Areas (WMAs) of KwaZulu-Natal was available and some data was lacking on Thukela and Mhlathuze WMAs rivers for 2017 (DWA 2019). According to South Africa's National Microbial Monitoring Programme (NMMP) guidelines, it is stipulated that for full and partial contact recreational activities in all rivers, faecal coliform and E. coli targets, should be less than counts/100 ml otherwise the river water pose health risks even on irrigated crops eaten raw (DWAF 1996).

The Umlazi results of 2017 had *E. coli* count of close to 7000 MPN/100Ml (Table 1 in the appendix). Yet, the government gazette of the 8th December 2017 indicated that the ecological reserve and its classification process of these rivers was expected to have E. coli and coliforms that meet recreational use targets. The Umlazi area is dominated by primary sectors such as irrigated agriculture and commercial forestry, therefore requires constant microbial monitoring of river water used for irrigation on both raw vegetables and fruits eaten raw or cooked, as theeconomic significance on river water uses in this Mvoti to Umzimkulu WMA (DWA 2019).

From this chapter, *E. coli* and Coliform results from different townships were compared from Thukela WMA; Usutu to Mhlathuze WMA and Mvoti to Umzimkhulu WMA and these townships included Ezakheni Ladysmith; ESikhawini; Umlazi; and Inanda. No

coliform results were found in all WMA of KZN province., as shown in figure 2 below and table 1 in the appendix.

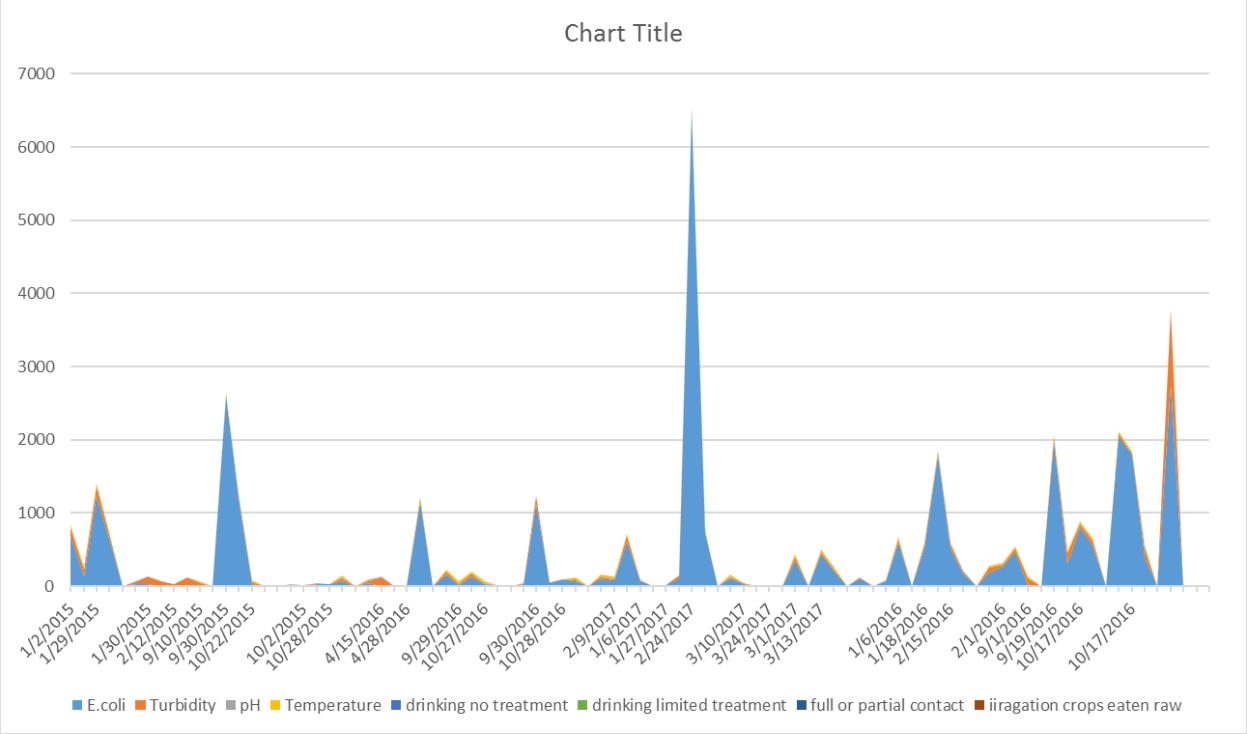

Figure 2. Showing WMA of Thukela, Usuthu to Mhlathuze and Mvoti to Umzimkhulu national microbial monitoring programme results

1.2.4 Determining Water Resources Status Quo of Umlazi Catchment Area

For water resource zoning to occur there must be similar water resource operation, unique functions of the catchments in setting of the larger system location and significant water resource infrastructure, even future infrastructure must be similar such as uMlazi and Lovu Tertiary catchments U60 and U70 (DWA 2008).

The uMlazi and Lovu tertiary catchments U60 and U70 catchment are dominated by irrigation and afforestation, with irrigation being the dominant water user. Water is economically significant in the Mvoti to Umzimkulu WMA as it covers the very important economic hubs of eThekwini Metropolitan Municipality (MM) (Durban) and

Msunduzi Local Municipality (Pietermaritzburg) which together represent more than 60% of the industrial output of the KZN Province (DWS 2015a). DWS (2015a) believes food supply for vegetables in Durban and Pietermaritzburg areas U60 and U70 water for irrigation is used. However, these catchments are largely unregulated yet, large farm dams are found in the upper reaches of the Lovu River. According to DWS (2018a), there are extensive nutrient inputs from agricultural activities on upstream reaches and four wastewater works in the middle and downstream, which has led to eutrophication and invasion by aquatic weeds (water hyacinth) (DWS 2016b). With the current poor catchment water quality conditions, the Shongweni Dam on the uMlazi River has silted up and is now only used for recreational and educational purposes despite the state of the uMlazi River (CSIR 2010; DWS 2017).

Table 1. Water quality hotspots across U60 Catchment (Umgeni 2017; DWS 2018a)

SQ reach	River name	Water quality impact (rating)		Water quality issues
U60C-4555	uMlazi	3	Large	Urban and industrial effluents, so high nutrient and salt load.
U60C-4556	Sterkspruit	4	Serious	Elevated salts, nutrients, toxicants; ID by eThekwini MM as a hotspot.
U60C-4613	Wekeweke	3	Large	Elevated nutrients and fertilizers.
U60C-4697	Sterkspruit	3	Large	Urban and industrial effluents.
U60D-4661	uMlazi	5	Critical	Elevated salts, nutrients, toxicants; ID by eThekwini MM as a hotspot.
U60E-4792	Mbokodweni	4	Serious	-esp Isipingo River High organic and nutrient load; Isipingo River ID by eThekwini MM as a hotspot.
U60F-4597	Mhlatuzana	5	Critical	Urban and industrial effluents, so high

				nutrient and salt load.
U60F-4632	Umbilo	5	Critical	Urban an industrial effluent, so high nutrient and salt load.

Red: critical water quality rating. Yellow: serious water quality rating

1.2.5 The Need for a Homogeneous Catchment and Integrated Unit of Analysis Knowledge on Umlazi Streams

The global rainfall average is about 860 millimetres and the driest (western) regions of the receive less than 200 millimetres a year (Ndlovu and Demlie 2020). South Africa has the rainfall is less than 500 millimetres a year. This then classifies South Africa as a semi-arid country and is classified as the 30th driest country in the world (WRI 2015). In dry areas, like South Africa, the low rainfall poses risks to human health and the environment, despite the fact sustainable economic development will cause more pressure (International Food Policy Research Institute (Veolia/IFPRI) 2015). Microbial pollution has been found in rivers and is one of the threats to human health(Chigor, Sibanda, and Okah 2014; Abia, Ubomba-Jaswa, and Momba 2017). judging by various reports, there appears to be is insufficient primary water quality of streams within Umlazi Township, KwaZulu Natal, South Africa.

DWS (2016a) states that South Africa's water supply system depends mainly on surface water networks (Green Cape 2017; DWS 2016a), 77% is surface water, 9% is groundwater and 14% is drawn from reusing return flows (DWS 2013a; Green Cape 2017), yet the nation lacks governs large rivers poorly (DWS 2017).

National Geographic (2017) classified stream water into two types: groundwater and surface water. Where groundwater is situated underground in large aquifers and requires a deep well drilling in order to extract out the water, surface water is found in lakes, rivers and streams. Streams gain water from inflow of groundwater through the streambed; hence both these systems are connected in most landscapes.

The UNDP (2010); Resurrección, Bee, Dankelman, Park, Halder and McMullen (2019); and IRP (2019) confirms that proper river wastewater management even from urban areas, provides gender equity; water security; food security; health protection; environmental protection; livelihoods just to mention a few as an extension of MDG now serving SDG (IRP 2019)

One of the major contributors to surface water quality problems facing South Africa's includes eutrophication and faecal pollution (DEA 2017). According to DWS (2016), Surface water resources and groundwater can directly contribute into Integrated Unit of Analysis (IUA). Moreover, a homogeneous catchment includes river, wetlands, estuary and socio-economic status can contribute to IUA (DWS 2018a). Proper water quality assessment requires catchment assessment in order to clearly identify water resource targets (DWA 2003) as indicated in table 1.

1.2.5.1 Catchment Effect on Stream and River Systems Water Quality

According to Glanz, Sallis, and Saelens (2015), the physical environment or social factors such as lack of toilets or poor infrastructure of the country, can act as a barrier to environmentally healthy behaviour, causing high faecal matter on surface water in urban areas of developing countries. WWAP (2017) notes that basic services like access to public toilets and finding a suitable toilet location are particularly difficult for women, which endagers them, leads to humiliation, and hygiene issues (WWAP 2017).

A catchment is a basin-shaped region of land that is bounded by natural features such as hills or mountains, and from which surface and subsurface water flows into streams, rivers, and wetlands (Rambally, 2013). DWA (2014) defines catchment as the region from which allrainfall will drain into the watercourse or part of a watercourse, by surface flow to a common point or points, is referred to as a watercourse or part of a watercourse.

Lintern *et al*. (2018) contends that there is lack of understanding on how attributes of acatchment affect the associations between landscape characteristics and water quality forming further complications in stream water quality.

A stream is the amount of water flow carried by a small or large river or a body of water surface flowing within the bed. Streams adopt different shapes depending on the landscape through which they flow (National Geographic 2020). The chemical composition of its water and its ability to support life is determined by its catchment and the activities in the catchment. Therefore, the stream water quality is only as healthy as its surrounding catchment. Therefore, it is important to study the catchment area surrounding a stream as well as the ecosystem surrounding it. The mouth of the main stream or river is called the outlet and can flow into another river or stream, or empties into a lake, estuary, wetland or ocean, therefore considering the water quality of estuary and ocean is crucial(National Geographic 2020).

According to DEA (2014a), increased land use pressures and poorly controlled activities place a strain on river systems. Poorly controlled land use activities have been blamed in numerous reports for the declining river water quality (DEA 2014a; DWS 2018b). As a result, land use practices occurring within a catchment are also responsible for the gradual deterioration of riverine and estuarine health and function (DEA 2008; DWS 2018b).

In Sub-Saharan African, 62 percent of the urban population live in slums. In such cases, there are high loads of discarded faecal matter and solid waste into surface water, and often poor sewage and storm drainage infrastructure (UN-Habitat 2013). Such illegal dumping conditions create drainage system blockages, resulting in flooding (UN-Habitat 2013).

According to DHPKZN (2015), the large population, informal housing and poor infrastructure in uMlazi area has resulted in poor sanitation to streams and rivers and poses serious threat to public health , with a diarrhoea outbreak because of high *E. coli* rates in streams being reported (DWAF 2011). As previously mentioned, diarrhoeal disease is the second leading disease in this area with a mortality rate of of 8.7 percent in the eThekwini Municipality district, this epidemiological disease is followed by HIV (DHPKZN 2015). The UN-Habitat (2013) characterise slums types

generally by a lack of paved roads, long-lasting housing, water and sanitation infrastructure, and proper drainage.

Pillay, Pillay, and Ballabh (2016) state that the Isipingo River and Estuary were receiving raw sewage at rates ranging from 3.67 to 6.7 ML/day. Approaches such as traditional end-of-pipe treatment should be prioritized over wastewater mitigation and water pollution reduction, as remedial actions to clean up polluted sites and water bodies are generally much more expensive than measures to prevent pollution from occurring (WWAP 2017).

E. coli is a human gut bacterium, and if found in water indicates that there is faecal contamination. According to DWAF (1996), water should be free of such a contaminant to be safe for drinking, and for recreation, the presence of E. coli as a count should not exceed of 400MNP/ 100 ml. In 2002, due to informal communities and inadequate sanitation of infrastructure the Mayville small stream water result showed *E. coli* was 290 000MNP/100ml. In the Umhlangaan River above KwaMashu township, wastewater works over 240 000 counts was found due to broken sewers in Kwamashu Township (Dicken 2002) and in uMlazi (DHPKZN 2015)

Dicken (2002) believes that the uMngeni and uMlazi catchments due to there location which is between the port of Durban and the Gauteng region, generally pose a high risk to human health because of their proximity to road, rail and pipeline routes and the industries surrounding them. Such pollutants include but are not limited to hydrocarbons; pesticides; heavy metal compounds; acids and these materials end up in rivers causing severe damage to the environmental (Dicken 2002).

Although river systems provide many goods and services, the availability of such depends on the state surrounding environment (DWA 2013a). People have exploited river systems to increase land availability and promote economic growth and development since ancient times (King and brown 2003). As mentioned before, poor social determinants has a negative impact on river system. In eThekwini about fifty-four percent (54%) of the population are without jobs, witha31% currently living in poverty. Such populations as a result of their socioeconomic status, depend heavily on public services and are more vulnerable to communicable and non-communicable diseases (SSA 2011; DHPKZN 2015). Unfortunately, pollution of rivers has resulted in

the the delapidated state of the Isipingo estuarine system (Forbes and Demetriades 2008).

It is believed that if a stream is steep it will be fast-flowing and energetic, meaning it carries large amounts and large-sized pieces of rock and gravel which have been eroded from stream beds and banks. According to the slope analysis of Umlazi environmental analysis, uMlazi is identified by undulating hills and varying slopes a large portion of the area is habitable. Slopes ranging from 1:5 to 1:30 and even steeper cannot be utilised to construct residential areas developments (Umlaz and Malukazi LAP and TRS 2011).

Pratt and Chang (2012) agrees that urban, industrial, and agricultural land users generate high levels of sediment and deplete nutrients, and this eventually runs into rivers as observed in a study of North-West USA rivers. According to Edwards and Withers (2008) there was a positive correlation between total phosphate nutrient concentrations in 14 river locations and the urbanized catchment section via (1) wastewater runoff, (2) building debris, and (3) manure and fertilizer application on lawns and parks in urban areas, as well as crop and grazing lands, yet there are only a fewparks in Umlazi and no grazing land.

According to United States Environmental Protection Agency (USEPA) (1999), as sewer system networks age, the risk of deterioration, blockages, and collapses becomes a major health and safety concern. DWS (2016b) confirmed that unskilled plant managers, old and obsolete facilities, and poor maintenance further threaten surface and drinking water quality in peri-urban and rural areas. Hence sewers that leak directly to the streams are not priority to the policy makers and the municipality (Parker and Oates 2016) instead, the IWRM-related research management approaches are more on an increased societal demands and pressures on resources (Parker and Oates 2016).

The increase of informal settlements with poor sanitation in Durban and Pietermaritzburg surroundings have contributed immensely to stream pollution (Dicken 2002). WWAP (2017) believes that slum dwellers often use unsewered communal toilets and open spaces, often washing sewage to the nearest river. De Troyer, Mereta, Goethals, and Boets (2016) witnessed the streams and wetlands in around Jimma city, Ethiopia, inadequate sanitation led to exceedingly high faecal

coliforms in the surface water (>320 MPN¨ mL´1). Lately, the lower catchment of uMlazi, crude sewage discharges to the river and was transported to the treatment plant (Sethebe *et al*. 2016).

1.2.6 WasteWater effect on Stream and River Water Quality

WWAP (2017) believes lack of facilities for collecting and treating surface and ground water, as well as high energy costs and a lack of reinvestment to mention affect wastewater treatment and this has results in the pollution of these resources in Africa. According to Taiwo (2011) Rrain washes sewage and other contaminants through rudimentary drainage networks, which then flow into surrounding rivers and groundwater. The problem is made worse by the lack of implementation of town planning principles and legislation, as well as noncompliance with them (Taiwo, 2011).

Wastewater in urban areas can be defined as a combination of one or more of: domestic effluent consisting of black water from excreta, urine and faecal sludge and greywater; storm water and agricultural runoff just to mention a few (WWAP, 2017). US EPA (2003), defines wastewater as “water that has been used and contains dissolved or suspended waste materials”.

In 2009, almost 1.1 billion people still lived in areas that contained saline traces on it groundwater as mentioned earlier aquatic system can be polluted by wastewater from urban-run offs (WWAP, 2017). Fish that dies in river systems are can be caused by chemical pollutants, such as pesticides or phosphate. FAO/CGIAR (2017) states that this wastewater from urban-run offs have contributed on pathogens of crop production, livestock and aquaculture such as pathogen indicators.

1.2.6.1 Risks of Using Waste Water for Irrigation Purposes

Chemical pollutants are part of wastewater that has a lot of suspended solids (particulates) and dissolved nutrients (Mateo-Sagast, Zadeh, and Turral 2017). The

excess of elements like nitrogen and phosphates can leak further to groundwater, or on surface water (FAO, 1996). Major water pollutants from agriculture Pesticides of Crop production such as Herbicides, insecticides, fungicides and bactericides (Mateo-Sagasta et al., 2017) especially in third world countries (WHO, 2008); Salts Livestock and Aquaculture such as sodium (Na+), chloride (Cl-), potassium (K+), magnesium (Mg2+), sulphate (SO42-), calcium (Ca2+) among others (Mateo-Sagasta *et al*., 2017).

Indirect use wastewater in agriculture through sewage discharged into reservoirs, either treated or untreated for agriculture may pose more health problems since the users are uninformed of the wastewater existent (FAO, 1996).

1.2.7 Benefits of a Healthy Ecosystem Surroundings on Stream and River Water Quality, Biodiversity and on Surrounding Communities

WWAP (2017) believes sustainable wastewater management and healthy habitats are inextricably linked, therefore this relationship is known and managed well can be mutually beneficial. Near water resources, there are vegetated areas protect water quality also removing pollutants regulating water flow and sediment storage is semi-natural ecosystems such as constructed wetlands also improves the water quality of that ecosystem and reduce floods (WRI, 2015).

Local ecosystem service such as green area offers individuals a relaxed environment that enhances both mental and physical health of individuals and provides animals such as birds with a habitat (WWAP, 2017). Birds are very sensitive to human disturbance with most systems in urban areas having suppressed numbers (DWA, 2013).

1.2.8 Barriers of Surface Water Quality

According to Lintern, Webb, Ryu, Liu, Bende-Michl, Waters, Leahy, Wilson and Western (2018); Galbraith and Burns (2006) barriers of wastewater that eventually affect surface water include wastewater treatment (WWT) not licenced; WWT that has almost full capacity as all sewage pipes for new developments are connected to same

sewage line of the same plant WWTs. Such challenges wastewater sources have impact of the landscape characteristics on riverine water quality decreases.

Due to a lack of infrastructure, technological and institutional resources, and financing, the release of untreated wastewater is still a common practice, especially in developing countries (UN, 2017). However according to Water Research Commision (WRC) (2014) affirms that energy efficiency audits, pump and systems upgrades are essential to conduct at all water treatment services within four to five years by the municipalities of South Africa.

Yet, according to DWS (2018b) from the effluent tests only 0.3 %: microbial tests; 3.1% of chemical tests and 7.5% of physical compliance tests were successful in meeting regulations of audits KwaZulu- Natal WWTW for Green Drop Audit and the rest of the WWTW were not complaint according Green Drop standards. Green Drop Regulatory standards of SA measures the performance of wastewater systems owned by water service institutions counter to that of the relevant legislations and best practice requirements, however, there is still data limitations in particular lack and incomplete data.

The impact of illegal dumping increasing threats for diseases like TB and contamination of rivers and floods (Ali, Masud, Ali, Abbasi and Hussain, 2014). Looking at the epidemiological disease profile HIV is the third highest disease affecting the eThekwini district with 8.6 percent (DHPKZN, 2015). Anti-inflammatory drugs of such as Nevirapine (0.4 ng/l) were found in two of the WWTPs (Swanepoel, Bouwman, Pieters, and Bezuidenhout, 2015). Prasse, Schlusener, Schultz and Ternes (2010) believes a successful WWTP is based on the plant's process and efficiency.

Swanepoel *et al*. (2015) maintains that WWTPs are not designed to manage pharmaceutical product and remains are therefore washed down the surface water and on environment, affecting humans that use these natural resources.

It is therefore possible that dysfunctional WWTPs pollutes drinking water source of downstream citizens, therefore, such concerns require a swift improved procedure in the WWTP to protect citizens and the environment. As it is also stated that more than

80 percent of wastewater is without proper treatment, waste is released into the environment. (WWAP, 2017).

1.2.8.1 Ground –Waste Water's Quality

The level of the wastewater treatment as well as the operating efficiency of the wastewater treatment system is expensive (Teklehaimanot ,2013) and is often more unreliable as compared to ground-water sources, while it contributes further to deteriorating receiving water quality of bodies like streams and rivers (Swanepoel et al. 2015). In ground water the water undergoes a natural purification due to physical, chemical and biological filtration through the soil (Taylor, 2004 and Sithebe ,2017).

In South Africa only 16% of nearly 7,500 million m3 ground water is used, and the rest is underutilised, undervalued and not properly managed (DWS, 2017). The challenges facing the water sector of South Africa directly affect the costs of ground water includes high water leakages; poor infrastructure planning and maintenance; weak investment; inefficient revenue and debt management; and direct and indirect pollution. This therefore require this department to educate it citizens about being good custodian of water to reduce these costs (DWS, 2017).

However, still large numbers of individuals in Africa depend on groundwater as their main source, with the increase in pollution increases the availability of threaten groundwater resources (World Bank, 2012, WWAP). According to Knüppe and Meissner (2016) groundwater has the ability to play a critical role in supplying water for drinking and sanitation, promoting agricultural irrigation schemes and industrial uses, alleviating poverty and disease, and preserving vital aquatic and terrestrial habitats (Thukar, Harris, Thukur & Onwabu, 2019).

There are some opportunities in desolation an artificial which is the process of removal of salts and minerals from any water source to produce water suitable for consumption or irrigation. Industry seawater desalination for coastal villages to be expensive, although it includes brackish groundwater treatment that allows desalination on housing developments (DWAF, 2014).

According to a desktop investigation by DWS (2018a) Umlazi catchment has insignificant volumes of groundwater utilized in the water resources IUA and there is a potential for further groundwater development in the area since it is underlain by faulted Natal Group rocks. The locality of the groundwater resources relative to potential users and the viability for development however needs to be confirmed, indicated in table 4 appendix.

Since global increasing interest in cumulative investment in desalination plants reached for groundwater was approximately USD 21.4 billion in 2015 (WDR 2016). This is estimated to double by 2020 population growth and economic growth (Green Cape,2017).

However according to Council of Canadian Academies (2009) the most challenges institutional and political causes, conflicting and obligations, contradictory interests, conventional policies, rights and water pricing schemes, and divergent views are all issues that global groundwater governance must address.

1.2.8.2 Effect of Catchment on Surrounding Estuaries

According to Pillay (2013), estuaries are used for recreational activities such as fishing and swimming. Estuaries provides shelter for marine species and birds; supply of nutrients and sediments to the coastal environment; it even acts as water supply; reduces flood risks; improves waste treatment and recreational activities (McLean ,2016; Sukdeo, 2010).

In South Africa an estuary is measured as part of a river system which now and again connect with the sea (CSIR, 1992). An estuary is partially enclosed coastal salty water mixed with one or more rivers or streams inflow from the land connected freely forming a convergence zone between river and maritime environments to the open sea (Sukdeo, 2010). However, in KwaZulu-Natal, lots of river systems and estuaries suffer from deteriorating water quality and reduction of river flows due to fast development in recent years (Philip, 2010). The Mvoti to Mzimkhulu Water Management Area's Internal Strategic Perspective paper raised concerns about faecal contamination in the Isipingo River (DWAF, 2004).

McLean (2016) believes the River Health Program (RHP) was by evaluating fish and invertebrate populations, riparian vegetation, and river ecosystems, the aim was to establish standard data on the ecological condition of the EMA rivers. However, from the results obtain on 59 study sites, only 2 were still in a natural condition, while 17 were in poor state. These findings increased raised worries about the feature state of estuaries due to poor surface water it receives from surrounding rivers (McLean, 2016).

Estuaries within the eThekwini Municipality showed the health declines as it influenced by anthropogenic activities of the catchments (Sukdeo, 2010; Pillay, 2013). Therefore, estuaries are categorized as one of the most defenceless ecosystems in South Africa. Moreover, the lack of past data hinders clear understanding of direct ecological status trends for most of eThekwini estuaries (McLean ,2016).

Since surrounding catchment water quality can determine or even affect variables in the water and sediment columns of Estuarine health monitored. Therefore, both Ezimbokodweni Estuary and Isipingo estuary water quality assessment was also used in this study to conduct a documentary review of assessed stream water quality in the primary streams within Umlazi Township, KwaZulu Natal, South Africa. Since uMlazi is one of the nearest catchment areas with severe urbanization and inappropriate urban planning that cause lack of freshwater in the estuaries

Isipingo estuary is low on freshwater flow, due to the upstream alterations of the rivers from uMlazi canal and eziMbokodweni and chemical and organic pollution from surrounding industries (McLean ,2016).

Rambally (2013) state that Ezimbokodweni estuary is situated in the eThekwini Municipality, is located at sea, approximately 1.5 km south of the estuary mouth. However, according to McLean (2016) Ezimbokodweni estuary open mouth is affected by excessive flows from the iSipingo and upstream WWTWs, that has reduced marine species diversity. Ezimbokodweni estuary is therefore temporarily closed estuary as eziMbokodweni catchment is heavily polluted by heavy metals and nutrients transported from rivers eventually affecting it estuarine system even though previously this estuary was ranked as one of the highest estuary in fish diversity with 27 different species present in previous years, however the fish were affected by organic pollution (Rambally, 2013).

Major alterations of the hydrology system were caused by Umlazi River diversion that was combined with Isipingo River near estuary mouth (Rambally, 2013 and Pillay et al., 2016). Clean estuaries attract riparian vegetation birds (McLean, 2016). However, Durban's estuaries are facing extinction threats caused by rapid and continuously population and industrialisation putting strain in the coastal zone (McLean, 2016).

In some estuaries, water quality of these estuaries has been compromised at the point source of WWT. Also, the water quality of estuaries has been greatly modified by agricultural runoff that contains traces of fertilizers and pesticides (DWA, 2013). Port development, water quality in these regions of the Bay significantly threatens ecological integrity of these estuaries. The Port of Durban Bay also stands out as a highly transformed estuary as a result of port development (DWA, 2013).

1.3 RESEARCH PROBLEM

As of 2014, Global Water and the WHO estimated that up to a quarter (28%) of the world's population, that is, up to 1.8 billion people relied on unsafe water and were therefore at increased risk of developing water-borne illnesses (Liu et al. 2016; Bardsley, Blunt, Davies, & Dixon, 2013). This is an especially concerning figure given that it represents an increase from 23% recorded in 1990. Poor water quality has widespread negative impact on human health, and this can be manifested in a range of ways for example, through pathogens that cause gastro-intestinal diseases, vector breeding and chemical pollutants. Several WHO and UNICEF programmes have, over the last decade, highlight of 21st century as the century of water supply sanitation. In achieving this, the Sustainable Developmental Goals (SDGs) indicate that an additional 1.2 billion of the world's population continue to use water from sources and systems with significant sanitary risks (Liu et al. 2016; Tsakiris & Alexakis 2012). Important to note also, is the fact that the growth of the world's human population and urban development have increased at an unprecedented rate and so too, has the burden of maintaining a safe water supply. Like many other developing countries, South Africa has significant water quality problems particularly in townships.

According to DWA (1996), the development of South African water quality guidelines was essentially to developed a set of water quality standards to safeguard freshwater ecosystems in South Africa. However, the aquatic ecosystems are vulnerable to changes in water quality and have few selections for alleviating the negative impact of poor water quality. A preventative approach is therefore essential to protect the ecological functionality of aquatic ecosystems (DWA, 1996).

Tempelhoff (2006) specialists indicated that the country's local authorities are more and more incapable to deal with the endless demand for efficient sewage treatment especially in urban areas. Wepener, Mamba and Musee (2013) state that the increased threat of faecal pollution in South Africa resulted to government developing a national microbial monitoring program for surface water in order to improve and protect humans' health.

There a relationship between pollution due to illegal dumping and diseases (Alfredo et al. 2015). This was researched on dioxin contamination of air, soil, water, animals, and humans in the Campania region (Legambiente Report Land of Fires,2013 and Altavista at el,2004). In South Africa water pollution especially on the inland's stream is one the major challenges for townships management (CSIR, 2010 ; Department of Water Affairs and Forestry (DWAF), 2014). Poor water resource management in urban areas put citizens at high health risks that even lead to death. Diarrhea is a disease that is caused by discharging faeces into water bodies detected by the presence of E. col and coliforms microorganisms (WHO, 2014 c). Diarrhoea still a reason for worry in the KwaZulu Natal district, with the peak number of deaths that arose in the South West Sub-district of KwaZulu Natal according to the report from R K Khan Hospital (DHPKZN ,2015).

Although, the government of South Africa has initiated Drop Green and Blue Drop initiatives that focuses on monitoring against industries from contaminating the rivers and streams as stipulated in section 24(b) of SA Constitution (Republic of South Africa (RSA), 1996 and DWAF, 2014). However, the element of assessing the effect of water quality on community is not yet tested, yet there is an increase in water pollution demanding management to prevent such deterioration (CSIR, 2010). While the impacts of illegal dumping include: destroying flora; contamination of river; deflation of

land or property; diseases like tuberculosis and exposure to floods (Ali *et al*., 2014, WHO, 2014d).

The water quality of streams and rivers are polluted by poor administration of human exercises and infrastructure associated to faecal pollution as indicated in uMlazi for children under the age of 5 years (DHPKZN, 2015). Then the river system goods and services that include maintaining the habitat and quality of marine species and opportunities for recreational activities can be compromised and therefore must be managed (WWAP, 2017 and DWS, 2017). Yet there is lack of historical data hinders true reflection of ecological status trends of most eThekwini rivers and estuaries (McLean, 2016).

1.4 THE AIM OF THE STUDY

The primary aim of the study was to present an analysis of the influence of policy and water quality practices on community knowledge, attitudes and behaviour toward stream restoration practices in Umlazi township, KwaZulu Natal.

1.5 RESEARCH OBJECTIVES

1. Conducting an initial assessment of community knowledge about stream water quality policy and practices in Umlazi Township, KwaZulu Natal, South Africa.
2. Conducting an initial assessment of community attitudes about stream water quality policy and practices in Umlazi Township, KwaZulu Natal, South Africa
3. Conducting an assessment of community behaviours in response to about stream water quality policy and practices in Umlazi Township, KwaZulu Natal, South Africa.
4. Developing a knowledge, attitude and behaviour modification framework / recommendations that support stream water quality restoration practices.

1.6 SIGNIFICANCE OF THE STUDY

As noted by many including (Liu *et al*., 2016) water scarcity assessments have previously looked exclusively at water quantity with minimal exploration of the role of water quality as a possible causal factor and likely solution to the widespread water shortages. Nationally, in SA, the importance of ensuring good-quality water is reflected in the initiation of the drinking water quality framework for South Africa. This framework is founded on preventative risk management. As previously indicated that during the focus group meeting, many suggested indicated that interventions of incremental approach to the improvement of surface water in urban areas does not make specific guidelines about the role and involvement of water or consumers within communities. Guided by acknowledgement of the significance of water quality problems in South Africa and in indeed the world, the current study aims to address the paucity of related research and in so doing will also offer an analysis of the impact of policy and water quality practices on community knowledge, attitudes and behaviour toward stream restoration practices in Umlazi Township, KwaZulu Natal, South Africa.

1.7 THE UNIQUE CONTRIBUTION OF THE RESEARCH

Environmental and health problems related to poor water quality represent a serious public and environmental health problem that health and environmental health specialists continue to struggle to find a community centered solution to. This study offers a unique opportunity (within the South African context) for the development of a framework for modifying public knowledge, attitudes and behaviours towards positive water quality improvement behaviours. Through developing an in-depth knowledge of public knowledge, attitudes, and behaviours, the study will culminate in the development of best practice recommendations and or a behaviour modification framework to support stream water quality restoration practices.

1.8 DEFINITION OF KEY CONCEPTS

Contaminants and Pollutants: These may be pathogenic and harmful to human, animal and/or plant health. Chemicals and microorganisms can be introduced into water resources by consumers or by creatures in the natural environment, where they remain in the water for undefined periods. Recent research has indicated that some of these pollutants may not be treatable by conventional technology. Many microorganisms are known to cause disease in humans, such as cholera, typhoid and shigellosis, while the effect of pollutants, such as microcystins, endocrine disruptors and partially metabolised medication, requires further research.

Ecosystem services (ESS) place an emphasis on ecology and the advantages of ecosystem conservation (Parker and Oates, 2016).

Environment knowledge is classified as a branch of knowledge centered on facts, principles, and relationships with the world, with a focus on whether or not a person is aware of what is happening to the environment (Mostafa, 2007).

Environmental attitude is a collection of expression, beliefs, and intentions to act on environmental issues, where an individual change their attitude to getting environmental solutions (McIntyre and Milfont ,2016) and commitment (Harun, Hock, & Othman,2011)

Environmental Benefits are benefits that improve air quality, water quality, biodiversity. Environmental benefits can be divided into social, economic and strategic benefits (Parker & Oates, 2016). According to Rasul (2015), these benefits are often indirect, such as social or economic benefits connected to river health (Rasul, 2015). Social benefits donate to the well-being and the functioning of the society (Fisher et al., 2014). Economic benefits can overlap to social well-being that contribute to the country's economy and create jobs (Parker and Oates, 2016). Strategic benefits contribute to poverty decrease and economic development, the water-energy-food security nexus, disaster risk mitigation (DRR), and climate resilience are all important factors to consider.

Environmental value is composed of following dimensions in this study. (1) Cognitive component: Such as knowledge where understanding and judgment of the environment is determined. (2) Affective component: such as attitude where like/dislike emotion to the environment, with emotional tendency is determined (Liu and Guo, 2018).

Integrated Water Resource Management is a related research management approaches that is more on a societal demand for resources (Parker and Oates ,2016)

Resource Quality Objective it the components and implementation procedures emanate from the National Water Act (NWA) of South Africa (RSA, 1998) that requires that all water supplies be safeguarded in order to ensure their long-term use. The purpose of RQOs is determining a balance between the need to protect and sustain water resources and the need to use them. Also, to establish clear goals relating to the quality of the relevant water resources and stipulates that determining a balance between the need to protect and sustain water resources and the need to use them (DWA, 2011).

Social-Ecological System (SES) is a transdisciplinary framework approach on river management and emphasizes adaptability, flexibility from management and yet is difficult to apply (Colding & Barthel ,2019) SES is a system “where social and ecological systems are mutually dependent” (Fidel *et al*. 2014). According to Thomas and Thomas (2004), SES is a system of people and nature”. SES consisting of two interacting subsystems: the biological as an epidemiological ecosystem and the social as the internal regulator subsystem (Cherkasskii 1988:321).” While Delgado-Serrano, Oteros-Rozas, Vanwildemeersch, Ortíz Guerrero, London, and Escalante (2015) defines SES as a “complex adaptive systems with key characteristics such as: (1) integrated bio geophysical and socio-cultural processes, (2) self-organization, (3) nonlinear and unpredictable dynamics, (4) feedback between social and ecological processes, (5) changing behaviour in space (spatial thresholds) and time (time thresholds), (6) legacy behavioural effects with outcomes at very different time scales, (7) emergent properties, and (8) the impossibility to extrapolate the information from one SES to another” (Delgado-Serrano *et al*., 2015).

Water Quality Index (WQI) is an index that is used in the evaluation of surface water quality (Kumar and Dua ,2009). WQI is a useful tool for "communicating water quality information to the public and legislative decision-makers; "it is not a complex predictive model for technical and scientific application" (McClelland, 1974).

Water quality: This is defined as the physical, chemical and biological characteristics of water in relationship to a set of standards for primary use of drinking water, safety of human contact, and the health of ecosystems parameters (Bhagwan, 2008).

1.9 RESEARCH METHODOLOGY

1.9.1 Research Design

The proposed study was a sequential mixed method design. Creswell (2009) defines mixed methods research as a design for collecting, analyzing, and mixing both quantitative and qualitative research (or data) in a single study or series of studies to understand a research problem. This approach was deemed especially appropriate because it can offer understanding and meaning that might otherwise be overlooked in mono-method strategies and possibly produces more thorough knowledge to inform practice and policy (Clark, 2005; Creswell & Plano Clark, 2007; Meissner, Creswell, Klassen, Plano Clark & Smith, 2011). More specifically, an explanatory mixed method design was utilised for the assessment and this was based on a three-phase empirical study as diagrammatically represented in the figure below.

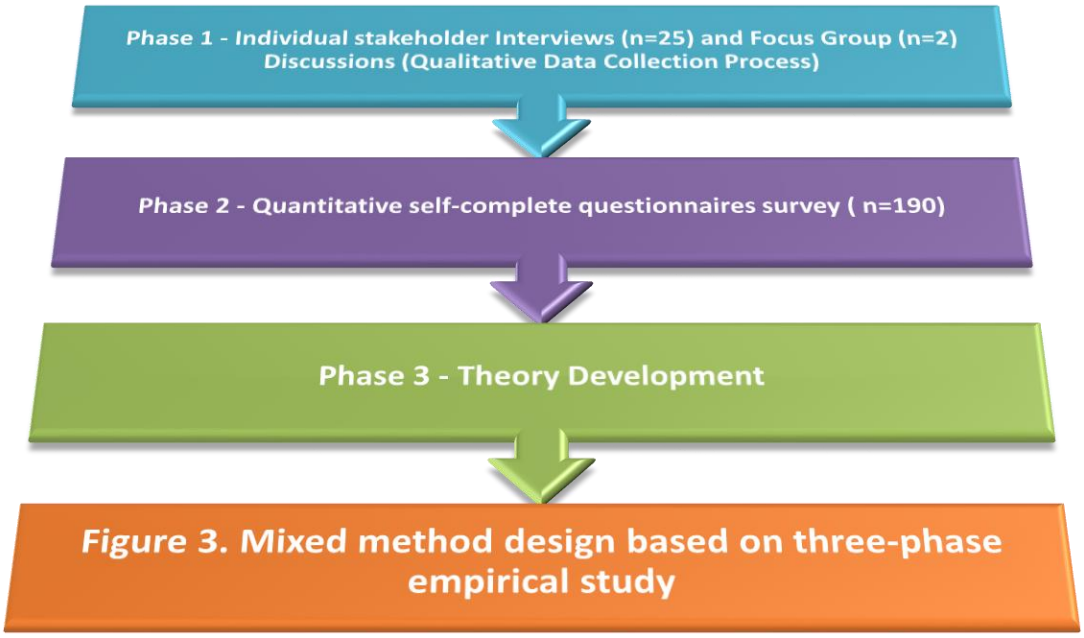

Figure 3. Mixed method design based on three-phase empirical study

Figure 3. Mixed method design based on three-phase empirical study

An exploratory mixed method design was proposed. Mixed methods research is a design to understand the research issue, research is a method for gathering, evaluating, and combining quantitative and qualitative data in a single study or series of studies (adapted from Creswell and Plano Clark, 2007). This approach was deemed especially appropriate because it be overlooked in mono-method strategies and possibly produces more complete knowledge to inform practice & policy (Plano Clark, 2005).

Within the proposed mixed method study, data was collected via a Three-Phase empirical study, as illustrated above. This included data collection combination of individual interviews and focus group discussions (**Phase 1**) which explored the perceptions of purposively sampled community members, employees of the water management and waste management departments about their knowledge, attitudes and behaviours as they relate to stream water management and how their health beliefs may impact behaviour. This phase included individual interviews (n=25) and focus group discussions (n =2).

Phase 2 involved a quantitative self-complete questionnaire administered via a combination of door to door and online survey formats.

Phase 3 involved model /framework development in the form of a corrective-framework

1.9.2 Population\Target Population

The eThekwini Municipality Water and Sanitation department reportedly has 205 staff members who work in positions related to water management. Inside this group, staff members are for the most part included in directing and encouraging effectiveness over the more extensive run of water quality support forms that are central to the capacities of the municipality.

1.9.3 Sampling Method

The parent or source population of individuals who could be potential study participants comprised staff of eThekwini Environmental Health Department (n=205), This group was comprised of Environmental health assistants (n=8); Environmental health monitors (n=17), Environmental health officers (n=23); Environmental health practitioners (n=95); Environmental health managers (n=16); Senior Environmental health managers (n=46);

In addition to the 205, above-identified staff, there is Catchment management group (n=87); Coastal services (n=22); Records and services (n=25); storm water engineering (n=25); Catchment management n=190 and Administrative staff (n=2).

In total, these different groups represent the target population (n= 292). The proposed study included three-data collection approaches that is, semi-structured interviews and focus group discussions and quantitative online and postal surveys. The proposed sampling strategy was therefore separated out into the sampling approaches used per data collection approach.

Phase 1 Sampling Plan (Focus Group Discussions and individual Interviews): Given the qualitative nature of Phase 1 of the study, non-probability sampling approaches will be used in this preliminary aspect of the study. As such, purposive sampling will be used. Purposive sampling is a non-probability sampling method, which involves identifying participants because they possess the characteristics of interest (Parahoo, 2006). In this study, a specific type of purposive sampling that is heterogeneous or maximum variation sampling was utilized. This method of purposive sampling ensures the inclusion of all stakeholder categories and this was concluded on as interviews (n=25) and focus group discussions (n=2). Focus group discussions made up of each stakeholder category groups were facilitated in the following ways with each focus group of 8 participants.

Phase 2 Sampling Plan.

The sampling plan was based on the following: Target Population =292 respondents. Using the epi-info sample size calculator with a confidence level of 95%

and confidence interval of 5%, the predicted sample size should be 167 respondents. To allow for attrition, a further 10 percent are added to the proposed sample size that is, respondents. A total of 190 respondents will be elicited.

1.9.4 Measuring instrument(s)

The study was structured as a three-phase enquiry which required data collection instruments development of the following

1. The interview and focus group discussion schedules.

2. A self-complete questionnaire for completion by respondents.

Interviews allow for in-depth exploration of complex phenomena and allow the research to gain an in-depth understanding of concepts under investigation. Within the current study, the use of interviews was to facilitate a sound and robust exploration of participant's knowledge, attitudes and resulting behaviours, as they relate to safe water practices. The combined use of focus group discussions allowed for the verification and further validation of issues that would have emerged from individual interviews. Furthermore, focus group discussions are seen as a useful counterbalance in that they allow the safety of the group to be a central feature of the data collection process.

The data from the interviews and the focus group discussions was based on small sample sizes and as such, it will not be possible to glean any cause-effect relationships however, the inclusion of a complimentary survey allows for a wider exploration of the phenomena understudy. This increases the likelihood of greater generisability of the findings. Schedules of each of the above-highlighted are attached herewith.

1.9.5 Pretesting

The main purpose of conducting the pre-testing procedures is to ensure that all of the research's data collection tools have been tested prior their full use in the conducted

research. In this regard, five participants were selected as potential participants in pilot interviews to check the interview schedule. Firstly, each of the interview questions were assessed for concept validity ensuring reflection of predicted issue of interest on participants' replies. Secondly, the pre-testing pilot was assessed whether the posed questions possess enough clarity for participants to understand and finally, to assess practical issues as they relate to the interview tool for example, the length of time each interview took. In keeping with research practice, the pilot interviews were adopted if no resulting changes are triggered by the pilot-testing process (Parahoo, 2006).

1.9.6 Data analysis

Data that was collected from the focus group conversations and individual interviews' qualitative processes research tools were analyzed utilizing a combination of methods that included the use of NVivo; thematic analysis and content analysis. NVivo permits the responses to questions to be inserted and analyzed by computer supported data analysis tool. The application was centered on deriving themes that are commonly reported by participants. Emergent themes and variables on interest was explored further via a door to door survey that was based on a quantitative design. Descriptive and inferential analysis of data was carried out using the Social Sciences Statistical Package (SPSS version 26). Measures of association such as using Chi Square test, F-test regression model was used to determine relationships between different factors.

1.9.7 Delimitations/Scope

The study was conducted in Umlazi Township, Durban, KwaZulu Natal and focused on employees of Ethekwini Municipality and Environmental Health Department and also on community members who reside in Umlazi Township. Participants and respondents will only be recruited from the sample frame of residents of Umlazi. The professional perspective will be elicited from employees of the municipality who will be selected randomly.

Category of people/events, the study focused on adult members of the community (18 plus years).

1.9.8 Limitations

The study was based on research of residents of Umlazi Township, and is such any emergent findings were not generalisable, however they will provide transferable observations that may help to inform corrective practices across a range of provinces within South Africa. The study also serves a Potential function a study which others would replicate within their provinces and as such, could have further value than is immediately apparent. The study has been conducted as a cross-sectional enquiry and more reliable insights could have been facilitated through conducting this as a longitudinal study over a period of time. It noted too, that the study was conducted by single research with limited resources and this may be seen as a limitation of the study. A wide range of employees of the municipality and water management services were identified as part of the target population and this broad range of potential participants were required that a varied repertoire of participant recruitment strategies be used to minimize the potential for participant non-responsiveness.

1.9.9 Validity and Reliability/Trustworthiness (Qualitative Research)

Parahoo (2006) identifies validity is described as the degree to which an empirical measure accurately reflects the concept's true meaning investigated. The use of a combination of data collection approaches of the individual interviews, the focus group discussions and the survey do allow for triangulation of methods which ensures that the benefits of each of the approaches are maximised. This aligns well with Meissner et al. (2011) who describe three types of validity in qualitative research, known as descriptive; interpretive validity and theoretical validity. In this study the researcher ensured that triangulation of these method was conducted to further validate this scientific research study (Creswell, 2009).

1.9.10 Ethical Considerations

In line with the DUT ethical requirements, the proposed study adhered to a code of principles and to rules of conduct. The identification and maintenance of expected ethical standards is accepted as the primary responsibility of the researcher whose intentions and plans are described below. As indicated by Polit & Beck (2012), ethical considerations included providing protection of the participants and their rights. The researcher took the following steps to ensure compliance with specified ethical principles. Permission for completion of the research was based on a three-step process centered on (i) obtaining ethical clearance from the DUT and (ii) seeking out site-permission from the eThekwini Municipality Departments and the water treatment department within Durban and finally obtaining informed consent from all the prospective participants.

Agreement to take part or consent was requested and obtained from most prospective participants. This Will call articulating, to All the participants, the purpose of the study, the roles that they need to play, and possible discomfort (if any) that may result from the study and related processes. Consent forms were given to all prospective participants and were signed prior to participation. The researcher also made certain that the researcher-participant relationship did not allow for the participants to be exploited, coerced, or manipulated.

1.10 STRUCTURE OF THESIS CHAPTERS

Chapter One: Background, Outline and Overview of the study

Chapter one provides a summative overview of the research and will include the introduction, background of the study, research purpose, methodology and objectives and an overview of other related introductory, scene-setting

Chapter Two: Literature review

Chapter two presents a thematic review of primary and secondary data sources and will review papers that that focus on water supply management, stream water quality

issues. The primary aim of the review is to assess literature to determine the state of knowledge and to determine the knowledge gaps as they relate to the focal topic area.

Chapter Three: Theoretical or Conceptual Framework

This chapter will present a brief discussion of relevant theoretical frameworks that relate to the concepts central to the study. This chapter will also discuss how key elements of the health belief model will be used to guide the development of the data collection instruments.

Chapter Four: Research methodology and data collection approaches. The research design, data collection methods and analysis approaches will be discussed here. Issues related to validity, reliability and overall study quality will be considered along with ethical considerations.

Chapter Five: Presentation of Results, data analysis and interpretation

Qualitative findings and analysis and the interpretation of the study results will be addressed in this chapter.

Chapter Six: Quantitative findings and analysis and the interpretation of the study results will be addressed in this chapter

Chapter Seven: Theory Development and Validation

This chapter will focus on theory /model development and will include the presentation of a proposed “best-practice” framework.

Chapter Eight: Conclusion and recommendations

This final chapter offer a summative overview of the entire study and provides a chapter-by-chapter summary and discussion of key observations, debates and issues that warrant further exploration. A consideration of limitations of the study, findings, and recommendations for future empirical work will be made.

1.11 CONCLUSION

Since the availability of water resources is intrinsically linked to water quality, then proper river wastewater management even from urban areas will provide health protection; environmental protection is serving SDG. However, without a comprehensive understanding of how and why water quality varies in different areas, differ within and between river catchments, it would rather be impossible to enjoy such a viable natural resource and its goods as Lintern *et al. (*2018) and UN (2016) maintains. Yet, in order to influence of policy and water quality practices on identified stakeholder knowledge, attitudes and behaviour toward stream restoration practices in Umlazi township, KwaZulu Natal, the ecological and socio-economic status quo of the Umlazi streams must be determined and define Umlazi area into Integrated unit by analysis firstly by catchment assessment for water quality status which was defined above.

CHAPTER TWO
LITERATURE REVIEW

2.1.1 Anonymity and Confidentiality

The study focused on a range of issues related to water sanitation issues and these involved the discussion of sensitive topics. As portion of the ethical provisions of the study, all participants in this study will be guaranteed confidentiality and privacy. To certify this, participants were all anonymised and only known using numeric code this procedure was used.

2.2 INTRODUCTION

Chapter two presents a thematic review of primary and secondary data sources and will review papers that that focus on water supply management, stream water quality issues. The primary aim of the review is to assess literature to determine the state of knowledge and to determine the knowledge gaps as they relate to the focal topic area. Although the literature as simple summary of the sources was used as the foundation to support new insights to be contributed, but it usually follows a pattern and combines summary and synthesis. Literature review is a reshuffling or reorganization of the knowledge that may result in a new interpretation of old material or the combination of new and old interpretations (Dudovskiy, 2018).

2.2.1 Types of Literature Review

Neuman (2000) classifies the literature a context review, a historical review, an integrative review, a methodological review, a self-study review, and a theoretical review are the six types of reviews. Larabee (2017) though insist that there are seven categories in literature namely: argumentative review; integrative review; historical review; systematic review; methodological review; theoretical review and thematic review. However, Cronin, Ryan & Coughlan (2007) classified literature reviews into four sub-types that include a narrative review, systematic review, meta-analysis, and

meta-synthesis. Dudovskiy (2018) believes that there are: narrative literature review; systematic literature review; integrative literature review reviews and; theoretical literature review.

A chronological literature review describes each work in succession starting with the earliest available information. Historical review according to Larabee (2017), focuses on determining research throughout a period of time on a concept or theory.

A thematic literature review, according to Saunders, Lewis and Thornhill (2012) the researcher organizes and explores current literature based on themes or theoretical principles that are relevant to understanding the subject. Thematic reviews of literature are based on a single subject or issue rather than chronological order. The subsections of thematic literature it may be how they're personified, how their proportions are exaggerated, or how their actions are misunderstood. This thematic methodological scope influenced the types of documents in the review and the way in which these documents are or were discussed (Dudovskiy, 2018; Saunders et al, 2012).

Methodological review: A methodological approach differs from the two preceding in that the focusing factor is usually unrelated to the content of the material. Methodological review for example, the economic effect of whaling on a society may be the priority. A methodological scope will influence the types of documents included in the review as well as the manner in which these documents are discussed. (Dudovskiy, 2018). According to Larabee (2017), methodological review approach also provides a structure for interpretation at various levels that draws on a broad range of experience from the intellectual to the practical.

Systematic review according to Walsh and Downe (2005:204-205), the systematic review is a good way of comparing quantitative research process and include statistical analysis using meta-analysis. Dudovskiy (2018) defines systematic literature review include both meta-analysis and meta-synthesis categories. Systematic review focuses on a very specific empirical question, often posed in a cause-and-effect form, such as "To what extent does A contribute to B?" (Larabee 2017:3).

Narrative literature review is the literature that gives the summary of the body of a knowledge by drawing topic’s conclusions and identifies gaps or inconsistencies in a body of knowledge but requires focused research questions (Dudovskiy, 2018).

Argumentative literature review, selectively reviews literature to support a claim that has already been developed in the literature, however, it is associated with bias challenges (Dudovskiy, 2018). Larabee (2017), also attested that argumentative reviews introduce bias challenges when summarizing systematic reviews.

Integrative literature review, critiques, and reviews and combine secondary data such that new frameworks and perspectives on the topic are created (Dudovskiy, 2018). Integrative review according to Larabee (2017) includes all studies that address related or identical hypotheses with the aim of reaching same standards as primary research in regard to clarity, rigor and replication (Larabee 2017).

Theoretical literature review focuses on establishing in theories that already exist by determining the connections between them, to what degree the existing theories have been investigated, and to develop new hypotheses to be tested (Dudovskiy, 2018).

2.2.1.1 Literature Mapping

According to Polit and Beck (2014), first part of the literature review chapter presents the summary of the sources that indicates the diverse search engines were utilised to identify the relevant literature for the topic; eligibility criteria for inclusion of studies within the review; the implementation of inclusion and exclusion criteria of the sources of data and the pre-review considerations (Trafford & Leshem, 2008; Makua, 2014). In this step, data is analysed through arguments evaluation by using presented literature, to identify the consistency of the use of concepts and for ensuring that a valid, clear and significant analysis of relevant literature was carried out.

Moreover, Makua (2014) believes that the literature review emphasizes the approving of the writing, as the researcher draws deductions and justifies the motives for the chosen research topic and the influence that will result from the study. In this study, the researcher has adopted the thematic review of literature. The literature mapping of an analysis of policy impact and stream water quality practices on knowledge, attitudes and behaviour toward stream restoration practices in Umlazi Township, KwaZulu-Natal, South Africa focused on the following research topics:

Thematic presentation of the literature findings of the socio-economic impact on the stream status and the impact of individuals' professional knowledge and skills on surface water quality management focused on the impact of individuals' professional knowledge and skills on surface water quality management; the context and severity of water scarcity and related disease (as environmental stressors). Impact of lack of consistency on surface water quality methodological variations by professionals followed in the discussion. The literature then focused on an individual's behaviour review where individuals are indicated as the cause of poor water quality and not infrastructure. The impact of environmental education on citizen science approach as a water monitoring tool is part of the literature review discussion. Perceived benefits of using stream management to reduce malnutrition vulnerability as a benefit to change behaviour was then explored followed by water related challenges and health care barriers. Finally, the global perspective of water and sanitation challenges and; malnutrition threat in urban areas was discussed in an analysis of policy impact and stream water quality practices on knowledge, attitudes and behaviour toward stream restoration practices in Umlazi Township, KwaZulu Natal, South Africa. This section of the literature review process helped to organise the information in a way that makes the writing process simpler and focused.

According to Machi and McEvoy (2008) though, literature mapping as a diagramming tool used to summaries the literature review work. This map highlights the connectedness of the literature amongst the researchers using the below frameworks as the basis of the relevant literature review.

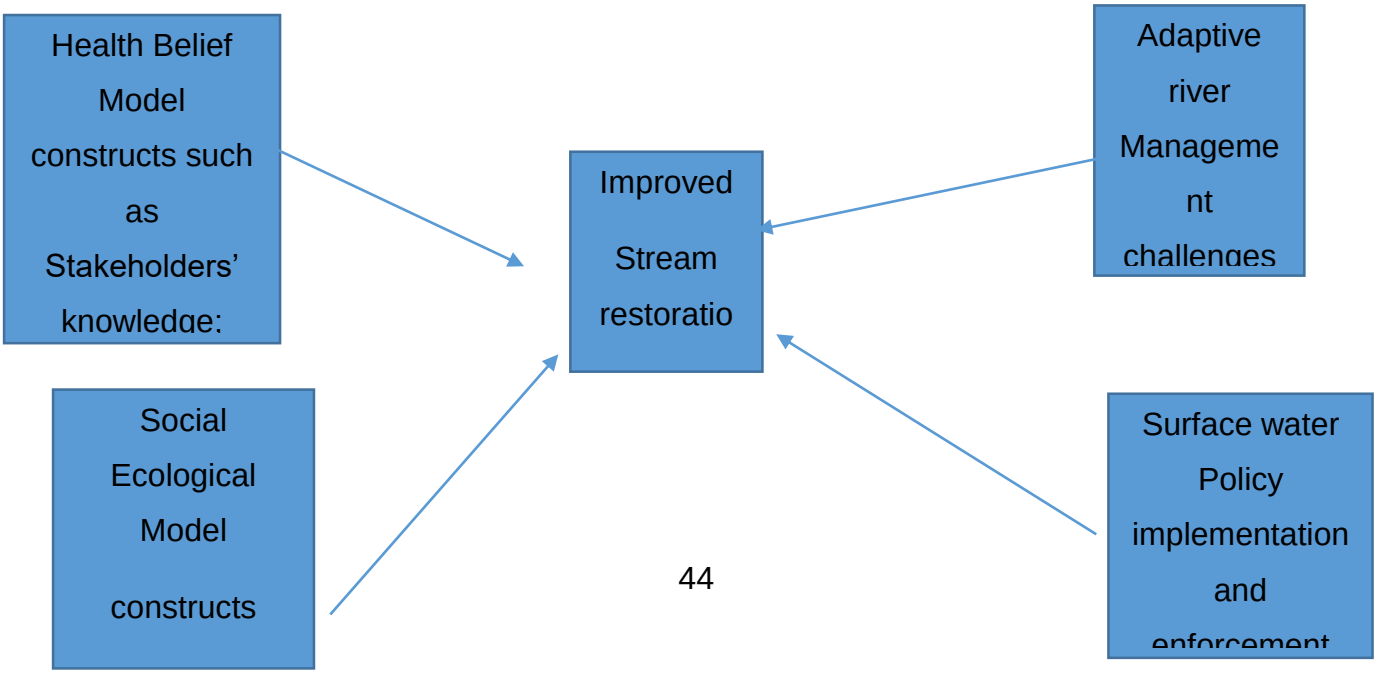

Figure 4. Concepts of policy impact and stream water quality practices on knowledge, attitudes and behaviour toward stream restoration practices

2.3 DATA SEARCH STRATEGY

In this phase the summary of the different search engines sources that were employed to ascertain the literature that is applicable to the research subject being discussed. This included the data strategy, the proof hierarchy, the application of data source inclusion and exclusion requirements, and pre-review considerations.

The search for studies that met the eligibility criteria included browsing through several electronic databases including:

1984-1992 Environmental and Conservation Psychology (Psychology)

2009-2017 South Africa Water Quality Journals

2010-2019-Adaptive management journals

2010-2019-Health-Communicable Diseases Journals

2010-2020-Social Ecosystem Systems Journals

2010-2019- WQI Journals

2010-2018- Ecological Management Journals

2010-2018- Applied Geography Journals

2010-2018- Environmental Psychology Journals

2010-2018- Multidisciplinary Journals

2.4 ELIGIBILITY CRITERIA FOR INCLUSION OF STUDIES WITHIN THE REVIEW

- Types of participants (Different departments government officials, NGO, experts, community members)
- All reviewed studies that were published (not only peer-reviewed articles and journals but all documents that were relevant for this thematic methodological scope) Age (18-80)
- Only studies published in English were included in this review.

The selection review criteria included not only peer-reviewed articles and journals but all documents that were relevant for this thematic methodological scope. The present information was essential to understand the topic of this literature review. Finally, the review offers an opportunity to highlight, examine and address conflicts and the benefits of the combination of all three frameworks within the relevant literature.

This study compiles 35 peer-reviewed journal papers from 2012 that published similar findings. A total of 436 peer-reviewed journal articles on participatory environmental monitoring were used to create this list.

2.5 REVIEW TABLE

The focuses on the synthesis of sources that cluster the literature according to the prominent scholars within this topic, the research methodologies applied during those studies, the population sample, key research findings and the recommendations from those studies (in the appendix section).

2.6 PRE-REVIEW CONSIDERATIONS

To ensure that a valid, clear and significant analysis of relevant literature was carried out, the format and structure of the ensuing review was guided by predecessors such as, Becker (1974) who asserted that the modifying factors of demographic variables such as education, age, sex, income and political ideology had the most consistent relationship with environmental concerns or measures such as pollution and

population; therefore poor education (Van Liere and Dunlap, 1981; Liu and Guo, 2018), and lack of motivation can act as a barrier of pro-environmental behaviour Steg, Bolderdijk, Keizer and Perlaviciut (2014). These findings backed up Fishbein and Ajzen's (1975) theory of rational behavior, which claims that broad attitudes influence behavioural intentions indirectly through their influence on behavioural values and conformity to social norms.

Agreeing with Van Liere and Dunlap (1981) who proposed that, depending on the particular environmental issue, different people want to express their concern for the environment in different ways. While Geller, Winett and Everett (1982) discovered that removal of the reinforces results in the extinction of the behaviours; that is, people stop recycling when they no longer get the incentive. Geller (1995) believes that behaviour-change and environmental protection will "actively care." Vining and Ebreo (1992) from designing recycling projects using a behavioural analysis approach found that the use of monetary incentives reinforcers the recycling behaviour concluded with the same results. That is, the lack of accurate measures of environmental indicators or measurements or environmental concerns such as environmental spending scale; environmental behavioural scale; environmental regulations scale can act as barrier towards pro-environmental behaviour (Van Liere and Dunlap, 1981). As De Young (1984) argued that motivation as an environmental measure, is the most powerful factor to describe and predict recycling behaviour outcome. Such measurements can allow it is possible to influence attitudes toward particular conservation concerns by using general conservation attitudes. (Black, Stern and Elworth, 1985; Dunlap and Van Liere, 1984).

Guided by De Young (1984), the personal satisfactions like in low spending conditions caused by economy instability, individuals' participation in irrigation of plants and health risks awareness are some of the reasons why people bother to conserve resources necessary enough to be a part of human psychological well-being. Although, Tortajada and Joshi (2014) stated that for citizens' attitude and behaviour to improve, citizens must be involved in conservation of water resources. However, Newson (1997) still detailed that different experts and groups of people perceive the river environment through their disciplinary and experiential knowledge. Therefore, an in-depth study of perceptions can help determine specific reasons of lack of support

and identify relevant actions and specific requirements of different users, to ensure long-term support and the success of conservation (Gelcich, Edwards-Jones and Kaiser, 2005). This review highlights what individuals perceives as environmental stressors associated with stream water quality. In identifying individuals' (environmental stressors) perceptions on stream water quality, the susceptibility; severity; barriers; self-efficacy and cues of action of the individuals' knowledge, attitude and behaviour associated with stream water quality can be identified and measured.

All environmental factors that have an influence on human behaviour and well-being that have potential of promoting pre-environmental behaviour of individuals and community at large are described by the following authors. For Steg *et al*. (2014) it environmental risks perceptions Böhm (2003); for Tanner, Goldman, Ross and Grate (2014), it environmental stress; for Joye & van den Berg, (2011) it the health benefits of nature; Joye, & Van den Berg, (2011) state that it restorative environment; urban environmental quality for Gifford (2006) and; how cues in the environment affect normative behaviour (Lindenberg, 2008; Lindenberg & Steg, 2007). Bagozzi and Yi (1993) believe intention needs to be well-formulated to be consistent with behaviour to ensure long-term support and the success of conservation (Gelcich *et al*., 2005).

This section highlights what individuals perceives as environmental stressors associated with stream water quality. In identifying individuals' (environmental stressors) perceptions on stream water quality, the susceptibility; severity; barriers; self-efficacy and cues of action of the individuals' knowledge, attitude and behaviour associated with stream water quality can be identified and measured.

Another factor that has a bearing on prevalence estimates is the location from which surface water quality are sampled, as is shown by surveys conducted in areas where operational policies specify the exclusion of service-users with secondary substance misuse problems. The existence of such exclusions may result in lower rates of re-admission than in other service areas with less strict admission protocols. Additionally, the failure by some studies to account for differences in the level of service provision in terms of (socio-economic and infrastructure factors) for some urban areas in the developing countries sub-groups within study populations may explain some of the

observed variations in the rates of surface water quality deterioration service-users presenting in crisis. As illustrated above, research in the area of psychiatric recidivism is fraught with methodological problems which make comparisons between studies and the drawing of conclusions very difficult. To minimise flaws arising from this, the literature review has adhered to the strict inclusion and exclusion criteria, detailed earlier.

From the identified location of where the surface water quality is sampled, further to pre- review considerations described above, there are a number of notable issues relating to 'methodological variation' which need clarification before the review proper - factors which have contributed to the diverse findings in this area. The fact that studies often utilise inconsistent definitions water quality parameters on the local rivers to describe frequently deterioration of surface water quality, naturally produces prevalence rates that are very difficult to compare. For example, some studies have adopted the view that *E. coli* should be part of Water Quality Index (WQI), how is it monitored in terms of scales for example, at national river or local river level and how many times it should be monitored locally monthly; daily or yearly-and will this be due to severity and susceptibility of the stream water quality and it impacts on humans refers to those individuals with more than two admissions within a 12-month period. In contrast, others in the study area have loosely used the term to describe water quality parameters of surface water like RQOs used in South Africa. Clearly this lack of consistency in defining the problem gives rise to a number of variations which have to be acknowledged and factored into analyses to ensure that valid comparisons between studies are made.

2.7 LITERATURE REVIEW ON THE SOCIO-ECONOMIC IMPACT ON THE STREAM STATUS

The literature portion that follows reports on the research objectives. The literature will be used to connect the research problem to the patterns and trends identified in the cited literature in order to shape opinions on the topic under investigation. The literature is used to provide a context for the research the socio-economic status of

the streams that is currently lacking as well as assisting the report in identifying gaps in the literature that need to be addressed in order to achieve the study's goal.

In the main, the review follows conventional thinking by focusing on literary sources which explore the range of variables and factors considered causal by professionals within the study area. Notably, the inclusion of the Health Belief Model (HBM) as an explanatory framework challenges the central assumption of ‘objectivity' often ascribed to the accounts of water quality results provided by professionals within related literary sources. In practical terms, the inclusion of the HBM raises questions about the notion that professional feedback offers the most accurate representation of ‘fact' about urban surface water quality management or restoration practices rather than focusing on ecological models such as SES and Adaptive River Management for surface water quality studies. Significantly, the HBM puts forward the argument that professional assertions and viewpoints represent individual perspectives relating to surface water practice in urban areas. In this respect, they should not be seen as ‘facts' but instead, they should be acknowledged as ‘viewpoints' or ‘selective explanations' with less certain truth value (Lambert, Garfield & Bergin, 2004). Because much of the literature relevant to frequent poor surface water quality or water quality deterioration lends its self to the view that professional representations are ‘facts of causality'; integrating health believe model with the ecological frameworks of SES and Adaptive River Management perspectives within this review may appear radical by suggesting that professional and service-user reasons for water quality deterioration are, in fact, reflections of reality in urban surface water deterioration as other individuals internal or external factors which offer ways of seeing one experience from two differing perspectives (White et al., 2015 and Hampson, Ferrini, Rigby & Bateman, 2017). The latter view represents a more relativistic individual perspective that creates less certainty about how, despite water scarcity awareness campaigns; floods risks awareness campaigns; improved infrastructure development in terms of water piped houses in urban areas yet simultaneously water-related microorganisms are still found in vegetables due to polluted surface water. Individuals and households affected by floods and high diarrhoea levels that continue to increase among children of these areas can be explained. Furthermore, the promotion of a balanced exploration of differing insider and outsider causal explanations central to the HBM, SES and

Adaptive River Management attribution theories has a bearing on the methodology and critically supported a mixed-method qualitative approach to inquiry.

The review focused on the socio-economic impact of stream water quality on a community as part of the thematic literature review that are consistently highlighted by relevant literature as notable influences in surface water quality management or restoration. The selection review criteria included not only peer-reviewed articles and journals but all documents that were relevant for this thematic methodological scope. The current situation information was necessary to understand the topic or focus of the literature review. Finally, the review offers an opportunity to highlight, examine and address conflicts and the benefits of the combination of all three frameworks within the relevant literature.

2.8 THE IMPACT OF INDIVIDUALS PROFESSIONAL KNOWLEDGE AND SKILLS ON SURFACE WATER QUALITY MANAGEMENT

Policies are either embraced by citizens or rejected. Policies are dependent on external support of government agencies to be effective and implemented and in addition require finances. Policies act as external catalyst to behavioural change of an individual.

Muhammad, Al Mamun, Syed, Masud and Su (2018) assert that there are positive and significant connections between attitude and behaviour. However, use of RQOs locally to communicate surface water quality results seems to not affect community knowledge, attitude and behaviour, as littering increases and as a result diarrhoea disease is high in Umlazi area.

Poor adherence with environmental law even after awareness of water scarcity can be as a result of poor understanding of environmental consequences also called environmental stressors (Steg, van den Berg & De Groot, 2013) that can include health risks (Joye & van den Berg, 2011); floods, malnutrition, drought due to river

vulnerability have influence on human behaviour and well-being (Steg *et al*., 2013; Nel & Drivers, 2015; DWS, 2017). This section will highlight what individuals perceives as environmental stressors associated with stream water quality. In identifying individuals' (environmental stressors) perceptions on stream water quality, the susceptibility; severity; barriers; self-efficacy and cues of action of the individuals' knowledge, attitude and behaviour associated with stream water quality can be identified and measured.

2.8.1 The Context and Severity of Water Scarcity and Related Disease (as Environmental Stressors)

Water scarcity and water-related disease awareness are the reality that ought to trigger some kind of panic or fear in an individual as water is said to be a basic need of life and some water disease have caused the majority of deaths of children below 5 years old especially in the developing countries (WHO and UNICEF,2017) .Such water scarcity and water-related diseases triggers are supposed to have informed environmental value that should have resulted in behavioural change towards water as a natural resource. Monitoring the ecological condition of site rivers are usually large for main rivers, and monitored in the long-term effects in large catchments an ideal world, ecological conditions should be given not only for a country's main rivers, but also for its smaller tributaries. The addition of tributaries would provide a finer-scale view of the drivers of change and signals patterns that could have a detrimental impact on the downstream main rivers.

White *et al*. (2015) believe it is an ethical requirement of screening initiatives that presumptive identification of disease leads to improved prognosis. However, screening activities depend on the availability of funds, the need, and skills of technicians' availability. Also, professionally qualified inspectors ensure that standards are upheld since communicable disease control measures are legally mandated and resources are committed for it. Hence, the policy under health legislation addresses roles and responsibilities. The impact of a diagnostician or professional is crucial as

they may recognize opportunities for treatment. Yet, too often, senior managers and professionals in centrally based agencies tend to assume that, even without training in community development or local experience, they "know best" what communities need and how to lead change. However, technical know-how is not enough, public health professionals need skills in community development so as to involve community representatives as partners or stakeholders (White *et al*., 2015).

Virapongse, Brooks, Metcalf, Zedalis, Gosz, Kliskey and Alessia (2016) affirm that the use of the transdisciplinary approach in social-ecological system (SES) framework of river management emphasizes adaptability, flexibility from management and yet is difficult to apply. Use of co-development knowledge where managers must develop facilitators, community builders' skills by connecting to the local community and their knowledge is necessary. OECD (2015) argues training and educating professionals is essential as professionals' direct knowledge influence their decision making in their workplaces to work under, and to influence several institutions. Kelly-Quinn, Bruen, Carlsson, Gurnell, Jarvie and Piggott (2019), believes that to tackle surface water complex challenges, the interaction with stakeholder involvement about freshwater ecosystem vulnerability needs to be improved. While, Bandura's (1977) believes that social learning theory (a construct of HBM) emphasizes that learning occurs when there is attention, retention, reproduction, and motivation (Cele, 2015 and White, Stallones & Last, 2013). The use of the transdisciplinary approach of river management can further highlight the susceptibility and severity of drought environmental stressors.

2.8.2 The Extent and Severity of Water Scarcity and Related Threats in SA

Water quality professionals should consider investing on the impact of community perception research for a holistic surface water quality management and restoration approach. With over half of South Africa's rivers, streams and wetland ecosystem types have been reported to be highly threatened, by the National Biodiversity Assessment (Nel and Driver, 2015) indicating susceptibility to drought. Donnenfeld, Crookes and Hedden (2018) state that South Africa is currently overexploiting its renewable water resources. Moreover, withdrawals are estimated to increase in all

three sectors agricultural, industrial and municipal. Enabling greater monitoring reporting of the small stream network by professionals is essential to integrate them into policy. Management strategies and measures for sustainable resource use, is internationally recognized requirement by the Water Framework Directive (WFD) and the other legislative and policy targets are impacted (Keiser and Shapiro, 2018 and Kelly-Quin et al., 2019). According to Keiser and Shapiro (2018) involving volunteers in both biological water quality and hydro morphological assessments of surface water through citizens' science helps and citizens to evaluate, contribute better and in connect scientifically robust knowledge of small stream networks as streams management is becoming more essential especially during this era of climate change.

From Dunca (2018), knowledge of anthropogenic pressure formed on water resources and the WFD requirements, it is important to determine the quality of water sources so that adequate steps can be taken to preserve and recycle water in Romania region because of it many transboundary rivers and through the construction of efficient wastewater treatment plants. In Europe, Kelly-Quinn *et al*. (2019) highlight the need to focus attention on small streams have been the emphasized in various research for example, by Meyer and Wallace (2001); Meyer, Strayer, Wallace, Eggert, Helfman and Leonard (2007); and more recently by Wohl (2017) and Riley, Potter, Biggs, Collins, Jarvie, Jones, Kelly-Quinn, Ormerod, Sear, Wilby, Broadmeadow, Brown, Chanin, Copp, Cowx, Grogan, Hornby, Huggett, Kelly, Naura, Newman and Siriwardena (2018). A recent evaluation of the nutrient water quality status and eutrophication of headwater streams in Great Britain rivers has also been done by Jarvie, Smith, Norton, Edwards, Bowes, King, Scarlett, Davies, Dils and Bachiller-Jareno (2018).

According to DWS (2017), unskilled plant operators, old and insufficient infrastructure and poor maintenance contribute immensely on surface and drinking water quality, in peri-urban and rural areas Cele (2015) confirms that South Africa appears to be at risk of inconstant climatic conditions. From research conducted, such challenges of climate change in South Africa will increase more, due to lack of preparedness to deal with its impacts at the community level (Hughes, Mantel & Slaughter, 2014). Yet, SES Monitoring approach is concerned with presenting accurate, complete and consistent

data, which makes it reliable and valid. Instead, the data collected by community groups is hardly used by decision-makers due to poor sampling procedures (Conrad and Hilchey, 2011).

Therefore, this lack of accredited data suggest that citizens are still left in the dark about water quality. Pahl-Wostl, Craps, Dewulf, Mostert, Tabara and Taillieu (2007) agree that South Africa has four types of river uncertainties that include: socio-economic research in river knowledge, that is, uncertainty about climate change effect on nature and extreme events likelihood. Secondly, stakeholders' perception and action uncertainty in the adaptive river management framework and thirdly, SA seems to lack in environmental education campaigns. Environmental education, according to Ho (2013), is "integrated" education, rather than being practiced for specific age groups or groups of people; it emphasized universality, lifelong learning, and dignity, as well as integration of politics, economics, community, culture, and aesthetics, and was a type of value and lifestyle (Pienaar, Brent and Musango, 2015). Agreeing with Jordan, Gray, Howe, Brooks and Ehrenfeld (2011) findings that there was little change in behaviour regarding invasive plants due to lack of understanding as scientific goals, educational goals, and the motivation of participants were not clearly defined during programme design and even after participation.

According to Munhall (2008) persons' subjective perceptions can become their truths as perceptions are not necessarily objective. Hence, evaluating of perceptions towards the environment become more imperative as conservation activity gradually depends on the actions of stakeholders (De Groot and De Groot, 2009). Leleu, Alban, Pelletier, Charbonnel, Letourneur and Boudouresque (2012) emphasises that perceptions are more important to understand as they highlight why stakeholders support or do not support an initiative. According to Gelcich and O'Keeffe, (2016), to face the potential challenges associated with aquatic conservation, researchers and practitioners have begun to concentrate on recognizing society's expectations. Perceptions are a broad concept that encompasses desires, social values, personal perceptions, perception, and assessment (Bennett, Roth, Klain, Chan, Clark, Cullman, Epstein, Nelson, Stedman, Teel, Thomas, Wyborn, Curran, Greenberg, Sandlos and Veríssimo, 2017).

Yet, Steg *et al*. (2013) findings showed that environmental conservation behaviour is still lacking. The findings of van der Vyver. (2014) stated that about 64 percentage of

SA citizens said they do not see the need to change their behaviour even though there is water scarcity, indicating that citizens do not understand the impact of their behaviour regarding water scarcity in the country. Sorice and Donlan, (2015) indicated that the fishermen and farmers' reactions to policies are influenced by their perceptions, personalities, and livelihoods. in the emerging research (Gelcich et al., 2009). Bennett *et al*. (2017) and Bockstael, Bahia, Seixas and Berkes (2016) believes that after policy or conservation initiative is implemented, perceptions can be valuable for evaluating its legitimacy and efficiency and further highlight the Susceptibility and Severity of Health Environmental Stressors that are necessary for natural resources especially the water quality.

2.9 IMPACT OF LACK OF CONSISTENCY ON SURFACE WATER QUALITY METHODOLOGICAL VARIATIONS BY PROFESSIONALS

It has been started earlier that from the identified location of where the surface water quality is sampled, ‘methodological variation’ utilises inconsistent definitions water quality parameters on the local rivers to describe frequently deterioration of surface water quality. This inconsistent of methodology and definitions naturally produces prevalence rates that are very difficult to compare has resulted in death even hospitalization of surface water users. For example, some studies have adopted the view that E. coli should be part of WQI. According to CDM Smith (2016) even defining environmental flows for rivers is important aspect of understanding stakeholders’ perceptions and priorities.

According to Rochelle-Newall, Nguyen, Le, Sengtaheuanghoung and Ribolzi (2015). The pathogens such these water-borne diseases are vulnerable to changes in hydrology and water quality because bacteria, viruses, and protozoa cause them (Cho, Lowrance, Bosch, Strickland, Her and Vellidis, 2010; Ratajczak, Laroche, Berthe, Clermont, Pawlak, Denamur, Petit, 2010). This is especially significant for developing countries, given the expected rise in rainfall and floods as a result of climate change.

in survivals coliforms bacteria such as *E. coli* to be prevalent on adjacent water bodies (Pandey, Soupir, Haddad and Rothwell, 2012) these are some of the environmental stressors-temperature.

Measuring environmental impact is not the same as measuring behaviour and the two different types of measures may therefore not necessarily overlap in factors influencing environmental behaviour (Steg *et al*., 2013). In this literature the impact of the lack of consistency on surface water quality monitoring methodology by professionals is highlighted. Showing the variations of policy design and implementation influencing environmental impact measurements in attaining real-life objectives of policies associated with stream water quality.

Considering the unpredictable weather that can be in extreme conditions of drought and floods, the identified of location on where the surface water quality is sampled should be monitored closely as a result of these environmental threats (Maclean, Ross, Cuthill & Witt, 2017). Van Liere and Dunlap (1981) agrees that how environmental concerns are measured does make a difference as all are not equivalent. Ecosystems would not be able to proceed if they do not have the resources to do so to provide water purification there will be no economic or social development as all human activity is dependent on nature for food, air and water (White et al., 2015). National Planning Commission (NPC) (2012) maintains that not only is sustainable growth economically and socially, but it is also environmentally sustainable. As a result, ensuring that a natural resource does not become depleted or harmed over time is critical to its long-term viability. Sustainability in water resource management, according to Loucks *et al*. (2005), means "water resource networks that are regulated to meet evolving demands."

Social ecological systems (SES) framework emphasises sustainability importance as one of the solutions in these unstable weather conditions through the integration approach of humans and ecology yet, the ecological measurements so far still at large scales such as regions (Holling, Gunderson, and Ludwig 2002) and does not include the social dimensions (Brown, 2014). This was found true for the ecological system of South Africa as large scales to define the ecological system are used on the identified location of where the surface water quality is sampled (Nel and Driver, 2015).

SA has relied on RQOs of the catchment classification and National Coastal Management Programme (NCMP) data policy to determine the maintenance of that catchment (Snyman, and Herselman, 2006; RSA, 1998; DWAF, 1996; DWAF, 2004; DWS, 2018a). However, according to Harring, Jagers and Matti (2017) a proper measurement of the environmental carrying capacity that support sustainability is by measuring or evaluating the: relating the existing condition evaluation; the future condition projection, and their strengthening strategies. The use of RQOs for surface water does not reflect the reality of the current use of rivers and streams in urban areas. According to the RQOs of urban areas, rivers and streams are mainly used for agricultural purposes (DWS,2018a). However, the studies indicated SA rivers to be highly threatened such that estuaries of Embokodweni and Isipingo were closed due to high contamination of *E. coli* of raw sewage ranging from possibly 3.67 to 6.7 ML/day was flowing to the Isipingo River and Estuary (Pillay *et al*., 2016; Nel and Driver, 2015; McLean, 2016) and uMlazi River below Fongozi Stream, *E. coli* was up to 720 000 sources again was the broken sewers in uMlazi township (Dicken, 2002, Sithebe, 2017; DHPKZN ,2015) .While DWS (2018a) agreed that there is deficient implementation of RQOs, that the RQOs currently have no guidelines for the implementation of RQOs. Therefore, the policymaking and priority of development programmes need to consider the existing situation, condition, characters, and local potentials that are reflected from their environmental carrying capacity (Harring, Jagers and Matti, 2017).

Liu and Guo (2018) believe that while people seldom develop responsible environmental behaviours, the observation of the real society, indicates that the environment is worsening, and environmental incidents happen endlessly. Environmental knowledge helps changes people's attitudes to be more environmentally friendly and eventually influences behavioural change that adheres to environmental policies.

RQOs of Umlazi and Izimbokodweni rivers at a tertiary catchment level of Mvoti to Umzimkulu WMA indicated that E. coli and coliforms to meet recreational use targets (DWA,2017). Moreover, Health River Programs have not yet included *E. coli* results in their local river and streams, this will affect the interpretation of these environmental measures by the community members. The community members can unknowingly interpret their local RQOs as safe and at an acceptable range, yet the opposite is true

(Dicken, 2002; Sithebe, 2017). Nel and Driver (2015) indicated that the network of tiny streams that feed into tributaries is not reflected in the 1:500 000 in the national river network, limiting the identification of the relevant set of characteristics of ecosystem condition and more detailed planning and assessment at a local level however over half of South Africa's rivers and wetlands ecosystems are threatened.

Syamsir, Birawida and Faisal (2018) indicated that using WQI helps citizens interpret water quality results in a more meaningful way regarding their health risks associated with surface water, WQI includes parameters such as especially for coliform bacteria salinity, pH and temperature (Kumar & Dua ,2009; McClelland, 1974). Newson (2009, 2011) insists that to conserve or restore river ecosystem integrity and policy of land in urban areas requires land-use and land-management planning and control at a river or stream level this level. Up till now, the attention of public policy towards anthropogenic physical impacts, are mainly scaled at the catchment level via the run-off or sediment system not at a river or stream level. Although, Nel and Driver (2015) argued that individual ecological condition indicators used by DWS to assess the Present Ecological State (PES) of rivers in 1999 and again in 2011 is more difficult to this approach is difficult to communicate with civil citizens for example because they are not familiar with rivers ecological conditions and spatial analysis (Nel & Driver, 2015; DWS, 2018a).

The type of surface water quality data collection methodology and its interpretation have an impact on stakeholders' knowledge, attitudes and behaviour practices. The trend of water quality results in return, informs other policy regulations of that area. Also, the successful implementation and abiding of those regulations depends on and is determined by stakeholders' perception of its importance. Water has long been used for recreational purposes in human societies, especially where the climate is favorable. There is inadequate monitoring of bathing water conditions in Brazil, and the existing approach has some shortcomings, including a lack of clarity about how to view variables other than faecal bacterial indicators. Xaba (2019) found that the community does not have any knowledge of the importance and significance of biodiversity and environmentally sensitive areas in Umlazi. The participants were not able to make the connection between these areas and sustainable development. They also could not

relate to global warming concerns about such areas. This was noted through the participants indicating that they use open spaces to build houses as well as using wetlands as dumpsite full of diapers and forest for building houses as well as for medicinal purposes without regulation (Xaba, 2019:77).

To increase the adoption of water conservation behaviours, and more involvement of professionals at a community level should reinforce the behaviours they want people to continue by specifically targeting and providing support for people who engaged in landscape water conservation in the past especially in urban areas of developing countries.

2.9.1 Impact of Urban Population Growth on Surface Water Quality

White *et al*. (2017) argue urbanization contributes immensely to the deterioration of water quality. Brennan and Lo (2020) showed concern about population growth and serious environmental crises resulting from human activities. The emphasis is based on it being morally incorrect for humans to continue polluting and destroying parts of the natural world, as well as using a large portion of the planet's natural resources.

The population growth element has a significant impact on the water quality of surface water and its supply even if there is sufficient water in the country. Djuwansyah (2018), posits that future Water Resource Carrying Capacity (WRCC) assessment in humid tropics even in water-scarce countries should consider water quality deterioration besides quantity depletion. In SA, the country's scarce water supplies have been placed under greater strain as a result of economic development and rapid population growth (DWA, 2014). It has been shown that the quality of storm-water coming from urbanized areas degrades water quality over time. (Pillay et al., 2014). Donnenfeld et al. (2018) believes that a more balanced outlook would come at the expense of lower agricultural production, making the country more vulnerable to foreign commodity shocks and jeopardizing long-term food security.

Steg *et al*. (2014) mentioned earlier that adjusting policies, designing and implementing projects or programs by using goal adjustments can cause conflicts between policy makers and community, especially if the all stakeholder's perceptions and intentions were not identified or understood. Hence the evaluation of perceived barriers and perceived benefits, encourage individuals to engage in pro-environmental actions or behaviour. Environmental policy implementation in urban areas like that of reserving 30% of land for conservation can cause a conflict with government's housing department who's aim is to provide houses for citizens. While according to Steg *et al*. (2013) having a goal that is a focal one or goal-frame influences better processing of information for all stakeholders involved than each department focusing on other goals that are in the background as this will decrease the strength of the focal goal. That is although integration approach as a world view is ideal and necessary in meeting diverse demands and needs. The goal-frame approach should be considered and discussed by different stakeholders during policy or project design and implementation where the goal-frame is in need of external social and institutional support in order to become focal especially in meeting the environmental conservation goals.

2.9.2 Adjusting the environmental policy due to climate change.

As earlier mentioned, there seems to be a need to adjust the environmental policy due to climate change. According to Rochelle-Newall *et al*. (2015) tropical countries with higher rainfall occurring in hotter months can have consequences on both survivals and increase of Faecal indicators bacteria like *E. coli* and coliforms in surface water. In developing countries especially an anticipated increase in rainfall and floods caused by climate change would also wash faecal matter from land-based latrines into drinking water sources, contaminating bore holes and reservoirs.

According to Jeon, Ligaray, Kim, Kim, Lee, Pachepsky, Cha and Cho (2019). As Jeon et al. (2019) insist that increased precipitation (53.3%) resulted in a rise in Faecal coliform bacteria (FCB) loads from the soil to the water body (96.0%–115.5%). The dominant mechanism influencing the amount of FCB in stream in the in-stream setting

was resuspension from the stream bed. As a result of the increased peak channel velocity and volume of water used as a result of the increased peak channel velocity and volume of water used, the final FCB loads increased by 71.2 percent. In return affecting agricultural products, health and the economy at large of the country by becoming a barrier due to lack of specific tools and skills in managing it (Rowe and Smithers ,2018).

Although, in South Africa, a national database containing 50 years of rainfall, temperature, Apan evaporation, and other climate variables is available and has been used for a variety of water resource management applications. Yet, Design Flood Estimation (DFE) techniques within South Africa are outdated and in need of revision for flood risk assessment (Rabba, Fatoyinbo and Stretch ,2018). However, many catchments in South Africa and Ethiopia are poorly gauged (measured) and totally ungauged and this hinders water resource management and flood prediction of these countries. Floods as environmental stressor in Durban, South Africa. Sithebe et al. (2016). an increase in total rainfall is bound to elevate the microbial contamination levels. This relationship was also evident in a study conducted by Sithebe et al. (2016) in which E. coli log10 MPN/ 100 mL concentrations were correlated with rainfall events (on the day of sampling) from the Palmiet River. Sithebe et al. (2016) found a positive trend between *E. coli* concentrations and rainfall (r= 0.2646 and p-value = 0.2724) (Sithebe et al., 2016) and was verified in this study when no rainfall and rainfall events were compared. In terms of drought as environmental stressor, Pienaar, Brent, Musango and de Kock (2017) South Africa, Western Cape Province according to the model, could have life-threatening water shortages in the near future if the province continues as business-as-usual.

2.9.3 Impact of Stream Water Quality Data on Floods and Drought Models

Williams, Szaro and Shapiro (2007) affirm that poor river management can result in disease and disaster liabilities but this can be minimized by community knowledge input in river restoration programs as acknowledged by adaptive river management to

be rather a liability caused by uncertainty element in river management (McDonald, Fielding and Louis, 2004). The use of a transdisciplinary approach in SES river management also agrees with the co-development knowledge where community skills can be improved on river restoration and also will form a closer connection between community members in the process.

As global trends indicate high threats level on river's ecosystems, rivers and tributaries vulnerability, Harring *et al*. (2017) believes that a significant problem is related to the population growth which results in a decline in the environmental carrying capacity is likely as observed in studies like that of Yogyakarta Urban Area (YUA). Djuwansyah (2018) also confirms that many countries use such model measures to forecast the future sustainability of regional development based on water availability. In Indonesia for example, many places in the densely populated regions, actually suffer water scarcity during a dry season and are ironically struck by floods and landslides during the rainy season. The use of land capacity regulation is now a norm in this country, however lack of space for agriculture sector is still limited yet granting land for building and other infrastructure has no practical limitation as long as it is technically and economically feasible. To regulate the spatial arrangement of land use, the Indonesian government implemented the Spatial Planning Regulation (Djuwansyah, 2018).

Rochelle-Newall *et al*. (2015) confirms that in tropical countries higher rainfall occurs in hotter months which can have consequences on both survivals but also there-inoculation of Fecal Indicator Bacteria (FIB) to the adjacent water bodies for such tropical city like Durban, South Africa is (Pandey *et al*., 2012). Rodda, Stenström, Schmidt, Dent, Bux, Faizal, Hanke, Buckley and Fennemore (2016) maintains that SA requires urgent interventions to protect water security within this developing country. Perceived challenges include lack of both skills and political will in government, citizen's trust in government, lack of understanding of Green and Blue Drop program impact and knowledge on the process of water supply. Lack of awareness about water security protection of both quantity and quality is required in all stakeholders. Meanwhile, much of the country's water infrastructure is inadequate and dam levels are riskily low for 2035, SA national-level forecast of water supply and withdrawals and will to overcome this will require lots financial investment and political will (Rodda *et al*. 2016). Up until now, nothing is done both at a national and local levels.

Environmental conditions in the community or the population are considered as one of the patterns that increase the risk of disease. This refers to how less measures are taken that inhibit the emergence through the establishment of environmental, economic, social, and behavioural conditions and cultural patterns known to decrease the risk of disease. Beaglehole, Bonita, and Kjellstrom (1993) believe primordial prevention is focused on underlying determinants that are open to long-range policy shifts.

According to Donnenfeld *et al*. (2018) what the drought did between 2014-2016 in SA was the highlight of existing vulnerabilities in SA's water system, and properly frame the magnitude of the challenge of ensuring water security for the country. Yet according to van der Vyver (2014), levels of awareness of stakeholder's perception about water scarcity was low; only 56 % were aware of water consumption aware; therefore, the campaign on water scarcity and water management is required in this country. Moreover, as droughts are common and are usually followed by equally disturbing floods in SA (Nel and driver, 2015) as was observed in Umlazi, Durban, South Africa (Dludla, 2019).

In Umlazi Durban, South Africa, floods affected 124 houses, families were destroyed, and 14 people died in these areas whilst another 80 deaths results in KwaZulu-Natal. The damage was over R650 million (Dludla, 2019). SA's stakeholders' perception on flood risks is poor according to Rowe and Smithers (2018) and according to Buytaert, Zulkkafli, Grainger, Acosta, Alemie, Bastiaensen, De Bievre, Bhusal, Clark, Dewulf, Foggin, Hannah, Hergarten, Isaeva, Karpouzoglou, Pandeyab, Paudel, Audel, Sharma, Steenhuis, Tilahun, Van Hecken and Zhumanova (2014) water consumption and scarcity is misunderstood and can be improved by the use of citizen science which is lacking in this country. According to Rodda et al. (2016), the use of the WQI approach is important to all stakeholders as it is said to show transparency that reboost social knowledge in South Africa. Public buy-in and awareness are highly recommended by participants to impact stakeholder's perception, belief, and attitude. Lack of information on floods and drought impact at a local level can cause a role's ambiguity between balancing between public rights and obligations versus responsibilities (Rodda *et al*., 2016).

As mentioned previously, dry areas like SA jeopardise both environment and human health and but also cripple sustainable economic development due to poor surface and groundwater that cause diseases (Veolia/IFPRI, 2015; Chigor *et al*. 2014; Steyn and Genthe, 2009; Abia *et al*., 2017; WRI, 2015). Due to population growth and climate change, impact in urban areas is increasing high risks for floods and drought impact; there is an increased need for research on local drought and flood models.

2.9.3.1 The importance of Local Drought and Flood models

In this literature the impact of the lack of consistency on surface water quality monitoring methodology by professionals is highlighted. Showing the variations of policy design and implementation influencing environmental impact measurements in attaining real-life objectives of policies associated with stream water quality. According to Donnenfeld *et al*. (2018), the entire south-western region of SA will be at increased risk of severe drought throughout this century due to climate change. While the January and February rains of 2017 have offered a brief reprieve from the 2014–2016 drought, Donnenfeld *et al*. (2018) still maintains that SA is still overexploiting its renewable water resources and, without additional interventions, will continue to do so for the foreseeable future. Rainfall received in SA in 2015 was the lowest annual total on record since the South African Weather Service began collecting rainfall data in 1904. This caused SA's average dam levels to plummet from around 93 percent in March 2014 to a low of 48 percent in November 2016 (Donnenfeld *et al*., 2018). As mentioned earlier that measuring environmental impact is not the same as measuring behaviour and should be influencing environmental behaviour (Steg *et al*, 2013).

While globally, drought is one of the greatest threats from climate change but in Durban local, South Africa's coastal areas are being affected by rising sea levels. From research, floods occurrences (Hirabayashi *et al*., 2013) and droughts (Hirabayashi *et al*., 2013) (IPCC, 2013) usually change with rise in temperatures for countries like India, Central, and Eastern Africa. After floods or drought, there is usually pollution of water sources, making the necessity for wastewater use even greater (WWAP, 2017). In the large part of the KwaZulu-Natal drought dramatically intensified in November and December 2015 (DWA, 2017). According to Green cape (2017), SA recorded its

worst drought since 1904 and its impact was felt nationwide in 2015/16, where agriculture was constricted by almost 15% from R78 billion in the fourth quarter of 2014 to R66 billion in the second quarter of 2016 in SA (Green Cape, 2017). Winsemius and Ward (2015) show that the flood damage in urban areas could reach US$0.7-1.8 trillion per year by 2080. Thus far, urban runoff is considered as main cause of flooding and pollution (WHO and UNCF, 2018). The effect of illegal dumping will increase flood susceptibility according to Ali *et al*. (2014) as the frequency and severity of floods and droughts having the possibility to change in many river basins worldwide (UN, 2017).

Kelly-Quinn *et al*. (2019) believe that water quality and flows measurements (Nitrogen, Phosphorus & sediment) for overall ecosystem services management is required during modelling of drought and floods susceptibility and vulnerability in the small stream network programmes applied in the CMT catchment modelling tool (Mockler, O'Loughlin & Bruen, 2016)

According to Djuwansyah (2018), many countries use Direct WRCC assessment to estimate the future sustainability of regional development based on water availability. WRCC assessment tool involves population number determination combined with their activities that is supported by available water. Whereas indirect WRCC assessment comprises the analysis of supply-demand balance status of water. Increasing of diarrhoea at uMlazi, can as a result of using irrigation of E. coli contaminated surface water due to slow economic growth (DHPKZN, 2015; Sithebe, 2017). This condition of this area is an indication of land resources carrying capacity degradation as the open space land is used for illegal dumping and informal settlements which are on the increase and development plans that are being considered by land-use regulators (Health Department Province of KwaZulu-Natal, 2015 and Sithebe *et al*., 2016). Capacities of affected communities should be enhanced to enable them to comprehend and participate meaningfully in development and planning processes affecting them (Umlazi and Malukazi LAP and TRS, 2011, OECD, 2015).

The disadvantages of HBM theory research in environmental management is that it rarely focuses on physical, community and organizational environment but rather on social environment behavioural intervention (Glanz, Rimer & Viswanath,2008). Unlike

SES and Adaptive management frameworks which focus on physical, community and organizational environment. Harring *et al*. (2017) also acknowledge that there is limited data regarding attitudes towards a range of different pro-environmental policy measures. Jagers, Matti and Nordblom (2016) attests that the negative attitude of the public limits the policy-making process. The actual trends of urbanization, population growth and regional developments are almost unavoidable. Prevention of environmental deterioration and hazards, through setting Carrying Capacity (CC) limitation is necessary. This limitation exceeded the CC resource limit of sustainable utilization in the USA, Indonesia, and particularly China studied. However, the resource limit should be able to recycle the wastes as it is beneficial in preventing both water resource and land exploitation (Djuwansyah, 2018). SA as a country has not yet set CC limits. However, to reduce overexploitation that cause negative impact of land and water resources will be extremely hard if the CC Limits are not used, since the land and water deterioration increase as population increase in areas USA, Indonesia, and particularly China (Djuwansyah, 2018). Measuring environmental impact factors influences environmental behaviour (Steg *et al*., 2013), as mentioned before, poor adherence with environmental law even after awareness of water scarcity can be as a result of poor understanding of environmental consequences also called environmental stressors (Steg *et al*., 2013).

2.9.4 Acquiring Relevant Knowledge to Alleviate Water Scarcity

According to Liu and Guo (2018) acquiring environmental knowledge and intangible environmental value in the environmental education to develop the maximal learning effect can in return accommodate challenges of health issues like obesity and depression due to lack of space in urban areas. By changing perception towards pro-environmentally friendly, even observing rivers as a place to relax and unwind one's mind and not a dumpsite can have benefits. This can be achieved by enhancing environmental values to individuals. Rivers in SA have been mapped at the national level as a river network, excluding land cover data or land cover classes causing a knowledge gap in a local river and stream water quality data (Nel and Driver, 2015). Above this, Cele (2015) as noted by Graham (2012) mentions that water quality testing

is costly and uses procedures to generate data and this on it own may act as a barrier for constant river monitoring in SA.

Harring *et al*. (2017) still emphasise the importance of professional skills requirement in the technical policy making aspect and political will, in addressing ecological improvement benefit that is still poorly understood. For example, the lack of understanding on the impact of urbanization on individual's mental and behavioural health especially in urban areas like uMlazi where population growth continuously escalates. Instead, lack of professional skills reduces changes of impactful communication and awareness even support from public authority to reduce their uncertainty and produce behavioural change as well (Greif, 2006; Mansbridge, 2014). Yet, in order to overcome such national large-scale challenge of surface water policy implementation requires accurate data generated from skilled personals and intervention and cooperation of these authorities also as emphasised in all HBM, Adaptive management and SES framework approach .Using such integrated approach allows decision-makers to better understand the costs of not adopting proper investment strategies that favour environmental improvements that were previously poorly understood (Jagers & Matti, 2010).

External motivation change behaviour of individuals, according to Yıldırım and Semiz (2019) teachers also play a key role in fostering students' beliefs, attitudes, values and behaviors about sustainable water consumption. As teacher's personal norms was determined as the strongest predictor of behavioural change for them and their students influence. Yıldırım and Semiz (2019) believes that personal norms influence the relationship between acknowledgement of responsibility; sustainable water consumption behaviour; biospheric altruistic values and ascription of responsibility. Acknowledgment of responsibility influences the relationship between awareness of consequences and personal norms (Steg *et al*., 2014; Yıldırım & Semiz, 2019). How people perceive such risks is a crucial question as risk perceptions can prompt or oppose actions to address particular risks (Böhm, 2003 & Tanner *et al*., 2014) as different stakeholders perceieve risks differently. Newson (1997) affirmed that the perspectives of different experts and groups of people disciplinary and experiential knowledge determine the how they perceive the river environment, with their understandings. But also, the implications for education programs and environmental program designers should be adopted establishment biospheric-altruistic values,

environmental beliefs and personal norm of all teachers and students' sustainable water consumption behaviours.

As mentioned earlier that measuring impact is not the same as measuring behaviour and the two different types of measures may therefore not necessarily overlap in factors influencing environmental behaviour (Steg *et al*., 2013). The costs of drought and floods affect the socio-economic and environmental perspective if local rivers and streams are not well maintained and managed by both professionals and local citizens. The impacts range from lower agricultural productivity and disturbances of ecosystem functioning to increased food prices, while insecurity and famine can trigger mass migration. From a policy impact point of view, such consequences must be minimized through consistent relevant models update at a local level (Kelley, Mohtadi, Cane, Seager and Kushnir, 2015). This can be achieved through citizens' science input can speed up and contribute to the methodology of environmental stressors measurement.

2.9.4.1 Citizen Science Lack of Data in River Eco-Status Monitoring Programme (MiniSASS) usage (Barrier)

In developing countries, the lack of data on all aspects of water quality and wastewater management is one of the difficulties in tracking SDG Target 6.3 indicators. Reliable data should also include social, in both the public and private sectors, there are economic and environmental advantages these characteristics can support and encourage political commitments and investments, as well as stronger decision-making at all levels of society (UN-Water, 2015). Although targets and goals are monitored and reviewed are set as global indicators, it is however dependent each country to identify its national goals in terms of wastewater treatment and water quality (United Nations General Assembly (UNGA), 2015).

Armitage, Marschke and Plummer (2008) believe adaptive co-management is best tool for addressing a well-defined, small-scale resource system that has clear property rights, social entities, and when leaders prepared to support the effort on local stakeholder collaboration. Hence using an adaptive co-management framework on a large scale will not work properly. SA uses this framework on a large scale, for

example, the IRMW approach in river management is at the National scale of 1:500 000 which does not consider local rivers. Hence this approach is not effective in uMlazi rivers. Local stakeholders are not involved, if they are as is the case of Sihlanzimvelo, their knowledge is limited (Xaba, 2019).

It is essential for iterative decision-making process through the lenses of an adaptive management framework as part of management interventions treatments to be implemented process as part of research. The iterative decision-making approach is usually used due to a lack of information on river management (Virapongse *et al*., 2016). According to Pahl-Wostl et al. (2007); William et al. (2011); Virapongse *et al*. (2016), structural decision making that involves iterative decision making in the face of uncertainty is recommended. This process is well suited for uncertainties like environmental variations that have been established as always uncertain and largely uncontrollable and unrecognized through the application of Adaptive manangement. Iterative decision making will help in river management lacks understanding and current data (Pahl-Wostl *et al*., 2007; William *et al*., 2011; Virapongse *et al*., 2016).

As stated earlier, SES major entities are identified through constructive communication between experts and stakeholders who understand the SES at different scales and perspectives (Walker, Carpenter, Andries, Abel, Cumming, Janssen & Pritchard, 2002); and through the need to consider human adaptability emphases constantly (Gunderson and Holling 2002, Walker, Price and Stephens, 2006) and the level at which they interact. This is, however, lacking between experts and stakeholders and human adaptability is less communicated in South Africa and creates (Waddington, Snilstveit, White and Fewtrell ,2009).

Otherwise, the use of RHP is much based on mini-South African Scoring System (miniSASS), even SES or SEM without equipping the community as part of RPH creates as the gap between theory and application (Tallis, Kareiva, Marvier & Chang, 2008), RHP although part of poverty alleviation but lacks decision support systems on the use of ecosystem services (guidelines) in SA. Cele (2015) believes as part of community participation, miniSASS is easy to use by every school, environmental centre and non-governmental organization in SA as an indicator for identifying aquatic pollution sources. However, seventy-nine percent of the respondents showed concern

with the safety of the river as an issue. River safety included the presence of dangerous animals, polluted water, a lack of swimming ability. Therefore, protective clothes and adult supervision will be required during the collection of data in the river or streams. Also, the identification of macroinvertebrates poses perhaps the biggest problem to the miniSASS user, particularly in differentiating between mayflies, damselflies, and stoneflies. This may result in unreliable results if the general public is adding the data themselves (Cele, 2015).

Although the use of SES or SEM conceptual frameworks proved more applicable when used to classify potential natural resource-based enterprises, lack of current water quality data from local authorities and knowledge on environmental management from the communities serve as a huge limitation on the application of these frameworks. As per Deverka, Lavallee, Desai, Esmail, Ramsey, Veenstra and Tunis (2012) definition of stakeholders' engagement or involvement is an iterative process of actively soliciting the knowledge, experience, judgment, and values of individuals selected to represent a broad range of direct interests in a particular issue, for the dual purposes of i) creating a shared understanding; and ii) making relevant, transparent and effective decisions"(Deverka et al., 2012:185). The above-mentioned models cannot be ideal as a tool until stakeholders hold sufficient information and knowledge that equips them to preserve rivers and in-stream as a natural resource.

Hampson *et al*. (2017) perceive river management as a consistent challenge that requires more research that will demonstrate different remedial measures, aimed at either ecological or microbial water quality improvements. This iterative approach may trigger entirely diverse benefits and diverse levels of market and non-market values by policymakers (Hampson *et al*.,2017).

Since these trade-offs were previously poorly understood, this knowledge helps decision-makers to better grasp the risks of implementing alternative investment policies that favor either ecological or recreational changes, or a combination of benefits (Jagers and Matti, 2010). Streams are among the most vulnerable water bodies to contamination, according to Köse, Tokatli, and Içek (2014), since surface water quality is a matter of serious global concern today.

However, there are some stakeholders' discrepancy, such as, government agency, land managers, for example, the ecosystem and its importance are often viewed in

terms of resources by the US Forest Service. Different to, local land users, such as tribal communities, place a high emphasis on the land's cultural and spiritual elements, which are seldom measured in agency-driven management plans. As a result of this disparity in viewpoints and cultural constructions, collaborative structures are harmed (Donnenfeld *et al*., 2018).

According to Dicken (2002), a natural classification of a river helps meet conservation, tourism requirements even though it could be used for agriculture improving the socio-economic. A good class river can be used for drinking water, or agriculture, or tourism, or some combination of these sources (Dicken,2002). However, to effectively identify SES factors and benefits, constructive communication between experts and stakeholders at different scales and perspectives is required (Walker *et al*., 2002) and also emphasizes the need to consider human adaptability (Gunderson and Holling, 2002, Walker *et al*., 2006).

However, the increase in social grant spending program to R528.4 billion is an indication of extreme poverty, another challenge SA is currently facing although using SDGs as a guideline (SA, Department of National Treasury, 2019). Yet, SDGs aims to bring about sustainability in the development goals by addressing extreme poverty and focuses on socio-economic inclusion and ecological sustainability despite the Phakisa initiative establishment in 2012. Good maintenance of surface water quality can reduce malnutrition vulnerability faced mostly by developing countries. Such intervention requires all stakeholders' involvement and a good understanding of environmental sustainability (Republic of South Africa Operations Phakisa,2014). Reduction of poverty and malnutrition will however require attitudinal change of an individual more than that of a group. Colding and Barthel (2019) believes that an integration approach involving all stakeholders is required. This review argues that all adaptive Management, HBM and SES frameworks were discussed as part of the integration approach in managing and restoration of stream water quality in Umlazi and reduce health risks and poverty.

2.9.5 Policy Implementation using Integration Approach on Urban Surface Water Quality

Adjusting environmental policies to meet sustainability goals requires an integrated approach, otherwise can cause conflicts between policy makers and community if these environmental concerns are not measured accurately and communicated to all affected stakeholders to get their perceptions and commitment, even if the environmental concerns are already measured.

Acknowledging that environmental concern has changed over time to becoming more integrated into a broad ecological world view. This can be achieved by the use of an integrated ecological approach world view in surface water quality management is emphasised by different researcher (Bennett *et al*., 2017). As many researchers believe that not relying only on professional's views in the vulnerability state of rivers and streams water quality management but rather studying all involved stakeholders' knowledge, attitudes and behaviour practices will improve water quality policy and management of the scarce and polluted surface water globally. Harring *et al*. (2017) acknowledges that limited data regarding attitudes limit the policy-making process especially if the public attitude is negative towards pro-environmental policy measures (Jagers, 2016). As indicated earlier that the community does not have any knowledge of the importance and significance of biodiversity and environmentally sensitive areas in Umlazi (Xaba ,2019). The participants were not able to make the connection between these areas and sustainable development for example, while wetlands are used to purify surface water quality, however, these wetlands were used as dumpsite for diapers. They also could not relate to global warming concerns about such areas. Instead, it was noted uMlazi participants use open spaces to build houses as well as using forest for building houses as well as for medicinal purposes without regulation (Xaba, 2019:77). Mondal (2019) attest that developing countries like Bangladesh are vulnerable environmentally and socio-economically unstable due to urbanization, population growth, climate change, and poverty.

However, Chaudhary, Warner, Lamm, Israel, Rumble and Cantrell (2017) maintains that to increase the adoption of water conservation behaviours, extension professionals should reinforce the behaviours they want people to continue by specifically targeting and providing support for people who engaged in landscape water conservation in the past. The study of the environmental impact policy on surface water quality helps both humans in terms of health and safety risks reduction and environment such as plants and animals. This study serves as a restoration plan

for all, plants, animals, humans, air, water, soil through behavioural change towards a proenvironmental behaviour (Steg *et al*., 2013), however, river monitoring programme still lacks data. Hence, Bennett *et al*. (2017) believed that conservation as a practice is necessarily in multi and interdisciplinary studies; that is, an understanding of both natural resources and social systems such as knowledge gap and, collaboration between natural and social scientists is required. As policies and adaptive management are necessary in this behavioural change (Berkes and Turner 2006; Pahl-Wostl *et al*., 2007), both environmental behaviour and environmental impact are factors that influence environmental behaviour (Steg *et al*., 2013).

Although Virapongse *et al*. (2016) affirm that the use of the transdisciplinary approach in river management emphasizes adaptability, flexibility from management and it is difficult to apply though. Nonetheless, Virapongse et al. (2016) believed that use of co-development knowledge where managers must develop facilitators, community builders' skills by connecting to the local community and their knowledge is necessary. As public awareness and knowledge campaigns in Singapore, of the Environmental Public Health Act, 1968 aided in improving the quality of the urban environment and catalyzed its revolutionizing into what ‘a garden city' (MoE, 1973; Tortajada & Joshi (2014). Umlazi current conditions of open vacant space that is environmentally sensitive being as unappealing as it is used as citizens use it as a dumping ground; causing the Umlazi to continue to become an increasingly unsafe place for humans as there is no more available land to build in this township can be minimized even prevented if possible, in return (Umlazi & Malukazi LAP & TRS, 2011:43; Sithebe, 2017). Cele (2015) concerns that South Africa are faced with the rapid climatic change and has poor preparedness on dealing with its impacts at the community level (Hughes et al., 2014). Instead, a better management of catchment classification and policy implementation can be determined in this area (Snyman & Herselman, 2006; RSA, 1998; DWAF, 1996; DWAF, 2004; DWS, 2018a).

Not all responsibility can be placed on professionals regarding stream or river water quality management. Citizens meaning the local communities play a vital role in the management of such as well. As previously explained not abiding by environmental law even after awareness water scarcity may be due to a gap between the intention

and the actual action of an individual (Bagozzi and Yi ,1993). According to Steg et al (2013) human activities cause deteriorating the natural resources. It is therefore of paramount importance to determine what is stakeholders' perception on stream water quality is, since perception of individuals determines whether they abide to the environmental policies or not (Mohiuddin, Al Mamun, Syed, Masud & Su. 2018).

2.10 INDIVIDUALS BEHAVIOUR CAUSE POOR WATER QUALITY NOT INFRASTRUCTURE

Individuals intentions, attitude, knowledge and behaviour do cause and contribute to environmental consequences or threats or stressors. Community's and professionals can either choose to abide or not abide to the law. This kind of behaviour will agree with Bagozzi and Yi (1993) who state that there may be a gap caused between the intention and the actual action of person in abiding by those regulations and policies, moreover, such can be determined by stakeholders' perception of its importance (Mohiuddin *et al*. 2018). Environmental psychologists' researchers believe that attitudes are the main reasons for negative behaviour towards these practices. These researchers believe that even if knowledge is there if the individuals are not willing to change their attitude, their behaviour will remain unchanged.

According to De Young (1984), knowledge and recycling attitudes indicated positive, moderate, statistically significant relationships with recycling behaviour to reduce environmental pollution. According to Alam, Islam, Muyen, Mamun and Islam (2007) the water quality of the Surma River is deteriorating day by day due to human activities and industries that have negatively impacted ground water resources near the industrial area, the river's BOD and fecal coliform concentration was found higher in the dry season. Clasen, Boisson, Routray, Torondel, Bell, Cumming, Ensink, Freeman, Jenkins, Odagiri, Ray, Sinha, Suar and Schmidt (2014) argue that sanitation programme using latrine in rural Odisha did not reduce exposure to faecal contamination or prevented diarrhoea, soil-transmitted helminth infection, or child malnutrition. According to Patil, Arnold, Salvatore, Briceno, Ganguly, Colford Jr and Gertler (2014), 41 percent reported that adult men or women still practiced daily open defecation amongst the 630 households in the intervention villages that had improved

sanitation. The main reasons for daily open defecation in spite of having IHL were culture, habit, or preference for defecating in open followed by inadequate water availability. However, the intervention did not improve child health measured in terms of multiple health outcomes such as diarrhoea, HCGI, helminth infections, anaemia, growth.

Jordan, Gray, Howe, Brooks and Ehrenfeld (2011) believes that there was little change in behaviour regarding invasive plants due to lack of understanding as scientific goals, educational goals, and the motivation of participants were not clearly defined during program design and even after participation. While Niitsu, Takaoka, Uemura, Kono, Saito, Kawakami and Shimizu (2014) findings revealed that house damage due to earthquakes and anxiety about radioactive contamination were significantly associated with psychological distress of 48.0 percent. Middle-to-low educational status and unemployed females were additional risk factors for psychological distress. Guglielmucci, Franzoi, Zuffranieri and Granieri (2015) states that disasters like nuclear accidents, oil spill, asbestos manufacturing causes anxiety, somatizations, rage, depression. Also such disasters and post-traumatic conditions may cause death, injury, illness or other health outcomes, as well as social and economic disruption or environmental degradation for the individuals, the community and the entire society including their children (Guglielmucci et al.,2015).Lopes, Davies-Colley, von Sperling and Magalhães (2016) from the evaluation using the Delphi panel of potential water quality variables affecting bathing-water quality, it was possible to discern which health hazard variables that were the most applicable to Brazil rivers, waterfall plunge pools, dams and lakes, as well as sea coasts through the use of WQI in the policy.

The establishment of such policies important especially for the low income countries to reduce diseases. According to CSRI (2010), South Africa is one of only 12 countries in which mortality rates for children have increased since the baseline for the Millennium Development Goals (MDGs) was set in 1990 with almost 2 000 children die annually before they reach one month, and an additional 51 300 die between 29 days and five years with diarrhoea, malnutrition. Major sources of deteriorating microbiological water quality in South Africa includes human settlements, inadequate sanitation and waste removal practices, storm water wash-off and sewage spills.

Moreover, SA citizens has poor intentions towards behavioural change, as 64% indicated that they feel that they do not have to change their habits even though the water consumption is sufficiently low in the country (van der Vyver ,2014). People seem unaware of the impact they can have simply by changing their own water consumption; therefore, a fair level of water management awareness is required for this country. While the DHPKZN (2015) maintained that uMlazi remains the second populated township in the country with high reports of death levels due to diarrhoea outbreak during the rainy season of October to February and the rotavirus season April to August. Umlazi's high diarrhoea outbreak is as a result of contamination of water and poor infrastructure and remains a reason for worry in the KwaZulu Natal district. Yet, Rodda *et al*. (2016) confirmed that still in South Africa, information on the contaminant burden for potential water re-use sources is presently limited.

It is from this that Morowatisharifabad, Momayyezi, and Ghaneian (2012) believe that Health Belief Model constructs, is more powerful than is Reasoned Action Theory (RTA) in predicting water saving behavior and may be used as a framework for educational interventions aimed at improving water saving behaviors. Otherwise, conditions of stream management expressed by McDowell, Cox and Snelder (2017) can be observed to be costly if individuals' attitude, behaviour are not changed towards a restorative practice. In taking the alternative, government policy implementation and private sectors initiative are designed only to restore surface water using treatments and policies can be an economic burden and does not directly change individuals' attitude and behaviour of stakeholders of that area. For example, when fencing the streams to avoid animals, such as sheep from polluting the streams was used as an alternative, it indicated as a high-priced cost alternative (McDowell, Cox and Snelder,2017) .Keiser and Shapiro (2018) agrees that the improvement of water pollution of rivers and streams accounted for $650 billion in expenditure using the Clean Water Act's grants to municipal wastewater treatment plants; whereby to make one river-mile fishable for a year, it cost around $1.5 million (2014 dollars) from these grants to avoid health susceptibility and severity caused by poor water quality.

2.10.1 Poor Water Quality of Streams and Rivers Harbours Diseases Susceptibility and Risks

Patil *et al*. (2014) observed 89 percent of the households in the intervention group that had access to improved water source of tap or piped water, tube well and protected dug wells. Yet 41 percent of participants from this study reported that adult men or women still practiced daily open defecation amongst the 630 households despite the intervention in the villages that had JMP defined improved sanitation facilities at follow-up

Freeman, Majorin, Boisson, Routray, Torondel and Clasen, (2016) in recent studies of the impact of expanding on-site sanitation coverage in rural (Clasen *et al*., 2014; Patil *et al*., 2014) as well as urban settings (Freeman *et al*., 2016) have found no relationship between sanitation and child diarrhoea. Patil *et al*. (2014) use of the well-controlled efficacy trials study using high levels of sanitation and hygiene infrastructure and behaviours necessary to deliver the health benefits, but the same levels of infrastructure or behaviour change are not guaranteed to accrue to large-scale programs. Steg *et al*. (2014) believes that policy implementation by the government can act as the normative since officials perceive that protecting the environment is the right thing to do through policy implementation.

Poor water resource management in urban areas puts citizens at high health risks that even lead to death. Swanepoel *et al*. (2015) state that excretion of HIV-ARVs vary depending on the compound, but some such as Tipranivir, are excreted at 80 percent, and Nevaripine at 2.7 percent via urine. Assuming a mean 30 percent excretion to sewage via urine and faeces, and also based on assumptions an estimated 159 000 kg of HIV-ARV could reach the aquatic systems of SA every year, however this is founded on assumptions. Affecting fish and other aquatic biota to this accumulative HIV-ARVs drug contamination directly from water via their gills, through food, or both, however, for now, the effects are not known (Swanepoel *et al*., 2015). Siegrist, Ternes and Joss (2004) believe that these chemicals of the pharmaceutical products could negatively impact the reproductive rates of fish speies, making fish particularly vulnerable.

Protection of surface water in urban areas is essential for the survival of humankind, reducing mental health disorders, obesity and other risks of diseases. As Sapci and Considine (2014) maintain that each person's intrinsic environmental value would affect the attitudes and intrinsic motivation to the environment and form the environmental paradigm.

Studies of Global Climate Risk are essential for countries like SA that have started to be vulnerable to disasters and drought due to climate change especially in the urban area. Citizens' knowledge of climate change vulnerability is essential in preventing more disasters from occurring. USAID (2018) confirmed that raising awareness within communities, local government, focusing on natural resources like rivers is essential in reducing vulnerability in climate change and disaster. The country's scarce water supplies have been placed under greater strain as a result of the country's economic expansion and rapid population growth in SA (DWA, 2010). Emphases on environmental value where the responsibility and role of humans in the environment should be encouraged and emphasised as important to be practiced by every individual (Wolters, 2014). The value depends on how one perceives something which may cause rehabilitation. Although there are more environment-friendly products nowadays and more consumers present positive attitudes towards environmental issues and green consumption, the actual consumption is full of contradiction and inconsistency. Ho (2013) still maintains that environmental value is composed of the cognitive component in terms of knowledge, understanding, and judgment of the environment. The environmental value is also determined by the attitude component, where the individual either has a like or dislike emotion towards the environment. Hence, citizens' perceptions about knowledge, attitude, behaviour was undertaken to rehabilitate the environmental value towards the streams restoration that is part of the current. heavy polluted surface water

Disease vulnerability and severity that stems from surface water include cholera and diarrhoea (Eckstein, Hutfils and Winges, 2018). In Bangladesh, women are considered more vulnerable than a man due to freshwater fetching including cholera and diarrhoea (USAID,2018). Puerto Rico-North America is a high-income country that has also suffered 2978 deaths due to a hurricane (Eckstein *et al*., 2018).

As mentioned earlier that despite water scarcity awareness campaigns; flood risk awareness campaigns; improved infrastructure development in terms of water piped houses in urban areas yet simultaneously water-related microorganisms were found in vegetables due to polluted surface water; individuals and households are affected by floods and as such high diarrhoea levels continue to increase in children of these areas. There is a lack of behavioural change in terms of illegal dumping in Umlazi and open vacant space in these environmental sensitive areas are unattractive as it used as dumping area in this township (Umlazi and Malukazi LAP and TRS,2011). There is a relationship between polluted water and the risk of ill-health on it users (Hampson *et al*., 2017; WHO, 2003).

Both environmental behaviour and environmental impact are factors that influence environmental behaviour (Steg *et al*., 2013) where both adaptive management and policies are necessary in this behavioural change (Berkes and Turner 2006; Pahl-Wostl *et al*. 2007). According to Virapongse *et al*. (2016), SA is using adaptive co-management framework, as part of IRMW approach in river management, however this is at a large scale for example, is at National scale of 1:500 000 that does not consider local rivers will not work properly, since this scale is large. Hence this approach is not effective in uMlazi rivers instead has levels of vulnerabilities and responses to human health and safety impacts, which in turn impacts ecosystem service delivery. This may affect local stakeholders' involvement especially if their knowledge is limited by such an IRMW approach. The lack of appropriate scale usage in South Africa's surface water can hinder prevention interventions of water pollution, especially on the inland's stream. This is one of the major challenges for townships management (CSIR, 2010 and DWAF, 2014). Hence, other environmental psychologists have identified lack of knowledge and education to be some of the factors that influence individuals to behave poorly towards surface water quality management and restoration practices. Otherwise, education and knowledge can change an individual’s behaviour.

2.11 WATER MONITORING TOOLS: IMPACT OF ENVIRONMENTAL EDUCATION ON CITIZEN SCIENCE APPROACH AS A TOOL

Lack of community skills serves as a barrier to meeting SDG 6 (Wall, Derham & O'Mahon, 2016). Tortajada and Joshi (2014) agree to participation of the public in conservation of water resources. Since SES framework, river management depend on on non-scientist, local users and helps share both top-down and bottom-up knowledge through community- based monitoring (Peters, Eames & Hamilton, 2015). The research also highlights the importance of environmental education on citizens through skills transfer in water quality monitoring and methodology used to collect water quality data. Such environmental education can in return be a useful tool in river restoration, otherwise, if the community does not understand the methodology used to collect water quality data of their local rivers or streams, their interpretation of the importance of water scarcity will be limited.

Since SA is part of IWRM that uses public participartion as it building blocks to determine RQOs (DWAF, 2004), stakeholders' involvement should be high, yet, according to William (2011) monitoring of rivers is not functional at a local level as there is a shortage of data at this level. The more there is a lack of surface water quality data, the more citizens are left in the dark with water quality status and management. Pahl-Wostl *et al*. (2007) agree that SA has four types of river uncertainties that include: socio-economic research in river knowledge; uncertainty about climate change effect on nature and extreme events likelihood; stakeholders' perception and action uncertainty in the adaptive river management framework. SA seems to lack in environmental education campaigns, environmental education, according to Ho (2013), is "integrated" education, rather than being practiced for specific age groups or groups of people; it emphasized universality, lifelong learning, and dignity, as well as integration of politics, economics, community, culture, and aesthetics, and was a type of value and lifestyle (Pienaar *et al*., 2015).

Although both adaptive river management and SES framework approach globally acknowledge community-based monitoring, citizen sciences programs and collaborative efforts as tools to monitor environmental systems (Virapongse *et al*., 2016). In South Africa, other challenges stated in water monitoring systems include robbery, vandalism, post-installation harm due to floods, and policy barriers that obstruct the execution of the system (Cele, 2015).

Cele (2015) emphasizes that without accurate data on the quality and quantity of water, the water assets authorities cannot appraise the supply required for diverse uses. Rabba *et al*. (2018) agree that the catchment measurement for floods and water resource is poorly or not at all conducted. Lack of knowledge-correct information of river or stream inflow can help in predicting disease spread in case of outbursts or flood disasters that is if the river or stream is too polluted, citizens can be advised to relocate from that risk area. Instead, citizens are more susceptible to health risks resulting from citizens' lack knowledge of stream management. Djuwansyah (2018) also confirms that many countries like Indonesia use model measures to forecast the future sustainability of regional development based on water availability as many densely populated places in this country suffer water scarcity during a dry season. Often, group of citizens that participate in data collection don't get a chance to meet with the decision-makers (Conrad & Hilchey, 2011). Therefore, policy impact on the RQO system used in South Africa should play a role in reducing citizens' lack of knowledge, attitude and behavioural change on improving water quality.

Rabba *et al*. (2018) confirm that the catchments in developing countries are poorly measured and this delays water resource management and flood prediction in these countries. To generate reliable stream flows, models require reliable streamflow data (yet, spatial data of SA is large scale). Hence, Vicente-Molina, Fernández-Sáinz and Izagirre-Olaizola, (2013) indicated that environmental education also can reduce the vulnerability of both environment and humans through people being taught to make decisions when facing environmental quality-related issues and to develop self-behavioural environmental value.

Lack of positive river behavioural change is caused by the local community knowledge base, local stakeholders will not be involved in river restoration if their knowledge about the subject is limited unless there are benefits (Das and Ramalingam, 2019). Government institutions of SA in the past have failed to sustain public interest in science as most society projects lacked prioritisation and implementation. Dickinson, Shirk, Bonter, Bonney, Crain, Martin, Phillips and Purell, (2012) suggest that retaining of experienced participants is another aspect that contributes to structured leadership in surface water quality data collection that is also limited. Yet to measure and track changes in ecosystem assets and ecosystem services over time is essential in ecosystem accounts. This intends to inform policies, planning and decision-making

process the use of ecosystem services and measurements of ecosystem (Nel and Driver, 2015).

Community-based monitoring relies on non-scientist, local users and helps incorporate and share both top-down and bottom-up knowledge in SES (Peters *et al*., 2015). Hence using an adaptive co-management framework in a large scale will not work properly (Virapongse *et al*., 2016). Another SES approach is education and training, this approach changes the culture and institutional norms of environmental stewardship (Village Earth, 2016). Therefore, community skills are needed to keep projects maintained and these skills are rarely taught to graduates. (Blickley, Diener, Lacher, Meek, Porensky, Wilkerson, Winford and Schwartz, 2012). DWS (2017) agrees that there is a need for citizens or other stakeholders' engagement where, the assessment of modification of each indicator should be based on a quantitative measurement, and not depend on expert judgment.

Vicente-Molina *et al*. (2013) indicate that environmental education can also reduce the vulnerability of both environment and humans through people being taught to make decisions when facing environmental quality-related issues and to develop self-behavioural environmental value. Rodda *et al*. (2016) agrees that SA requires urgent interventions to protect water security within these developing countries. Perceived challenges towards this include lack of both skills and political will in government, citizens' trust in government, lack of understanding of Green and Blue Drop programme impact and knowledge on the process of water supply. Lack of awareness about water security protection of both quantity and quality is required in all stakeholders.

Pienaar *et al*. (2017) define system dynamics as a method used to, model, simulate, and analyse 'real-world' issues dynamically (Pruyt, 2013). It takes incorporate nonlinearity, feedback, and time delays, which are what characterize complex systems; and it has been used to investigate water resources problems (Mirchi, Madani, Watkins & Ahmad, 2012). According to Sterman (2001) generally the process can be categorized into five phases: problem identification, conceptualization, model building, model testing, and. Even though these phases incorporate policy analysis and are very useful as it uses iterative and involve qualitative and quantitative

modelling, however, this approach is difficult to communicate with civil citizens for example because they are not familiar with rivers ecological conditions and spatial analysis Nel and Driver (2015).

Bagozzi and Yi (1993) mentioned earlier that intention requires to be well-formulated to be constant with behaviour. The type of surface water quality data collection methodology and its interpretation used has a negative impact on stakeholders' knowledge, attitudes and behaviour practices (Rodda *et al*., 2016; Xaba *et al*., 2016; Vicente-Molina et al., 2013; DHPKZN, 2015 and Sithebe, 2017). The trend of water quality results in return informs other policy regulations of that area. The person in abiding by those regulations and policies depends on and is determined by stakeholders' perception of its importance (Mohiuddin et al., 2018).

Hence, Pienaar *et al*. (2017) believes that population growth, GDP growth, and climate change drive demand increases water demand in a form of green and blue drop programs not on industries only but on every stakeholder. Such scenario requires more emphasis on the necessity of models that is inclusive of all users of water resources, focuses on leakage repair and educating the users.

Although much of it is still scattered across the country, and database information is often incomplete or referenced with incorrect geographic coordinates. Furthermore, the sampling sites focus more on main rivers monitoring instead of streams monitoring increasing bias data (Nel and Driver, 2015:58).

According to Hill and Carroll (2009) strengthening the skills and capabilities of individuals, but also actions directed toward changing social, environmental, and economic conditions to alleviate their impact on public and individual health is critical. The community skills breakdown of employed uMlazi residents extracted from the Standardised Regional dataset for SA in 2004, showed that only 13.09 percent of employed uMlazi residents were highly skilled, 40.47 percent were skilled, and 46.45 percent were not skilled or semi-skilled (Standard regional data SA: 2004, Umlazi and Malukazi LAP and TRS, 2011). This could be the reason why an assessment of the impact of meaningful engagements with communities is not implemented. Pride and Joy Consultants (2015) also confirms that there is poor performance from eThekwini unicipality regarding citizens being given full accurate information about the public

services they are entitled to receive as mentioned earlier (Pride and Joy Consultants, 2015).

According to White *et al.* (2013), the disease prevention strategies at the community level are designed to promote attitudes, beliefs, and behaviours that ultimately prevent such risks. However, specific approaches may also include education and life skills training (White *et al*., 2015). These factors of an individual's age, education, income, substance use, or history of risk influence the likelihood of disease risk at an individual level biological and personal history. White and Nanan (2008) also maintain that health is mostly practiced in households and at the community level where actions that promote health is best understood as to how people live, in what control they may have over their health conditions, and how this is facilitated. This practice has been established from Africa to America and at this level of diseases risks may either be reduced or increased, so this level is an important second level of disease prevention (White and Nanan, 2008).

A community is a human society with characteristics that give people a sense of belonging, such as shared racial, religious, or cultural characteristics, or economic cooperation that necessitates interdependence. Risks can be reduced through belief systems and shared insights or wisdom of experience and skills since clinical practitioners only become aware when an individual's symptoms or signs at a later stage when compared to interrelated family members or friends of that individual. Or when an individual visits some specialists at a later stage when the disease has evolved to be more severe, or when symptoms, signs and test results are more advanced (White *et al*., 2013).

Hence for sustainable communities to be developed and established, the ecological foundations of human settlements that embrace the economic, social, political, and cultural means must evolve in ways that are socially and environmentally sustainable. According to Hancock, Spady and Soskolne (2015), sustainable communities are characterized by being able to adjust to changing social and economic circumstances, thereby to survive and thrive while preserving the environment that supports it even as external geopolitical and economic forces influence prospects. Part of fair and good governance requires that Involved parties have a right to see details about land use and development plans that land-use regulators are considering. Affected

communities' capacities should be improved so that they can understand and engage meaningfully in development and planning processes that concern them (Umlazi and Malukazi LAP and TRS, 2011, OECD, 2015).

South Africa uses the United Nation's post-2015 development agenda that recognised 17 Sustainability Development Goals (SDGs). The right to water and sanitation for all is identified in goal six (6) and the 2030 targets for this goal are written below: Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally (DWA, 2017). DWA has committed to protect and restore water-related ecosystems and this include rivers, forests and wetlands to mention a few by 2020 (DWA, 2017). The importance of stream water quality for the sustainability of the urban areas especially in the developing countries below SDGs is addressed. All SDG 1,2.3,6,11 address poverty and well-being of individuals; SDG 12 and 14 address the environment (UN, 2015).

South African agricultural products meet internationally recognized standards for human safety, (SA Budget Speech, 2018). Ending hunger or even increasing food sufficiency as part of SDG Target 2.1, and doubling smallholders' productivity and incomes (SDG Target 2.3) are crucial to reduce poverty (SDG 1). Nevertheless, the attainment of SDG 2 also suggests a growth in agricultural productivity, that can result to water demand increase and the use of pesticides and fertilizers, eventually affecting water quality and quantity if resources are not properly accomplished as is the case with rivers and streams water of South Africa (WWAP, 2017).

Otherwise, conditions of stream management expressed by McDowell et al. (2017) can be observed to be costly if individuals' attitude, behaviour are not changed towards a restorative practice. In taking the alternative, government policy implementation and private sectors initiative only to restore surface water using treatments and policies can be an economic burden.

2.11.1 Water Related Challenges, Tourism and the Economy

Environmental analysis of the habitable areas next to the rivers are prone to flooding although people reside there. It is, therefore, necessary to implement mitigating measures to prevent flooding of residential areas (Umlazi and Malukazi LAP and TRS, 2011). Niitsu et al. (2014) affirmed that in Japan, the area near nuclear power plant, the explosions and leaked radioactive material when the earthquake and the tsunami occur in Fukushima Daiichi, leaving the people in the area susceptible to health and safety risks.

According to Novacek (2008), the shortfall in knowledge leads to uncertainty or ill-advised conclusions and actions is clearly obvious in biodiversity conservation. When communicating with the public, although people know the meaning of biodiversity, they are still unacquainted with the meaning and significance of biodiversity loss. More value on the more familiar and charismatic in nature is still emphasised than identifying the integral roles and prominence of all species, even insects, fungi, and microbes, in various ecosystems (Wilson, 1992 and Novacek, 2007). A lack of appreciation for the richness and interconnectedness of diverse species is the cause. Hence an integrated educational approach is required.

SA has just begun to notice tourism as economic growth potential and urban communities (Timothy, 2003). Tourism development is one of tools that can be used revitalise the economy, whether for rural or urban areas (Chen & Chen, 2010). However, citizens' perception, attitude for participation and support determines success of the tourism industry (Andriotis, 2005). If citizens consider benefits of tourism to exceed their costs, they will be support that to development as they perceive it as a benefit (White *et al*., 2015).

Therefore, involving citizens in decision-making at all levels encourages involvement and ownership especially marginalized groups such as ethnic minorities and citizens that live in extreme poverty. Decisions such as to what types of sanitation facilities are desirable and acceptable (WWAP, 2017). Also, engaging women in these initiatives is crucial since they experience health consequences due to unsafe management of human waste (WWAP, 2017).

Flexibility is important in fitting the initiative to particular settings, that is, avoid one-size-fits-all assumptions, at the level of monitoring and evaluation. Impacting everyone

to adapt to potential success of socio-cultural norms and beliefs, and environment, (Yamey, 2011). This will also enable the lessons learned to be translated to other locations where similar opportunities may exist and can be achieved through community skills empowerment. As Lynch and Stretesky (2013) state that community engagement is a tool for decreasing environmental degradation instead participation increases health and diversity of the ecosystem of that community and also improves community satisfaction with environmental policy enforced.

Stakeholders' knowledge, attitudes and behaviour practices in water management is impacted by available, methodology and interpretation of surface water quality data collection, impacting especially the survival of urban citizens' health and safety.

2.11.2 Community's Skills as a Barrier to Surface Water Quality Management

In surface water quality, management or restoration uses ecological literature that focuses on the professionals' views, complexity and uncertainties of river management. These sets of socio-economic, demographics variables rarely focus on the impact of community's attitude, knowledge and behaviour influence or role in river management and restoration programmes (Kollmuss & Agyeman, 2002; Owens, 2000; Stern, 2000; McDonald *et al*., 2014). According to Mascia, Brosius, Dobson, Forbes and Demetriades (2008); Schultz (2011) a major barrier to the success of conservation programs worldwide is getting people to change their behaviour and lack of knowledge (Sapci &Considine ,2014). Getting people to change their perspectives also requires their participation in conservation programs and decision making. From Peters *et al*. (2015), it is highlighted that the SES framework and river management rely on non-scientist, local users and helps incorporate and share both top-down and bottom-up knowledge through community- based monitoring (Peters et al., 2015). Hence, lack of community skills serves as a barrier to meeting SDG 6 (Wall *et al*., 2016).

Studies using SES and adaptive management approach highlight river management complexity and uncertainties' even after considering a multidisciplinary approach in urban areas. Part of SES approach according to Virapongse *et al*. (2016) is the use of a systematic world view approach, emphasizing stakeholder involvement where managers take less control over and accept decentralization to guide the decision-making process. Thus, allowing self-organized cultural change and a large degree of trust and confidence through information collected through interviews, workshops and focus groups. However, Mohiuddin *et al*. (2018) believe the lack of significant correlation between subjective norms and purchase intention of green vehicles can influenced by the fact that in developing countries awareness on environmental issues to the level of developed market consumers have not yet been developed. Stakeholders' knowledge, attitudes and behaviour practices in water management is impacted by available, methodology and interpretation of surface water quality data collection that can directly affect the state of the community's food security and ocean's economy. As Nel and Driver, (2015) indicated rivers and streams are highly threatened and polluted.

Other researchers insist that not focusing only on barriers such as river management complexity rather highlighting benefits of changed behaviour or of clean river or stream can act as motivation. As mentioned before, the most powerful factor to describe and predict recycling behavior is motivation. Even Vining and Ebreo (1992) maintained that persons living in communities with fewer recycling opportunities were more likely to say that inconvenience influenced the level of their recycling behaviours. Hence challenges indicated by Sethebe (2017) that poses a major impact on the health and wellbeing of the community as some of the people from the surrounding community use the river water for domestic use, as well as for irrigation purposes for small scale market gardens that produce products that is sold in the local community must be minimised. Using motivation as a tool can encourage the individuals to be willing to change their behaviour (De Young ,1984), even through use of additional social incentives can be the type of motivation that affects consumers more strongly (Vining and Ebreo, 1992).

2.12 USING STREAM MANAGEMENT TO REDUCE MALNUTRITION VULNERABILITY AS A BENEFIT OF CHANGED BEHAVIOUR

From a global perspective, a large number of policy measures towards individual-level behavioural change have been proposed (Chang & Chang, 2017). This statement agrees with that of De Groot and Steg (2008) that state that the attitude of an individual is more likely to be positive on pro-environmental activities compared to a group of people. According to Mohiuddin et al. (2018) the stronger the individual's pro-environmental attitudes, the more likely the individual will engage in various pro-environmental behaviours. Also, Harring *et al*. (2017), Tjernström and Tietenberg (2008) believe that public attitudes seem to govern environmental policy choice.

In low-income countries like SA, the Millennium Ecosystem Assessment (MEA) provides a valuable classification of ecosystem services (MEA, 2003). Ecosystem facilities, according to this assessment, are used for provisioning, governing, cultural, or supporting purposes. Hence South Africa's National Strategy for Sustainable Development (NSSD) uses SDG as a guideline in the implementation of stream water restoration to improve sustainable development (MEA, 2003).

A challenge facing the stream management or ecological sustainability is the health aspect where many streams in SA have been shown to have poor water quality and as such, the water that flows within them is rendered unusable and in many cases disease-causing (Keeler *et al*., 2012). CSIR (2010) confirms that in urban areas where there is overpopulation, the records of biodiversity show serious declines over recent times in these SA areas, as challenges of ground and surface waters pollution; land usage often unproductive; and air quality poor persist. Ecological sustainability and socioeconomic growth are at odds may be due to population levels and consumption patterns which continue to rise the impact on natural resources although SA uses SDGs approach and targets. The SDGs used the MDG framework and was argued to go beyond the earlier MDG program, stated that it addresses extreme poverty and focuses on socio-economic inclusion and ecological sustainability even though the MDGs implementation challenges were not sufficiently addressed (Spaiser, Ranganathan, Swain and Sumpter, 2017).

As mentioned before a well-managed river from urban areas can be a useful resource proving SDGs such as health, the climate, livelihoods, gender equality, water security, and food security are all issues that need to be addressed. just to mention a few (IRP, 2019). As per SDG: "1. Ending poverty in all its forms everywhere; 2. End hunger, achieve food security);3. Ensure healthy lives and promote well-being for all at all ages - Child Mortality (CM): Number of children under five dying per 1000 births (CM); 6. Ensure availability and sustainable management of water;11. Make cities/human settlements inclusive, safe, resilient and; 14. Conserve and sustainably use the oceans, seas, and marine resources" (UN, 2015; DEA, 2015; Umlazi and Malukazi LAP and TRS, 2011).

UNICEF and WHO (2015) states that 2.4 billion people in the world do not have access to improved sanitation, and almost 1 billion people defecate in the open., therefore, this target of sanitation is still not achieved. Also the SDG 6 state that: By 2030, improvement of water quality by reducing pollution, removing dumping and lessening release of hazardous materials, halving the proportion of untreated wastewater and substantially growing recycling and safe reuse globally with good ambient water quality indicator should be achieved (UNICEF and WHO, 2015; UN-Water, 2015; UNGA, 2015 and WWAP, 2017).

The core of sustainable development will only occur if there is only a firm control of the population, improved quality and protected environment that endorses economic and social development under the premise of sustainable development use of resources (Mingtai & Jinhuo, 2007; Pride & Joy Consultants, 2015). Also, sustainable development and use of these natural resources can be witnessed through educational led environmental campaigns where people will be educated people on how to live in the environment (Siew, Yacob, Radam, Adamu & Alias, 2015). Feng, Xindi, and Fushen (2014) agree that a deep environmental education referred to ecological philosophy, environmental ethics, and responsible environmental value that is necessary for sustainability development from the viewpoint of ecology. Perception research to inform the design of conservation initiatives according to Gelcich and Donlan, (2015) and Sorice and Donlan (2015) are needed since the needs and values held by stakeholders may vary from those of the conservation programme provider and conservation targets. Perceptions research provides in-depth knowledge of a group's preferences and priorities (Pita, Pierce, Theodossiou and Macpherson, 2011),

which can serve as a basis for determining the unspoken needs of the potential participants.

2.12.1 Ocean's Economy as a Tool of Restoration Through Education and Knowledge

From Van Liere and Dunlap (1981) study, where the sociodemographic measures of education was 20 percent, age 60 percent, sex 40 percent, political ideology 33,3 percent was included or considered in the environmental study, the study had the most consistent relationship with environmental concerns or measures such as pollution and population. While Dunlap (1987) found that the president convinced the public that environmental protection should be eased in pursuit of economic growth. Environmental quality is becoming a more political issue in US society. Also, Liu and Guo (2018) findings showed, positive relationships between: environmental education and environmental knowledge; environmental knowledge and environmental value, and environmental education and environmental value. However, education and the economy in South Africa according to Van der Merwe-Botha (2009) is weak. According to Van der Merwe-Botha (2009), the poor qualitative fundamental drivers of water quality such as socio-economic environment, where the structure of the economy and behaviour of its actors, indicate and influence natural and cultural legacies and policy choices; With poor education for the majority in the past has resulted in large sections of society not having the pool of skills required to understand and manage public services effectively. As result, this national problem of water quality and quantity challenges in South Africa in 2008, resulted in a drop in economic growth of at least 2 %, to the value of around R45 billion.

As stated earlier, the application of European perspective such as adaptive river management in a third world country problems may result in different perspective than that purposed for by developed countries. According to White *et al*. (2017), lack of information about behavioural factors like beliefs, values, and experiences where behavioural change helps in the long sustainability of water and sanitation as it

improves knowledge, attitude and practice on diarrheal outbreak seasons is needed. According to Maclean *et al*. (2017) policies are viewed as hypotheses and management implementations are viewed as experiments to test these hypotheses therefore, implementing these policies allows flexible and iterative process that focusing on an individual and organisational learning simultaneously (Berkes and Turner 2006; Pahl-Wostl *et al*. 2007).

The growing impatience of communities as reflected by rise in service delivery protests and on affordability of water against the constitutional right to water; unemployment; and the unique circumstances that rural communities face, define the socio-economic delivery environment including, inequality in water allocation and access to water services and sanitation (DWA, 2017).

Vulnerability to malnutrition and poverty can be reduced by the application of citizen science and community participation approach that is enhanced by environmental value through education. The use of accurate and current surface water data trends, improved community participation, improved environmental implementation can act as modifying factors to stakeholders' knowledge, attitude and behaviour towards stream water quality restoration in return reduce malnutrition and poverty susceptibility and severity. Dunca (2018) believes the trend in the water quality index is determined by the economic activities in the agriculture, industrial, and residential areas in the sampling stations vicinity in the Timis, Bega hydrographical basin. Therefore, constant monitoring is important to ensure the water quality of Timis¸ and Bega rivers at the optimum level. Findings from Liu and Guo (2018) research indicated that strengthening the citizens' responsible environmental is achieved through environmental education on people's environmental knowledge and environmental value.

Phakisa is the South African initiative who’s focus area involves ocean protection, encapsulating enforcement, surveillance, pollution monitoring, and MPAs since illegal and unregulated activities have significant negative impact on marine resources trade and food security that results in substantial economic and employment losses. This initiative addresses these challenges by investment program in earth observation technology enabling both environmental and compliance monitoring to facilitate

sustainable development of ocean economic is a safeguard of biodiversity and the ecosystem services provided by the ocean, and in so doing opportunities (Republic of South Africa Operations Phakisa, 2014).

South Africa also lacks a good image of coastal and ocean water quality, making it impossible to pinpoint the source of contamination that poses a risk to human and environmental health. Having a national water quality monitoring program supposed to address this issue by identifying areas of accumulation and aggregation of pollution along the coastline as the ocean economy grows (DWA, 2017).

Spaiser *et al*. (2017) encountered limitations in several ways; there are either incomplete or no valid data on the environment (with exception of CO2 emissions), equality, social matters rather economic data are largely complete in most developing countries. This alone creates a misbalance and bias for all data analysed requiring the models suggested to be evaluated with attentiveness (Spaiser *et al*., 2017).

Begg (1978) conducted a survey in the Isipingo lagoon area, recording between 12 and 15 fish and crab species. The estuary also had a lot of juvenile mullet, prawns, and crabs, according to Ramm (1987). The number of different organisms and overall densities, however, decreased in the estuarine system's upper reaches, according to the survey (Forbes and Demetriades, 2008). Forbes and Demetriades agree on this, according to the aforementioned study, the number of registered fish species has decreased dramatically. The rest of the Isipingo River is not known, but aerial photos show a lot of riparian vegetation and floodplain that has been disturbed by urbanization and other events (Forbes and Demetriades,2008).

Instead, between 2002 and 2008, there was a rise in the number of fish killed at the lagoon district, which was due primarily to sewage overflows caused by pump station failures, drainage line breaks, and blocked manholes (Philip, 2010). Upstream of the sluice gates, the water quality is often considered poor (Forbes and Demetriades, 2008; Pillay, 2014). WWAP, (2017) believes the achievement of SDG 6.3 also helps to reduce land-based emissions in terrestrial and marine habitats (SDGs 14 and 15).

Poor decision support systems for guiding the use of ecosystem services part of poverty alleviation according to Tallis et al. (2008) is also influenced by the existing

gap between theory and practice. Tallis et al. (2008) found that only 16 percentage made significant progress on both objectives. Since SDG is part of theory and science in public administration of South Africa, Spaiser *et al*. (2017) maintain that it is important to make the best and most efficient use of the data available in order to gain a deeper understanding of growth and sustainability. Since data analysis is a useful tool for tracking improvements (United National Department of Economic and Social Affairs 2015), it can be used to track progress toward the SDGs as well as revise the models currently in use.

The mismanagement of water or even water scarcity directly affect as food prices and this is a major challenge in developing countries such as South Africa currently. One of the South Africa's macroeconomic objective is economic growth which is part of SDGs goals 8 ‘economic growth and productive employment that continues to be far from being achievable (Szirmai, 2015 and Schiller, 2008). It is therefore crucial for the government and its departments, in this case, DWA to establish laws that will not only protect the natural resources but also teach the citizens about the importance of the laws associated with water management. Since it is unclear which theory should be used to research SDGs. Szirmai (2015) argue that the SDGs presented a list of targets but no concrete objectives or theory on how to achieve these goals.

Even Warmink, Brugnach, Vinke-de Kruijf, Schielen and Augustijn (2017) believes that stakeholder’s engagement is crucial even on adaptive management model as collection of natural resource information is not enough without stakeholders’ participation in addressing river management uncertainties. The use of stakeholder’s engagement especially on the socio-institutional context, where solving stakeholders’ role's ambiguity and policymakers’ perception on river management has been observed to difficult, yet is important (Pappenberger & Beven, 2006 and Warmink et al., 2017). While, Village Earth (2016) still maintains that education and training approach changes the culture and institutional norms of environmental stewardship from SES framework. Therefore, community skills are needed to keep projects maintained and these skills are rarely taught in graduate (Blickley *et al*., 2012).

To establish and modify the existing governance structures needed on the socioeconomic landscape that will benefit ecological environmental management,

again determination of all stakeholders' perceptions must be known by authorities (Gelcich, Hughes, Olsson, Folke, Defeo, Fernández, Foale, Gunderson, Rodríguez-Sickert, Scheffer ,2010). Basically, perceptions research findings provide a setting for discovering what is desired and what is achievable in a given ecological, social, and political context related to environmental conservation initiative (Bennett *et al*. ,2017).

Again, perceptions felt or received by stakeholders are needed to be determined to identify the socio-economic benefits when ecological environmental management is maintained and to, establish the modifying existing governance structures that may be needed (Gelcich et al., 2010). According to Bennett *et al*. (2017) results from research on perceptions can be incorporated into decision-making processes and increase the socio-economic benefits associated to a particular conservation intervention.

This section highlighted what individuals perceives as environmental stressors associated with stream water quality. In identifying individuals' (environmental stressors) perceptions on stream water quality, the susceptibility; severity; barriers; self-efficacy and; cues of action of the individuals' knowledge, attitude and behaviour associated with stream water quality can be identified and measured. However, other researchers insist that if external and modifying factors like, lack of professionals' knowledge, a proper infrastructure and socioeconomic needs are not provided can act as behavioural change barrier, even if the individuals were willing to change their behaviour.

2.13 WATER RELATED CHALLENGES AND HEALTH CARE

According to Van Liere and Dunlap (1981), sociodemographic of education 20 percent, age 60 percent, sex 40 percent, political ideology 33,3 percent had the most consistent relationship with environmental concerns or measures such as pollution and population, therefore poor education can act as a barrier of pro environmental behaviour and no significance in residence. In Dunlap (1987), the president convinced the public that environmental protection should be eased in pursuit of economic growth. Environmental quality is becoming a more political issue in US society.

According to De Young (1986) other of family, neighbors, peers, and the culture or society at large may all exert social control. Family, neighbors, and peers can encourage recycling by acting as role models or by raising questions about self-image. Nevertheless, Hopper and Nielsen (1991) discovered that social influence from more formal sources such as block leaders resulted in increases in recycling behavior and more recurrent confirmation of altruistic norms regarding re- cycling.

According to Heymann (2008), Public Health Professionals (PHP) are accountable to communities, other health professionals, as well as in decision-makers like politicians for actions taken on their behalf. PHP commit to action in pursuit of achieving social good as in ensuring the rights of all to health. Kelly-Quinn *et al*. (2019) believes that greater public engagement is essential to effectively address environmental challenges that include loss of biodiversity. Health Department Province of KwaZulu-Natal (2015) from the statistics of the Umlazi area revealed that children under the age of 5 years were highly infected with diarrhoea disease; diarrhoea is a surface water-related disease usually present with E. coli contaminants. Yet, NWA section I and J 151 is against illegal sewer connection flowing into rivers and streams and section 21 states that prevention of pollution arising from illegal discharge and storm water contamination in urban areas needs to be controlled by local authorities (King, Strydom and Retief, 2018:19). Environmental education has become a common trend globally that assists people in understanding the ecological role in the natural environment and the effect on the environment as well as taking rational preparation (Varela-Losada, Vega-Marcote, Perez-Rodríguez and Alvarez-Lires, 2016). Removal of wetlands and forests in the uMlazi area can be witnessed as a lack of environmental understanding on the community's side with the effect of climate change and water scarcity as wetlands assists in surface water purification and trees minimizing the global warming effect due to a lack of space (Xaba, 2019). In Indonesia, environmental carrying capacity and environmental quality have decreased due to urbanization growth that has resulted in environmental degradation (Harring *et al*., 2017).

Glanz, Rimer, and Lewis (2002) believe health educators should be aware of the factors that may influence the learning capacity of the people to succeed in changing or maintaining a healthy behavior (Glanz *et al*.,2002). Lack of knowledge regarding how much crops and animals contribute to surface water pollution from agricultural sector are substantial high especially in third world countries. Yet, such data is crucial

for national governments to comprehend the actual challenge so to develop impactful and inexpensive policies for their countries (WWAP, 2017). In the eastern parts of Bangladesh, large streams and rivers lack necessary data to determine state water quality standards (Alam *et al*., 2007).

In China and Turkey, Köse *et al*. (2014) affirms that multivariate statistical techniques to evaluate surface water quality are reliable and deliver valuable data for various freshwater habitats. Such techniques are recommended and used are also used for a better understanding of the ecological status of the systems in these countries (Najar & Khan, 2012). According to Kelly-Quinn *et al*. (2019), to recruit stakeholders and introduce the project better, the availability of streams ecological systems and data is crucial and act as the basis of the project. The objective of Small Stream Network (SSNet) is to improve knowledge on the role of small streams in water quality, biodiversity, and ecosystem services protection and later used to that will formulate policy, evaluate options to meet water quality and other protection targets. According to Conrad and Hilchey (2011) though, SES monitoring approach is still concerned with the fact that in most developing countries, data collected by community members is hardly used and not taken seriously by decision-makers due to poor sampling procedures credibility (Conrad & Hilchey, 2011). More lack of data suggest that citizens are still left in the dark about water quality (Conrad & Hilchey, 2011).

2.13.1 The Effects of the Department of Water and Sanitation on the On-going Water Challenges in SA

In SA, the Department of Water and Sanitation (DWS) available data used for river assessment of SA is old data of 2011 (DWS, 2017). While, Greencape (2017) reports noticed that there are skills gaps in SA, as there is approximately 10 percent of qualified engineers in the water industry working for local government, instead of an ideal percentage of long-term viability of about 30 percent. This has resulted in a great neglect on asset management, the municipal business of water, operations and maintenance of the country's municipalities. As a result, about half of SAs municipalities are not able to provide reliable water balance data because of a shortage of water meters shared with lack of skills and capacity (Greencape, 2017). WWAP (2017) maintains that poor maintenance and unskilled professionals severely

hinders the effectiveness of the treatment process, resulting to the high pollutants present in the environment where infrastructure exists (WWAP, 2017).

From the Stakeholder Consultation Workshop in May 2014 that had over 91 representatives from various institutions funded by the DWS and the WRC, the capacity gap and skills gap methodology on inside and outside of the water sector in South Africa was mainly discussed (Vienings and Lima, 2015). Vienings and Lima (2015) determined the demand for capacity in Water Sector Institution (WSI) began by examining their mandate as established by applicable legislation, in this case the National Water Act (No. 36 of 1998) and the Water Services Act (No. 108 of 1997). These mandates are then mapped to the organograms of the agencies, and then to individual work titles.

Vienings and Lima (2015) maintained that the total number of technical staff required is 205 at Umngeni Water and almost 100 percent was outsourced to the private sector. The skills gap is the difference between the skills needed by the institution (as per the Skills Matrix) and the actual skills posed by staff from the online skills audit. In DWS, the percentage vacancy rate for engineers and scientists in DWS was 16.1 percent in 2013, in 2014 it was 17.5 percent, 2015 it was only 11percent (DWS, 2017). Vacant spaces for employment included: 14.8 percent for planning and information; 25.00 percent for sanitation services and; 27.16 percent of corporate management 27.16 percent (DWS, 2017). Although in the 2017/18 financial year the DWS was to roll out training interventions to close the training gaps identified in the previous financial year (DWS, 2017). In South Africa, van der Vyver (2014) confirmed that perception of stakeholders about water scarcity is low in terms of levels of awareness, people unaware of water consumption, only 56 percent were aware and therefore, campaigns are required. According to Rodda *et al*. (2016), awareness about water security protection of both quantity and quality is required in all stakeholders in South Africa. According to Rodda *et al*. (2016) SA requires urgent interventions to protect water security within these developing countries. perceived challenges include lack of both skills and political will in government, citizens' trust in government; lack of understanding of Green and Blue Drop programme impact and knowledge on the process of water supply.

Ng (2012) states that public health officials should make decisions in an open and accountable manner by using local media and roadshow campaigns to announce and transfer the information to the community (Ng, 2012). This situation of no data to provide specific guidance for specific circumstances cannot occur because needed scientific information is not available quickly enough for a response in a crisis (Ngu, 2012). This is the case of the uMlazi area as there are no relevant historical studies on stormwater available for the uMlazi area (Umlazi and Malukazi LAP and TRS, 2011). Environmental analysis of the habitable areas next to the rivers are prone to flooding although people reside there. It is, therefore, necessary to implement mitigating measures to prevent flooding of residential areas (Umlazi and Malukazi LAP and TRS, 2011).

According to DWS (2015) at a sub-national level, there is a need for a more thorough planning and valuation to use finer scale for river mapping. Therefore, lack of proper monitoring, geomorphology or longitudinal river zones characterize the ability of river to transport sediment. DWS (2016a) commend that river extent and condition accounts be created every five years in South Africa. The main problem is deficiency of planning so far national assessment of the PES of rivers (DWS, 2016a).

Pahl-Wostl *et al*. (2007) agree that South Africa has four types of river uncertainties that include: socio-economic research in river knowledge, that is, uncertainty about climate change effect on nature and extreme events likelihood. Secondly, stakeholders' perception and action uncertainty in the adaptive river management framework and thirdly, SA seems to lack in environmental education campaigns. Although, Ho (2013) regarded environmental education as the "integrated" education however, infrastructure cause poor water quality that can cause health risks and illegal dumping or sanitation behaviour.

2.14 THE GLOBAL PERSPECTIVE OF WATER AND SANITATION CHALLENGES

According to UNICEF and WHO (2015); McDowell *et al*. (2017); Ahmed, Omer, Osman, Ahmed-Abakur (2017) and, WHO/UNCF (2018) socio-economic and

infrastructure external factors do cause and contribute to environmental consequences or threats or stressors and act as barriers of surface water quality. Therefore, infrastructure must be improved. Otherwise if such factors are not provided they can act as behavioural change barriers, even if the individuals were willing to change their behaviour (White *et al*., 2015).

In Africa, Ethiopia is threatened with inadequate sanitation even the drinking water infrastructure is poor. According to Beyene, Hailu, Faris and Kloos (2015) 52.1 percent of the population in 2014 still used unimproved sanitation facilities, more so about 35.6 percent practiced open defecation (McDowell *et al*., 2017). Köse *et al*. (2014) believe it is necessary to evaluate a large number of physicochemical and chemical water quality data for effective pollution control, to better interpret and better decisions (Dixon & Chiswell, 1996; Koklu, Sengorur & Topal, 2010).

2.14.1 Urban Areas Susceptibility and Vulnerability to Health Hazards

According to Glanz *et al*. (2008), the use of HBM focusing on social environment behavioural intervention puts a greater burden on health promotion professionals to identify critical factors for each behavioural application. Focusing on health professional to identify susceptibility and severity of both human survival and surface water restoration has hindered proper interventions from being implemented as HBM does not focus on the uncertainties and complexity of surface water in urban areas rather on disease burden on the citizens.

Using a tailor-made approach is required, that provide guidance about behavioural influences or belief, attitude is important. Instead of use of some ecological models only that is based on physical structural perspective, lacking the information about how the broader levels of influence operate across all levels of behaviour-specific ecological models. Consequently, the models broaden perspectives without identifying specific constructs or providing guidance about how to use ecological models to expand research, making combination with SES and Adaptive Management Framework is more efficient on this regard. A major trial for those working with ecological models is to develop more complex models that lead to testable hypotheses

and useful guidance for interventions. Intervening on multiple levels instantaneously may be inhibited by budgetary and practical limitations, such as policies and environments not being evaluated lack planning as (White and Nanan, 2008). Therefore, ecological models such as SES and adaptive management framework cannot be the only solution on policy impact on stream water quality. According to Colding and Barthel (2019) SES acknowledges the integration concept in management of natural resources in terms of social-ecological systems subjected to diverse ecological and social challenges of climate change and other environmental stressors. 61 percent of the papers analysed of some 12,990 publications since 1970 did not even provide a definition of the term SES, a shortcoming that makes case comparisons difficult and reduces the usefulness of the concept (Colding and Barthel, 2019).

Therefore, consideration of all frameworks in stakeholders' knowledge, attitudes and behaviour practices in water management can be impacted by available, methodology and interpretation of surface water quality data collection. Such factors in return, can influence the survival of urban citizens' health and safety of the developing countries especially (Kelley & Kelley, 2015).

Hence, the following section, focuses more on HBM contracts and less focus on SES and adaptive management framework. The susceptibility and vulnerability of human health and survival is affected by obesity due to urbanization; population growth; malnutrition; poor water quality; lack of WWTW maintenance; poor sanitation and illegal dumping monitoring which eventually affect surface water as a natural resource. Management of water as a natural resource is discussed in the following sections.

2.14.1.1 Poor Infrastructure Affect Water Quality of Streams and Rivers and Harbours Diseases Susceptibility and Risks

Wolf, Pruss-Ustun, Cumming, Bartram, Bonjour, Cairncross, Clasen, Colford Jr, Curtis, De France, Fewtrell, Freeman, Gordon, Hunter, Jeandron, Johnston, Mausezahl, Mathers, Neira and Higgins (2014) agrees with other that improved

community water supply (Waddington *et al*., 2009), and some water quality improvements such as water filters upgrade reduces diarrhoeal illness (Clasen, Roberts, Rabie, Schmidt and Cairncross; 2006; Hunter 2009; Waddington *et al*., 2009; Cairncross, Hunt, Boisson, Bostoen, Curtis, Fung and Schmidt, 2010). Norman, Pedley and Takkouche (2010) found sanitation mediations of better sewer connections have resulted in the to decrease of 30-40% in diarrhoeal disease (Waddington et al. 2009; Cairncross *et al*. 2010).

The poor water quality of streams and rivers due to aging and poorly designed infrastructure also harbours diseases susceptibility and risks. In Bangladesh, there has been an increase of 2000 patients in April suffering from diarrhoea in 2017 still due to unclean water and obstruction of sewage pipes (WHO/UNCF, 2018). Most countries are highly affected by climate change with disasters like floods that are severe and made vulnerable by water-related diseases like diarrhoea, especially the third world countries. Hence the current South Africa study of streams.

McDowell *et al*. (2017) affirm that there are challenges facing a lot of African cities and this include fast increase of urbanization, population growth and inadequate infrastructure to mention a few, exacerbating these issues. Additionally, McDowell *et al*. (2017), state that the fast urbanization in various Ethiopian cities demands an upgrading in urban sanitation. Madagascar in the continent of Africa is one of the world's countries that has been affected by a great storm in 2017 which left 270 000 people losing their houses. According to Randremanana, Razafindratsimandresy, Andriatahina, Randriamanantena, Ravelomanana, Randrianirina and Richard (2016), Madagascar's children under the age of 5 years suffered severely with diarrhoea due to a lack of personal hygiene between 2007-2017. Diarrhoea is still the most cause of premature death in this country with 9.3 percent in communicable diseases.

According to Franz, (2005) microbial contamination of water sources like streams, rivers, and groundwater is one of the main causes of waterborne disease spread. In low-income countries, there is a lack of improved sanitation and water sources (WHO, 2015). As a result of this Africa's children under the age of 5 years and the elderly die due to diarrhoea which is also a waterborne disease (Kotloff, Nataro, Blackwelder, Nasrin, Farag & Panchalingam ,2013; Liu, Johnson, Cousens, Perin, Scott, Lawn, Rudan, Campbell, Cibulskis, Li, Mathers & Black, 2012; Walker, Tam & Friberg, 2013;

DHPKZN, 2015). Contaminated water can be in the form of wastewater which is said to increase disease burden when used for irrigation purposes or during playing with this type of water (WHO and UNCF,2018).

As mentioned before that diarrhoea is caused by discharging faeces into water bodies detected by the presence of *E. coli* and coliforms microorganisms. It remains a reason for concern in the KwaZulu-Natal, SA district, with the highest number of deaths that arose in the South West Sub-district of KwaZulu-Natal according to the report from R K Khan Hospital (Health Department Province of KwaZulu-Natal, 2015:78).

Prüss-Üstün *et al*. (2014) maintain that diarrhoeal disease prevalence that was responsible for 361, 000 deaths in 2012 is associated with sanitation, water and hygiene challenges making both women and young girls prone to this risk during water collection in their villages (UNICEF/WHO, 2015). Such diseases increase the poverty challenge as it prevents individuals from working and attending school, and this increases the cycle of poverty (UNDP, 2006). Thus, citizens in developing countries like SA are susceptible to diarrheal disease. According to Prüss-Ustün, Wolf, Corvalán, Bos, and Neira (2016), 45 percentage deaths in Africa are from diarrheal diseases as the main cause then after protein-energy malnutrition, and schistosomiasis a disease caused by infection with freshwater parasitic worms in certain tropical and subtropical countries (Prüss-Ustün *et al*., 2016). Manning (2008) maintains that without water security, there will be no food security, and poverty reduction and economic growth will not be sustainable as is the case.

Another waterborne disease that has killed lots of people is Cholera. According to Cowan (2012), the municipality water contamination of Cryptosporidium in Wisconsin during the1990s affected 370 000 people. Later on, Dicken (2002) insist that the frequency of cholera is also related to HIV/AIDS since people with immune systems weakened by HIV/AIDS are easily attacked by cholera since this is a highly opportunistic disease. Bilharzia disease blood in stools or urine is another waterborne disease responsible for the death of many people in these developing countries (Prüss-Ustün *et al,*.2016). Hence the strict control of the population, to improve quality, protect the environment and promote economic and social development under the premise of sustainable use of resources should be the core of sustainable development (Mi, 2014).

Traces of tuberculostatic, antifungals, and antimalarials that are given to HIV positive patients is found in contaminated water sources (WHO, 2014). While Swanepoel *et al*., (2015) maintains that numerous pharmaceuticals discovered HIV-ARVs in some drinking water samples (Swanepoel *et al*.,2015).

2.14.1.1.1 Lack of healthy food in Urban Areas is caused by Streams and Rivers poor water quality

According to Chaudhary *et al*. (2017) demographic factors may reveal further insights into whether people will engage in environmental behaviours (Stern, 2000). For example, studies conducted by Lam (2006) reported females exhibited more pro-environmental behaviour. In a review of 12 studies, Lam and Chao (2003) found females had greater intentions to demonstrate pro-environmental behavior. However, Clark and Finley (2007) reported sex had no effect in their study on water conservation behaviors in Florida, all residents had an overall positive disposition toward landscape water conservation. According to Alender (2016) although there was no variation by gender was found, but younger volunteers had different motivations and preferences than older volunteers.

According to Prüss-Ustün *et al*. (2016), obesity and overweight are on the rise in low- and middle-income countries (LMICs), especially in urban settings in Sub-Saharan African countries. According to Biadgilign, Mgutshini, Haile, Gebremichael, Moges, and Tilahun (2017), more than 1.9 billion adults aged 18 and older were overweight in 2014, with non-cooperation rising. Similarly, in 2014, 13 percent of the world's adult population was obese (11 percent of men and 15 percent of women). In Africa, the number of children who are overweight or obese has nearly doubled from 5.4million in 1990 to 10.6million in 2014 (Prüss-Ustün et al, 2016). The clear picture of obesity and overweight is that it can affect a child’s immediate health, educational attainment and quality of life (Biadgilign et al., 2017). Yet, drinking plenty of water is publicly believed to be useful for health and has been recommended in various dietary guidelines (Haghighatdoost, Feizi, Esmaillzadeh, Rashidi-Pourfard, Keshteli, Roohafza and Adibi, 2018).

According to Statistics South Africa (SSA) (2018) research on variety of food eaten by children between the age of 0–6 years in their household, it was alarming to notice that above 70% of children did not eat beans/peas/groundnuts/cashew nuts or other form of nuts-72.1%; spinach-62.7%. It was also worrying that 50% of children between the age of 0–6 did not eat any fruits in the past 24 hours in their homes (SSA, 2018). Yet, Section 28 of the Bill of Rights (Act No. 108, 1996), which formed the second chapter of the South African Constitution, includes nine broad rights for children, including the right to basic nutrition (SSA, 2016 a).

Looking at the South African during the period 2015/2016, the following is a breakdown of government spending that had a direct effect on children: of the total R1,52 trillion, used, only 11% on health, and under 19% of education used 4% only was used on families and children (SSA, 2017). Behavioral change is through self-efficiency adopting preventative behavior and perception that benefits are more than challenges. Behaviour change can be being due to two factors: the perception that the benefits of adopting the behaviour outweigh the costs and the person's confidence of adopting the preventive behaviour as part of self-efficacy. However, despite water scarcity awareness campaigns; floods risks awareness campaigns; improved infrastructure development in terms of water piped houses in urban areas are simultaneously water-related microorganisms are still found in vegetables due to polluted surface water (Patil et al, 2014).

White, Turpie and Letley (2017) maintains that eating health food is part of preventative behavior from susceptible diseases and is part of self-efficiency. Lifestyle changes explain why obesity and mental disorder occur simultaneously (White *et al.*, 2015). Depression according to Gangwisch, Hale, Garcia, Malaspina, Opler, Payne, Rossom & Lane (2015) is associated with sugar-sweetened beverages and carbohydrate-containing food. Hence, adopting a healthy lifestyle, eating less sugar-sweetened beverages but more intake of fruits and vegetables is recommended by medical health practitioners. However, irrigation of these fruits and vegetables as healthy food requires supply of reliable water quality. In urban areas where there is

low income and water scarcity risks, the community members resolve to using river and stream water for irrigation purposes.

As streams, rivers, and groundwater is one of the main causes of waterborne disease spread (Franz, 2005). Clasen *et al*. (2014) argue that behaviour is the main factor in diarrhoea increase more than infrastructure. As a result of this Africa's children under the age of 5 years and the elderly die due to diarrhoea which is also a waterborne disease (Kotloff *et al*., 2013, Liu *et al*., 2012; Walker *et al*., 2013, Health Department Province of KwaZulu-Natal, 2015). Contaminated water can be in the form of wastewater which is said to increase disease burden when used for irrigation purposes or during playing with this type of water (UNEP, 2015).

As explained earlier, Umlazi results for 2017 had E. coli count of close to 7000 MPN/100Ml and that Umlazi is dominated by primary sectors such as irrigated agriculture and commercial forestry therefore requires constant microbial monitoring of river water used for irrigation. Aarts, Dijksterhuis and Midden,1999; Fielding, Russell, Spinks and Mankad (2012); Gregory and Di Leo, (2003); Ouellette and Wood, (1998) advise professionals to consider residents' past behaviours carefully when developing. These researchers believe that past water conservation behaviours significantly influence intentions and agree with others who have asserted that residents who conserved water in the past are likely to conserve water in the future water conservation outreach and new water conservation programs.

2.14.1.2 The Impact of Urbanisation on Individual's Mental and Behavioural Health

According to Guglielmucci, Franzoi, Barbasio, Borgogno, Granieri, (2014), the exposure to a pathogen is a traumatic event that can arouse catastrophic affects, thus entailing the loss of healthy aspects of the "Self". Steg *et al*. (2014) argue that environmental consequences or stressors such as floods, malnutrition, drought due to river vulnerability does have an influence on human behaviour and eventually affect individual well-being and mental health (Steg *et al*., 2014; Nel and Drivers, 2015 and DWS, 2018b).

From the study that evaluated whether coastal zones influence human's well-being Peng, Yamashita and Kobayashi (2016), citizens who lived by the seaside showed higher positive psychological effects and had lower negative psychological effects. Yet, in Durban, the city that is along the coast, about 80 000 people take their own lives every year proving that South Africa is the sixth-highest rate of suicide in Africa (Somduth, 2018). These results agree with the other environmental challenges at Umlazi although situated along the coast (eThekwini Municipality, 2016), has dirty, smelly streams (Pillay, 2013). These findings contradict the results from Peng et al. (2016) reveal that coastal zones positively affect individual well-being. Also Haghighatdoost *et al*. (2018) and Stevenson, Ambelu, Caruso, Tesfaye and Freeman (2016) maintains that insecurity with anxiety and depression, more prevalent women's health well-being in Ethiopia is associate water (Stevenson et al., 2016). Ethiopia (Stevenson *et al*., 2016). While according to Peng *et al*. (2016) coastal environments have more positive impact on females than on males.

Good mental health is an SDG 3.4 objective related to mental and psychological well-being, stating that by 2030 one-third of premature mortality will be reduced. With SA's recent suicidal reports due to depression, where children and wives are killed even raped shows there is a need for more recreational activities in the urban areas. In S.A., the average suicide rate is 17.2 percent per 100 000 deaths, and these are the ones that are reported in the academic hospital and in reality, the figure is higher (Mars, Burrows, Hjelmeland and Gunnel, 2014:4). In 2016, Prüss-Ustün et al. revealed that about 11.6 percent of every 100 000 people in SA commit suicide (Prüss-Ustün *et al*., 2016). SA has a suicide mortality rate higher than that of Botswana, Egypt, Malawi, and Nigeria (Somduth, 2018). The SA anxiety group reports 40 000 phone calls on its suicide helpline since January 2019 (Govender, 2019).

According to Stevenson et al. (2016) women's health and well-being is more prevalent and causing women to be more vulnerable in anxiety and depression due to water insecurity in Ethiopia. The prevalence of common psychological disorders has been increasing over recent decades (Mojtabai, 2011). Yet, as mentioned earlier, the pathogenic microorganisms from human sewage are discharged into the river catchment due to poor sewage system monitoring (Teklehaimanot, 2013, Sithebe *et al.,* 2016. As indicated that the sampling point next to WWTW of Isipingo river was highly contaminated (Sithebe *et al*., 2016) and with Amoah *et al*. (2011) who confirmed

that safety measures are required in WWTW with insufficient wastewater treatment especially where irrigation practices are common in Durban South Africa.

According to Berger (1997), mental health promotion aims to promote psychological well-being, competence, and resilience, by creating supportive living conditions and environments. Development of new models that focus on sustainable development measurement is urgently required otherwise urbanization and global demand which affects human health disorders will increase to 15 percent by 2020 since already half a billion people suffer from these disorders worldwide (White *et al*., 2015). In recent report, one person dies every 40 seconds from suicide and mental disorder in particular depression and alcohol users' disorder. This suicide is also linked to conflict, disaster, violence, abuse or loss experiences (WHO ,2019).

Suicide rates are high amongst vulnerable groups who experience discrimination such as refugees, migrants, and indigenous people. WHO (2019) agrees that a multidisciplinary approach among multiple sectors such as health, education, law, politics, and communities is required.

2.14.1.2.1 Lack of recreational activities in Urban Areas

Another socio-economic challenge for the South African township is the lack of entertainment and recreation activities for citizens in these areas. Chili (2015) argues that in townships of SA, taverns are the only forms of business and entertainment of the community that attracts tourists and increase the local economy entertainment. Chili (2015) maintains that township tourists rarely come and do not spend a long time in the townships since there is nothing else that attracts them. Umlazi township is no different, in this township, there is insufficient social facilities present when compared to its population thresholds. Proper understanding of environmental value can help citizens reduce other health hazards like depression (Varela-Losada *et al*., 2016). Umlazi is recently famous for Max's Lifestyle Lounge and Eyadini Lounge restaurants locally termed as Shisanyama; both host artists, sell food and alcohol. According to

Umlazi and Malukazi LAP and TRS (2011), Umlazi as mentioned earlier has a limited number of social facilities, limited infrastructure, does not comply with the guidelines for social facilities within an area of its population, hence poor quality of life is experienced. According to Mojtabai, (2011) the prevalence of the common psychological disorder has been increasing over recent decades. Drinking plenty of water is publicly believed to be useful for health and has been recommended in various dietary guidelines (Haghighatdoost *et al*., 2018).

The above-mentioned living conditions of Umlazi promote socio-behavioural disorders such as alcoholism, drug abuse, problem gambling and various forms of other disorders and ill health (Murray & Lopez ,1996). Chili (2015) confirms that Gauteng is the only province in SA with townships that seem to do well in tourism, but this is due to its political landscape and unfortunately even Gauteng has no sustainable development in the area as well. Hence, a cleaner community appearance, renovated recreational facilities, a wider offering of leisure activities, more events, shopping opportunities, better preservation of historical buildings. Also, other cultural assets and a better quality of life, in general, are the benefits that Umlazi citizens need to reduce such socio-behavioural disorder risks the township is prone to (Gursoy, Jurowski & Uysal, 2002). Feng *et al*. (2014) believe that personal value influences attitudes, which further influence responsible environmental behaviours. Therefore, determination of stakeholder's values in this study is required, as stated earlier that if an individual perceive something as precious, the individual wants to keep it even utilizing changing their behaviour thereby becoming more responsible. keep it even utilizing changing their behaviour thereby becoming more responsible.

2.14.1.2.2 Obesity caused by lack of physical activity and space

Population growth is another threatening factor which require more land further modify local hydrologic regime and weather dynamics especial in the urban areas like Umlazi (Osborne, Lawrence, Slingo, Challinor & Wheeler, 2004). With the influence of global climate change that sometimes cause severe drought, there is an increase in water

consumption demand especially in the urban areas, also production of more waste that could also contaminate the water body or source comes through frequent floods (Djuwansyah, 2018). Moreover, land resources overexploitation is also accompanied by repeated floods, and streams water turbidity increase especially during a rainy season which increases waste concentration in water body Djuwansyah (2018). This water exploitation according to Djuwansah (2010) is beyond WRCC.

Breen, Curtis and Hynes (2018) believe that apart from health impacts, pollution can decrease the appreciation of recreational events by affecting the stakeholder's ability to participate in that particular activity because unpleasant odours of surface water site (Food and Agriculture Organisation, 1996; Dodds, 2008). Dickinson et al. (2012) affirms that children have the right to achieve a high standard of health hence all countries and families should think carefully about what affect children. At a social level priority regarding children's safety and health should be considered otherwise this can be acknowledged as a vulnerability state (Purcell, 2012).

White *et al*. (2015) confirms that in the Social-Ecological System (SES) individual's behaviour is determined largely by their social environment, for example, community norms and values, regulations, and policies, although individuals are often viewed as responsible for what they do. One of the objectives of an effect of the built environment is to promote safety and physical activity however recent studies have shown that there is a huge challenge with childhood obesity which is a result of a lack of physical activity (White *et al*. ,2015). Physical activity is primarily being achieved through information, education, and awareness activities. This could also be due to public health programs that have barely focused on the regulation of direct marketing of unhealthy foods to children; industry standards for food sold directly to children, for example, advertising and selling of soft drinks and sweets to children.

White *et al.* (2015) maintains that behaviour change can be being due to two factors: the perception that the benefits of adopting the behaviour outweigh the costs and the person's confidence of adopting the preventive behaviour as part of self-efficacy. Umlazi has no more available land free for human settlement and this has resulted in citizens building in what is considered to be an environmentally sensitive area, contributing to a lifestyle shaped by the unattractive environment of this area (Umlazi

and Malukazi LAP and TRS, 2011). Exercising is obviously a good way to improve our mental well-being, however going for a run or walk by the ocean will increase these benefits tenfold. Going for a swim in a lake or cycling along a river trail will give you more of a mental boost than working out in a crowded city or gym environment. Yet obesity statistics in urban areas continue to increase.

According to White *et al*. (2015), barriers to healthy behaviours is a combination that reinforces efforts at all levels that includes individual, interpersonal, organizational, community, environment and, public policy. To achieve behaviour change that is sustainable such barriers must be lowered or even removed across community and society at large. However, according to Pride and Joy Consultants (2015), the community members of the eThekwini Municipality perceive eThekwini residential areas to have poor access to parks and recreation amenities making this as a health behavioural barrier even for children growing up in these areas. From the political economy perspective, the demand for leisure by today society is one of the largest economic activities in the world (Urry ,1991; Urry & Larsen ,2011) where leisure is pleasure and experiences is a way to escape from a monotonous everyday life. Haghighatdoost *et al*. (2018) insist that drinking plain water is associated with decreased risk of depression and anxiety in adults.

2.14.2 Sanitation and Illegal Dumping Threat

The sound of waves crashing on the shore can actually induce a conscious, meditative state in people. The sound of waves has been shown to change brain wave patterns, resulting in a meditative, relaxed state. Up till now though, water flow is heavy obstructed by illegal dumping waste in Umlazi. Even simply observing the movement of water causes our minds to be calm, Peng *et al*. (2016), shows higher positive psychological effects and had lower negative psychological effects, therefore keeping the surface water clean from illegal dumping that obstract the flow of water can improve our psychological heath

However, according to Alfredo *et al*. (2015) there is a relationship between pollution due to illegal dumping and diseases. Xaba *et al*. (2016) indicated that 50 percent of

participants said that poor sanitation and illegal dumping contributes to stream water quality contamination of the Umlazi L-section area; 60 percent of the agreed said that the infrastructure in this place is not adequate for improving water quality of the stream with 62 percent using private toilets in these informal settlements instead of the government communal toilets in their area. WWAP (2017) agrees that slum dwellers often use unsewered communal toilets and open spaces. Department of Environment Affairs (2013) confirms that 81 percent of the sewage plants surveyed in the municipalities have with sludge insufficient disposal challenges. A total of 83 percent of the citizens confirmed that the stream is smelly at Umlazi L/M section Umlazi (Xaba *et al*., 2016).

UN (2016) believes that proper sanitation of wastewater treatment helps to achieve SDG Targets 3.3 of reducing diseases and 3.9 of reducing the number of deaths from hazardous chemical, water, and soil pollution through a suitable wastewater collection and treatment provides better water quality in river basins. Proper wastewater management of the environment provides health and economic benefits contributing to poverty easing of SDG Targets 1.1 and 1.2 (WHO/UNCF, 2018; IRP, 2019). From Pride and Joy Consultants (2015), Ethekwini Municipality citizens argue that there are very poor sanitation services in informal areas and of formal low-cost housing provided by the government of this municipality. Yet DWS (2017) states that basic water supply includes to support life and personal hygiene in the set minimum standard of water supply services for the reliable supply for houses and this should include RDP standard that needs a tap in the road at least 200m away from households even informal households (DWS, 2017).

Virapongse *et al*. (2016) still maintain that this discrepancy may be as a result of perspectives and cultural constructions subsequently undermine intended collaborative processes where citizens view streams as a sewage disposal tool while the government views local streams as a vulnerable natural resource that requires protection from deterioration. As another challenge is communal toilets are scarcely used as they are expensive maintenance and require water supply. Hence, wastewater increase is one of major challenges that increases as associated informal

settlements increases in the developing world as a result of economic inequality and urbanization. Giving a more difficult challenge to health promotion professionals to classify critical factors for each behavioural application due to heavy reliance on the HBM framework on social individual behavioural intervention research that lacks SES and adaptive river management framework application (Glanz *et al*., 2008).

According to McDowell *et al*. (2017), since waste is unavoidable, collection and waste treatment should be reviewed, improved and even through application of environmental policies at an individual and organisational level (Berkes and Turner 2006; Pahl-Wostl *et al*. 2007). As Feng *et al*. (2014) believe that personal value affects attitudes, which further influence the responsible environmental behaviours. Therefore, the individual will choose to change their behaviour if they perceive that particular determinant importance or precious by becoming more responsible.

2.14.2.1 Lack of Laws and By-Laws Enforcement

In McDowell *et al*. (2017) research, Southwest Ethiopia was found to have a poor environmental awareness and poor waste management and this waste eventually finds its way to the surface water and increasing human health risks.

According to Köse *et al*. (2014), one of the most significant branches of the Sakarya River is the Seydisuyu Stream Basin, which is considered to be polluted by agricultural and domestic waste. However, the levels of arsenic and boron found in Seydisuyu Stream were dangerously high. Peddie (2008), agrees that estuaries are mostly affected by siltation, wetlands are disappearing, and some rivers evaporating while lakes and dams are being contaminated. According to DWS (2015a), bacteriological impacts in terms of solid waste can threaten the health of contact (for example, swimmers and kids playing in the river) and limited contact recreational users (for example, canoeists). Of particular concern are bacteria and viruses associated with disposable nappies, medical wastes, animal carcasses, and human and domestic pet wastes in SA. Nel and Driver (2015:1) maintains that about 98 percent of South Africa surface water supply are developed. According to DWS (2015a) impeding flow and

bank destabilization through the accumulation of floating solid waste, dumping of building rubble, or dumping of large objects such as car bodies, broken furniture, tyres, and shopping trollies can redirect stream-flow and destabilise the river channel.

Simanjuntak (2014) maintains that surface water pollution occurs frequently when the river is next to to the illegal dumping site and more so during the rainy seasons. Illegal dumping contributes heavily to a depreciation of the land and property nearby the dumpsites (NWS Environmental Protection Agency, 2013). The citizens near the dumpsites have been reported are affected by diseases as tuberculosis, asthma (Etengeneng, 2012).

Martuzzi, Mitis, Biggeri, Terracini and Bertollini (2002) shows relative risk estimates of cancer mortality associated with exposure to toxic and solid wastes within the provinces of Naples and Caserta. These risks include soil contamination, groundwater pollution, and surface water degradation through wastewater use (Hanjra, Blackwell, Carr, Zhang & Jackson, 2012). Therefore, using not fully treated urban wastewater for irrigation instead of access to freshwater sources can pose health risks. The Italian Civil Protection Department, in particular, undertook an epidemiological correlation analysis to estimate the relationship between exposure to illegal waste disposal and adverse health effects in areas affected by this environmental crisis, taking into account a variety of socioeconomic factors.

United Nations Rights Office of High Commissioner (UN) (2011) declaration of human rights stated that "everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing, and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age, or lack of livelihood in circumstances beyond his control" (UN, 2011).

There has been an increase in sanitation coverage and treatment levels in other countries (UNICEF/WHO, 2015), yet, in Asia and Latin America millions of people are at health risk due to poor sanitation. One-third of all rivers in Africa are affected by severe pathogen pollution where the existence of faecal coliforms, which come from human and animal excrement, has been discovered. (UNEP, 2016). Instead, not one Sub-Saharan African country has met the MDGs target of sanitation even though improved sanitation reduces health risks (UNICEF, 2015).

Pollution of a water resource's physical, chemical, or biological properties, either directly or indirectly also alters the image of the residential property. According to UNEP (2016) failure to improve wastewater, sanitation affects the economy of the country or the affected citizens. This is evident in terms of increased financial burden on healthcare from diseases like tuberculosis, asthma, and malaria (Ali *et al*., 2014). Increased trade barriers, higher water treatment costs (for human use and other uses), and lower property prices near polluted water sources all add to the financial burden (UNEP, 2016). The safe removal of human waste and black and/or greywater from the premises, promotes the communication of good sanitation, cleanliness hones (DWA, 2017).

The by-laws stipulated have not been enforced in South Africa. There are no physical repercussions for such an act, which may be attributable to a lack of an effective surveillance mechanism, a lack of private-public involvement, inadequate educational awareness programs, or a lack of community motivation and lack of changed perceptive on material dumped on rivers and streams to using such material for recycling purposes (Ball, Chalmers, Dunywa, Lovelock, Nkata, Pearton, & Smart, 2014).According to Chapter 2 of The Bill of Rights, section 24(b), (i- iii) the environment must be protected through the prevention of pollution, ecological degradation and promoting conservation (RSA, 1996). As discussed earlier, Patil et al. (2014) maintained that even though 89 percent of the households in the intervention group had access to improved water sources in taps or piped water, there was no improvement in diarrhoea diseases on children due to poor citizens' behavioural change as they continue to practice open defecation. Bancalari and Martínez (2017) insists that in policy solutions will help to low sanitation coverage emphasised the construction of on-site facilities with the aim of reducing exposure to faecal pathogens from open defecation.

2.14.3 Vulnerability of WWTW in South Africa Infrastructure

Generally, when individuals are near water, the brain switch off from busy mode to relaxed mode. This naturally leads our brains to open up because they are not focused on the millions of thoughts swirling around that can often lead to stress or anxiety. Yet

these surrounding areas have unbearable sewage smell that has resulted in streams perceived as a health and safety hazard to both children and adult; where medical needles and other waste is thrown.

As mentioned before, to prevent disease spreading, the natural history of the disease must be explained. Natural history explains the way in which disease evolves and progresses from susceptibility to severity depending on the perception of individual and the community around them as some diseases could be prevented if the perception of those affected or those around them was different as this case with diarrhoea caused by water pollution resulting in death as major severity (White *et al*., 2015). Virapongse *et al*. (2016) agreed that the lack of demographics data is another challenge of SES framework, hence the use of co-development knowledge to be addressed at a community level through the use of focus group and interview studies can improve the lack.

As previously indicated, there is a relationship between pollution due to illegal dumping and diseases (Alfredo *et al*. 2015). In SA water pollution, especially on the inland's stream is one of the major challenges for townships management (CSIR, 2010 and DWAF, 2014). Virapongse *et al*., (2016) believe this discrepancy in perspectives and cultural constructions subsequently undermine intended collaborative processes from authority's ability. For example, stakeholders' discrepancy - government agency land managers, such as the U.S. Forest Service, often view the landscape and its value in terms of resources. In contrast, local land users, such as tribal groups, value cultural and spiritual aspects of the land, which are rarely considered as metrics in agency driven management plans.

According to Sithebe et al., (2016) the sampling point next to WasteWater Treatment Works (WWTW) of Isipingo river was highly contaminated as well. Yet NWA section I and J 151 is against illegal sewer connection flowing into surface water and section 21 states that prevention of pollution arising from illegal discharge and stormwater contamination in urban areas needs to be controlled by local authorities (King, Strydom & Retief, 2018). In Cele, (2015) on a study that focused on uMngeni River in KZN, the uMngeni river continuously received poor treatments due to the effluent discharges from the Howick WasteWater Treatment Plant, near Pietermaritzburg. Yet, according to Schedule 1, of Sections 4(1) and 22(1)(a)(i) and Item 2 of Schedule 3

(1) A person may, subject to this Act (a) take water for reasonable domestic use in that person's household, directly from any water resource to which that person has lawful access; for (i) reasonable domestic use; (ii) small gardening not for commercial purposes; (c) store and use run-off water from a roof; (d) in emergency situations, take water from any water resource for human consumption or firefighting; (e) for recreational purposes (NWA, 1998) .

The rate of infection among recreational users rises steadily with increasing concentrations of harmful microorganisms and, with a constant concentration of microorganisms, has been shown to have a dose-response relationship with the risk of illness in microbiologically contaminated water. Infection rates are higher among recreational users who have had more exposure in these polluted surface water (Hampson et al., 2017:4; WHO, 2003).

According to Donnenfeld *et al*. (2018), untreated wastewater accounts for about 40 percentage of South Africa's wastewater. Improving wastewater treatment may help the country's water supply and quality, as well as increase groundwater extraction. According to the DWS, SA has the potential to greatly increase groundwater usage.

During water analysis on ARV drugs' presence and fish toxicity assessment living in this water, industrial chemical, pharmaceuticals, and biological compounds were found in the water and also on fish samples. In countries like SA where a large poor population may depend on fish that is caught from rivers and dams and used as food daily is an alarming reality of an imminent health threat (FAO/CGIAR WLE, 2017). Pride and Joy Consultants (2015) attests to poor municipal results on environmental and conservation issues; the municipality of Ethekwini also performs poorly in terms of reducing contamination of rivers and wetlands. One of the major impacts of the fast-growing casual settlements in and around Durban and Pietermaritzburg is the defilement of the streams and conduits with crude sewage.

Thus far, there is a relationship between pollution due to illegal dumping and diseases (Alfredo *et al*.,2015). Diarrhoea is a surface water-related disease usually present with E. coli contaminants. The statistics of the Umlazi area revealed that children under the age of 5 years were highly infected with diarrhoea disease (Health Department Province of KwaZulu-Natal, 2015). While Philip (2010); Xolo (2017) and Dlamini (2019) confirmed that sewage blockage is a challenge in this area due to illegal dumping and

uncollected garbage by the municipality of Ethekwini. Such poor infrastructure conditions accelerate the children under the age of 5 years of severity and susceptibility of malnutrition and other health risks associated with poor water quality of streams and rivers especially in the urban developing countries.

2.15 MALNUTRITION THREAT IN URBAN AREAS

Besides the need for water for drinking, water resources play a vital role in various sectors of the economy such as agriculture, livestock production, forestry, fisheries and other creative activities (Sivaranjani, Rakshit & Singh, 2015). According to USAID (2019) about 30 percent of women suffer from malnutrition that is accompanied with disease vulnerability and severity in relation to freshwater fetching and utilization that stems out of surface water includes cholera and diarrhoea (Eckstein *et al*., 2018; USAID,2018).

Rodríguez, Cervantes and Ortiz (2011) believe monitoring of malnutrition is very important in situations of acute respiratory infection as it leads to child death, hence malnutrition conditions may result in more susceptible even severe outcomes as death. Nutrition is considered important in reducing an individual's susceptible to diseases, especially children. A poor regulation on unhealthy foods to children by public health programs can significantly contributing factor to malnutrition as previously mentioned with White et al. (2015) confirming that urban areas with low economic income are more prone to malnutrition. USAID (2018) confirms that climate change contributed to vulnerability of about 40 percent of children in Bangladesh that suffer from severe malnutrition. South of Asia Bangladesh's water and agriculture and coastal infrastructure are vulnerable resources which is one of the third world countries.

According to UNDP (2006), water-related infections and lack of healthy sustenance avoid individuals from working and going to school, both of which fortify the cycle of poverty. Destitution is multidimensional and incorporates hardships, such as poor wellbeing and sustenance, lacking schooling, as well as the psychological trauma of dealing with embarrassment (Narayan & Pritchett, 2000; UNDP, 2010). According to

WHO and UNICEF (2017), environment-related health problems have the greatest impact on people living in the world's poorest regions. According to Niraula, Barnawal, Poudel, Mishra, Dahal, Das, Pradhan, Ghimire, Khanal, Sharma, Rajput, Bhattarai and Jha, (2013) and WHO (2017), persistent diarrhoea only deepens in poor health and children with malnutrition condition and often leads to underdeveloped growth due to loss of appetite and poor nutrient absorption (Niraula et al. , 2013; WHO, 2017).

Households with children aged 0–6 who missed a meal or multiple meals because there was insufficient food in the house in the previous 12 months in 2016. More than 1,5 million children (21%) out of a total of 7,2 million children dwelled in family units that skipped suppers within the past 12 months. Among those who skipped a supper within the past 12 months, generally 511 000 skipped a dinner for five or more days within the past 30 days (SSA, 2018:38).

2.15.1 Using Community River Monitoring Programmes in Stream Management to reduce both Health and Malnutrition risks

Robins and Roberts (1997) describe sustainable consumption as not an increasing burden on the earth to supply improved quality life such as food, health, and shelter rather than the demand for goods and services required to meet basic needs. Present production and consumption practices, such as an environmentally unsustainable urban development paradigm and rising inequality, have the potential to jeopardize some of these assets. Since the definition of sustainable development highlights the reuse of natural resources. The stream can be defined as a small river that flows to the sea. The river or stream is used for different functions which include tourism and recreation especially in the urban areas where houses have water connections and all citizens have excess to clean water.

The capacity to purify and store water, renew soil fertility, clean the air, pollinate crops, and prevent topographical instability are all examples of ecosystem services. However, all of these activities that are undertaken either on the catchment, river or

stream are dependent on a health aspect of that area aspect therefore, the use of the health belief model in this study is important to determine the relevant stakeholder's knowledge, attitudes and behaviour toward stream restoration practices since the health aspect are not emphasized in the NSSD (DEA,2011,2015).

Liu and Guo (2018) also insist that using a community-based monitoring program mechanism is a good tool in enhancing and instilling environmental values in the citizens of the area. This part of the environmental education teaching process encourages citizens to present their own opinions in solving problems through group decisions. The process allows such citizens to gain much understanding and knowledge on environmental issues as environmental values are reclassified through criticism and comparison. Nurwidodo, Al Muhdar, Rohman, Iriani, Herlina and Fausan (2019) believe that not only does it positively add to citizens' environmental knowledge and understanding but rather has a positive impact on their behavioural change towards environmental value issues. According to Bolderdijk, Lehman, and Geller (2018) overcoming environmental damages in the society can be achieved through environmental-based education, as environmental-based education is a key element in developing a positive attitude towards pro-environmental behaviour.

In Canada, for example, Nova Scotia catchment, in more than 10 catchments, community groups conduct water quality monitoring activities. According to Sharpe and Conrad (2006), parameters of biological indicators such as benthic invertebrates and faecal coliform bacteria are measured. The physical indicators in this community monitoring include, temperature, total suspended solids and chemical indicators dissolved oxygen, nitrates and pH levels are monitored (Sharpe & Conrad, 2006; Cele, 2015).

In the African continent different water quality monitoring tools are used, for example in Namibia, a Namibia's Scoring System (NASS) is used; in Botswana, a Okavango Assessment System (OKAS) is used and in Zambia, a Zambia Invertebrate Scoring System (ZISS) is used (Elias, Ijumba & Mamboya, 2014). Other African countries using community-based tool such as the Management-Orientated Monitoring System (MOMS) as a for monitoring natural resources (Mulale & Pelane, 2013). In Botswana, to avoid the killing of more animals, community members were trained in monitoring the community's adherence to hunting procedures (Mulale &Pelane, 2013).

Education and training approaches change the culture and institutional norms of environmental stewardship from SES framework are needed in the community (Village Earth, 2016). Adaptive management is a process of improving policy management and strategies (Bormann, Haynes & Martin, 2007). The application of European perspective such as adaptive river management in a third world country creates problems as it has a different perspective altogether (Pahl-Wostl *et al*., 2007). According to White *et al*. (2015), lack of information about behavioural factors like beliefs, values, and experiences is detrimental whereas behavioural change helps in the prolonged sustainability of water and sanitation as it improves knowledge, attitude and practice on diarrheal outbreak seasons.

The application of the co-development knowledge approach in SES framework for uMlazi stream water quality restoration study is essential as it addresses local community problems at community level and search for demographic information that is usually lacking from the professional side of HBM framework (Virapongse et al., 2016). According to Cele (2015), residents in SA are in an enhanced position of knowing the causes of pollution, as they are ‘eyes and ears' on the ground (Cele, 2015). Citizens have been trained to collect water quality data to support the DWS's RHP monitoring on certain studies (Nel and Driver, 2015). Yet, Nel and Driver (2015) affirms that even though some of the past river health data were recorded on a single database using South African Scoring System (SASS), Much of it is still dispersed throughout the world, and database information is frequently incomplete or incorrectly referenced. Furthermore, since sampling sites appear to concentrate on tracking accumulated effects of major rivers, tributary monitoring is severely underrepresented, and more effort should be made to address this bias (Nel and Driver, 2015). Nel and Driver, (2015) suggest for river reaches in sub-catchments of 150-200 km2, ecological condition data will be collected.

According to DWS (2017) the role of DWS in the socio-economic development of the country is defined clearly in the National Development Plan (NDP), where the DWS drives a number of activities that contribute to this NDP macro-economic outcome; and is the mission of the DWS. Fulfilling NDP requires DWS prioritizing to support all economic programs. As the economy grows, the demand for water and sanitation also

increase, demanding interventions high levels of financial and the roll-out of new infrastructure

The NDP of SA does address SDG, so does the IDP through the budget plan. However, the deficit due to expenditure being higher than income does not allow job creation and proper economic growth. It is believed that focusing on and promoting the Local Economic Development (LED) of each municipality's economic growth as part of the SDG objectives can be met. The application of mini SASS as a tool for LED in the communities can help in reducing the conditions of the deteriorating rivers. The use of statistical analyses for analysing samples of macroinvertebrates is a common practice as can be seen in Elliot (1977) (Mackereth, Heron & Talling ,1978). CDM Smith (2016), states that the miniSASS tool is a water quality analysis tool that measures macroinvertebrate presence to determine river health that has been adapted from the more complex SASS5 tool.

The RHP developed by the Department of Water Affairs and Forestry (DWAF) in 1994 was used to assess the health of the aquatic environment by using in-stream and riparian biological communities for example fish, invertebrates, vegetation, to characterize the response of the aquatic environment to multiple disturbances. In 2016, the River Eco-Status Monitoring Programme (REMP) was developed and replaced RHP, the REMP is a component of the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP). MiniSASS could operate as a perfect indicator to analyse the ecological status of rivers and to serve as an early warning system for decreased river health and increased pollution (Cele, 2015; CDM Smith, 2016). MiniSASS is also an important educational tool which can be used to link ideas such as sustainability, conservation, and human impacts on their environment as part of surface water quality management since the 2030 Agenda for Sustainable Development recognizes eliminating poverty as the greatest of all global challenges (UNGA, 2015).

There is a need for SASSA in streams and tributaries to explore how the data are collected and collated and at what scale as Nel and Driver (2015) focused on biomonitoring tools. Biomonitoring alone, however, cannot give water quality assurance for drinking purposes but helps in raising a ‘red flag' indicator on streams condition (Graham, 2012). Also, Dickens and Graham (2002) have reasoned that other

forms of monitoring, such as, chemical monitoring, may not be sufficient data for monitoring water resources.

Prior to the late 1980s, only chemical and physical water quality variables were used to track water quality; the SASS was introduced in the late 1980s as part of South Africa's river monitoring initiatives (Dickens & Graham,2002). Nel and Driver are a couple (2015). SASS is a bio assessment protocol that assesses the condition of aquatic invertebrates in the field by identifying their families (Nel and Driver,2015). SASS users need to identify up to 90 aquatic invertebrate groups to generate surface water quality data (Taylor, 2004; Graham, 2012; WRC, 2014).

The MiniSASS, a citizen science tool that needs only the identification of 19 invertebrate groups but provides scientifically accurate data comparable to SASS findings, requires only the identification of 19 invertebrate groups. According to Cele (2015), science knowledge such as the use of miniSASS to measure the water quality of rivers and streams remains with the population for a long time and allows for knowledge transfer from one generation to the next (Rivett, Taylor, Chair, Forle, Mrwebi, Van Belle and Chigoma,2012, Graham, 2012).

The South African National Water Act (NWA) developed in 1998 after RHP emphasized the services and goods of the aquatic ecosystem as a role of RHP. This incorporated the Strategic Framework for National Water Resource Quality Monitoring Programmes and the National Water Act (Act 36 of 1998) and river database. The REMP focuses on the characteristics of the abiotic drivers of the system: the hydrology, geomorphology and physicochemical conditions that determine the habitat template for instream and riparian biota. Hoekstra, Chapagain, Aldaya and Mekonnen, (2011) state that policies and approaches that acknowledge wastewater as a resource and emphasize the clear connection between ecosystem resources and human well-being are also needed.

The introduction of ambient water quality standards is critical for avoiding harmful environmental consequences and preserving natural habitats which eventually improves the health of surrounding citizens (Hoekstra *et al*.,2011). Prüss-Ustün et al. (2016) emphases that people in the world's poorest areas are the ones who are most affected by environmental health issues. Bowd, Quinn and Kotze (2015) believes that

this aspect of RHP is viewed as having the potential to help alleviate poverty in rural South Africa, as it is dependent on ecological and socioeconomic variables. These variables communicate with each other at different spatial and temporal scales, forming a dynamic adaptive social-ecological structure (SES) (Bowd *et al*., 2015). Walker *et al*., (2002) argue that communities living and interacting with one other as interdependent systems are part of social ecosystem of SES definition.

According to Cele (2015), community members living in the nearby informal settlements along the banks of the uMngeni River were educated in water quality monitoring techniques, including sampling and measuring with simplified clarifier tubes and maintaining data records. Residents of the selected informal settlements who participated in this process were rewarded for their contributions. As the Howick Waste Water Treatment Plant (WWTP) became aware of the situation, they began treating the effluent to meet appropriate standards (Taylor, 2004; Graham, 2012; Rivett *et al*., 2012). As a result, the wastewater treatment plant implemented new methods for handling effluent to meet appropriate requirements (Graham, 2012).

As previously mentioned, overcoming environmental damages in the society can be achieved through environmental-based education, as environmental-based education is a key element in developing a positive attitude towards pro-environmental behaviour (Bolderdijk *et al.*, 2018). Mini SASS promotes environmental education and is a good tool in building a pro-environmental behaviour on citizens. MiniSASS allows citizens to have first-hand experience in the effect of severity and susceptibility on surface water pollution which can impact their perception of such issues because it enhances HBM, perception of seriousness of pollution. Lack of community participation can as a result affect knowledge gain and understanding resulting in citizens not being fully involved in the decision-making process and even lacking understanding of policies implemented by Bolderdijk *et al*. (2018). Challenges of citizen science or MiniSASS, SES or SEM on River Restoration can be overcome by NGO's active participation in River or stream management.

2.16 CONCLUSION

This section highlighted what professionals and individuals' community members perceived as environmental stressors associated with management of stream water quality policy were. In identifying, the susceptibility; severity; barriers; self-efficacy and; cues of action of the individuals' knowledge, attitude and behaviour perceptions associated with stream water quality the environmental stressors would be identified and measured. The following chapter will discuss the theoretical framework that guides this study comprising an analysis of policy impact and stream water quality practices on knowledge, attitudes and behaviour toward stream restoration practices in Umlazi Township, KwaZulu Natal, South Africa.

CHAPTER THREE

THEORETICAL FRAMEWORK GUIDING THE STUDY

3.1 INTRODUCTION

This chapter presents the theoretical framework that guides this study comprising an analysis of policy impact and stream water quality practices on knowledge, attitudes and behaviour toward stream restoration practices in Umlazi Township, KwaZulu Natal, South Africa. The researcher draws on the manner in which key elements of the integrated health belief model will be used to guide the development of the data collection instruments. This will be achieved through the following; a documentary review of assessed stream water quality in the primary streams; conducting an initial assessment of identified stakeholders' knowledge, attitudes and behaviour about stream water quality policy and practices. and through the development of a knowledge, attitude and behaviour modification framework/ recommendations that support stream water quality restoration practices.

3.2 RELATED THEORIES/MODELS TO THE STUDY

A theory is a collection of interconnected concepts, meanings, and propositions that present a systematic view of events or situations by defining relationships among variables in order to explain and predict them (Glanz *et al*.,2008). The explanatory theory/ These theories predict behavior under given conditions and direct the quest for modifiable factors such as experience, attitudes, self-efficacy, social support, and a lack of resources.

Change theories/theory of action are there to guide the development of interventions, basis of evaluation of how the program should work. Implementation theories are change theories that link theory specifically to a given problem, audience, and context (Institute of Medicine, 2001) and these include preventative and control models.

A theory's main components are its building blocks or primary elements; they are the theory's building blocks or primary elements. Constructs are principles that are created or implemented for use in a specific theory (Kerlinger,1986).

Variables are the empirical counterparts or operational forms of constructs. They specify how a construct is to be measured in a specific situation. Variables should match constructs when identifying what should be assessed in the evaluation of a theory-driven programme.

The driving principles for shaping health behavior are much too nuanced to be described by a single, coherent theory. To explain a specific problem in a specific setting or context, models rely on a variety of theories (Earp and Ennett,1991)

According to Morowatisharifabad *et al*. (2012) people's behaviour and intentions about healthy behaviours depend on their beliefs, values and knowledge incooperated by both theories of planned action and health belief model (HBM). Various models of health education are used in determining predictors of different healthy behaviours but their usefulness in cultural behaviour, such as in stream water saving behaviour has not been studied where intention can change over time and knowledge acquisition, resulting in a greater likelihood that unforeseen events will produce changes in intentions.

This chapter covers three essential theories to our understanding of healthy behaviour: Health Believe Model but as an extension and bases of Theory of Reasoned Action (TRA), Theory of Planned Behaviour (TPB); Adaptive Model; and Social Ecological Model. To better guide the appropriate use and application of these theories, it's important to understand the history and development, similarities and differences of each.

3.2.1 Theory of Research Action (TPA)

TRA was first introduced in 1967 by Fishbein; it asserts that the most important determinant of a person's behaviour is a person's behavioural intention (comprised of attitude and subjective norms associated with the behaviour). In contrast to previous theories, Fishbein distinguishes between attitude toward an object (for example, breast cancer) and attitude toward a behaviour (for example, mammogram screening) with respect to that object (Shafer *et al*.,2017).

Later, it was discovered that the accuracy of TRA in describing behavior was dependent on the degree of volitional regulation of the behavior (that is, the degree to which an individual can exercise control over the behaviour). As a result, Ajzen and coworkers suggested TPB as an addition to the TRA system. TPB is intended to predict actions in which people's freedom of choice is restricted. This extension, referred to as perceived behavioral regulation, attempts to account for variables outside the individual's control that can influence their purpose or behavior (Glanz *et al*., 2015).

3.2.2 Theory of Planned Behaviour (TPB)

While the theory of planned behaviour (TPB), intentions (and behaviours) is influenced by pose of three basic determinants, one of which is personal in nature, the second of which reflects social power, and the third of which deals with control issues. The individual's attitude toward the behavior is a personal factor. The person's sense of social pressure to perform or not perform the behavior in question is the second determinant of purpose. The third determinant of intentions is the sense of self-efficacy or ability to perform the behaviour of interest, termed perceived behaviour control (Vinothkumar, & Subramanian, 2016; Fishbein and Ajzen ,2005). People intend to engage in a behavior when they think it will benefit them, when they are under social pressure to engage in it, and when they feel they have the resources and opportunities to do so (Ajzen,1985 and 2005) and that acquiring specific skills by observing social norms and through reinforcement and reputation process leads to development of new behaviour that eventually becomes permanent (Kotler & Lee ,2008).

Nam, Dong and Lee (2017) believes part of self-efficacy are the perception that the benefits of adopting a certain behaviour outweigh the costs and that a person’s confidence of adopting the preventive behaviour that causes behavioural change under social cognitive theory.

3.2.3 Social Learning Theory (STL)

SLT also known as Social Cognitive theory (SCT) has its roots (Bandura, 1977; Bandura, 1986). Bandura views learning as an interaction between humans and their environments. Bundura (1986) proposes environmental and personal influences on behaviour. However, this theory focuses on social environment behavioural intervention and rarely on physical, community and organizational environment (Glanz *et al*.,2008), but SEM focuses on all; Human behaviour is a continuous reciprocal interaction between cognitive, behavioural and environmental determinants (King, 1999; Smith & Berge, 2009). The theory originally evolved from theories of behaviourism (Stimulus-Response theories) which emphasized that observable behaviour is a result of environmental stimuli concepts of cognitive response as opposed to internal events like thinking and emotion. Social learning theory also reasons that learning may take different forms, including new behaviour patterns, judgmental standards, cognitive competencies, and rules for creating behaviours. According to Bandura (1986), most human behaviour is learned by observation through modelling.

According to Smith & Berge (2009) SLT is an imitation that defines modelling Imitate, as described by Flett (2007), is the act of doing what others do. This can be interpreted as observing other people's behaviors and imitating them, or as a person using another person's behavior as a stimulus for imitative behavior.

There are determinants of behaviour which individual's attribute means the factors which influence behaviour: these are positive and negative reinforcements for behaviour (White *et al*., 2013; Matumbu, 2019). These are (1) perceived consequences (2) self-efficacy which is the person's feeling of adequacy to perform a new behaviour and, (3) social norms which suggest that people do things to please or follow people they admire (Smith & Strand , 2008; White *et al*., 2013).

According to Bandura (1986), through the years, modelling has always been acknowledged as one of the most powerful means of transmitting values, attitudes and patterns of thought and behaviour imitation or modelling.

Vicarious, symbolic, and self-regulatory mechanisms, such as cultural appropriate behavior, play an important role in social learning theory. When an individual has his own ideas about what is acceptable and improper behavior, he or she engages in self-regulatory behavior (Smith & Berge, 2009). Anything that deviates from the tradition, for example, is considered unacceptable such as throwing a party in the morning and not observing cultural rituals after the death of the love one.

Consequences from much social learning is fostered by observing the actual performances of others and the consequences for them. For example, a student who changes to fit in with certain group of students has a strong likelihood of being accepted and thus reinforced by that group Ormrod (1999).

Under perceived benefits, behaviour effects and acts that bring rewards are controlled, and they will be replicated. Whereas perceived barriers is a behaviour perceived to bring punishment tend to be discarded and individuals may refrain from certain behaviours as they observe their models being punished for exhibiting them (Bandura, 1986). Bandura (1986) asserts that people may acquire certain behaviours but never perform them especially when it has little functional value or if carries high risk of punishment.

3.2.4 Health Believe Mode (HBM)

3.2.4.1 The Origins of Health Believe Model

HBM was originally formulated to explain (preventive) health behaviour. As defined by Kasl and Cobb (1966) health behaviour is defined as “an activity undertaken by a person who believes himself to be healthy for the purpose of preventing disease.

From Lewinian theory (Lewin 1935), theory of goal setting in level-of-aspiration situation, hypothesized that behaviour depends mainly upon two variables: (1) the value placed by an individual on a particular outcome and (2) the individual’s estimate of the likelihood that given action will result in that outcome (Becker, 1974).

3.2.4.2 Post-Lewinian Models

From this, Becker (1974) added five other predictives to describe action involved in risk taking under uncertainty (1) Tolman's analysis of performance (Tolman 1955) , (2) Rotter's concept of reinforcement or "social learning"(Edwards 1954, 1955), (3) Edwards' decision theory model of Subjective Expected Utility (SEU), (4) Atkinson's view of risk-taking behaviour as a theory of achievement motivation (Atkinson 1957) , and (5) Feather's analysis of decision making under uncertainty (Feather 1959).

Tolmins analysis include (1) "valence", the value placed by the individual a particular outcome or goal that is a pull or attractiveness of the goal for the individual and (2) "subjective probability", the individual's expectation (attitude) that a particular individual's expectation that a particular action will produce the desired outcome.

Rotter's theoretical formulation of choice behavior is a social learning theory (SLT) that is focused on previous experience where a person received reinforcement for a specific behavior and discovered that such reinforcement followed the behaviour (Rotter 1954).

The achievement theory motivation has tendency to approach success is an elaboration of resultant valence theory, which is motivation. a desire to escape failure. It involves relationship among positive and a negative component (1) expectancy(depends on past experience and knowledge), (2) incentive(good/bad, success/failure) and, motivate(Atkinson 1957). Expectancies and incentives are aroused, depending upon past experience in situations confronted (perhaps that why educated people strive to learn more about their surroundings and improve environment because they know the feeling of success unlike those that do not care). A motive is stable characteristic within the individual which causes him to approach positive incentives and to maximise satisfaction avoid negative incentives.

Finally, a stimulus must occur, which may be internal (perception of bodily states) or external (interactions or messages, personal awareness of someone affected by the condition) behaviour and this is called cue to action. A motivation is a stable characteristic within the individual which causes him to approach positive incentives and to maximize satisfaction (to achieve success) to avoid negative incentives (avoid failure) explained by Father,1959.

Feather (1959) describes attractiveness related to both attractiveness of the object and to the value of attaining the object. Also, a goal object is that is more difficult to attain, will hold greater value. Finally, it is assumed that: (1) an ego-related situation (success related to efforts and skill of the individual than chance-related situation, (2) an achievement- oriented situation (test-like situation involving pressure to success) than in a relaxed situation. Attractiveness is related to both the attractiveness of the object and to the value of attaining the object. It assumes that :(1) An ego-related situation (success related to efforts and skill of the individual than a chance-related situated; (2) an achievement-oriented (involving pressure to successes). Feather's experiment study involved: (1) attainment attractiveness related to success probability and (2) choice potential (Feather, 1959).

Kasl and Cobb (1966) defines HBM as a model that analyses an individual's motivation to act as a function of the expectancy of goal attainment in the area of health behaviour. HBM is derived from the social- psychological theory of Lewin(Lewin 1935) and (Becker, Drachman and Kirscht 1974). HBM follows theoretical conditions and components (1) the individual's psychological; "readiness to take action" relative to susceptibility and by his perceptions of the severity and (2) the individual's evaluation of health action of its feasibility and efficaciousness, and barriers or costs.

3.2.4.3 Domain key components of HBM

Individual perceptions

Individual perceptions speak directly to the knowledge, experience and beliefs that a person has about his behaviours and the outcomes they could have and this includes; perceived susceptibility and perceived severity (Becker,1974; White *et al*., 2015).

3.2.4.3.1 Perceived Susceptibility

Susceptibility refers to the risk at which person thinks or feel they are facing due to the condition or disease at a given time. If the individual feels that the risk of getting that particular disease is great, they are assumed to change their behaviour however; if they do not feel it, they would not change their behaviour. Individual's opinions about how likely the behaviour they partake in are going to lead to a negative health outcome

that is likelihood. As one of goals of HBM is to change perceptions of susceptibility in order to move towards behaviour greater quality of life for both mentally and physically change (Burke, 2015).

3.2.4.3.2 Perceived Severity

In the HBM, perceived severity accesses seriousness susceptibility of an individual's condition or diseases (Burke, 2015; Li, Yang, Zhang, Fisher, Tian & Sun, 2015). Susceptibility as stated before displayed how someone acknowledged that their behaviour could lead to a specific disease. Threat takes the idea one step further by examining just how likely it is that the disease could be developed. For example, at this phase an individual is asked if they feel that this condition or sickness will lead to death or affect their social life like a job or family matters (White et al, 2015). It is therefore important to understand how modifying factors can affect someone's decision to change in the state of perceived threat. The cough could be a symptom that increases his level of threat and triggers his decision to quit (Burke, 2015).

3.2.4.3.3 Modifying Factors/ Other Variables (External factors)

While individual perceptions were internalized, in the HBM modifying factors looks at factors outside one's body and use outside influences to affect how threatened a person feels by the outcomes of that action. There are four elements in relation to decisions to act, given presentation of symptoms, and the relationship of these elements to social-structural characteristics. Decisions taken for oneself and others are included (example children dependent on decision maker). Among the most important factors include (1) Health motives elicited by symptoms, (2) the threat posed by the symptoms, including physical harm, (3) the benefits or value of an action to reduce the threat, (4) barriers of action.

3.2.4.3.4 Cues to Action or intervention/triggers

According to White *et al.* (2013), little acceptance susceptibility or severity of a disease, can be an intense stimulus needed to trigger a response(action) of change behaviour. Such a trigger, or cues to appropriate action severity provided force to act and the perception of combination of these without event occurring (trigger or nothing done).

The trigger can be events internal- for example perception of the bodily states or external for example interpersonal interactions, the impact of media communication and this phase is termed. Even due to relatively high levels of perceived susceptibility and severity slight stimuli may be adequate. For example, the person who barley accepts his susceptibility to tuberculosis will be unlikely to check upon his health until he experiences rather intense cues, even more so some kinds of cues with the passing of time, it is easy to forget (Freidson 1961). Cues to action, according to Freidson (1961), are explanations why a person knows he is at risk of serious disease. This may be members of the media or concerned family members. Anything that prompts a decision to alter behavior is referred to as a cue to action. Likelihood of Action is the product of the previous two categories building on each other. Likelihood of Action after being aware of the risk of contracting a disease if one's behavior does not improve, it's important to consider the advantages and disadvantages of taking action to see if it's worthwhile (Marmarà, Marmarà, & Hubbard, 2017; Burke, 2016, Li *et al*, 2015).

3.2.4.3.5 Perceived Benefits of Taking Action and Likelihood of action or recommended preventative health action

The acceptance of one’s susceptibility provides a force leading to action. The direction that the action takes is influenced by effectiveness of known alternatives (knowledge and experience) in reducing the disease threat. A benefit to change would then increase health on an individual ‘s level, however, there are other factors that can influence action existing, like social pressure. The behaviour of individual depend on how that individual believes the action is beneficial to them and this process is termed likelihood of taking recommended preventive health action. This likelihood occurs

when an individual perceives benefits of preventative action that is greater than perceived barriers to preventative action. Action is taken through belief that disease will decrease, and that is a benefit in HBM (Becker,1974).

3.2.4.3.6 Perceived barriers (in terms of Decisions to seek care)

The beliefs can be influenced by the norms and pressures of social groups, but action itself may inconvenience, or be expensive, unpleasant, painful or upsetting to the individual. These negative aspects of health action serve as barriers to action and if willingness to act was high, the negative aspects or barriers are seen as weak. If willingness or intention to act is low, then negative aspect function as barriers to prevent action. Example anxiety or fear, lack of education, low income, negative experience and family issues can be a reason enough that an individual can reconsider taking an action (Hyman 1970; Anderson and Bartkus 1973).

Severity in terms of threat is experienced in daily living and these require learning to interpret symptoms at an early age (Morris, Health & Chipman 1965). During illness behaviour, a process of active decision making occurs prioritizing of such issues to be part of decision making during the phase of illness (Zola 1973).

3.2.4.3.7 Self-efficacy

A self-regulatory process is when a person has his own ideas about what is appropriate behaviour (Smith & Berge, 2009). For example, anything deviating from the culture is regarded as inappropriate and unacceptable such as throwing a party during mourning. Consequences from much social learning is fostered by observing the actual performances of others and the consequences for them Ormrod (1999).

Social information can have powerful effects on behaviour when it does not come from medical experts but from fellow citizens who have been equipped with knowledge and skills. Patients who spend time with and observe other patients with sickness (Kulik and Mahler, 1987). Therefore, social network can delay perceived severity or even

symptoms. Individuals often select targets for social comparison in order to make themselves feel better rather than obtaining an accurate conception of their own state of affairs (Perloff and Fetzer, 1986; Taylor, Wood & Lichtman, 1983) for example, it represents a barrier that can lead to overly appraisals about individual risk (Leventhal, Brissette & Leventhal, 2003).

3.2.5 Adaptive Management Model

Janecky, Whicker and Doerr (2009) describe adaptive management model as a deliberate and systematic approach for gathering information by applying management actions that is associated with management of natural resources but it has also been effectively applied in a limited set of restoration activities at contaminated sites (Janecky *et al.*, 2009). According to Nyberg (1999) adaptive management is an inherently circular process, which recognises the uniqueness of each situation and does not promote a “standard procedure” or recipe to be used for all situations.

According to Stankey, George, Clark and Roger (2005) adaptive model is divided into three types, namely: incremental adaptive management that is described as a reactive management, with no specified objectives; passive adaptive management which uses historical data to identify linear approach assumed to be correct. However, this process cannot differentiate between natural changes and management impacts, and; Active adaptive management that provide data and feedback on the relative efficacy of alternative models and not relying on a single model.

Adaptive Management approach is based on four main principles: First, adaptive management, the uncertainty can be associated with our knowledge. The second principle requires performance metrics and monitoring of progress and the ability to adjust actions (Williams *et al*., 2007). The third principle is that stakeholder participation is mandatory. Fourth, approach must be consistent with applicable laws and regulations, therefore, operational and regulatory agencies must be able to develop, adopt, or accept flexible standards and site-specific remediation plans.

However adaptive management's role as a theory in this study would also require information on believes of stakeholders, without this, information can result in an incomplete set of performance metrics. These principles clearly interact and influence the design and specific methods used in adaptive management. Early resolution of uncertainties at any stage of the restoration process for example, from data collection through stakeholder acceptance is critical to the success and speed of the restoration process and is a central feature of the adaptive management paradigm

Challenges of river management address uncertainties in the socio-institutional system (Walters, 2007). There is also uncertainty in the management where governments often enact policies, but their execution is hampered by governance challenges, such as policymakers' unwillingness to accept and embrace uncertainty when making policy decisions (Walters, 2007). There is a scarcity of federal funds to sustain long-term learning from river monitoring projects (Allan & Curtis,2005; Walters, 2007; Failing, Gregory & Higgins, 2013). According to Van Asselt and Rotmans (2002) and Walker, Harremoës, Rotmans, Van der Sluijs, Van Asselt, Janssen & Krayer von Kraus (2003) uncertainty in the river system is generally thought to be caused by a lack of knowledge (epistemic uncertainty) or intrinsic random variance (ontological uncertainty). (Walker *et al*., 2013).

Adaptive model is based on three types of loops for learning. Single-loop learning refers to circumstances that improve the dialogue between policymakers and the general public, such as when policy results are tracked and actions are adjusted as needed. Double or second-loop learning implies that underlying values and assumptions are questioned and involves reframing. If first-loop changes do not provide an adequate response to uncertainty, second-loop changes may be required. When a problem's solution necessitates more details, for example (Warmink, Janssen, Booij & Krol, 2010). Triple or third-loop learning involves structural changes in the governance regime.

Third-loop changes involve responsibility change that can reduce the role's ambiguity by changes in the institutional sense, including lawmakers' references and the governance framework This necessitates a profound shift in the actors' attitudes and mindsets, as well as shifts in underlying norms and principles and the governance system (Lawrence, Reisinger, Mullan, & Jackson, 2013; Pahl-Wostl, 2009). A third-

loop transition, according to Pahl-Wostl (2009), can mean that a flood protection strategy is changed from preventing floods to acknowledging floods under certain circumstances and prioritizing evacuation strategies. Where flood protection in the event of (extreme) discharge is no longer solely the responsibility of the government, but is shared by the public by various means of insurance, local authorities and democratic decisions. Since politicians can find these changes undesirable, they can be very important.

Hommes *et al.* (2009a) in a study of how stakeholders' perceptions processed knowledge to make decisions investigated the effect of the expansion of Rotterdam's Mainport on the local ecosystem in the Netherlands. Hommes *et al.* (2009a) confirms that since it exposes previously unknown uncertainties, new knowledge can also raise uncertainty. It's critical to build a scientifically valid knowledge base; dealing with uncertainties necessitates striking a balance between process (dealing with ambiguities) and content (dealing with uncertain or a lack of knowledge).

Limitations in the application of this model on this study includes the two key conditions: first, the fact that uncertainty can be associated with stakeholders' knowledge of the issues and the application of existing response tools (Williams *et al*., 2007), whereas in South Africa there is no data available on coastal and ocean ecosystem monitoring according to Republic of South Africa Operations Phakisa (2014). The second principle, it requires performance metrics and monitoring of progress, hence there is no way one can monitor something that is not available Williams et al. (2007) there and the ability to adjust actions depending on the observed trends versus the desired outcome (Williams *et al*., 2007).

Another criticism of over-studying a problem without taking substantive steps toward project goals is commonly made, but the intent of experiments in the adaptive management paradigm is to study the problem (Hommes *et al*., 2009).

3.3 Variables

Variables are constructs' empirical equivalents or organizational types. They define how a construct should be evaluated in a given situation. When determining what

should be evaluated in the assessment of a theory-driven program, variables should fit constructs.

3.3.1 The use of HBM and SEM in this study

In South Africa the study has shown that rivers and streams are constantly polluted by human activities in the urban areas (DEA, 2012 and CSIR, 2010). Illegal and uncontrolled practices have a major negative effect on marine resources, infrastructure, commerce, and food security, resulting in severe economic and job losses (Republic of South Africa Operations Phakisa, 2014). During the rainy season (October-February) and the rotavirus season (April-August), more cases are discovered. Greater Inanda/Tongaat, Phoenix, KwaMashu, Inanda, and Umlazi sub-districts are the worst affected by diarrhoea cases due to water pollution and weak infrastructure (DHPKZN, 2015).

Several WHO and UNICEF programs have been implemented over the last decade, that focuses on water supply and sanitation (Bardsley *et al*., 2013). In achieving this, the sustainable developmental goals (SDGs) indicate that an additional 1.2 billion of the world's population continue to use water from sources and systems with significant sanitary risks (Liu *et al*.,2016 and Tsakiris & Alexakis, 2012). Important to note also, is the fact that the growth of the world's human population and urban development have increased at an unprecedented rate and so too, has the burden of maintaining a safe water supply.

South Africa's NSSD uses SDG as guideline, the research conducted will investigate the NSSD approach of South Africa in the implementation of healthy stream water restoration to improve sustainable development especially that of the ecosystem; enhancing systems for planning and implementation and; building sustainable. South Africa uses nest model to achieve it sustainable development goals however, this model also lacks it environmental data. Moreover, data-driven approaches are moreover criticized for lacking theoretical foundations (Republic of South Africa Operations Phakisa, 2014 and DEA, 2014).

According to London, Naledi and Petros (2014) the majority of Low Middle Income Countries (LMIC) governments do not invest in health research because the public and policymakers are not fully aware of its value assessment of health research project. In the Western Cape Province of South Africa for example, it was found that between 2010 and 2011 South African government funded 92 projects and only 8% of projects were dedicated to water management, 65% of projects funded addressed HIV/AIDS and TB, a research scope that neglects the population's other priority health issues (London *et al*., 2014).

Water scarcity and the lack of safe water supplies represent a serious global public and environmental health problem with nearly 1.8 billion people, that is, out of the world's population of 7.6 billion being identified as having little or no access to safe drinking water (Sandhu, 2014). Efforts to improve the prognosis of this challenge have traditionally identified water scarcity rather than water quality as the primary area of difficulty and by inference, the focal point for all viable solutions to the water supply problem. However, more recent literary contributors identify the management of water quality as the single most important human intervention that can be affected to address this problem which is responsible for up to 385 000 deaths per year globally (Bardsley *et al*., 2013; Liu *et al.,* 2016). The responses to water quality issues are therefore largely vested in the dominant theories of public health and to this end, there is acceptance that health related behaviours may be modified by existing knowledge and attitudes of communities (Dean, Fielding & Newton, 2016). Guided by this, the current study will analyse the impact of policy and water quality practices on community knowledge, attitudes and behaviour toward stream restoration practices in Umlazi Township, KwaZulu Natal, South Africa.

In river management Adaptive model argue that policymakers often perceive uncertainty analysis as a lot of even unnecessary work (Pappenberger & Beven, 2006) while uncertainty occurs natural in policymaking. Again, Adaptive management is influenced by people's role; beliefs and by change in policies. Therefore, the use of HBM fully explains the beliefs, knowledge and attitude of individuals in the study however this model lacks contextual factors as mentioned by Dreibelbis, Winch, Leontsini, Hulland, Ram, Unicomb & Luby (2013).

The HBM can help explain and predict health behaviours by measuring health beliefs; perceived susceptibility (likelihood of health problems like diarrhoea for self and close others); perceived severity (how serious is diarrhoea or polluted stream water); perceived benefits (pros of donating clean stream water), and self-efficacy (confidence that individual could keep stream clean if she or he wants to). Once perceived barriers and benefits are established, there arise a need for cues to action, which may include exposure to a media message promoting health and clean stream water donation. The use of SEM can be seen as an intervention since it directly speaks to the environment.

Combining HBM and SEM is important in this study because in public health, behaviour is influenced by individual-level attributes of HBM such as beliefs, knowledge and attitude, even, stakeholder's involvement can be influenced by the individuals living condition (White, 2012). While SEM studies the interaction of human and the environment, health behaviour resulting in behavioural change through knowledge of the population is influenced by altering physical environment (like restoration of stream) and improving conditions in which people live in yielding better public health outcomes are created through behavioural change (White *et al*., 2015).

3.3.1.1 Perceived Susceptibility

Perceived susceptibility is defined as the risk at which person thinks or feel they are facing due to the condition or disease at a given time. If the individual feels that the risk of getting that particular disease is great, they are assumed to change their behaviour, however, Perceived susceptibility is often the most predictive variable with preventive health steps. This variable refers to a participant's belief about her likelihood of risks associated with polluted stream water, the risk assessment is then conducted assessing if the risk is high or low (Severtson, Baumann and Brown ,2008). Moreover, in urbanization or large crowd of increasing population can result in reintroduction of a disease even endemic that is not usually seen in that area, put community at higher risk of disaster. Usually in situations where water and sanitation infrastructures are compromised, the disease burden tends to come from an array of enteric pathogens other than cholera. In developing countries, it is important to promote as a core, local health practice. According to Quibell (2011) South Africa's

National Strategy for Managing the Water Quality Effects of Settlements suggests that areas with a density of over 35 dwellings per hectare may be prone to pollution problems.

3.3.1.2 Perceived Severity

Perceived severity refers to a person's assessment of the severity of disease's effects (Floyd, PrenticeDunn, & Rogers, 2000). Vulnerability perception refers to a person's subjective perception of his or her risk of contracting a disease. Perceived severity accesses seriousness susceptibility of an individual's condition or diseases (Burke, 2015; Li et al, 2015; Burke, 2016). Where specific consequence and condition or threat can be severe requiring an individual to change their behaviour (Burke, 2015; Marmarà *et al*., 2017).

Each year, 1.5 million children under the age of five die from diarrhoea, which affects virtually all developing countries (Pruss-Ustun, Bos, Gore & Bartram, 2008). And clean water, sanitation, and hygiene could prevent 88 percent of these deaths (Mosler, 2012). Public health professionals are becoming more aware, but not nearly enough, as they report unused or misused toilets all over the world and abandoned of newly constructed wells which would have reduced such diseases (Peal, Blackett, Hawkins & Heymans, 2014).

3.3.1.3 Perceived Barriers

According to Glanz, Bader and Iyer (2012) perceived barriers can be described as an individual's opinion of physical and psychological obstacles and difficulties to change behaviour (Glanz *et al*.,2002). Glanz *et al*. (2015) and Shafer *et al*. (2017) emphasises that perceived barriers are also considered as another important predictive health process, therefore assessing barriers such as buildings, quality of the life, economy or urbanization, lack of knowledge can be of high or low health risks according to SEM perception.

While perceived symptoms linked to an illness label are the most common way to identify illness risks, Severton *et al.* (2006); Severton *et al*. (2012) and European Commission, Science for Environment Policy (2016) propose perceived environmental signs (aspects of the environment that can be sensed), a safety level, and assumptions about identifying personal and community danger are used to identify environmental risks. (Severtson *et al*., 2008; Severton, 2012).

The lack of environmental data according to Spaiser *et al*. (2017) in the SDGs provides a list of objectives with no specific aims and no theory about how to achieve them. As a result, it's unclear which theory should be used to research SDGs. Arrow, Dasgupta, Goulder, Mumford & Oleson (2012) and Dasgupta (2013) maintained that the cross-country, time series data availability issues are currently severely limiting, especially when it comes to environmental data. Furthermore, even if SDGs data is available on environment (with the exception of CO2 emissions), equality, and social issues, there are still gaps and poor quality (Spaiser *et al*., 2017) worldwide. All results involving these data would be skewed and biased as a result of this (Spaiser *et al*., 2017). According to DEA (2012) and Republic of South Africa Operations Phakisa (2014) South Africa lacks a good image of coastal and ocean water quality, making it impossible to pinpoint the source of contamination that poses a threat to human and environmental health.

3.3.1.4 Perceived Benefits

Perceived benefit is defined as individual's belief in their ability to perform behaviour advised in order to decrease the perceived risks or severity (Glanz *et al.*, 2002). According to Severtson *et al*. (2008) attaining goal of environmental health risk communication can be possible if the information that supports informed decisions and actions is required. Individuals should be aware of how they could be affected by a disease based on their environmental awareness (Albarracin, Gilette, Earl, Glasman, Durantini & Ho, 2005), for example knowing the possibilities for pathogen contamination.

South Africa New Growth Path (NGP) according to Republic of South Africa Operations Phakisa (2014) can create an additional five million jobs in the next ten years through ocean's economy (DEA, 2012). This can be achieved by a national water quality monitoring programme which will address this issue by identifying areas of accumulation and aggregation of pollution along the coastline as the ocean allowing economy grows promoting health stream restoration behaviour to all stakeholders.

Adaptive management of policymakers is influenced by people's role; beliefs and by change in policies. HBM constructs that explain the belief, knowledge and attitude of individuals in the study can be perceived as a benefit for policymakers of river management (Dreibelbis *et al*., 2013; Dreibelbis Freeman, Greene, Saboori & Rheingans ,2014). However, policymakers even perceive uncertainty of river management as lot of work (Pappenberger & Beven, 2006). Adaptive management of policymakers is influenced by people's role; beliefs and by change in policies. Therefore, the use of both IBM and SEM that includes environmental factors which will expand the contextual factors of the stream restoration. This will in return be used to increase the amount of data available on development (Leadership Council of the Sustainable Development Solutions Network 2015) in order to investigate possible inconsistencies in the SDGs.

3.3.1.5 Self-efficacy

Self-efficacy relates to ability factors that represent a person's belief in his or her own abilities to perform a behaviour where people have action knowledge and know how to perform the behaviour (Frick, Kaiser & Wilson, 2004). Where self-regulation factors or when attempting to enforce and sustain behavior, management assists the individual in balancing competing objectives and distracting cues (Gollwitzer and Sheeran, 2006). Also, action planning representing thought about how to set up the behaviour by specifying the where, when and, how of the behaviour (Gollwitzer and Sheeran, 2006). For example, knowing the water condition data could have helped participants with higher arsenic levels had stronger beliefs about recognizing personal danger (Severtson *et al*., 2008).

Self-regulation systems represent set goals and defined procedures for goal attainment, and which lead to specific action plans are generated in contexts of self and the social system. Self-regulation system refers to self-knowledge and social factors when drawing conclusions about a disease. For example, deciding a symptom reflects illness or age requires reference to the self and what it means.

Self-efficacy is a person's feeling of adequacy to perform a new behaviour. Continuous feedback on assessments or reports will increase individual's efficacy and in return improve monitoring goals of SDGs. According to Bandura (1977) the principles of self-efficacy include: focused feedback or social persuasion; past performance is the effective way of developing strong sense of efficacy is through experiences success, the individual has more confidence; the modelled behaviour of observing someone with similar task and physiological responses of individuals expect to fail find the task difficult to do therefore weak self-efficacy. The example of modelled behaviour becoming a barrier is when individuals assess their personal risk of contracting HIV by comparing themselves to peers who are more promiscuous than they are or assess risk of lung cancer by elderly person who not yet showing symptoms or the sick although they smoke all their life (Perloff and Fetzer, 1986; Taylor *et al*., 1983).

Social relationships can serve to set reference values that individuals strive to achieve. For example, doctors instruct patients about the appropriate level for weight and an advert on it may establish reference value Leventhal et al. (2003). Social relationship also influences selection and implementation of coping strategies to manage health conditions through both direct and indirect means (Brissette, Scheier & Carver, 2002). Family members and medical practitioners can offer instruction to individuals regarding how they can alter their behaviour becoming a reference value (Lewis and Rook, 1999). The actions of family members and peers can serve as models to follow (Leventhal *et al*. ,2003).

It is a misconception to think of self-regulation as a process carried out in solid or to think of the individual as an isolated problem-solving machine. Self-regulations are dependent on the input and expertise of others. The presence of others may be a necessary condition for successful self-regulation of both physical health (Li &Yan, 2020; Umberson and Montez, 2010; House, Landis & Umberson, 1988; Thoits, 1995)

and psychological health (Jaco, 1954). Individual's developmental history will be shaped by social environment.

3.3.1.6 Cues to Action and Intervention/ Triggers

For example, the person who barley accepts his susceptibility to tuberculosis will be unlikely to check upon his health until he experiences rather intense cues, since the kinds of cues may easily be forgotten with the passage of time. However, according to Freidson (1961) even difficulties in assessing interpersonal influences as cues can increase individual's susceptibility. According to Burke,2016 states that cues to action are indications that a person is in danger of contracting a serious illness. These could be media or concerned loved ones. Cues to action are anything that triggers a decision to change behaviour. The first two groups have built on each other to produce Likelihood of Action. Likelihood of Action After becoming aware of the potential for developing a disease if behavior does not improve, it is necessary to weigh the advantages and drawbacks of taking action in order to decide whether it is worthwhile (Marmarà, *et al*., 2017; Li *et al*., 2015).

HBM external factors according to Glanz *et al*. (2015), White *et al.* (2015) and Shafer *et al*. (2017) argue that an individual needs knowledge and skill to carry out behaviour therefore, even if a positive intention exists for a specific behaviour, it is still possible that an individual lacks the necessary knowledge and skills to perform that behaviour and this lack of knowledge can prevent an individual from performing the behaviour. Therefore, according to Fishbein and Ajzen (2005) TPB behaviour can provide general guidelines of strong social pressure that could be considering persuasive communications, perhaps in a form of newspaper ads, flyers distributed in certain neighbour's, or TV service messages. Outputs of this study is based on this concept that through the development and implementation process of this study include: Planned Roadshow presentations to partner municipality offices in KwaZulu Natal; Presentation of Public Presentations / workshops to identified stakeholders, community members of Umlazi Township and Presentation of dissemination workshops to key stakeholders at completion of the study are planned to be implemented.

3.3.1.7 Modifying Factors

HBM modifying factors considers external factors outside one's body and use outside influences to affect how threatened a person feels by the outcomes of that action. For example, elements to social-structural characteristics like crowdedness due to urbanization that ultimately cause physical harm to the structure. As mentioned earlier, Glanz *et al*. (2015) and Shafer *et al*. (2017) considers buildings, quality of the life, economy or urbanisation, lack of knowledge as modifying factors for individual behaviour.

In South Africa, the demand for new housing is outpacing the capacity of local governments to meet it. As a result, informal settlements are becoming a larger part of urban growth in SA. In urban areas, almost a quarter of the population of South Africa lives in slums. Many studies have shown that the water quality downstream of these settlements has degraded, with high levels of faecal coliform, solid waste, and organic contamination, posing health hazards to those who live in these and surrounding areas (Quibell, 2011). While, Globalization, according to Hartungi (2006), is a mechanism that breaks down international boundaries in order to create more integrated service, products, and capital markets. South Africa's population has increased to 59.28 million as a result of the globalisation process or impact. Increased population has a positive impact on economic development, but it has also contributed to a negative image of clean water.

3.3.2 SEM

SEM is divided into five levels which include: individual; relationship; community; societal and; policy level. However, the individual and the relationship concepts are similar to that of HBM. Therefore, for the purposes of this study only community; societal and policy constructs will be discussed.

3.3.2.1 Community Level

At the community level, according to Dahlberg and Krug (2002) this model can be used to prevent violence, as it acts across multiple levels of the model at the same time. SEM approach is sustaining prevention efforts over time than any other single intervention. (Dahlberg & Krug ,2002; Robinson, Casiano & Elias-Lambert, 2020)

The social ecological systems perspective is particularly useful in the study of autonomous geographic communities, focusing on population characteristics. The social systems perspective further suggests that getting to know the networks through which a community's members, organizations, and leaders interact is imperative to further strengthening that community and working better with it (CTSA Consortium et al., 2011; Duran, Wallerstein, Avila, Belone Minkler & Foley, 2012; Minkler &Wallerstein, 2008) like NGO or co-operatives. Therefore, SEM incorporates both perspectives similar to community organization and community building typology as the study also explore the Sihlanzimvelo cooperative's knowledge, attitude and behaviour on stream water quality during group discussion. Involvement of all stakeholders is important for informed decision making.

3.3.2.2 Societal Level

According to Mosler, Blo¨chliger and Inauen (2010) in Bangladesh, an eight-step general protocol for conducting water systematic behaviour change includes defining target behaviour and population must be included in the protocol . During this process the target population of behaviour to be changed must be defined and researcher must determine which and whose behaviours require improvement. (Mosler, 2012). Research should aim at understanding the benefit and barrier conditions of the behaviour in question (Mosler ,2012).

According to DWAF (1996), the development of South African water quality guidelines was essentially to derive a set of water quality criteria to safeguard freshwater ecosystems in South Africa. However, the aquatic ecosystems are vulnerable to changes in water quality, the fact that there are very few options for mitigating the

effects of poor water quality. A precautionary approach is therefore required to protect the ecological functionality of aquatic ecosystems (DWAF, 1996). Tempelhoff (2006) points out that the country's local authorities are increasingly unable to cope with the constant demand for effective sewage treatment especially in urban areas.

Water governance is the process of negotiating between society and government in order to efficiently enforce socially appropriate allocation and control by mediating behavior by both government and society's principles, norms, and rules (Hill & Carroll, 2009).

Poor health system governance practices result in population needs and health spending priorities being compromised and demoted (El-Zein, Jabbour, Tekce, Zurayk, Nuwayhid, Khawaja, Tell, Al Mooji, De-Jong, Yassin,2014; Rabbani, Shipton, White, Nuwayhid, London, Ghaffar, Ha, Tomson, Rimal, Islam, Takian, Wong, Zaidi, Khan , Karmaliani, Abbasi & Abbas, 2016) structural loans to LMICs limit the policy space to address health system and population health concerns (Wright, 2015). Rural to urban migration and refugees are a product of low investment in rural agriculture economics, political uncertainty and violence, and deteriorating environmental conditions, putting a strain on the country's infrastructure and health systems (McLeman, 2017; Thomas & Thomas, 2004).

3.3.2.3 Policy Level

The policy level is a level at which activities of interpreting and making sure that the existing policies are implemented. At this level spheres of local, national government departments and agencies required to support policies that promote healthy behaviour, including screening. Including: collaborating with coalitions to communicate policy decisions to the public ; translating local policies for community members (for example, proclamation by a mayor for colorectal cancer awareness month).The prevention strategies at this level are typically designed to impact the social and physical environment for example, by reducing social isolation, improving economic and housing opportunities in neighbourhoods, as well as the climate, processes, and policies within school and workplace settings (Dahlberg & Krug ,2002)

In making this shift on poor health and system policy, multidisciplinary projects with local stakeholders into curricula (Farquhar and Nathanson, 2011). Furthermore, these public health programs can explore pressing human rights and social justice issues into curricula so that students can also develop values of social responsibility (Grishan, Martiniuik, Negin, Wright (2015). Knowledge generation through health and related development for decision-making on policy, prevention and treatment strategies, and resource allocation (Mokwena, Mokgate-Nthabu, Madiba, Lewis & Ntuli-Ngcobo ,2007). SPHs can play a significant role due to differences of opinions existing at various levels that is society, national, regional and international assemblies (Hussey & Hawkridge,2012; Rabbani *et al*., 2016).

The National Environment Management Act (NEMA) of no. 107 of 1998 was adopted by DWA in 1998. The NEMA was put in place with the aim of making decisions more open and transparent, making knowledge more available, and ensuring that the cost of pollution remediation and environmental degradation is paid, for the benefit of citizens' health improvement, and to it provide tools to protect the environment.

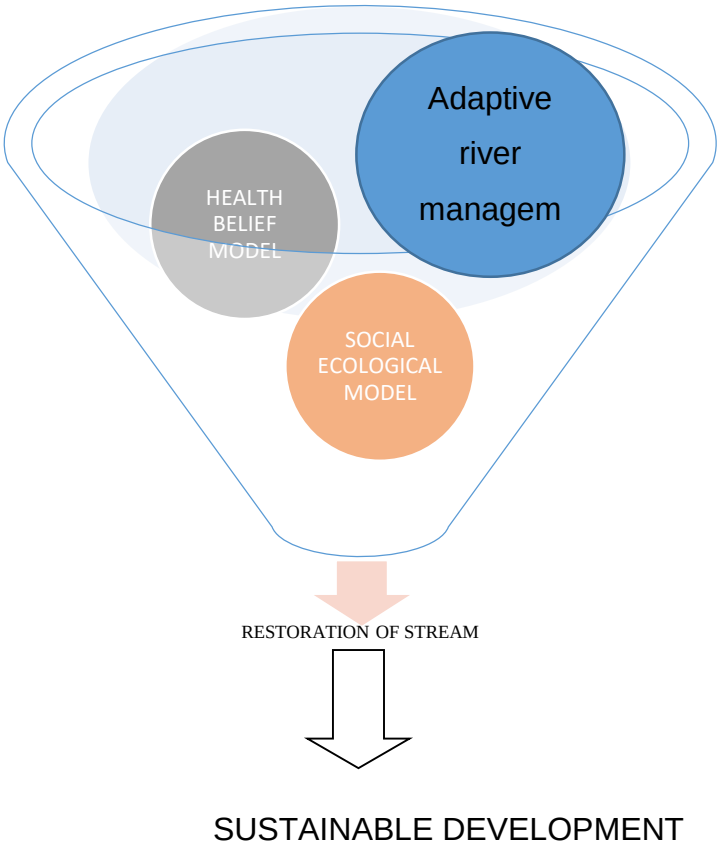

Figure 5 Use of HBM, SEM and Adaptive river management on stream restoration

3.3.3 Relationship between variables- Theoretical frameworks that relate to the concepts central to the study

Since policymakers in charge of river management have many, often conflicting responsibilities. They must establish long-term strategies that strike a balance between the needs of various players and multiple river functions, such as navigation, drinking water supply, environmental development, tourism, and flood risk. River management is a highly dynamic challenge since these roles are interconnected and include many and varied stakeholders and uncertainties. River management strategies are created and enforced at various scales and levels of governance. Implementation and maintenance responsibilities are often devolved to local or regional governments, while legislative processes and legislation are implemented at a national or supranational level.

Policy impact of LMCIs should address environmental degradation or pollution practices on water course, ground water by industries and community members where heavy metals and chemicals: direct effects may be incurred by ingesting toxins in water, while indirectly toxic effects may occur are a result of ingesting fish or wildlife that have consumed from a contaminated source (Water, health and ecosystems, 2012). Mergler (2002) affirms that there are concerns especially the practice of hydraulic fracturing of rock structures, antibiotics and hormones when they reach watercourses such as toxic materials of fish consumed as a dietary mainstay in the Amazon and in the Great Lakes.

The lack of understanding of regulating services has been the major reason for overexploitation and degradation of ecosystem assets and services ecosystem provide to human (Wealth Accounting and the Valuation of Ecosystem Services (WAVES) ,2013). Therefore, finding out what people value can help evaluate which, and how certain programs or policies can be impactful, implemented and maintained. The importance of responsible coastal development initiatives, river impoundments, water pollution, harbour development and other coastal development are all factors that influence fish and the economy as a whole (Forbes, Demetriades and Cyrus,1996; Crafford & Hassan, 2014.).

The values are attributes that people or individuals perceive as threat or dangerous and will make an effort to minimize such action leading to risks or consequences and those values that individuals or people value as positive attribute, these they will uphold. Illegal dumping has a major impact on the value of the land and property surrounding landfill sites (NWS Environmental Protection Agency, 2013). Etengeneng (2012) and Bockarie (2011) states that diseases such as tuberculosis, asthma, and malaria have been identified among community members living near dump sites and Simanjuntak (2014) maintains that water source contamination is possible when the river source is situated, adjacent to the illegal dumping site.

South Africa's NSSD uses MEA criteria, this study also adopts the same concept in analysing streams of Umlazi regarding cultural services; regulating and its provision. Therefore, for the purposes of stream water quality study only three out of five strategic interventions of NSSD will be discussed namely:

- Improving integrated planning and execution processes by tracking and reporting
- Use sustainable assets and natural resources to sustain our habitats and use natural resources effectively.
- Shifting perceptions and behaviors to create self-sufficient communities in order to create healthy communities (DEA 2011).

The above three strategies follow the organizational changes and learning cycle approach of coping with uncertainty in policymaking process (Hargrove 2002 and Pahl-Wostl 2009). Where environmental assets and natural resources needs to be determined by acquiring scientific environmental data or assessing stream water quality data through desktop. This approach aids in reducing uncertainty. Determining stakeholder's, the attitudes, behaviour towards stream restoration practice gives will reduce uncertainty knowledge gap allowing opportunity for stakeholders to change their behaviour as they understand their roles and responsibility, reducing roles ambiguity as room for and building self-sufficiency in river management (Warmik et al, 2017). The availability of reports on both social and scientific or natural data of

stream's water quality will in return allow such integrated planning to be monitored as data is validated, recorded and available (Warmik *et al.*, 2017).

Combining theories of uncertainty and organisational learning to show how social learning enables better coping with uncertainty in complex problems like river management and policymaking and gives a holistic perspective on uncertainty management (Pahl-Wostl *et al*., 2007; Van den Hoek, Brugnach, Mulder & Hoekstra, 2014).

Hence, the use of HBM and SEM will be ideal in achieving the NSSD objectives and implementation especially because these models attends to all sustainable development spheres of economic, social and environment. In achieving the NSSD objectives and implementation of all sustainable development spheres of economic, social and environment (Becker 1974, DEA 2012, White 2012 and Shafer et al 2017). The findings from this study can also be used to increase the amount of data available on development to investigate potential contradictions in SDG's (Leadership Council of the Sustainable Development Solutions Network 2015).

Therefore, this study aims to be an extension of how the indicators of Feedback Seeking Behaviour (FSB) influence role ambiguity of uncertainty within multiple organizational contexts by HBM constructs to impact role performance of behavioural change on stream water management restoration of uMlazi area. According to Srikanth and Jomon (2013) states that FSB have been studied in relation to role ambiguity (Ashford & Cummings, 1985) and in relation to performance (Taylor & Brown 1988; Wood, 1989) and their inter-relationship needs to examined.

3.4 INTRODUCTION OF RESEARCH TOOLS USED IN THIS STUDY

Exploratory research is a research design which will be used in this research. Exploratory research design is a versatile approach for identifying the issue of what is currently occurring and seeking new insights into the research problem. (Bhattacharyya, 2006:40-41).

The population selected for focused group discussions and interview tools in this study was chosen with the assumption that they are aware of the research subject discussed

or share shared research interests (Freitas, Moscarola & Jenkins,1998). Kumar (2010) believes that when deciding who should classify the population to be used, a researcher may use judgment sampling or purposive sampling.

According to McMillam and Schumacher (2010) interviews are considered to reflect research hypothesis in an in-depth way and understandings into the beliefs and behavioural difference of individuals interviewed better (McMillam and Schumacher, 2010). While Freitas et al. (1998) also believe that focus group discussion research tool is vital to understand what people think, feel and how they behave when supplied with information. The findings from this exercise can be used to formulate prevention programs. Questionnaires as a research instrument are designed to test attitudes and perceptions of subject evaluated or researched (Willems, Drossaert, Vuijk & Bohlmeijer, 2020; Bird, 2009)

Freitas *et al*. (1998) affirms that the use of focused group contributes to the individual interview especially during the planning phase of the individual interview when the focus group is small, this guides the interview topics constructions especially when the topic studied has not been studied extensively in the past or when the researcher is new in the field. This set-up aids the researcher to compare results among different groups of participants and eliminate areas that seem to be misunderstood by participants (Freitas *et al*.,1998).

Using focused group discussions with survey or questionnaire research tool helps especially if the focused group is used before questionnaires are distributed to the community at large to ensure complete picture of the participants' thoughts and understanding of the subject discussed. Freitas *et al*. (1998) believes that using focused group as pre-testing does not only identify problems but solve them as well.

Focus group discussions were used to design a choice modelling (CM) questionnaire for the estimation of population on Support Catchment (River) Management funded project. Consultations with specific technical expertise and policy experts, as well as focus group conversations, were used to create CM questionnaires. As a result, focus group meetings play an important role in the creation of CM questionnaires. They assist in determining what type of information should be included in the questionnaire, as well as the questionnaire's presentation, vocabulary, and structure (Mazur & Bennet,2008).

Focused group discussions population according to Morgan (1997) can be used as controlled population in the experimental research when focused group data is compared to the survey data of the same study. In this set-up the survey data is treated as uncontrolled population and focused group is used to define manipulations of independent variables and to measure dependent variable associated with the experiment of the study (Freitas *et al*.,1998).

3.4.1 Interviews

Interview is described as a qualitative data of one-on-one process, structured or semi-structured conversations with potential individuals, or experts (McMillam and Schumacher, 2010. Kumar (2010) defines interview as a direct method of collecting information from people by asking them question in a face to-face.

Semi-structured interview question guides are valuable because they help the analysis team stay focused on the analysis' goals and make the most of the interview time while enabling interviewees to discuss any unexpected issues. Question guides may also provide questions about gender roles and dynamics in value chains, such as how men and women behave differently when it comes to upgrading.

According to Dunn, Harris, Cook and Prystajecky (2014), literature review of current practices and interviews with practitioners from selected agencies was used in microbial risk assessment and management, from source-to-tap study. The findings revealed important water quality monitoring problems as well as significant variation in risk assessment and management methods across provinces and agencies. As a result, interviewing as a research method is critical in water quality studies for the literature for preventative, multi-barrier interventions that consider both environmental health and human health issues.

However, disadvantages of an interview as research tool include, expensive and time consuming; respondents may be hesitant to disclose personal views and information; interviewer bias is a possibility; and quantitative data is rarely useful.

3.4.2 Focus Group

Focused group is defined as a small, a organized community meeting of 5 to 20 members from a target market segment or a value chain cross-section, Freitas et al (1998) defines focus group as one of the qualitative research methods that is an in-depth interview type in a group set-up. This kind of discussion represents series of meetings characterised by participants that influence one another through their answers to the ideas and contributions during discussion.

According to Sim (1998) it has become clear that there is an increasing emphasis on the value of focus group discussion in understanding of health and illness behaviour of individuals. Akpabio, Asuzu, Fajemilehin and Bola (2007) believes nursing practice in community health necessitates a deeper understanding of health consumers' views, social relationships or values, behaviors and in-depth perceptions, stereotypes and concerns, conceptions and misconceptions therefore, focused group discussions as research tool were used. For a prevention- and community-based framework, community health workers and practitioners need to be ready to provide interventions that lead to improved health outcomes for the entire population, including vulnerable groups by engaging in a focus group discussion type of research tool.

Focus groups are particularly valuable for research when little is known about the phenomenon of interest (Stewart, Shamdasani & Rook, 2007). Holmgren and Dahlin-Ivanoff, (2004) used focus groups in the exploratory stages of a research project that examined the experiences of women who were on sick leave as a result of work-related injury in Sweden. The women perceived and explained their possibilities for and obstacles were explored highlight the importance of recognising the situation of the person and the interplay between the individual woman and her environment. Holmgren and Dahlin-Ivanoff, (2004) contended that this knowledge can be used as a basis for a rehabilitation programme for helping women return to work (Liamputtong, 2011). For the purposes of this study focused group in the Sihlanzimvulo cooperation as it is ideal for ascertaining interest in abstract or new concepts; Excellent for pre-testing individual’s perceptions or exploration of new and unrelated subjects as they arise; generation of new research hypotheses (Freitas *et al*., 1998).

3.4.3 Questionnaire

The most common method of gathering data is through questionnaires. This method is cost-effective, simple to score, and allows participants to consider their answers. However, threats of this technique can include questionnaire to be unable to probe and give clarity, are restricted to subjects who read it, can be bias and show ambiguity. Ponto (2015) and Kumar (1996) argue that this tool consists of a set of questions logically related to the problem, drawing about responses from the respondent and a gathering tool for collection of primary data in surveys.

The low cost, relative versatility, and applicability to a relatively large sample size are all major advantages of questionnaires. This is linked to the fact that the survey is anonymous, avoiding any of the issues that can arise during an interviewer-respondent interaction. The questionnaire may also be done at the respondent's own time, and the respondents may review the entire questionnaire prior to making a decision to something (McMillam and Schumacher, 2010).

In social science research, the questionnaire is a well-established method for gathering information on participant social characteristics, current and past behavior, expectations of behavior or behaviors, and values and reasons for action with respect to the natural hazards research topic (Bird & Dominey-Howes, 2008). The questionnaire is a widely used and essential instrument for gathering data on awareness and perception (Bulmer, De, & Fielding, 2004).

According to Sibiya and Gumbo (2013) the use of questionnaire in the study assessed the knowledge, attitude and practices (KAP) of learners on issues related to water, sanitation and hygiene in selected schools in Vhembe District, South Africa. However, the study revealed that the level of knowledge about waterborne diseases was relatively high (76.7 ± 1.75%), but knowledge on transmission routes was inadequate. Also, the majority of respondents (78.4 1.71 percent) had no knowledge of water-borne diseases and how to avoid them (Sibiya and Gumbo,2013).

Shortcomings of using questionnaires includes: the response rate is very low; the questionnaire will not be very effective if a high response rate is needed; the questionnaire will not be very competitive if a high response rate is required; the questionnaire will not be very successful if a high response rate is required; people

who are illiterate or uneducated are unable to respond to the questionnaire. Ambiguity, vagueness, technical phrases, and other factors can frighten respondents and demotivate them. Only when the questions are sufficiently simple and straightforward is the questionnaire approach accurate and adequate.

3.4.4 Secondary Analysis or Data

Some sociologists' researchers conduct research using secondary data that they have already collected. When a researcher is encounters a condition where collecting new data is impractical or unnecessary, the researcher can use the publicly accessible information and this process is known as secondary analysis. According to Chengi and Philips (2014) secondary analysis has become an increasingly popular method of enhancing the overall efficiency of the health research enterprise. Sociologists may generate their hypotheses, obtain statistical data for analysis from businesses, academic institutions, and governmental agencies, just to mention a few sources. There are a number of freely accessible health-related electronic resources that can be used to study a wide range of topics, a few examples follow. According to Chengi and Philips (2014) for countries all over the world, the World Health Organization offers statistics on a variety of health-related issues. However, since these figures are normally at the national level, regional or population subgroup-specific data is rarely available. In ensuring that EMS that states assessments are documented, implemented, maintained and continuously improved as Tibert (2008) asserts.

Based on the above-mentioned facts, an exploratory mixed method design will be used where both quantitative and qualitative research (and data) in a single study or series of studies to understand a research problem (Creswell and Clark, 2007). This approach was deemed especially appropriate because it can provide insight and sense that mono-method methods might miss, and it arguably produces more complete information to inform practice and policy (Plano Clark 2010).

Data will be collected in a sequence that will include an initial phase 1 where combination of individual interviews and focus group discussions will explore the

perceptions of purposively sampled community members, employees of the water management and waste management departments about their knowledge, attitudes and behaviours as they relate to stream water management and how their health beliefs may impact behaviour. Phase 2 will follow where a quantitative self-complete questionnaire administered via a combination of door to door and online survey formats.

As discussed, Freitas et al. (1998) believe that using focused group as pre-testing does not only identify problems but solve them as well. Using focused group discussions with individual interview first (phase 1) is useful as it contributes to the planning phase of the individual interview in ratifying unclear questions on participants. Questionnaire research tool is used in phase 2 of data collection and this helps to ensure a complete picture of the participants' thoughts and understanding of the subject discussed during pre-test of interview and focused group phase 1. The choice of research tools used in this study will aid in understanding individual stakeholder's attitude, knowledge and behaviour as discussed earlier as part of phase 3 which involve model /framework development.

3.5 LIMITATIONS

3.5.1 Limitations of SEM

A weakness of many ecological models of health behaviour is their lack of specificity about the most important hypothesised influences. As a result, health promotion practitioners are under more pressure to recognise key factors for each behavioural application. However, some ecological models provide more guidance about behavioural influences but it cannot be based on structural or behavioural changes only, rather belief, attitude must be included as well and this can be addressed by the diagram behaviour-specific ecological models and the lack of information about how the broader levels of influence operates or how constructs interact across levels. Thus, the models expand perspectives without defining particular constructs or offering guidance on how to use ecological models to enhance research or interventions, making their use in conjunction with SEM more effective. The development of more

sophisticated models that lead to testable hypotheses and useful intervention guidance is a major challenge for those working with ecological models. Intervening on multiple levels simultaneously may be constrained by budgetary and practical limitations, such as policies and environments not being under the control of investigators and due to lack planning (White and Nanan ,2008), therefore ecological models cannot be the only solution on policy impact on stream water quality.

Another problem with SEM is the fact that it focuses more on behavioural change whereas other studies like SCT confirms that behaviour can be more influenced when attitude, values and knowledge are changed. Integrated models are more effective on issues that interlink local citizens, national and international countries. Such as IFHPS: Links to other multi-level models with: Sweat/Denison and Intention-Integrated Believe Model is a better theory for intervention programmes used on this study. (McLeroy, Bibeau, Steckler & Glanz ,1988)

3.5.2 Limitations of HBM

Disadvantages of HBM, although it use in many studies have examined individual relationships between constructs and outcome behaviours, fewer have identified relationships between constructs or identified moderator or mediator effects Brewer, DeFrank, and Gilkey (2016) and Weinstein (2007), further discuss study designs and methods to test health behaviour theories. This theory focuses on social environment behavioural intervention and rarely on physical, community and organizational environment (Glanz *et al*.,2008).

3.6 CONCLUSION

This chapter presented and discussed relevant theories underpinning this study and an analysis of policy impact and stream water quality practices on knowledge, attitudes and behaviour toward stream restoration practices in Umlazi Township, KwaZulu Natal, South Africa. The theories were carefully selected based on the theoretical framework that guides the objectives of this study. Policy impact and water quality as independent variables in this study, while knowledge, attitudes and behaviour

according Burke (2016) HBM is an intrapersonal principle that is used to develop intervention and preventive strategies in health promotion. The HBM's main goal is to measure people's health behavior by looking at their attitudes toward illness and the negative consequences of those behaviors (Marmarà *et al*., 2017).

CHAPTER FOUR
RESEARCH METHODOLOGY

4.1 INTRODUCTION

The research design, data collection methods and analysis approaches were discussed here. Issues related to validity, reliability and overall study quality will be considered along with ethical considerations. This chapter will first look at the philosophical model of the research design; research philosophy focusing on the mixed method approach; method of data collection; reliability and validity or trustworthiness in qualitative research; administration of research tools; method of data quantitative analysis and lastly discuss qualitative data analysis.

4.2 PHILOSOPHICAL MODEL OF RESEARCH INTRODUCTION

According to Burton (2002), analysis can be approached in a number of different ways. Every approach represents a distinct philosophical viewpoint on life and the methods for legitimately gaining information from the universe (Burton, 2002; Wright, 2006; Wright, 2007). The metaphysical assumptions that make up our social life as we know it, or ontology, are the focus of theory as a framework. Finally, theory considers what we accept as the truth of that fact, or epistemology, as well as the methods we use to analyze these backgrounds, or methodology, and the means we use to collect facts, or methods (Gay & Weaver 2011; Chilisa & Kuliwa 2015).

4.2.1 Ontology

While using an inductive and deductive strategy to think about the relationship between theory and study and to understand the theoretical foundations upon which research design and methods are developed is a standard and useful approach, it should be noted that theory is not the only factor affecting the conduct of social research. The approach and nature of research studies are often influenced by epistemological and ontological assumptions (Denzin & Lincoln, 2000; Guba, 1990).
Since this study aim is to determine policy impact and stream water quality practices on knowledge, attitudes and behaviour toward stream restoration practices in Umlazi

Township, KwaZulu Natal, South Africa. Therefore, the nature of this research focuses on ontology. As ontology looks at the individual's core beliefs about the social environment and its relationship to other individuals (Burton, 2002 Wright, 2006; Wright, 2007). As Klemke (1998) insists that there are a few issues with the paradigm that need to be addressed.

As previously mentioned, ontology is concerned with the essence of existence. The central issue in social ontology is whether or not social structures may and should be considered objective entities with a reality outside of social actors, a stance often referred to as "Objectivism", or whether they can and should be considered social constructions resulting from social actors' expectations and behavior, a stance known as "constructionism" (Bryman, 2008).

4.2.2 Epistemology

Although ontology investigates the central belief that the individual holds about the social world and its relationship to individuals, however the strategies used to gather that truth is also important. According to Gay and Weaver (2011) epistemology approach investigates what individuals accept as the truth of that reality and lastly it looks at the research methodology, that is, which means are employed to investigate or to gather evidence on these backgrounds, (Chilisa & Kuliwa 2015).

Epistemology is concerned with deducing results from arguments on how we can understand the universe (Hughes & Sharrock, 1997). Several philosophical viewpoints on science or research paradigms (as they are often known) exist on these foundations, but initially, inquirers focused on what became known as 'positivism' (Guba, 1990), which emphasizes objectivity and concise definition through quantification and classification. The term "paradigm" refers to a fundamental collection of beliefs (Guba, 1990).

According to Bryman (2008), there are two fundamental epistemological positions (philosophical perspectives): positivism, which imitates natural science, and 'interpretivism,' which is an alternative to the decades-old positivist orthodoxy. It brings together (logically) the perspectives of writers who believe that the subject matter of

social science, namely people and their institutions, is profoundly different from that of natural science, and thus necessitates a different research logic that represents the uniqueness of humans (Bryman, 2008; Bryman, 2012).

4.3 RESEARCH DESIGN

There are three common types of research design namely: exploratory; experimental and observational research (Bhattacharyya, 2006; Saunders, Lewis & Thornhill, 2009; Shajahan, 2010). According to Saunders et al. (2009) the classification of research purpose or design most used in the research includes: exploratory, descriptive and explanatory.

Sekaran (2003) states that the exploratory studies are useful for conducting situation analyses and benefit from drawing on both qualitative and quantitative methods. Exploratory research is a research design used in this research. Exploratory research design is a versatile tool for identifying the issue of what is currently occurring and seeking new insights into the research problem (Bhattacharyya, 2006). According to Saunders et al. (2009), this design is used when there are few or no previous studies to refer to or depend on in order to predict an outcome. Exploratory research can be done in three ways: searching the literature review, interviews with 'experts' in the field and performing focus group interviews. Its great the advantage is that it is adaptable and flexible to change as new data and insights emerge (World Economic Forum, 2016; Plano Clark & Ivankova, 2016). True experiments must have control, randomization, and manipulation, in return allows the researcher to identify the cause and effect relationships between variables, supporting the ability to limit alternative explanations.

Saunders *et al*. (2009) describe descriptive research, as an extension of or a forerunner to exploratory or, more commonly, explanatory research You must have a good understanding of the phenomenon from which you want to collect data before you begin collecting data. According to University of Southern California Libraries (2016) The aim of descriptive research is to learn about the current state of a phenomenon and to explain "what happens" in terms of variables or conditions in a situation observed in a fully normal and unchanged context.

Explanatory research is described as research that establishes causal relationships between variables. Studying a situation or a problem in order to understand the relationships between variables is the focus here (Saunders *et al*., 2012).

However, this research was based on mixed research design and Saunders et al. (2012) defines mixed methods approach as the general term used when both quantitative and qualitative data collection techniques and analysis procedures were used in a research design. Creswell (2015) believe there are three basic methods that underline all mixed methods and these are: a convergent design; an explanatory sequential design and; an exploratory sequential design.

4.3.1 The Explanatory Sequential Design

The intent of explanatory sequential design is to study a problem by beginning the design with a quantitative strands or component collection and data analyses, and then conducting qualitative research to explain how the quantitative results occurred (Creswell and Plano Clark, 2011:185). Quantitative results yield statistical significance, confidence intervals, and effects size and provide the general outcome of a study.

There is a consensus among social scientists that procedure for this design analysis quantitative findings is to determine (a) which results will require further investigation in the second, qualitative phase, and (b) which questions to ask participants in this qualitative phase; perform qualitative data collection and analysis in a second phase to help explain the quantitative results, and; draw inferences about the qualitative results to help explain the quantitative results (Creswell, 2015; Plano Clark & Ivankova, 2016 and; Tashakkori & Teddlie ,2009).

According to Tashakkori and Teddlie (2009) the advantage of this design is that these two phases build upon each other so that are distinct, easily recognized stages of conducting the design. In the study, the researcher can expand the investigation to explain important variables. However, some of the disadvantages of this design include time consumption when two individual phases in sequence were implemented. The Researcher has a challenge in ascertaining process as to which quantitative

results need further explanation as another challenge. Creswell (2015) suggests, design is popular among beginning mixed methods researchers and graduate students.

4.3.2 The Exploratory Sequential Design

The purpose of this method was used to investigate a problem by collecting and analyzing qualitative data. The second phase involved developing the qualitative analysed data into measures or a new instrument or new interventions for an experiment. Individual quotes, codes as aggregations of quotes, and themes as a set of codes are all generated by qualitative research. Themes were transitioned into measures or variables where new measures were developed in this design. Creswell (2015) believes that quantitative data collection is the third phase, where the new measures developed in the previous phase are applied. The idea is that the new quantitative dimension outperforms what is currently available because it is based on real participant experiences. The newly developed the validity and reliability of a quantitative instrument's scores was evaluated. The last move was to describe how the new instrument enhanced the existing collection of variables, resulting in a more contextualized instrument. The test of the new quantitative dimension offers insight into whether the initial qualitative findings can be extended to a broad sample since the qualitative data were taken from a small sample in the third quantitative phase. This design is said to the most difficult design of the three basic designs. The challenge of this is to develop qualitative results into a new variable, a new instrument, or some new intervention activities (Creswell, 2015).

DeVellis, (2012) state that there are many sources for scale development and instrument construction besides qualitative analysed data. The sequence for such development includes: review of the identified potential items; conduct exploratory factor analysis with a small sample; conduct reliability analysis of the scales; administer the survey to a large sample; conduct confirmatory factor analysis of the results; use structural equation modeling to identify latent variables and; search for proof of construct validity.

4.4 RESEARCH PHILOSOPHY/RESEARCH STRATEGIES

Plano Clark and Ivankova (2016) argue positivism and phenomenology are two research paradigms that include philosophical ideas and principles of nature's variety. While Fox and Bayat (2007) claim that research can be categorized into two types, qualitative and quantitative. Positivist research is defined as quantitative research, whereas phenomenological research is defined as qualitative research that focuses on understanding a phenomenon through simple, perceptive explanations, and the views of the research understudy (Plano Clark and Ivankova ,2016). This study focused on pragmatism philosophy.

4.4.1 The Convergent Design

Plano Clark and Ivankova (2016) suggest that the convergent design purpose is to join the quantitative and qualitative data results that were collected separately and the interpretation from these databases. Several studies have revealed that quantitative results produce general trends and relationships while qualitative results give in-depth personal perspectives of individuals. As highlighted by Creswell and Plano Clark (2011: 180), this can be done by reporting quantitative results first then followed by the qualitative results, a follow-up discussion then occurs, comparing results from the two databases by comparing the results from the database. The second phase of convergent is to examine to what extent the quantitative results are confirmed by the qualitative results (or vice versa). Study by Clark and Ivankova (2016) found that if results from these databases differ, then an explanation as to why these differences occurred should be stated. The convergent design enables one to gain multiple pictures of the problem from several angles (Morse, 1991; Creswell and Plano Clark, 2011; Morse and Niehaus, 2009).

The challenge with this design is that same assessments need to be used on both the quantitative and qualitative if the data is merged. Plano Clark and Ivankova (2016) indicated that theresearcher need to familiarise themselves on merging the two databases know-how and side-by-side comparisons otherwise this can be a limitation for this type of design (Creswell & Plano Clark, 2011; Teddlie & Tashakkori, 2009).

4.4.2 Quantitative Approach

Quantitative research describes the magnitude and distribution of change while exploring specific defined questions that examine the relationship between two events, or occurrences, where the second event is a consequence of the first event. While quantitative analysis, according to Nykiel (2007), is concerned with determining the magnitude of relationships between variables. Nykiel (2007) maintains that this approach provides in-depth knowledge of the social, political, and cultural context. Quantitative researchers will attempt to retain control over the various variables that may affect the relationship between events by randomly selecting respondents (Saunders *et al*., 2012 and Cresswell, 2009). According to Welman, Kruger, Mitchell (2005) experimental, non-experimental, and quasi-experimental studies are all types of quantitative research. Hence conducting an initial assessment of identified stakeholders' knowledge, attitudes and behaviour about stream water quality policy and practices in Umlazi Township, KwaZulu Natal, South Africa was investigated.

This method was chosen with the aim of analysing policy impact and stream water quality practices on knowledge, attitudes and behaviour toward stream restoration practices in Umlazi Township, KwaZulu Natal, South Africa. This was seen as a sensitive topic in general, and it was determined that the best way to receive truthful responses was to encourage participants to respond to a survey at their leisure. A quantitative approach, according to O'Neill (2008), is also concerned with seeking proof to either support or refute a concept or hypothesis (Curry, O' Cathain, Plano Clark, Aroni, Fetters & Berg,2012).

Positivism asserts that there is only one truth, and therefore attempts to define causal interactions using objective calculation and quantitative analysis (Firestone, 1987). The researcher is considered autonomous and impartial in the positivist model, and larger samples are used to evaluate carefully formulated hypotheses (Saunders *et al*., 2012 and Cresswell, 2009).

Different survey methods with different types of questionnaires are used in positivism study approach (quantitative) research. The survey method was chosen because it considers truth as something that can be measured and analyzed, and it is an

objective, dependable, and replicable method. The following measures can be used to perform the survey: defining the research's intent and objectives; selecting resources and a target population; selecting and improving data collection techniques; Instruments for research; sampling; letters of transmittal; pilot study; mail survey follow-up; and determining the percentage of non-respondents (McMillan & Schumacher, 2010).

According to Plano Clark and Ivankova (2016) it is important to recognise the limitations of the data. In quantitative research, the level to which findings are generalised to the wider population depends upon the quality of the sampling strategy used.

4.4.3 Qualitative Approach

The qualitative approach, according to Flick, Garm, Homolova, Herrrmann, Kuck, and Rohnsch (2012), is exploratory and attempts to clarify "how" and "why" a particular phenomenon, or program, operates in a specific sense. As a result, qualitative research often looks at I local awareness and interpretation of a given problem or program; ii) people's perceptions, definitions, and relationships; and iii) social structures and contextual factors (such as social norms and cultural practices) that marginalize a group of people or have an effect on a program. Non-numerical qualitative data includes photographs, videos, text, and people's written or spoken words. Individual interviews and focus group conversations using semi-structured or unstructured subject guides are popular ways to collect qualitative data (Lincoln and Guba, 1985).

The context of human experience must be examined in constructivism or qualitative analysis (Schwandt, 2000). Constructivism asserts that there are multiple realities and that any research project can yield multiple interpretations (Appleton and King, 2002). Post-positive, constructivist, or interpretative approaches are often referred to as naturalistic inquiry (Creswell, 1994). The aim of researchers is to irradiate other people's realities by providing detailed accounts of their experiences (Appleton and

King, 2002). The interpretative model uses a subjective researcher to learn more about what's going on with a smaller sample size (Clark, 2016).

According to Curtis and Curtis (2011) findings from qualitative research should not be used to make inferences about a wider population but can be used to provide examples of how or why in specific contexts. Qualitative method themed results were then used and in this analysis, we converted into variables and developed new tools for quantitative design. In exchange, strengthening reliability and validity of an initial assessment of identified stakeholders' knowledge, attitudes and behaviour about stream water quality policy and practices in Umlazi Township, KwaZulu Natal, South Africa study.

4.4.4 Pragmatism Approach or Mixed Method Approach

Creswell and Clark (2007) defines mixed methods research as a design for collecting, analysing, and mixing both quantitative and qualitative research in a single study or series of studies to understand a research problem. This approach was deemed appropriate because it can offer insight and meaning that might otherwise be missed in mono-method approaches and arguably produces more complete knowledge to inform practice and policy (Clark 2005:08). Using mixed methods research allows triangulation of findings, which can strengthen validity and increase the utility of the research. The way this process unfolded in a given study was shaped by mixed methods research content considerations and researchers' personal, interpersonal, and social contexts (Plano Clark & Ivankova ,2016).

4.4.4.1 Mixed Method Research (MMR)

Mixed methods research's benefits in addressing diverse study goals within the confines of a single study have contributed to its adoption and implementation across disciplines and countries (Alise & Teddlie, 2010; Creswell, 2010; Ivankova& Kawamura, 2010; Plano Clark, 2010). The mixed methods approach, which dates

back to the 1970s and 1980s (Greene, Caracelli, & Graham, 1989; Reichardt & Cook, 1979), is now widely used in the psychological, behavioral, and health sciences. The identification of mixed methods as the third research methodology (Johnson & Onwuegbuzie, 2004), the third methodological movement, emphasizes its usefulness, power, and acceptance (Teddlie &Tashakkori, 2003), the third research community (Teddlie &Tashakkori, 2009), and the third research approach (Creswell, 2014).

Greene (2008) proposed a framework of the field of mixed methods as a distinct approach, four methodological domains (philosophy, methodology, functional guidelines, and socio-political commitments) were used. Creswell (2009) divided the area into five domains: philosophical and theoretical problems, mixed methods techniques, mixed methods nature, mixed methods acceptance and use, and mixed methods politicization. Tashakkori and Teddlie (2010) divided the field of mixed methods research into three categories (conceptual, methods and methodology, and contemporary applications). These structures, on the other hand, appear to prioritize theoretical and analytical debates about mixed methods research directed at methodologists over practical guidelines for how academics can interpret and manage the field of mixed methods research. Additionally, such a framework can be helpful for considering the existing body of the literature about mixed methods research, interacting with the community of scholars that use mixed methods, and engaging in mixed methods research practices that are part of the field of mixed methods research (Tashakkori and Teddlie, 2010).

Socio-ecological perspectives of McLeroy et al. (1988), and others believe the Socio-Ecological Framework for the field of Mixed Methods Research conceptual framework that attempts to explain the system of dynamic complex relationships that exists in the field of mixed methods research and that uniquely shapes scholars' mixed methods research practices. The researcher chose the socioecological model as the basis for our conceptual framework to help understand and explain the field of mixed methods research because this model recognizes and explains the interwoven dynamic relationships that exist between various individual and environmental factors, such as personal, interpersonal, organizational, community, and societal contexts.

These factors form different levels within the system of relationships that aims at explaining the person's complex interactions with his or her environment and the

contextual nature of such interactions. From the socio-ecological perspective, these relationships shape an individual's beliefs, knowledge, and experiences in multiple unique ways and predetermine how an individual interacts with his or her environment. Likewise, mixed methods research practice is a dynamic and interactive process that involves multiple domains and contexts, and we wanted a framework for describing and understanding the many relationships that occur in this process. Tashakkori and Teddlie, 2010).

A worldview or paradigm was incorporated to this study research whether clearly stated or not. According to Guba (1990) worldview is a set of beliefs or values that inform how the researcher understands a study. The philosophical underpinning of pragmatism, according to Doyle, Brady, and Byrne (2009), directs and allows mixed methods researchers to use a variety of approaches to answer research questions that cannot be answered using a single tool. Healthcare researchers, in particular, profit from the ability to use such a diverse approach to solve the nuanced and multi-faceted research challenges that plague the industry. Morgan (2007: 47) defines a paradigm as 'the set of beliefs and practices that guide a field,' and it can be used to summarise the beliefs of researchers (Morgan, 2007; Morgan, 2014). According to Scotland (2012) a paradigm consists of the following components: ontology, epistemology, methodology, and, methods. Each component is explained, and then the relationships between them are explored. Paradigm will influence the questions that researchers will pose and the methods they employ to answer them and this process is referred to as philosophy of conducting research (Morgan, 2007).Curtis and Curtis (2011) believe that these beliefs may relate to the types of evidence or research tools used to claim epistemology, where the researcher feels that reality is found in a theory that helps to explain behaviour among large number of people in this case by using survey as a research tool. (Curtis and Curtis,2011).

Alternatively, the researcher may feel that reality is multiple or singular ontology in the study. Given the qualitative nature of Phase 1 of the study, non-probability sampling approaches was used in this preliminary aspect of the study. As such, purposive sampling was used. Purposive sampling is a non-probability sampling method, which involves identifying participants because they possess the characteristics of interest (Parahoo, 2014). In this study, a specific type of purposive sampling i.e. heterogeneous or maximum variation sampling was utilized. In ontology, reality is

better determined by different individual perspectives than one general explanation by using focused group or heterogeneous interview tool as a qualitative approach as used in this study (Curtis and Curtis, 2011).

Integration refers to how one brings together the qualitative and quantitative results in mixed methods study. The way the researcher combines the data needs to relate to the type of mixed methods design used since research tools are often associated methods with philosophy (Creswell ,2015).

Researchers have historically been forced to choose between the positivist scientific model of study associated with quantitative methods and the interpretative model associated with qualitative methods (Curtis and Curtis ,2011). (Howe, 2004). The logical positivist approach is assumed to be empirical, while naturalistic inquiry is assumed to be subjective. Quantitative research is an objective deductive method, while qualitative research is subjective and an inductive process that can only be interpreted in background (Morgan, 2007).

4.5 POPULATION

According to the eThekwini Staffing and Human Resources Development report for (2014-2015), the eThekwini Municipality Environmental Health department has 205 staff members who work in positions related to water management. Within this group, staff groups are generally involved in overseeing and facilitating efficiency across the wider range of water quality maintenance processes that are central to the functions of the municipality (eThekwini Human Resources, 2016).

4.6 METHOD OF DATA COLLECTION OR RESEARCH TOOLS

According to McMillam and Schumacher (2010) interviews, questionnaires are two frequently used research tools under exploratory design. Advantage interview it when it comes to testing research hypotheses and insights into interviewees' beliefs and behavioral differences it has in-depth testing capabilities (McMillam and Schumacher,

2010). While Freitas et al. (1998) also believe that focus group discussion research tool is vital to understand what people think, feel and how they behave when supplied with information and the findings from this exercise can be used to formulate prevention programs. Questionnaires as a research instrument are designed to test attitudes and perceptions of subject researched (Bird, 2009). This study was limited to simple random and stratified probability sampling.

The investigation will be structured as a three-phase process that will necessitate the development of the data collection instruments mentioned below: 1. The interview and focus group discussion schedules. 2. A self-complete questionnaire for completion by respondents

Within the proposed mixed method study, as shown above, data will be collected through a three-phase analytical analysis. This process of data collection consists of a mix of individual interviews and focus group discussions (Phase 1) which will explore the perceptions of purposively sampled community members, employees of the water management and waste management departments about their knowledge, attitudes and behaviours as they relate to stream water management and how their health beliefs may impact behaviour. This phase included individual interviews (n=25) and focus group discussions (n =2). Phase 2 – involved a quantitative self-complete questionnaire administered via a combination of door to door and online survey formats. Phase 3: - involved model /framework development in the form of a corrective-framework

4.6.1 Primary Source

4.6.1.1 Research Tools for Qualitative Approach-Data Interview

Interview is described as a qualitative data of one-on-one process, structured or semi-structured conversations with potential individuals, or experts (McMillam and Schumacher, 2010. Ponto (2015) and Kumar (1996) defines interview as a direct method of collecting information from people by asking them questions face-to-face.

According to Dunn *et al*. (2014), an individual interview is a structured and purposeful dialogue between two individuals. Its aim is to elicit the interviewee's knowledge or point of view on a topic. Individual interviews, which may involve key informant interviews, are useful for eliciting information about a person's beliefs, values, understandings, emotions, perceptions, and perspectives on a subject. Individual interviews often enable the researcher to delve deeper into a complex topic, gaining a better understanding of the contextual factors that shape individual experiences.

Saunders, Lewis and Thornhill (2007) state that there are three types of interview: structured interviews; semi-structured interviews and unstructured or in-depth interviews. Structured interviews use questionnaires based on a predetermined set of questions and such are called as interviewer-administered questionnaires (Section 11.2). Semi-structured and in-depth (unstructured) interviews are non-standardised. Semi-structured interviews require the list of themes and questions to be studied (King, 2004). Unstructured interviews are informal where non-standardised questions are used as the participants are allowed to express their beliefs, behaviour freely on the topic discussed Saunders *et al*. (2007).

Semi-structured interview question guides are important as they help the analysis team to remain focused on the objectives of the analysis and to use the interview time efficiently, while allowing interviewees the opportunity to address unforeseen issues. Question guides can also integrate questions related to gender roles and dynamics in value chains, such as how behaviours related to upgrading are different among men and women (Saunders *et al*. ,2007).

However, Saunders et al. (2009) suggests disadvantages of an interview as research tool includes: expensive and time consuming; respondents may be reluctant to share personal beliefs and information; possibility of interviewer bias and rarely yields useful quantitative data.

According to Saunders *et al*. (2009) interviews allow for in-depth exploration of complex phenomena and allow the research to gain an in-depth understanding of

concepts under investigation. Within the current study, the use of interviews will facilitate a sound and robust exploration of participant's knowledge, attitudes and resulting behaviours, as they relate to safe water practices. The combined use of focus group discussions will allow for the verification and further validation of issues that would have emerged from individual interviews. Furthermore, focus group discussions are seen as a useful counterbalance in that they allow the safety of the group to be a central feature of the data collection process. The data from the interviews and the focus group discussions will be based on small sample sizes and as such, it will not be possible to glean any cause-effect relationships however, the inclusion of a complimentary survey allows for a wider exploration of the phenomena under study. This increases the likelihood of greater generisability of the findings. Schedules of each of the above-highlighted are attached herewith. Also, semi-structured and in-depth interviews provide the researcher with the opportunity to 'probe' answers, when the researcher wants interviewees to explain on their responses. Saunders *et al*. (2009). The result should be that you are able to collect a rich and detailed set of data.

4.6.1.2 Focus Group

According to Curtis and Curtis (2011) focused group is defined as a small, structured group meeting consisting of up to 9 people or 5 to 20 participants from a target market segment or a cross-section of a value chain. Freitas *et al*. (1998) defines focus group as one of the qualitative research methods that is an in-depth interview type in a group set-up. This kind of discussion represents series of meetings characterised by participants that influence one another through their answers to the ideas and contributions during discussion.

According to Tynan and Drayton (2007); Baral, Uprety and Lamichhane (2016) a focus group discussion is an organised discussion between 8 to 12 people, more than 12 people, the group becomes difficult to manage (Mendes, 1980). However, Saunders *et al*. (2009) believes size of groups depends on the topic discussed, larger focus group if the topic is not an emotionally involved concept, such as attitudes to performance-related pay towards the management.

Participants in focus group discussions have the opportunity to address a specific subject in an environment where they are free to agree or disagree with one another. Focus group discussions allows researcher to learn about how a group thinks about a topic, the variety of views and ideas that exist, and the differences and variations that exist in a community's values, experiences, and practices (Saunders *et al*. ,2009). The researcher therefore purposefully recruited participants from different municipality departments and Sihlanzimvulelo co-operatives as previously mentioned to whom the issue is relevant both interviews and focused group discussions. Focus groups are particularly valuable for research when little is known about the phenomenon of interest (Stewart *et al*., 2007). For the purposes of this study, it is ideal for ascertaining interest in abstract or new concepts; excellent for pre-testing individual's perceptions or ideas; generation of new research hypotheses; exploration of new and unrelated topics as they arise (Freitas *et al*., 1998).

4.6.1.3 Quantitative Research Tools –Questionnaire Data

The most common method of gathering data is through questionnaires. According to Bulmer *et al*. (2004) this approach is cost-effective, easy to score, and gives participants time to consider their responses. However, this approach can be dangerous because it is unable to probe and provide clarity, is limited to those who read it, and is biased and vague. Kumar (2010) argue that this tool consists of a set of questions logically related to the problem, drawing about responses from the respondent and gathering tool for collection of primary data in surveys. Quantitative data can be gathered in a variety of ways and from a wide range of sources.

The questionnaire as a tool is a popular and fundamental tool for acquiring information on knowledge and perception (Bulmer *et al*., 2004). Epistemology approach beliefs may relate to the types of evidence or research tools such as a questionnaire is used to claim epistemology, where the researcher feels that reality is found in a theory that helps to explain behaviour among large number of people in this case by using survey as a research tool.

The following are some of the disadvantages of using questionnaires are: there is a very poor answer rate; if a high response rate is expected, the questionnaire will not be very good; the questionnaire is unable to elicit answers from the participants who are illiterate or uneducated; and finally, uncertainty and vagueness (Sibiya & Gumbo, 2013).

4.7 SAMPLE FRAME/TARGET POPULATION

The identified stakeholders on this study referred to: Umlazi community members and the employees of; eThekwini municipality department of Environmental health; eThekwini Coastal Stormwater and Catchment management; eThekwini Roads and Stormwater Maintenance; Durban Solid Waste department and Sihlanzimvelo cooperative members.

In total, these different groups represent the target population (n= 292). The proposed study used, included three-data collection approaches i.e. semi-structured interviews and focus group discussions and quantitative online and postal surveys. The proposed sampling strategy was therefore separated into the sampling approaches used as per data collection approach.

According to Stats SA (2011:52), Umlazi township is a highly populated township in KwaZulu Natal with over 404, 811 residents. This study serves as an initial step toward engaging the local community in water restoration.

4.7.1 Sample and Sampling Technique

The sampling process entails paying attention to sample size, to sample size, determining the sample participants, and deciding what questions to pose to them using instruments or more open-ended methods like interviews. The sampling within the design must be systematic and logical (Creswell 2015). According to Saunders *et al*. (2009), sampling techniques are set of techniques for reducing data collection through focusing on data from a subset of the population rather than all possible

scenarios or components, resulting time and budget constraints savings as well as data collection from the entire population (Saunders *et al*.,2009).

The two types of sampling techniques are probability or representative sampling and non-probability or judgemental sampling (Saunders *et al*. ,2009). With probability sampling the chance, or probability, of each case being selected from the population is known and is usually equal for all cases. Consequently, chance sampling is often linked to survey and experimental testing methods. Since the probability of each case being chosen from the total population is unknown in non-probability samples, it is difficult to answer research questions or meet the goals needed to draw statistical inferences about the population's characteristics. The researcher may still be able to generalize about the population from non-probability samples, but not on statistical grounds (Saunders *et al*., 2009). As a result, when employing a case study strategy, non-probability sampling (other than quota sampling) is more commonly used.

The choice of probability sampling technique depends on the researcher's research question(s) and your objectives. The structure of the sampling frame, the size of sample needed and, with which technique may be explained will also influence researcher's decision (Saunders *et al*. ,2009).

When a reliable and easily accessible sampling frame of the entire population, ideally stored on a disk, is available, simple random sampling is the best option. Although these are frequently obtained for workers within organizations or members of clubs or societies, appropriate lists for other forms of organizations are frequently unavailable. However, if population covers a large geographical area, random selection means that selected cases are likely to be dispersed throughout the area. Simple random sampling would still be suitable for a geographically dispersed area if an alternative technique of collecting data such as online or postal questionnaires or telephone interviewing is used (Saunders *et al*. ,2009).

According to Saunders *et al*. (2009) a modification of random sampling in which the researcher divides the population into two or more important and significant strata based on one or more attributes is known as stratified random sampling. From each of the strata, a random sample (simple or systematic) is taken. As a result, stratified

sampling has many of the same benefits and drawbacks as random or systematic sampling (Saunders *et al*. ,2009).

Purposive or judgmental sampling, on the other hand, allows the researcher to use his or her judgment to choose cases that will better allow you to answer your research question(s) and fulfill your research objectives (Saunders *et al*. ,2009). When dealing with very small samples, such as in study analysis, or when you want to pick cases that are especially insightful, this type of sampling is often used (Neuman, 2000). Researchers who use the grounded theory approach may also use purposeful sampling. Such surveys, on the other hand, cannot be considered statistically representative of the entire population. Patton (2002) illustrates this argument by comparing the need for purposive sampling to select information-rich cases with the need for probability sampling to be statistically representative.

In order to collect data that identify and clarify the main themes that can be observed, the researcher used heterogeneous or maximum variation sampling, which Patton (2002) argues is a power. Any trends that appear are likely to be of special interest and importance, and they will reflect the major themes. Patton (2002) recommends defining the diverse characteristics (sample selection criteria) prior to choosing a sample to ensure maximum diversity within it. This allows the type of data collected to record the sample's uniqueness.

Homogeneous sampling, focuses on a single subgroup in which all sample members are identical, as opposed to heterogeneous sampling. This allows the researcher to conduct in-depth research on the community (Saunders *et al*. ,2009).

According to Bryman (2006) in mixed methods, sampling refers to the procedures for selecting participants (and sites) in both quantitative and qualitative research and for the sampling strategies employed within each of the designs. Integration refers to how one brings together the quantitative results in a mixed methods study, and how this combination relates to the type of design used. Bryman (2006) suggest that most studies alleging to be mixed methods do not illustrate an integration of the two databases. Instead, researchers tend to keep them separate. The way the researcher combines the data needs to relate to the type of mixed methods design used while, different authors often associates research tools methods with philosophy.

The sampling plan was based on the following: target population =292 respondents. Using the epi-info sample size calculator with a confidence level of 95% and confidence interval of 5%, the predicted sample size should be 167 respondents. To allow for attrition, a further 10 % are added to the proposed sample size i.e. respondents. A total of 190 respondents was elicited (Demidenko, 2007).

Purposive sampling was used for data collection in this study, with the presumption that the people chosen for centered group discussions and interview tools are familiar with the research subject and have similar research interests (Freitas *et al*., 1998). When a researcher makes a decision or a "informed guess" on who should represent the population, Kumar (2010) believes judgment sampling or purposive sampling can be used.

Probability random sampling strategy as data collection was used for self-complete questionnaires quantitative approach for 404, 811 residents of Umlazi (Stats SA ,2011). Further, partitioning the uMlazi population into groups based on using stratified sampling based on a factor that this approach influences the variable that is being measured was applied on this study with the aim that heterogeneous population is split into fairly homogeneous groups. In this case citizens that live along the stream were treated as a different stratum, while the rest of the citizens of Umlazi as another stratum.

4.7.1.1 Quantitative Sampling

A good sampling strategy is random sampling. Sampling may fall into probability sampling, such as simple random sampling, stratified sampling, or multistage cluster sampling. It can also consist of nonprobability sampling, as in convenience or snowball sampling (Creswell, 2015).

This study was limited to simple random and stratified probability sampling. Any sampling method that uses some type of random selection is referred to as a probability sampling method. You must set up some mechanism or protocol to ensure that the various units in your population have equal chances of being selected in order to have a random selection system. Simple random sampling is the simplest way to

select participants from a population. Using these methods means that each individual in the population has the same chance of being selected for the sample (Curtis and Curtis, 2011). Stratified Sampling is possible when it makes sense to partition the population into groups based on a factor that may influence the variable that is being measured. According to Curtis and Curtis (2011) when a heterogeneous population is divided into reasonably homogeneous groups, stratified sampling works better. Under these circumstances, stratification provides more accurate estimates of the population percentage than a simple random sample.

Fowler (2008) argues that for sample size, it is important to select as large a sample as possible, because with a large sample there is less room for error in how well the sample reflects the characteristics of the population. In survey research, using a sampling error formula table shows appropriate calculation for determining the size of a sample based which will be evenly divided on a sampling error, a confidence interval. To estimate sample size for an experiment, this formula takes into consideration the level of statistical significance (alpha) (for example 0.95), and the effect size (Curtis and Curtis, 2011).

Phase 2 of the plan involved quantitative self-complete questionnaires and was hand delivered to potential respondents. Respondents were provided with a return address.

4.7.1.2 Qualitative Sampling Approach

Non-probability sampling approaches focused on human preference rather than random selection are used in qualitative sampling. Statistical theory, on the other hand, is unable to understand how this sampling would act and may be biased. There are two types of non-probability sampling methods: unintended and purposeful (Creswell, 2015).

Phase 1 of data collection of this study was followed by a combination of individual interviews and focus group discussions which investigated the perceptions of purposefully sampled community members, employees of the water management and waste management departments about their knowledge, attitudes and behaviours as they relate to stream water management and how their health beliefs may impact

behaviour. This phase included individual interviews (n=25) and focus group discussions (n =2).

According to Creswell (2013) qualitative research sampling is simply the purposeful selection of a sample of participants. There are a variety of purposeful sampling strategies available, including maximal variation sampling (heterogonous), which selects individuals who are diverse in order to achieve the diverse perspectives that are a target of good qualitative study. Additional forms of purposeful sampling, before the study begins and after the study has commenced (for example snowball sampling, confirming or disconfirming sampling) are available from 20 to 30 subjects for a grounded theory study, a single culture-sharing group for ethnography (Creswell, 2013).

In qualitative research, a small sample is studied in order to build individual perspectives; in quantitative research, a large sample is collected so that the results can be generalized from the sample to a population. A final approach is to accept the differences in sampling between the quantitative sample and the qualitative sample. Qualitative researchers might well argue that equal size is unnecessary because the data tell different stories, that is general trends on the quantitative side and detailed perspectives on the qualitative side (Clark, 2016).

4.7.1.3 Mixed method sampling

As mentioned before, there are three types of mixed methods sampling and these include: convergent sampling; explanatory sampling and, exploratory sampling and for the purposes of this research the study was limited to exploratory sampling because the intent of the design is to develop a new or modified instrument. Alsothis sampling design is useful in underdeveloped countries where limited information is available and researchers need to first explore what measures will work in the setting as the case of this study area.

Clark and Ivankova (2016) defines the explanatory sequential design, as the random sampling proceeds on the quantitative strand and the purposeful sampling on the

qualitative strand. However, the intent of this study is to collect qualitative data prior to the experiment in order to best recruit participants, therefore sampling needs of explanatory sampling does not focus on the recruiting, the experiment was the first thing that participants looked for. As mentioned earlier, with this topic, the researcher's philosophy or beliefs relate to the types of evidence or research tools used to claim epistemology, where the researcher feels that reality is found in a theory that helps to explain behaviour among large number of people in this case by using survey as a research tool. Another challenge with this type of sampling, is that the researcher had a challenge in ascertaining process as to which quantitative results need further explanation.

Plano Clark and Ivankova (2016) state that the sample for quantitative follow-up in an exploratory sequential design sampling analysis which vary from the sample for the initial qualitative strand. The qualitative data collection should be purposeful, and the quantitative sample should be chosen as randomly as possible. The data from the exploratory process is then used in an intermediate phase to create something quantitative, such as a new or updated instrument, new measures, or new intervention procedures. The developed quantitative aspect is then put to the test with a broad sample size. If the quantitative test in the final phase is intended to determine whether the qualitative themes in the first phase can be generalized to a large sample, then, yes, the two data collections need to be from the same sample. However, if the intent of the design is to develop a new or modified instrument, set of variables, the two samples may be different, not only in size but also in terms of their population membership (Plano Clark & Ivankova ,2016).

Purposeful sampling in the qualitative components can be used as the study's experimental component. If qualitative data is gathered prior to the experiment, the purpose must be stated and provided; if the goal is to gather qualitative data prior to the experiment in order to better attract participants to the experiment, sampling should deliberately concentrate on the experiment's participants, and the questions should be phrased according to the intent (Creswell, 2015).

A paradigm, according to Scotland (2012), is made up of the following components: ontology, epistemology, methodology, and methods. Each component is explained in

detail, followed by an examination of the relationships between them. Paradigm will influence the questions that researchers will pose and the methods they employ to answer them (Morgan, 2007). With this topic, these beliefs may relate to what types of evidence or research tools used to claim (epistemology) or whether the researcher feels that reality is multiple or singular (Ontology).

Creswell (2015) maintains that in the sample for the quantitative follow-up which vary from the sample for the initial qualitative strand of the analysis in an exploratory sequential design. The qualitative data collection should be purposeful, and the quantitative sample should be chosen as randomly as possible. Since the first step is exploratory, the sample drawn is focused on a limited number of people who were purposefully chosen to assist in the investigation of the issue. An intermediate phase then uses the data results from the exploratory phase to develop something quantitative-typically a new or modified instrument, new measures or new intervention procedures. The quantitative element then developed is tested with a large sample. As the intent of the design is to develop a new or modified instrument, set of variables, then the requirement that the two data collections are different, not only in size but also in terms of their population membership (Creswell 2015).

4.8 RELIABILITY AND VALIDITY OR TRUSTWORTHINESS IN QUALITATIVE RESEARCH

Parahoo, (2006) identifies validity as the extent to which an empirical measure adequately reflects the real meaning of the concept under consideration. The use of a combination of data collection approaches i.e. the individual interviews, the focus group discussions and the survey do allow for triangulation of methods which ensures that the benefits of each of the approaches are maximised (Curtis and Curtis, 2011).

This aligns well with Meissner *et al*. (2011) who describe three forms of validity in qualitative research: descriptive validity (concerning giving an accurate account of what is being studied); interpretive validity (concerning giving an accurate account of what is being studied); and predictive validity (concerning giving an accurate account

of what is being studied) (having the ability to provide the proper meaning of events as perceived by the participant, providing an emit perspective) ; validity in theory (refers to categories identified and relationships existing between these categories and abstracts and the explanation discovered by the researcher from the interpretations and descriptions given). In this study the researcher planned to use two appropriate methods to ensure triangulation that adds to the validity of the scientific research Creswell, (2009).

4.8.1 Anonymity and Confidentiality

The study will be focussing on a range of issues related to water sanitation issues and these may involve the discussion of sensitive topics. All study participants were guaranteed confidentiality and privacy as part of the study's ethical requirements. All participants were anonymous, according to Brikci and Green (2007), and were only known by a researcher-assigned numeric code. The following arrangements were made to ensure participant privacy and confidentiality.

According to Saunders *et al*. (2009) all participants in the investigation had a reasonable understanding that their identities would be secured, and to that end, no personally identifying information was included in any of the study's details. Anonymity and participant confidentiality are the most fundamental ethical values, and as such, they would be essential components of the proposed study plan.

4.8.1.1 Mixed Methods Research Ethics

Complying with the principles of mixed methods research ethics, defined as a set of moral principles that are aimed at assisting researchers in conducting mixed methods research ethically and in compliance with existing standards for research involving humans. Therefore, before a study inception, researchers are required to seek its approval from a local ethical review board, which sometimes may be time consuming due to a sensitive study topic and require several iterations to satisfy the board requirements. In addition, researchers need to solicit an informed consent from each study participant, disclose the study procedures, ensure participants' confidentiality,

and abide by appropriate codes of professional conduct (Teddlie& Tashakkori, 2009 and Brewer & Hunter, 1989).

4.8.1.2 Research Participant Considerations

Another critical aspect of interpersonal contexts to discuss is research participant considerations, which include concerns such as obtaining access and recruiting study participants, including community members as research partners, researching disadvantaged communities, and taking into account cultural contexts that affect participants' experiences (Creswell et al., 2011).

Advantages include considerations given to using mixed methods to study vulnerable and marginalized groups. These considerations relate to gaining access to special populations, involving them as research participants, establishing trust relationships, preserving their perspectives and values. The collection of articles written by international authors provides insight into using mixed methods research with different vulnerable groups, such as individuals with spinal cord injuries (Sullivan, Derrett, Paul, Beaver & Stace, 2014); deaf people (Wilson &Winiarczyk, 2014); students from disadvantaged economic backgrounds (Shuayb, 2014; Shuayb, 2016); vulnerable children from developing countries (Kim, 2014);strategies to studying marginalized groups such as combining mixed methods with participatory and action research approaches, policy analysis, concept mapping, and analysis of existing databases.

Disadvantages of designing and conducting a mixed methods study pose challenges associated with increased time commitment from participants necessary for collecting both types of data, the need to obtain participants' identifying information for follow-up purposes, and the potential loss of participants for follow-up in sequential designs (Creswell et al., 2011; Curry & Nunez-Smith, 2015; Morse &Niehaus, 2009).

4.8.1.3 Research Team Dynamics

Mixed methods research teams often include researchers from different disciplines and methodological traditions, who combine their knowledge and expertise to work together on designing and implementing a study. Along with the necessary knowledge and research skills, they bring their personal, professional, organizational, and cultural identities. While the diversity is welcome, it could also provoke tensions within interdisciplinary research teams (Hemmings, Beckett, Kennerly, & Yap, 2013; O'Cathain, Murphy, & Nicholl, 2008) and create barriers to effective collaboration and achieving the goals of the study (Curry, O' Cathain, Plano Clark, Aroni, Fetters & Berg, 2012).

Disadvantages, Johnson, Onwuegbuzie, Tucker and Icenogle (2014) proposed the dialectical pluralism implementation framework as a philosophical foundation for constructing mixed methods teams and dealing with the group processes related to different values and perspectives of the team members (Curry *et al*., 2012).

4.8.2 Pilot Test/ Pretesting

The primary goal of pre-testing is to ensure that all of the study's data collection instruments have been thoroughly reviewed prior to their complete implementation (Saunders, Lewis and Thornhill, 2008). In order to validate the interview schedule, five participants who were chosen as prospective participants were asked to participate in pilot interviews. The following aspects of the interview tool were evaluated during the pilot testing phase. To begin, each interview question was evaluated for concept validity, or whether the anticipated topic of interest was accurately expressed by participants' responses. Secondly, the pre-testing pilot assessed whether the posed questions possess enough clarity for participants to understand and finally, to assess practical issues as they related to the survey tool. In keeping with research practice, the pilot survey was adopted in order to trace if changes are triggered by the pilot testing process (Parahoo, 2014).

Fifty-nine participants were given questionnaires to help refine and develop the questionnaire so that respondents will have no trouble answering the questions and data would be recorded without difficulty. The researcher conducted a pilot study to ensure that the data collection instrument was successful in gathering data from the study participants. Participants who were not part of the study's sample were approached to help pilot the instrument used in the main study.

4.8.3 Limitation

The research study will be based on residents of Umlazi Township and as such any emergent findings not generalizable however, they will provide transferable observations that may help to inform corrective practices across a range of provinces within South Africa. Saunders et al (2009) argue that a researcher needs to gain access to sample population and attempt to maximise the response rate. The study has been conducted as a cross-sectional enquiry and more reliable insights could have been facilitated through conducting this as a longitudinal study over a period. It noted too, that the study is being conducted by single research with limited resources and this may have limitation on the study. A wide range of employees of the municipality and water management services were identified as part of the target population and this broad range of potential participants were required that a varied repertoire of participant recruitment strategies be used to minimise the potential for participant non-responsiveness.

For delimitations or scope the study was conducted in Umlazi Township, Durban, KwaZulu Natal and focused on employees of eThekwini Municipality and Environmental Health Department and on community members who reside in Umlazi Township. Participants and respondents were recruited from the sample frame of residents of Umlazi. The professional perspective was elicited from employees of the municipality who were selected randomly. Category of people/events: - the study will focus on adult members of the community (18 years plus and older).

4.9 ADMINISTRATION OF RESEARCH TOOLS

According to Shajahan (2010), there are four forms of questionnaire administration: postal, distribution and selection, telephone, and formal interviews.

The choice between postal or delivery and collection is often influenced by the population size. Since the sample size was small, the researcher enlisted the help of a group of five university students to distribute and compile the questionnaires. Since the postal type is used on a broad sample size that can be geographically scattered, and distribution and collection are dependent on the number of field employees.

Another benefit of using the postal and delivery method was that the type of questions used were closed questions with easy sequencing that should concern the respondent, and that the participants could complete the questionnaire whenever they want (Shajahan, 2010).

4.9.1 Collection of Questionnaires

The community members of Umlazi who were 18 years and older were given questionnaires over a two-week span. The researcher observed how the participants reacted to the questions, and if there were any ambiguities, the researcher clarified them and converted them into a language that the participants could understand. The data was gathered using a questionnaire that was designed to yield results from the survey. The survey was carried out in collaboration with uMlazi group members. The researcher dropped off all questionnaires at the agreed-upon location and later picked them up as agreed with community members.

4.9.2 Questionnaire Construction

A total of 191 questionnaires were handed out to the selected community members of Umlazi for this study. The questionnaire included unique investigation questions for each of the above-mentioned research objectives (Babbie and Mouton,2004). The

investigative questions were in the form household demographics, perceived susceptibility, perceived severity, perceived benefits, perceived barriers, policy impact, action to cue and self-efficacy questions

The use of HBM and SEM as underlying theories to carefully construct questions that were both open-ended and closed questions. There are advantages of using closed-ended questions includes: easy and quick to answer; answers across participants is easy to compare; answers easier to analyse on computer; response choices make question clearer and easy to replicate study. While the challenge of using closed questions includes putting ideas in participant's head; participants with or no opinion answer anyway; participants can feel constrained or frustrated; many choices can be confusing; can't tell if participants misinterpreted the question; fine distinctions may be lost; clerical mistakes easy to make; force respondents into simple responses. Therefore, using open-ended questions is beneficial because it allows unlimited number of answers; participants can qualify and clarify responses; can find the unanticipated; and this reveal participants thinking processes (Shajahan, 2005).

Rating questions used to collect opinion data was firstly through new instrument development in a formation of common themes during qualitative data analysis.

Questionnaire is divided into six sections:

Section A: Household demographics

Section B: Perceived Knowledge about health and safety susceptibility and severity

Section F: Perceived Barriers

Section G: Perceived Benefits

Section C: Perceived Attitudes

Section D: Perceived policy adherence and knowledge impact

Section E: Perceived Behaviour towards stream restoration impact

Section F: Perceived Cues to Action.

4.10 METHOD OF DATA QUANTITATIVE ANALYSIS

According to Cooper and Schindler (2008), the steps involved in data analysis enable the researcher to quickly determine answers to the research questions presented by reducing the amount of data accumulated in order to organize and statistical techniques are used to establish data patterns. The researcher was able to explore, identify, and analyse relationships and patterns within the data by using quantitative methods in this analysis (Saunders *et al*.,2009). According to Leek (2015) there are six types of data analyses and these include: descriptive; exploratory; inferential; predictive; causal and mechanistic.

4.10.1 Descriptive Analysis

Descriptive is a quantitative discipline that describes the main features of data collected especially if data to be analysed is a large population as census. This the simplest form of data analysis, according to Curtis and Curtis (2011) as descriptive analysis lists and summarizes the values of each variable in a data set. For example, a descriptive analysis may summarise questionnaire results by rating using median or standard deviation. Descriptive analysis helps researcher to be familiar with a data set and also in identifying problems with the data. This method of analysis uses the description and interpretation processes steps. According to Creswell and Plano Clark ((2010) this analysis is divided into univariate and bivariate types of statistical descriptive analyses.

4.10.2 Exploratory Analysis

Exploratory data analysis focuses on correlations among variables or elements of unknown data set relationships, the researcher can then only apply exploratory analysis if they understand the data of the study. Therefore, exploratory models are good for discovering new connections defining future questions. According to Leek

(2015) exploratory analyses are usually not the definitive answer to the question at hand, but only the start hence exploratory analyses alone should not be used for generalizing and or predicting purposes.

4.10.3 Inferential Analysis

Creswell and Plano Clark ((2011) affirms that inferential analysis is used to draw conclusions on data from a smaller sample of the population. Inferential aims to test theories about the nature of the world in general based on samples of “subjects” taken from the world (or some part of it). Understanding the sampling method used in inferential analysis because different conclusions can be drawn from the same data set by selecting different samples. Leek (2015) advise that inference depends heavily on both the population and the sampling scheme; type of data set applied to: observational, cross sectional time study, and retrospective data set – the right, randomly sampled population (Leek ,2015).

4.10.4 Predictive Analysis

Predictive analysis is very popular in business intelligence applications where, the data collected is used to predict an unknown outcome, and action based on that prediction. According to Leek (2015) this approach analyses current and historical facts to make predictions about future events. Data analysis project began by analysing each variable independently to describe the data hence, the accuracy of the prediction analysis depends heavily on measuring the right variables. The relationship among variables follows leading the researcher to certain inferences or conclusions about the population resulting to a mathematical model that predicts the results for data set that's not currently studied.

4.10.5 Causal Analysis

This type of analysis is used to as an experiment variable effect when another variable change especially in randomized studies of implementation. Causal models are said to be the “gold standard” for data analysis.

4.10.6 Mechanistic Analysis

The aim of this analysis is to study the careful changes in variables that lead to changes in other variables for individual objects. Mechanistic is said to be harder to infer, except in simple situations. Usually modelled by a deterministic set of equations of physical or engineering science in a randomized trial study.

According to Tashakkori and Teddlie (2010) statistics transforms quantitative data into useful information to helping with decision-making by describing patterns, relationships and connections. Statistics can be divided into two categories namely descriptive and inferential. Descriptive statistics summarise data, while inferential statistics identify statistically significant differences between groups of data in a randomised control study.

Generally, data is collected from a number of individuals or ‘units. Under quantitative analysis there are two types of variables, numerical and categorical. In research it is key to distinguish between these two types of variables, as the analysis done for each type is slightly different. Categorical variables are made up of a group of categories for example, sex (male or female) or rating for good or bad. While, numerical variables are numbers for example, number of participants in training) or measures in terms of height or durations in terms of age or time spent (Tashakkori and Teddlie, 2010).

According to Arkkelin (2014) determining how many times a category occurs is the analysis of categorical variables showing the frequency of that item. While the analysis of numerical variables uses the centre and the spread as the two statistics commonly described for numerical data. The centre describes a typical value and the spread describes distance of data from the centre. The most common statistics used to describe the centre are the mean also known as the average and the median. The

median is the middle value in a data set, half the data are greater than the median and half are less. The mean is calculated by adding up all the values and then dividing by the total number of values. Descriptive analysis was carried out using the Social Sciences Statistical Package (SPSS version 21) as SPSS uses standard deviation and table of frequency to generate each variable (Arkkelin, 2014).

Arkkelin (2014) maintains that spread is the second statistics easily described using the range of the data. This is the difference between the minimum and maximum. Other statistics describing spread are the interquartile range and standard deviation. The interquartile range is the difference between the is the difference between the upper quartile and lower quartile. A quarter (or 25%) of the data lie above the upper quartile and a quarter of the data lie below the lower quartile. The standard deviation depicts the average deviation between each data point and the mean. The standard deviation is low if all data points are similar to the mean, indicating that there is little variation in values. A large standard deviation shows that there is a larger spread of data. Calculating the standard deviation can be done easily in Microsoft Excel even SPSS.

4.11 QUALITATIVE DATA ANALYSIS

Qualitative data analysis, according to Bryne (2001), is a method that aims to minimize and make sense of large quantities of data, frequently from a variety of sources, allowing for the emergence of impressions that shed light on a research topic. Although Patton (2002) describes qualitative data analysis or analytical inference as a process that detects trends during the analysis of data rather than data gathered previously, the creation of these variables occurs just after the interview is completed (Curtis and Curtis, 2011). Curtis and Curtis (2011) describe it as a process in which descriptive data from various focus groups or interviews is combined to provide a summarized description or understanding.

Qualitative data analysis depends highly on the interpretations of key researchers. Since qualitative analysis also relies on researchers' impressions, it is vital that qualitative analysis is systematic and that researchers report on their impression in a

structured and transparent form. This is particularly important considering the common perception that qualitative research is not as reliable and sound as quantitative research (Bryne ,2001). According to Curtis and Curtis (2011) qualitative data analysis or inductive analysis ought to pay attention to the, context, consistency and contradictions of views, frequency and intensity of comments, their specificity as well as emerging themes and trends of ‘spoken word’.

4.11.1 The Process of Reducing Data

Thematic analysis and grounded theory are two methods of analyzing qualitative data or inductive analysis techniques used for in-depth interviews, according to Curtis and Curtis (2011). The terms thematic analysis and grounded theory are interchangeable (Curtis and Curtis ,2011). Thematic analysis and qualitative content analysis are two widely used methods in nursing research data analysis, but between the two lines there hasn't been a good distinction defined (Vaismoradi, Turunen and Bondas ,2013). Bulmer (1982); Ritchie and Spencer (2002); Bird (2009) agree that the ‘framework analysis,' which is a reasonably simple inductive analysis technique, may be used for policy and programmatic research with pre-determined interests. This method explores results using a pre-determined structure that represents the research's goals, priorities, and interests. This method helps the researcher to concentrate on a few specific answers while ignoring the rest (Pope, Ziebland & Mays, 2000). The majority of the time, qualitative research employs a combination of both methods Curtis and Curtis (2011). Yet, according to Rambaree (2013), ATLAS software necessitates three forms of qualitative data analysis: structure analysis as a grounded analysis, a deductive analysis, and a thematic network analysis (Rambaree & Faxelid, 2013).

However, this study focused on the semi-structured interviews allowing new impressions to shape interpretation in different and unexpected directions by considering all data collected taking a more exploratory sequential perspective as research design (Attride-Stirling, 2001). Since quantitative new instruments are developed from the qualitative analysed data. Therefore, a more thematic analysis approach interchangeable with framework analysis that aims on policy and programmatic research.

Data was gathered through qualitative methods, such as focus group discussions and individual interviews, which were analyzed using a hybrid of techniques, including the use of NVivo (Computer assisted qualitative data analysis). NVivo, according to Creswell and Plano Clark (2011), enables qualitative answers the questions that will be entered into this qualitative data analysis with the help of a computer. The application was centred on deriving themes that were commonly reported by participants. Emergent themes and variables on interest were explored further via door to door survey on community members of Umlazi area. Descriptive and inferential analysis of data was carried out using the Social Sciences Statistical Package (SPSS version 21). Measures of association such as T-test, Cronbach's alpha will be used to determine relationships between different factors.

The statistical significance of a t-test indicates whether the difference in averages between two groups most likely represents a "true" difference in the population from which the groups were sampled. A statistically significant t-test result occurs when a discrepancy between two classes is unlikely to have occurred due to an atypical sample. The magnitude of the difference between the group averages, the sample size, and the standard deviations of the groups are used to assess statistical significance (Tavakol & Dennick ,2011).

Lee Cronbach created Alpha in 1951 to provide a measure of a test's or scale's internal consistency; it is expressed as a number between 0 and 1. (Cronbach, 1951). To assess the reliability of data provided in an analysis or a research study, high-quality tests are needed. Alpha is a widely used test reliability metric (Tavakol & Dennick, 2011).

According to Curtis and Curtis (2011) descriptive analysis is used when data summarized is reported without interpretation, while the exploratory analysis route is ideal if the intention of the research is to use interpreted data not quantified (Leek, 2015). However, the intentions of this study was to investigate the effect of changing variables or measurements without predicting the measurements of individuals in order to develop new sample hence inferential analysis was adopted as it infers measures and patterns in the population (Leek,2015).

According to Creswell and Plano Clark (2011) the researcher has to familiarise himself or herself with data collected by making notes of thoughts that spring to mind and write

summaries of each transcript or piece of data that will be analysed in order to start coding the material. A code is a word or a short phrase that descriptively captures the essence of elements of your material (for example, a quotation) and is the first step in data reduction and interpretation.

Developing a coding framework, which consists of a list of codes that anticipate will be used to index and divide material into descriptive topics. If data approaching is following the deductive framework approach, coding will be guided by a fixed framework in this case SEM and HBM index of material according to the pre-defined codes. If, however, the researcher is following the more inductive thematic network approach, new codes are likely to be added in the coding developing coding framework. According to Curtis and Curtis (2011) the coding process is a long, slow and repetitive process, and the researcher is required to merge, split up or even rename codes as part of the process. Curtis and Curtis (2011) argues that there is no fixed rule on number of codes however, it is advisable to start merging if codes are more than 100-120 codes. According to Rambaree (2013) the abstracting themes from the codes process begins just after coding, where a researcher goes through codes and group them together to represent common, salient and significant themes.

Creswell and Plano Clark (2011) states that NVivo or Atlas. Ti. qualitative data analysis software's are used if the interview transcript is more than twenty as in the case of this study. McDonnell, Schoenebeck and Forte (2019) argue that data from focus group discussion and individual interviews will be analyzed using a hybrid of methods, including the use of NVivo (Computer aided qualitative data analysis); thematic analysis.

4.12 CONCLUSION

Given the volume of data to be handled when considering the sample size, the approach used for this research was acceptable. Using the quantitative approach, it was easy to use statistical analysis to analyze primary data from respondents. Using a qualitative approach to analyze such a large amount of data would have been extremely difficult due to the diversity of responses. All attempts have been

constructed to make the research tool as simple and straightforward as possible so that participants could complete the survey with ease. A pilot study was crucial in ensuring that the instrument was easy and straightforward to use.

5CHAPTER FIVE
PRESENTATION OF RESULTS, DATA ANALYSIS AND INTERPRETATION

5.1 INTRODUCTION

The previous chapter four discussed the research design, data collection methods and analysis approaches. Issues related to validity, reliability and overall study quality was considered as part of ethical considerations. Also discussed in chapter four was the philosophical model of the research design; research philosophy focusing on the mixed method approach; method of data collection; administration of research tools; method of data quantitative and qualitative analysis.

Presentation of results, data analysis and interpretation in mixed methods are done in two ways, by separating quantitative research and qualitative research into different chapters or by combining these findings to one chapter. Due to the volume of data, the decision to separate the data was taken, enabling the clarification of the data. The initial elements of the findings will be presented as qualitative findings as part of chapter 5 and quantitative findings as chapter six.

This chapter would first look at the demographic characteristics of participants, followed by results from the qualitative phase of the study. Later the results from the quantitative aspect of the study is discussed. Lastly, the inferential analysis extracted selected stakeholders' knowledge, attitude, policy and behaviour perceptions questions on from the survey method will be discussed.

Findings and analysis and the interpretation of the study results will be addressed in this chapter. An exploratory mixed method design was conducted. Mixed-methods study A research design was a method of gathering, analyzing, and combining quantitative and qualitative research (or data) in a single study or series of studies in order to better understand a research issue (Creswell and Clark, 2007). This approach was deemed especially appropriate because it offers insight and sense that mono-method methods might overlook, and arguably produces more comprehensive information to inform practice and policy (Clark, 2005).

Within the proposed mixed method study, data was collected via a Three- Phase empirical study. Interview phase of data collection followed by a combination of individual interviews and focus group discussions (Phase 1) which explored the perceptions of purposively sampled community members, employees of the water management and waste management departments about their knowledge, attitudes and behaviours as they relate to stream water management and how their health beliefs may impact behaviour. This phase included individual interviews (n=25) and focus group discussions (n =2). Phase 2 involved a quantitative self-complete questionnaire administered via a combination of door to door survey formats. Phase 3 will be discussed in next chapter 7. The identified stakeholders for interviews and focus group on this study were: the employees of eThekwini municipality department of Environmental health; eThekwini Coastal Stormwater and Catchment management; eThekwini Roads and Stormwater Maintenance; Durban Solid Waste department and Sihlanzimvelo cooperative members. For the survey, the stakeholder was community members of Umlazi.

The research objectives and questions were designed based on the health belief model, adaptive management and social ecological system. The study broadly aspired to answer the following research questions that were derived from the study objectives via the completion of two data collection phases. The questions were:

1. What is the stream water quality in the primary streams within Umlazi Township, KwaZulu Natal, South Africa.

2. What is the status of stream water quality across streams in Umlazi Township, KwaZulu Natal, South Africa through primary and secondary information sources.

3. What is the community knowledge about stream water quality policy and practices in Umlazi Township, KwaZulu Natal, South Africa.

4. What is the community attitude about stream water quality policy and practices in Umlazi Township, KwaZulu Natal, South Africa.

5. What is the range of community behaviour in response to stream water quality policy and practices in Umlazi Township, KwaZulu Natal, South Africa.

To reach the above research questions, qualitative methods was used to answer research question 1 to 3 using interview research tool. In addressing research question 4 to 5 focus group discussion tool as part of qualitative methods was used. Since the research study applied the mixed method research design, quantitative methods using survey was used to triangulate the findings of all research from questions 1 to research question 5.

The data for the first two subsections were collected using the interview tool; subsection three to subsection eight used the focus group discussion to collect data and; the last subsection of the inferential analysis was extracted from the survey method.

5.2 DEMOGRAPHIC INFORMATION

5.2.1 Qualitative Demographic information

The qualitative phase was divided into two sections namely interview and focus group discussion section. As indicated above, the study first conducted interviews then followed with focus group discussions.

5.2.1.1 Interview Demographics Introduction

The researcher visited the Sihlanzimvelo co-operatives involved in streams management to present the ethical clearance letter from Durban University of Technology and discuss the nature of the research study, its objectives and purpose. After a brief discussion on the purpose and objectives of the study, the directors of Sihlanzimvelo co-operatives involved in Umlazi streams management allowed the study to take place. The researcher handed in the ethical clearance letter with invitation letter to the study to selected participants that would participate in the study. The researcher then returned to the department to conduct interviews with employees and directors of Sihlanzimvelo project that lasted for up to sixty minutes.

The researcher also visited the municipality departments involved in streams management to present the ethical clearance letter from Durban University of Technology and discuss the nature of the research study, its objectives and purpose. After a brief discussion on the purpose and objectives of the study, the head of each department included in the study to allow the study to take place. The researcher emailed the ethical clearance letter with invitation letter to the study to selected participants that would participate in the study. The researcher then returned to the department to conduct interview of up to sixty minutes each, with selected in employees of the department that are involved in the Sihlanzimvelo.

5.2.1.2 Qualitative Demographics Analysis

Table 2. Age Group

	Frequency	Percent
20-29	7	28.0
30-39	9	36.0
40-49	5	20.0
50-59	4	16.0
Total	25	100.0

The age group of the participants is given in Table 3. Majority 36% of the them are within 30-39 years of age, 28% within 20-29 years of age, 20% within 40-49 years of age, and 16% within 50-59 years of age.

Table 3. Gender

	Frequency	Percent
Female	13	52.0
Male	12	48.0
Total	25	100.0

The gender of the participants is given in Table 4. The majority 52% were females while the males constitute 48% of the participants.

Table 4. Highest qualification

	Frequency	Percent
BTech	2	8.0
Masters	3	12.0
Diploma	3	12.0
Honours	4	16.0
Degree	5	20.0
Matric	**7**	28.0
Certificates	1	4.0
Total	25	100.0

The qualification of the participants is given in Table 5. The majority 24% are holders of Matric, 16% holds Honours and degree each, 28% holds Diploma and Masters each, 8% BTech, and 4% certificate.

Table 5. Participants department

		Frequency	Percent
Department	Catchment	4	16.0
	DSW	5	20.0
	Environmental planning and climate protection department	1	4.0
	Sihlanzimvelo Stream project	10	40.0
	Roads and stormwater	5	20.0
	Total	25	100.0

The participant's department are given in Table 6. The majority 40% are from the Sihlanzimvelo Stream project, 20% from DSW and Road and stormwater each, 16% catchment, and 4% Environmental planning and climate protection department.

Table 6. Participants work positions

		Frequency	Percent
Position	Catchment coordinator	1	4.0
	Civil Engineer technician	1	4.0
	Consultant	2	8.0
	Department manager	1	4.0
	Department Programme manager in restoration ecology, environmental planning and climate change. Other positions: Invasion biology; Involvement of rural communities in biodiversity management; Socio-ecological resilience; Ecological restoration action; Ecosystem functionality and Partnerships in IAS management	1	4.0
	Educational officer in environmental management	4	16.0
	Experiential learner in illegal dumping	1	4.0
	Manager	1	4.0
	Manager as Community engagement expert	1	4.0
	Manager in Township stream management	1	4.0
	Senior Civil Engineer technician and coordinator in Township Stream management	1	4.0
	Stream assessor	3	12.0
	Stream cooperative director	4	16.0
	Stream cleaner	1	4.0
	Technician	2	8.0
	Total	25	100.0

The work position of the participants is shown in Table 7. 16% are educational office in environmental management, also 16% are stream cooperative director. Other position indicated by the participants are highlighted in Table 7.

Table 7. Work experience of the participant

		Frequency	Percent
Work experience	1-5 years	6	24.0
	10+ years	5	20.0
	3-5 years	3	12.0
	6-10 years	11	44.0
	Total	25	100.0

The work experience of the participants is shown in Table 8. Majority 44% have had 6-10 years' experience, 24% 1-5 years, 20% above 10 years, and 12% 3-5 years.

Table 8. Experience on stream management

		Frequency	Percent
Stream management experience	3-5 years	3	12.0
	6-9 years	18	72.0
	0-2 years	4	16.0
	Total	25	100.0

The experience of the participants on stream management is indicated in Table 9. Majority 72% have had 6-9 years' experience, 16% 0-2 years, and 12% 3-5 years

Table 9. Another stream project

		Frequency	Percent
Another stream project	Adopt-A-River	3	12.0
	Clear river campaign	1	4.0
	Greening	1	4.0
	KZN Wildlife	1	4.0
	Mini SASS; Adopt-A-River	6	24.0
	no	11	44.0
	Vector control Mini SASS; Adopt-A-River	1	4.0
	waterwise	1	4.0
	Total	25	100.0

When asked whether the participants know any other stream project besides this one you are working on, 44% answered no. Among those who indicated yes, 24% mentioned Mini SASS, Adopt-A-river, 12% Indicated Adopt-A-River. Another mentioned stream project is highlighted in Table 10.

Table 10. Skills to manage stream

		Frequency	Percent
Do you have necessary skills to manage stream?	Yes	25	100.0

When asked whether the participants have the necessary skills to manage streams, they all indicated yes (Table 11).

5.2.2 Interviews Phase Data Presentation

This section addresses the first part of the first research question of conducting an initial assessment of community knowledge about stream water quality policy and practices in Umlazi Township, KwaZulu Natal, South Africa. The researcher firstly, determined the health and safety susceptibility and severity associated with streams, followed by determining the status of stream water quality across streams in Umlazi Township, KwaZulu Natal, South Africa. As indicated previously, part of research objective one was addressed using interviews tool and 5 theme main themes were generated and 19 subthemes.

5.3 THE IMPORTANCE OF STREAM CLEANLINESS

From perceived benefits, behaviour is regulated by perceived benefits effects and actions that bring rewards (Bandura, 1986). In this section, the researcher wanted to understand the association between the importance of clean streams benefits and stakeholder's knowledge on stream water quality practices in Umlazi Township, KwaZulu Natal, South Africa, in order to determine the initial assessment of community knowledge about stream water quality policy and practices in Umlazi Township, KwaZulu Natal, South Africa. As environmental knowledge helps change people's attitude to be more environmentally friendly and eventually influence behavioural change that adheres to environmental policies (Liu and Guo, 2018).

5.3.1 Subtheme One. Used for Swimming, Building and Fishing

In determining the importance of clean streams, some participants perceived that clean streams can be used for swimming, building and fishing purposes.

"Stream water is used by people, people can use clean water for household, farming and during times of drought". Unfortunately, no individual can determine the quality of the water by the colour of it source. Germs and diseases can emanate from dirty streams hence a clean stream will mitigate diseases "(participant 13, interviews)

Such factors mentioned by participants' highlight benefits of keeping the streams clean and from a researcher's view, these benefits agree with Parker and Oates (2016) views that rivers provide Ecosystem services (ESS) as rivers have the ability to benefit society in a variety of ways, including promoting key livelihood activities and economic sectors, fostering social connections and spiritual well-being, and contributing to strategic goals like food, energy, and water conservation, poverty reduction, and climate resilience. Another participant further said,

"If the streams are clean, citizens are happy and healthy; the entire community seems happy about cleaner streams. This implies the use of water and stream areas for recreational purposes". (participant 2, interviews).

However, different types of benefits depend more or less on different indicators of river health, such as water quality, flows or biodiversity. Some benefits require good health across multiple indicators. To a large extent the portfolio of benefits will depend on how a river is managed. This is logical and the water quality affects the health of the community.

5.3.2 Subtheme Two. Prevent diseases, Flooding and Reduce Dangerous Animals

Citizens in this study gave different reasons as to why they think a clean stream is important. They indicated that if the streams are cleared of litter, waste, and debris, this will promote better flow with no blockages. This will then prevent flooding.

" *before we cleaned the streams the water was stagnant; if it was raining the water entered people's houses; the rats; the snakes; and T.B. because when*

the water is stagnant it changes colour to green. This is what cause diseases and increased mosquitoes breeding." (participant 16, interviews).

From these findings, individuals understood the perceived benefits of maintain clean stream to be one of the solutions in reducing diseases and risks associated with unclean streams.

Another participant added by saying

"when there are floods river flows into the roads so clean stream is important as waste can be transported to people's houses during this time". *"(participant 18, interviews)*.

Thus far though, surface water remains as one of the most important vehicles of transmitting disease and many developing nations, as well as more technologically advanced countries, have high child mortality rates (Ford, 1999). As observed in South Africa, where diarrhoea deaths of under five years old is still a health burden and approximately 20% (Statistics South Africa, 2011). These high pollutants in the environment even where the infrastructure exists due to lack of skilled professionals in the water treatment sector (WWAP, 2017).

From the researcher's understanding, the area of Umlazi is still highly susceptible to health and safety risks associated with deteriorating stream conditions as observed previously from children between the age of 0-5 years in this area (Health Department Province of KwaZulu-Natal, 2015).

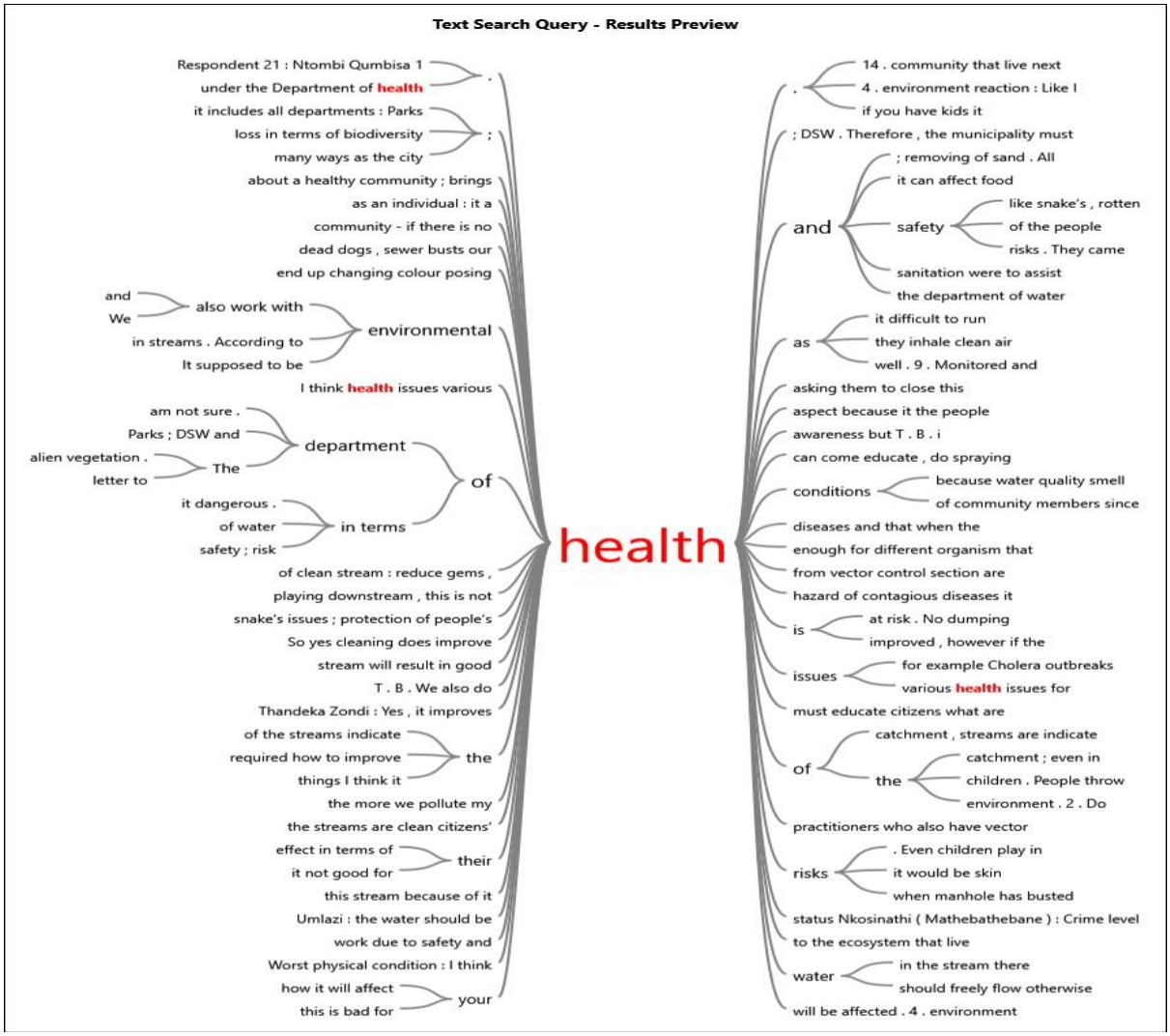

Figure 6. Perceptions on health issues related to poor stream conditions

5.4 CURRENT CONDITION OF STREAMS IS DETERIORATING

From the clean stream benefits highlighted in the above section, the researcher was then interested in knowing if the current streams condition of Umlazi can still provide the above-mentioned benefits that is found in clean stream. The participants were first asked if they live near or far from the stream. Then participants were asked what the current condition of the streams of Umlazi is.

Some participants lived near the streams while others stayed far from the stream. When participants were asked what the current condition of the streams of Umlazi is, they however indicated the streams condition of Umlazi to be deteriorating.

"Even though I do not leave next to the stream but there are streams in my neighbourhood that are not being maintained, where people throw anything and these are in a bad condition. However, there are also streams that are maintained and cleaned". (participant 1, interviews).

Stakeholders' perceptions on the streams condition confirm the findings of Nel and Driver (2015) who indicated that South African surface water is worsening, and environmental incidents happen endlessly in the real society (Liu and Guo ,2018). The following respondent is also in the same view as the first one.

"No, I do not live next to the stream, however, going back to Umlazi streams, it very neglected, people take for granted that it a place to throw whatever they want away and it will disappear. It polluted. It a man-made, man caused results". (participant 2, interviews).

The reasons highlighted by stakeholders indicated that actions of citizens are the opposite to the belief that there are any streams benefit that can be maximised and any disease that will be decreased as stated in the HBM (Becker ,1974). The citizens therefore do not see the need to change their behaviour and they do not percieve benefits to be worth it and to outweigh the barriers (Burke, 2016).

The researcher was then interested in determining the reasons for the streams deteriorating condition. Participants were asked for reasons for such conditions. There were different reasons for cause of the current streams condition deterioration highlighted by participants, and these included: bad attitude; lack of knowledge and poor behaviour that is, lack of knowledge can lead to poor pro-environmental behaviour.

5.4.1 Subtheme One. Community Is Being Educated by The Government

Since participants highlighted bad attitude as one of the reasons for the current streams condition. Participants were asked to offer comments on the involvement of

their attitudes on how they perceived water quality and in respect to that a number of observations were made.

> *"ag for yeas! She laughed. Because of slums and it not because lack knowledge but they are ignorance, lazy and not willing to take their waste to the collection points, they refuse to take it there rather throw it on the streams. As much as we are doing campaign and awareness but still do it. We do not know strategy to use because they still continue. It their attitude, one has to change their mind set and changing attitude takes a while". (participant 8, interviews).*

Although, McDowell *et al*. (2017) believe that even if you can educate someone but their perception and attitude is not changed your work is worthless. Some interview participants from the municipality also indicated that citizens are being educated by the government but still practice illegal dumping directly to the streams and other less pro-environmental stream restoration practices**.** From the researcher's point of view, this kind of action can be classified as social disapproval from citizens, that is, although they know about the importance of keeping the streams clean but continue to contribute to streams deterioration.

> *"It been a long time as much as streams are not cleaned and the community is being educated but it the laziness of the people because people when it comes to waste, they just throw it as this is the easiest thing to do to dispose on the stream. Also, when it comes to sewer, people do not want to pay rates, so they dispose on the streams". (participant 10, interviews).*

Mohiuddin *et al*. (2018) also attest that there are positive and significant relationships between attitude and behaviour. The researcher believes that, improving of such link between attitude and behaviour can help improve streams current condition through environmental knowledge which help change people's attitudes to be more environmentally friendly and eventually influences behavioural change that adheres to environmental policies.

5.4.2 Subtheme Two. Current condition of the Streams is Due to Lack of Education

Although it was highlighted earlier by the stakeholders that the current stream condition was due to citizen's poor attitude, other participants however, were observed to believe that citizens are not educated when participants were asked to offer comments on the involvement of education on how they perceived current stream water quality

Majority of the interviewed participants agreed that citizens need to be educated about the importance of stream management. This view was expressed by one of the participants

> *"I think it because people are not educated about the use of the stream or of the environment, people do not have the knowledge so I think for use to achieve what we want to achieve we need to teach them at a young age for example school kids litter because tell them why they should not litter so they grow up with that mentality until they are adults and so the cycle continues. (participant 1, interviews).*

According to Anderson, Jackson, Tharme, Douglas, Flotemersch, Zwarteveen, Lokgariwar, Montoya, Wali, Tipa, Jardine, Olden. Cheng, Conallin, Cosens, Dickens, Garrick, Groenfeldt, Kabogo, Roux, Ruhi and Arthington (2019), local knowledge and customary water management practices can strengthen environmental flow planning, implementation, and sustainable outcomes. Although the municipal authorities were aware of the streams deteriorating condition and the benefits the streams provided when clean, however, they failed to take the initiative to educate the community on the streams water quality importance.

> *"I am not sure, but it been happening from the time we grew up, for a long time because people were not well educated not to throw in the streams before, because we use to look at streams as a place to throw dirt but, now Sihlanzimvelo changed our mentally". (participant 18, interview).*

Mchunu (2012) believe that through on-going public participation helps to educate and enlighten authorities about residents' preferences, grievances and important issues,

thus averting confrontations before they occur and anticipating public concerns and attitudes (Mchunu, 2012)

5.4.3 Subtheme Three. Current Condition of The Streams Is Due to Lack of Service

USEPA (1999) states that as lack of services, sewer system networks age, blockages increase the risk of surface water quality deterioration and is a major health and safety concern affecting the ecosystem especially in the slums. In light of the above discussion, the participants were asked to offer comments on the municipality services on how they perceived it contribute to the stream water quality. According to the researcher, people in some areas do not receive services from the municipality such as the DSW and hence they continue to dump into the stream.

> "*The stream is not in a good state*, *this has been happening as long as there have been slums, people in these areas do not get services from the municipality like DSW cannot have access to waste management and they end up dumping to the streams." (participant 14, interview).*

These findings were in line with DWS (2016) who confirmed that surface and drinking water quality, in peri-urban and rural areas, is further compromised by unskilled plant operators, old and inadequate infrastructure and poor maintenance.

5.4.4 Subtheme Four. Current Condition of the Streams is Due to Sewer Leakages

The participants were asked to offer their comments and perceptions on sewer leakages and how it contributed to the stream water quality. The colour of the water as muddy and unclear as well as bad odours such as faeces were some of the main descriptions of current stream water condition by majority of the participants.

> "*I wouldn't say it clean currently because the stream is muddy due to the water supply construction. My only concern is the smell especially in the morning*

maybe because it comes from slums, I really do not know but it smells like faeces. This is between iSipingo rail and S section at Umlazi". *(participant 5, interview).*

Such observation is in agreement with Nel and Driver (2015) who believe that anthropogenic impacts on surface water are considered increase water insecurity, for example increased withdrawals exacerbate competition between water users. The need to maintain water ecosystem health as a precondition to the realisation of societal benefits is often not an explicit part of the methodological framework.

"*yes, bad odour due sewer busts, not from dumping, yet people next to stream are practising farming using water for irrigation the area is clean. This is at Waterloo area*" *(participant 13, interview)*

This finding of sewer leakages going directly to the streams agrees with Parker and Oates, (2016) that such impact of sewer leakages is not priority to the policy makers and the municipality of South Africa.

5.4.5 Subtheme Five. Offensive Smell in Streams

In light of the above generated subtheme of sewer bust, the researcher wanted to determine if in general there is an offensive smell on the streams of Umlazi and if so, what can be the other factors of this offensive smell. All the respondents confirmed that there is indeed an offensive smell on the streams of Umlazi.Then participants were asked what the cause of this smell is. Majority perceived illegal connection of sewer pipes, sewer bursts and used nappies as the main cause of such

"yes, a lot! (She laughed) illegal connections especially those in the slums, this is poor faeces, I do not know whether it being filth or what but that the life we live. They put faeces into plastics and throwing it into the stream, sometimes while we are cleaning. Yes, definitely like I mentioned sewer leakages and sometimes you find dead animals as well in the streams.". *(respondent 16, interview).*

De Troyer, Mereta, Goethals and Boets (2016) witnessed the streams and wetlands in around Jimma city, Ethiopia, that there was a lack of proper sanitation that led to exceedingly high abundances of faecal coliforms in the surface water (>320 MPN¨ mL´1).

> "*Yes, there are offensive smell, and I think the reason primarily is this illegal dumping and exposing of nappies in this area*. *People throw dead dogs inside the stream when children swim so it not good. for example, streams next to stadium three times in two weeks as its public eye, co-operatives cannot clean it well if there is sewage. There is also a mall and children that are playing." (participant 18, interview).*

This was the main factor of bad smell emanating from the river perceived by other participants that used nappies are thrown directly to the streams. In line with De Troyer *et al* (2016) above of poor sanitation as the streams have become a dumping place for baby's nappies.

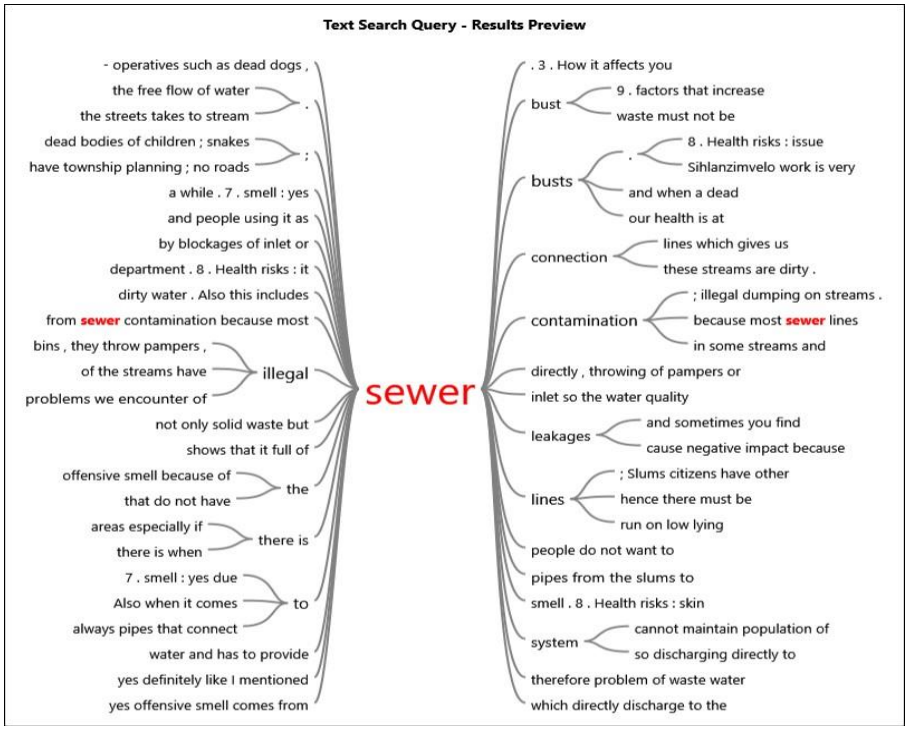

Figure 7. Indicating perceptions of interviewee participants on what the cause of an offensive stream smell is

5.4.6 Subtheme Six. Medical Waste and Bad Attitude of Citizens is the Cause

Other participants though perceived waste as the main factor. The participants were asked to offer comments on the dumping of waste on how they perceived it contribute to the stream water quality. Again, participants viewed illegal dumping of waste to be one of the causes of the current condition of the streams.

> "*The stream at uMlazi are dirty, there is medical waste, general waste-water; and maybe it the perception that is bad. When I think about uMlazi i just freek out. uMlazi requires serious intervention. The citizens think they are owed by the municipality because they are a big township. Illegal connection, illegal abortion. So, water quality issue is out. The situation is bad*." *(participant 13, interview).*

Common waste such garbage dumped into the streams contributes to bad odours and rubble from businesses such as Shisanyama adds to the odours. Guglielmucci *et al*. (2015) in determining the relationship between contaminated sites and mental health, disasters like oil spill causes anxiety, rage, depression and post-traumatic conditions may even cause death or injury,social and economic disruption, environmental degradation and affect whole the community.

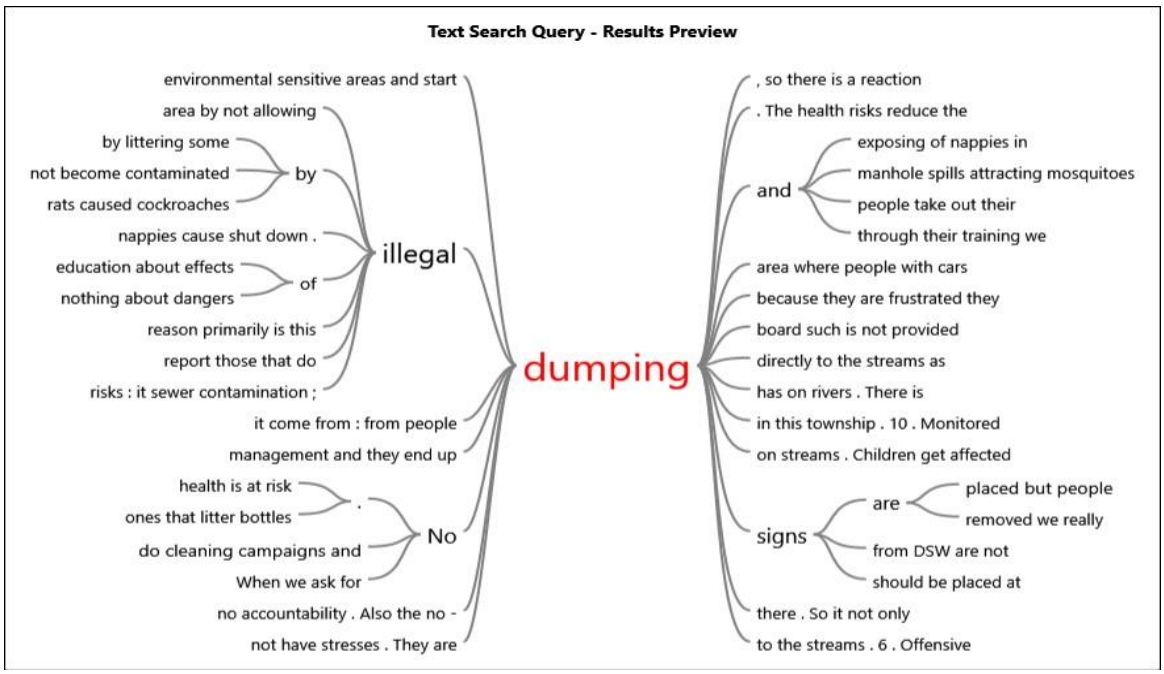

Figure 8. Perceptions on cause of current stream condition

5.5 CURRENT CONDITION OF THE STREAMS AFFECTS PARTICIPANTS AS INDIVIDUALS

Albarracin *et al*. (2005) attest that environmental health risk communication for individuals should have an understanding through environmental knowledge of how she or he could be affected by a disease. This kind of information can support informed decisions and actions thereof required (Severtson *et al*. ,2008).

In this section, the researcher wanted to understand if the current condition of the stream's deterioration affects participants as individuals in Umlazi Township, KwaZulu Natal, South Africa. To determine these effects, the participants were asked to offer comments on how they perceive the current stream water quality condition deterioration to contribute to the health and safety of the individuals' susceptibility and severity.

The participants viewed children swimming near or inside the stream and those close to the stream to be likely affected by diseases such as T.B.; Diarrhoea due to the current condition streams also affect them as individuals. Other stakeholders perceived the current condition prevent them from carrying out their work. From Sihlanzimvelo workers such condition was perceived as the worst physical condition or severity due to exposure to sewage pollution during work for Sihlanzimvelo worker. Stakeholders also perceived being exposed to dangerous animals and waste as severity when they are working on these streams.

5.5.1 Subtheme One. Children do Play Near or Inside the Streams but there are bad health implications

Since the participants highlighted that children are susceptible to diseases especially when they play in or near the streams. The participants were first asked if they believe children do play near or inside the streams and if so, they were asked to offer comments if there are health implications associated with children playing near or inside the stream water. Some participants believed that children do play near or inside the streams but that there are bad implications.

> "*yoo this not nice I just feel sick when I think about it, parents should take their kids to the clinic to get checked as people have lots of diseases especially if they find their children inside the streams. When we see children playing inside the water, we tell them to get out of the water*. *(participant 10, interview)*

This finding agrees with Bartlett (2008), that children's body size makes them more susceptible to dehydration, and children under age five living in poverty represent 80% of victims of sanitation-related illnesses and diarrheal disease. Cholera is more of a threat to children due to their weak system. According to Sigudu *et al.* (2015) the high infection rate of this group during the cholera epidemic is most probably due to their underdeveloped immune system resulting in them not being able to offer adequate protection against the infection.

5.5.2 Subtheme Two. Children do Play Near or Inside the Streams but there are no Bad Implications

Some participants believed that children do play near or inside the streams but that there are no bad implications.

> "*before the streams were cleaned by Sihlanzimvelo, the streams were dirty and children used to be affected by skin rash. But now children can play and not get rash. That why it important for stream water to be clean you cannot keep the eye on a child we only clean 5 km so once we pass that point it beyond our control because children will play one way or the other. (participant 6, interview).*

This view of confirming that children play in the streams is in line with that of Zivin and Shrader (2016), who believes that children are more sensitive to high temperature, because their physiological regulatory systems may be less effective. However, Zivin and Shrader (2016) though believes that children are more likely to depend on elders to help them regulate their behaviour. From the researcher view though, the participants were strategically ignorant of the reality of deteriorating streams conditions.As Freidson (1961) insists that the person who barley accepts his

susceptibility, will be unlikely to check upon his health until he experiences rather intense cues since the kinds of cues may easily be forgotten with the passage of time.

5.5.3 Subtheme Three. Children do not Play Near or Inside the Streams because of bad health implications

Some participants however view that children do not play near or inside the streams.

> "*No! At uMlazi! it they cannot, especially because the stream is dirty. I myself do not even know what there and what not there. The place is extreme dirty*. *(participant 13, interview).*

According to Department of Health Plan KwaZulu-Natal (2015), uMlazi remains the second populated township in the country with high reports of death levels due diarrhoea outbreak during the rainy season of October to February and the rotavirus season April to August.

5.5.4 Subtheme Four. Prevent Work from Being Carried Out

As indicated earlier that environmental pollution or degradation increases stress, such habit can affect the work of the municipality from providing services to the community. This was a subtheme generated when participants were asked if the current stream condition prevented them from going to work. Offensive smell; sewer blockages; continuous dumping and structural damages; the current pollution and status of the streams makes it difficult for various departments to carry out their duties.

> "*It does affect us as a municipal department because most of the complains about stream cleanliness are directed to our department. However, mostly the function of our department is to prevent stream erosion rather than cleanness per sec but obviously as catchment coordinators we have to look at the entire catchment condition and make sure that our catchment is clean and free if litter." (participant 15, interview).*

According to Bell *et al*. (2016) disruptions caused by natural disaster may weaken the infrastructure and impact people's physical health by making it more difficult to access health care or by potentially increasing exposure to pests or hazardous substances resulting in no garbage pick-up.

> "*Yes, it makes life hard for us as a department, when we want to access the site, we come back not feeling well because of the smell that is there and contamination you do not even know what there and what not there. It even hard to perform certain duties due to the condition." (participant 13, interview).*

Morii *et al.* (2008) maintains that mental status depression and cardiac arrest within 30-60 minutes occur with sewer related exposure to concentrations above 500 ppm. Majority of the participants especially from the Sihlanzimvelo agreed that the sewer system must be improved as it cannot maintain population of Umlazi and hence sewage ends up in the streams.

5.5.5 Subtheme Five. Dangerous Creatures, Pests and Insects

Furthermore, the dangerous creatures, pests and insects found on the streams current makes it difficult for various departments to carry out their duties. This was a subtheme generated when participants were asked if the current stream condition prevent them from going to their work. This is due to dangerous creatures that affect stream cleaners when cleaning risks these and animals pose a physical and health risk to people and children. This is due to such animals being attracted to polluted water, waste and overgrown vegetation. This includes: Snakes; Rats; Mosquitoes and is the largest contributor to health risks which can include malaria.

> *"the snakes and frogs are the worst for me but we clean the area for the frogs to swim freely as we were told no kill or disturb it when we cleaning. Although there are lots of snakes in the streams some colleague grabbed the snake by mistake while cleaning, but we afraid of it. (participant 16, interview)*

As described above that impact people's physical health by making it more difficult to access health care or by potentially increasing exposure to pests or hazardous Bell et al. (2016).

5.5.6 Subtheme Six. Stream Condition Has Improved and does not Affect them as Individuals

From theme two where stakeholders were asked what the current condition of the streams is, although most citizens perceived the stream condition to be deteriorating due to lack of knowledge. However, other participants though perceived that the current state of the stream does not affect them in a negative manner as individuals and perceived that the stream deterioration has improved.

> "*Unlike when we started, we were our skin was affected we could not even get access to get in. There is improvement, we are the ones that started the stream cleaning so if I look at it now the citizens are also happy and even acknowledge us, although there are those who has negative attitude, the they dump purposefully telling us that it our jobs to clean". (participant 16, interview).*

According to Parker and Oats (2016), streams and rivers have the potential to provide freshwater for domestic consumption, livelihoods and commercial production (agriculture, livestock and fisheries), industry and energy, and are used for transport and tourism, all contributing to national economic growth and poverty reduction. Are part of the societal benefits from the services a river ecosystem provides (Parker & Oats 2016).

5.6 THE WORST PHYSICAL CONDITION CAUSED BY THE CURRENT STREAM CONDITION

According to Burke (2015) when a susceptibility condition is left untreated the perceived severity develops of an individual's condition or diseases in the HBM (Burke, 2015). In view of this statement, the participants were asked to share their risk perception on what is the worst physical condition caused by streams deteriorating condition. The stakeholders indicated that prevention to work on the streams due to exposure to sewage pollution for Sihlanzimvelo worker was perceived as the worst physical condition or severity. Also stakeholders highlighted being exposed to

dangerous animals and waste when they are working on these streams as another worst physical condition.

5.6.1 Subtheme Two. Extinct Wildlife

Other participants perceived wildlife extinction as the worst physical condition

"*we have lost biodiversity a lot, some animals have become extinct such that the children growing up today they would not even know these animals. For example, cockroaches that were present along the streams but now extinct because they could not adapt in the stream's conditions. So, this is huge loss in terms of biodiversity; health and it can affect food source and recreational activities as some children playing there*. *(participant 15, interview).*

de Groot et al., (2012) highlighted that over-exploitation of ecosystems disproportionately affects the livelihoods of the poor and future generations. While, HLPE (2015) indicated that there are few papers that focus on social differentiations of access to water and other resources, as well as exposure to risks.

5.6.2 Subtheme One. Waste and Sewage

Participants perceived dumping as one of the primary causes of the poor stream conditions. This includes nappies and waste as well. It is as if people vent their frustration of service delivery on the stream.

> "*As explained before, the worst one I have seen was at the clinic where the child had picked up the condom that was floating in the stream and blown a balloon out of it and had terrible mouth soars that was the worst case I have seen*." *(participant 11, interview).*

According to Dunca (2018) water pollution and water quality assessment in Roma, the high degradation of river quality downstream was as a result of discharging of untreated waste waters from industry, households, and pollution from agriculture, sewage water from both rural localities and urban areas, from animal farms and from

industry are the main causes of pollution on surface water resources and ground water.

5.6.3 Subtheme Three. Death

Other respondent perceived death as the worst condition.

> "*Probably being sick to the point of death, when people are sick to the point of not being able to do anything for themselves*. *(participant 3, interview)*

This comment agrees with that of Bwire *et al*. (2016) of cholera outbreaks that has caused deaths especially in South Africa patients with multi-drug-resistant tuberculosis due to expensive costs.

5.6.4 Subtheme Four. Cultural and Economic Worst Condition

In the current study, citizens did not seem to consider economic and sustainability depreciation associated with river or streams conditions, that is irrigation of vegetables, water pollution, drought due to climate change as important as their health.

None of the participants from the interviews perceived cultural detachment due to stream condition such as reduction of swimming or other recreational activities. Yet, Vibrio pathogens in fresh water, surface water and food cause human health and economic losses (Lafferty, Harvell, Conrad, Friedman, Kent, Kuris, Powell, Rondeau, & Saksida, 2015). According to Anderson *et al.* (2019), the Athabasca River in Canada, is linked intimately to the culture and economy of the Athabasca and Mikisew first nations that recognises their rights to hunt, trap, fish along massive wetland complex.

5.7 LACK OF KNOWLEDGE ON SCIENTIFIC STATUS FOR STREAM WATER QUALITY

The type of surface water quality data collection methodology and its interpretation have an impact on stakeholders' knowledge, attitudes and behaviour practices. The trend of water quality results, informs other policy regulations of that area. Also, the successful implementation and abiding of those regulations depends on and is determined by stakeholders' perception of its importance.

Since it was observed that stakeholders perceived clean stream as important, however, the attitude and behaviour of citizens on using the streams sustainable on a daily basis was questionable on the researcher's side considering the streams current condition.

It was with these concerns that the researcher wanted to understand if the stakeholders have the streams water quality knowledge or scientific data at their disposal. In determining stakeholder's general knowledge on stream water quality status of this area, participants were asked what the scientific status of streams water quality in their area is. Participants highlighted that they are not aware of the streams water quality and for this reason they will never advise children to play in or near the stream waters.

> "*Actually, the children are the most vulnerable ones because they are not clued up to what is going on in the rivers and streams about the potential hazards so most kids get sick so they should not play there*. *(participant 9, interview)*

According to Severtson *et al*. (2008) knowing the water condition data could help participants identify personal risks and intensify a strong belief. Another participant further indicated that they have no clue on stream water quality status as departments involved in streams.

> "*This is a loophole in the project. The department of environmental health were to assist in water testing however, no follow-up was done as to when do they test water. Currently water quality we do not know how it would affect them as there are no specific records what is in the water and do not know the results*

of the streams that is which ones are clean. Even if clean we do not know what happening upstream". (participant 17, interview)

It is the authorities' (government) duty to determine RQOs implementation, monitoring and continuously process review by the authorities (DWS, 2014). The lack of data suggest that citizens are still left in the dark about water quality according to (DWS, 2017), therefore citizens are more vulnerable to diseases.

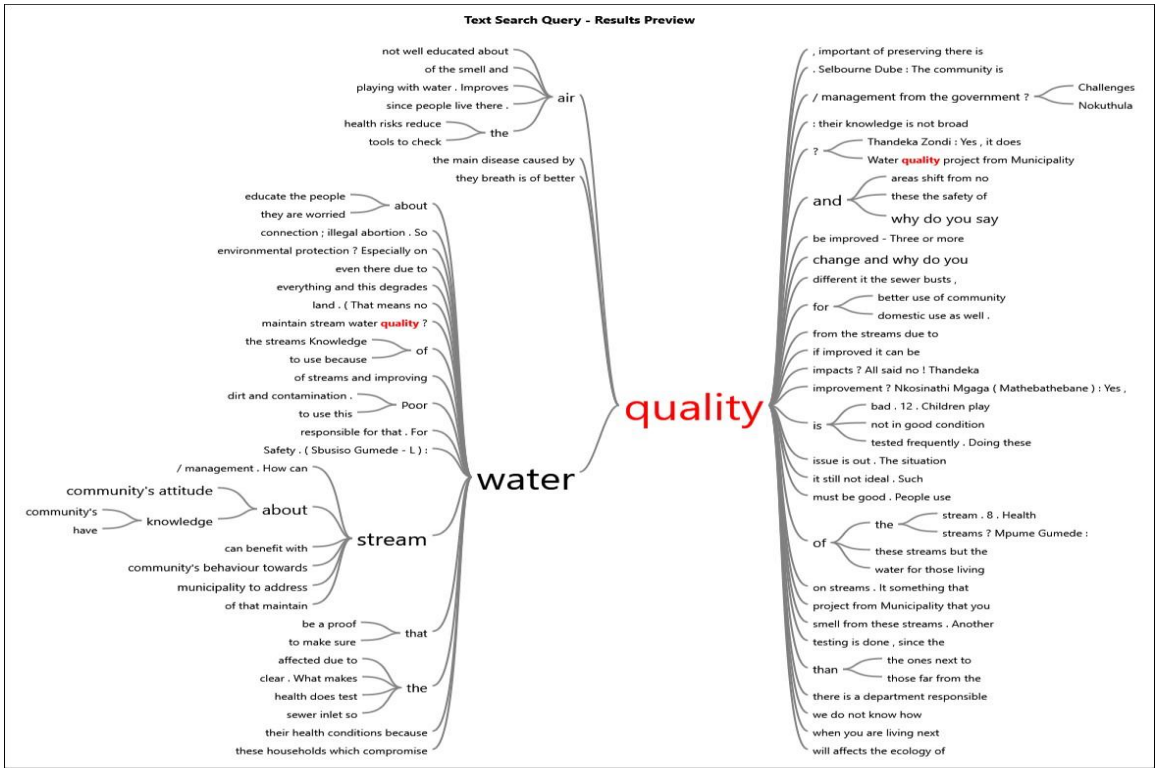

Figure 9. Perception on children playing near the stream

5.7.1 Subtheme One. The Attribute of a Clean Stream

After observing that the participants had no clue of the current water quality data of these streams. The researcher wanted to understand if the stakeholders can be able to do a generic assessment of clean stream. The stakeholders were asked to describe that the general properties of clean stream. All respondents from the qualitative findings described and understood the clean stream attributes the same. These

participants described that the properties of clean stream must include mainly clear water colour this subtheme was followed by no debris and litter, therefore there have an idea of the importance of clean stream. There should be no waste or sewerage discharge in the water. Based on responses, the following was found in relation to the attributes of a clean stream. Water should be flowing and not remain still and no overgrown vegetation, hindering water flow.

Some even went further with their observation on clean stream properties, they said that clean streams show signs of life, there must be visible signs of life in and around the stream. One respondent felt that more birds in the area near the stream indicated that conditions were good. At least '2 metres' safe distance between stream and land, there must be a safe distance between the houses and stream to mitigate flooding and contamination from dumping.

> ” *The stream should be without any litter; no overgrown vegetation, alien vegetation the water should be clean and flowing if the stream is being maintained. (participant 1, interview).*

These attributes are in line with Ezeugwunne, Agbakoba, Nnamah and Anhalu (2009:20) who believe that good quality water is odourless, colourless, tasteless, and free from faecal pollution. However, according to Lopes *et al*. (2016), rivers or streams water colour clearness cannot be the only indicator that can help swimmers make better decision about water quality or suitability of that river in urban areas more than rural areas. Other tests like *E. coli* and turbidity frequent monitoring is essential for minimal exposure of swimmers to health hazards. Good river health is often assessed in relation to water quality, environmental flows, connectivity of river habitats, and biodiversity, among other indicators (Lopes *et al*. ,2016).

5.8 SUMMARY OF THE KEY INTERVIEW FINDINGS

The interview section focused on answering research objective one of conducting on initial assessment of community knowledge about stream water quality policy and practice. In determining this objective, the researcher firstly, determined the health and safety susceptibility and severity associated with streams, followed by determining the

status of stream water quality across streams in Umlazi Township and; what is the community knowledge about stream water quality policy and practices in Umlazi Township.

During determining what is the status of stream water quality across streams in Umlazi Township and; what is the community knowledge about stream water quality policy and practices in Umlazi Township. Although, participants' knowledge on health and safety susceptibility and severity associated with the current surface water quality was broadly understood, but knowledge on the current stream water quality status was absent. Stakeholders did not know the contents of the water, yet they perceived such surface water to be used by citizens for various reasons for survival.

> "*This is a loophole in the project. The department of environmental health were to assist in water testing however, no follow-up was done as to when do they test water. Currently water quality we do not know how it would affect them as there are no specific records what is in the water and do not know the results of the streams that is which ones are clean. Even if clean we do not know what happening upstream"*. *(participant 17, interview).*

In HBM though, action is taken through belief that disease will be reduced and benefits will be maximised (Becker, 1974).

5.9 FOCUS GROUP DISCUSSION

The researcher's next step was to determine if community's lack of knowledge influenced the stakeholders' attitude and behaviour in adhering to stream water quality management policies and promoting sustainability towards stream management restoration practices. This section generated 4 main themes and 12 subthemes.

5.9.1 Focus Group Discussion Phase Data Presentation

This section firstly addressed the focus group demographics and its analysis. Following this, stakeholder's perception on stream policy adherence as the impact of policy is to promote healthy behaviour on citizens was determined as part of stakeholder's general knowledge on stream policies and management practices. Then the perceived barriers associated with maintaining Umlazi Township clean stream and during the discussion of challenges regarding stream management, both the research objective 3 of attitude of stakeholders regarding stream management and practices; behaviour of stakeholders regarding stream management and restoration practices was mainly highlighted by stakeholders as the main challenges; and lastly the researcher determined the cues to action to mitigate these challenges and maximise the benefits associated with clean stream water quality management and restoration practices.

These questions were discussed in the setting of focus group discussion where two separate groups were asked the same questions. The discussions were held in different times, but the responses were both incorporated in this section.

5.9.2 First Focus Group Discussion Demographics Analysis

Table 11. Age group of first focus group

	Frequency	Percent
30-39	6	60.0
40-49	2	20.0
50-59	2	20.0
Total	10	100.0

The age group of the participants is given in Table 12. Majority 60% of the them are within 30-39 years of age, 20% within 40-49 years of age, 20% within 50-59 years of age.

Table 12. Gender

	Frequency	Percent
Female	7	70.0
Male	3	30.0
Total	10	100.0

The gender of the participants is given in Table 13. The majority 70% were females while the males constitute 30% of the participants.

Table 13. Highest qualification

	Frequency	Percent
Honours	2	20.0
Matric	7	70.0
Certificates	1	10.0
Total	10	100.0

The qualification of the participants is given in Table 14. The majority 70% are holders of Matric, 20% holds honours and 10% holds matric education.

Table 14. Sihlanzimvelo participants'' position

		Frequency	Percent
Position	Sihlanzimvelo consultants	2	20.0

	Sihlanzimvelo co-operatives directors	2	20.0
	Sihlanzimvelo co-operatives assessors	3	30.0
	Sihlanzimvelo workers -cleaners	3	30.0
	Total	10	100.0

The participant's department are given in the table below. The majority 30,0% are from the Sihlanzimvelo assessors and workers, 20% from Sihlanzimvelo directors and consultants (Table 15).

Table 15. Work experience of the participant

		Frequency	Percent
Work experience	6-10 years	10	100.0
	Total	10	100.0

The work position of the participants is shown in Table 16. 100% of them indicated to have between 6-10 years working experience.

Table 16. Experience on stream management

		Frequency	Percent
	6-9 years	10	100.0
	Total	10	100.0

The work position of the participants is shown in Table 17. 100% of them indicated to have between 6-10 years working experience.

Table 17. Other stream project

	Frequency	Percent

	KZN Wildlife	1	10.0
	Mini SASS; Adopt-A-River	3	30.0
	no	6	60.0
	Total	10	100.0

When asked whether the participants know any other stream project besides this one you are working on, 60 % answered no. Among those who indicated yes, 10% mentioned KZN Wildlife, and 30% mentioned Mini SASS and Adopt-A-river (Table 18).

Table 18. Skills to manage stream

		Frequency	Percent
Do you have necessary skills to manage stream?	Yes	10	100.0

When asked whether the participants have the necessary skills to manage streams, they all indicated yes (Table 19)

5.9.3 The First Focus Group Discussion Demographics Introduction

The first structured group meeting comprised of 10 participants from Sihlanzimvelo project. The participants were 3 assessors; 2 consultants; five co-operatives workers. Sihlanzimvelo co-operatives workers' observations and perceptions on whether the community knowledge about stream water quality policy and practices in Umlazi Township was enough to maintain sustainability of these streams economic and social benefits of this area.

The researcher again organised a focus group discussion with the Sihlanzimvelo co-operatives involved in streams management that were part of the interview to discuss

further the perceived barriers in maintain streams of Umlazi clean were determined; the community attitude about stream water quality policy and practices; to determine what is the range of community behaviour in response to about stream water quality policy and practices in Umlazi Township, and; lastly to discuss the cues to action towards stream water quality restoration practices. The researcher firstly, probed the previous interview findings from municipality participants and explained the research purpose and objectives. The researcher again asked them for their consent to take part with the focus group discussion concerning their lived experiences in stream management.

Sihlanzimvelo participants' contribution is essential because they are individuals that work in this area on a daily basis and are also part of the community as they stay in the township. The overview of the group would contribute on understanding not only community members, but municipality departments involved in streams management perceptions. While Sihlanzimvelo assessors' contribution was more on assessing Sihlanzimvelo workers daily work, to confirm if the workers are really doing their job or just blaming the citizens for their own shortfalls.

Also, the assessors act as the middleman between workers and consultants, forwarding the concerns of the workers to the consultant's attention. In return, the contribution of consultants as the employees of Sihlanzimvelo workers and assessors was important to share the perceptions of the municipality side. The consultants work closely with the municipality, they are the ones that negotiate workers' salary and other concerns bringing it to the attention of the municipality. Consultants would generally know municipality's challenges and strengths as they work and have regular meetings with the municipality.

5.9.4 Second Focus Group Discussion Demographics Introduction

The second focus group discussion that was organised by the researcher was with the municipality department involved in streams management. This discussion was aimed to further discuss the perceived barriers in maintain streams of Umlazi clean were determined; the community attitude about stream water quality policy and practices;

to determine what is the range of community behaviour in response to about stream water quality policy and practices in Umlazi Township, and; lastly to discuss the cues to action towards stream water quality restoration practices. The researcher firstly, probed the both previous interview and focus group findings from Sihlanzimvelo participants of study's and explained the research purpose and objectives. The researcher again elicited their consent to take part in the focus group discussion concerning their lived experiences in stream management.

As indicated in the below tables below: the second structured group meeting consisting of 7 participants in total. Four from different government departments: 1x Roads; Catchment x 2; 1 x Climate Change and; 1x DSW and; 2 consultants from Sihlanzimvelo project representing Sihlanzimvelo workers. This second group discussion focus on addressing Sihlanzimvelo challenges.

Table 19. Age group of second focus group

	Frequency	Percent
20-29	2	28.6
30-39	3	42.9
40-49	1	14.3
50-59	1	14.3
Total	7	100.0

Majority of the participants, 42.9% of the them are within 30-39 years of age, 28.6% within 20-29 years of age, 14.3% within 40-49 years of age, and 14.3% within 50-59 years of age.

Table 20. Gender

	Frequency	Percent
Female	4	57.3
Male	3	42.9

Total	7	100.0

The gender of the participants is given in Table 21. The majority 57.3% were females while the males constitute 42.9% of the participants.

Table 21. Participants department

		Frequency	Percent
Department	Catchment	2	28.6
	Sihlanzimvelo consultants	2	28.6
	Environmental planning and climate protection department	1	14.3
	Roads and stormwater	1	14.3
	DSW	1	14.3
	Total	7	100.0

The participant's department are given in Table 22. The majority 28.6% are from the Sihlanzimvelo consultants and Catchment department each, 14.3% from DSW; Road and stormwater and; Environmental planning and climate protection department each

Table 22. Highest qualification

	Frequency	Percent
Honours	2	28.6
Masters	2	28.6
B-Tech	1	14.3
Diploma	1	14.3
Degree	1	14.3

Total	7	100.0

The qualification of the participants is given in Table 23. The majority 28.6% are holders of Masters and Honours each, 14.3% holds Diploma; degree each, and BTech each.

Table 23. Participants work position

		Frequency	Percent
Position	Catchment coordinator	1	14.3
	Department Programme manager in restoration ecology, environmental planning and climate change. Other positions: Invasion biology; Involvement of rural communities in biodiversity management; Socio-ecological resilience; Ecological restoration action; Ecosystem functionality and; Partnerships in IAS management	1	14.3
	Educational officer in environmental management	1	14.3
	Manager in Township stream management	1	14.3
	Senior Civil Engineer technician and coordinator in Township Stream management	1	14.3
	Sihlanzimvelo consultants	2	28.6

	Total	7	100.0

The work position of the participants is shown in Table 24. 28.6% of them indicated to Sihlanzimvelo consultants; 14.3% of them indicated to educational office in environmental management and other position indicated by the participants are each highlighted in Table 23.

Table 24. Work experience of the participant

		Frequency	Percent
Work experience	1-5 years	2	28.6
	10+ years	2	28.6
	6-10 years	3	42.9
	Total	7	100.0

The work experience of the participants is shown in Table 25. Majority 42.9% have had 6-10 years' experience, 28.6% 1-5 years and 10 years of each.

Table 25. Experience on stream management

		Frequency	Percent
Stream management experience	3-5 years	1	14.3
	6-9 years	6	85.7
	Total	7	100.0

The experience of the participants on stream management is indicated in Table 26. Majority 85.7% have had 6-9 years' experience and 14.3% have 3-5 years.

Table 26. Another stream project

		Frequency	Percent
Other stream project	Adopt-A-River	2	28.6
	Mini SASS; Adopt-A-River	3	42.9
	no	1	14.3
	Vector control Mini SASS; Adopt-A-River	1	14.3
	Total	7	100.0

When asked whether the participants know any other stream project besides this one you working on, among those who indicated yes 42.9% answered Mini SASS, Adopt-A-river; 28.6% indicated Adopt-A-River; 14.3% mentioned vector control miniSASS; Adopt-A-River and; only 14.3% answered no, they do not know any other stream project beside the one they are working on as highlighted in Table 27.

Table 27. Skills to manage stream

		Frequency	Percent
Do you have necessary skills to manage stream?	Yes	7	100.0

When asked whether the participants have the necessary skills to manage streams, they all indicated yes (Table 28).

As stated earlier that there are different municipality departments that are involved and contribute differently to the Sihlanzimvelo project. Again, the involvement of

consultants was essential on this second group discussion to further confirm or even raise other concerns flagged by Sihlanzimvelo workers. Consultants would generally know municipality's challenges and strengths as they work and have regular meetings with the municipality.

The second structured group meeting consisting of 7 participants in total. Four from different government departments: 1 x Roads; Catchment x 2; 1 x Climate Change and; 1x DSW and; 2 consultants from Sihlanzimvelo project representing Sihlanzimvelo workers. This second group discussion focus on addressing Sihlanzimvelo challenges.

5.10 CITIZENS' ARE NOT KNOWLEDGEABLE ON-STREAM MANAGEMENT POLICY STANDARDS

In HBM, even if a positive intention exists for a specific behaviour, it is still possible that if an individual lacks the necessary knowledge and skills to perform that behaviour and this can prevent an individual from performing the behaviour (Glanz *et al*. ,2015).

To determine if community's lack of knowledge on water quality status influenced the stakeholders' attitude and behaviour in adhering to stream water quality management policies and promoting sustainability towards stream management restoration practices. The researcher wanted to know first if lack of knowledge on water quality influences the knowledge on stream management policy management. The participants were asked to offer comments on the community's knowledge on how they perceived it contribute to the stream water quality policy and practices in Umlazi.

In determining stakeholder's general knowledge on stream policies and management practices. Participants were asked if citizens know and understand stream management policy standards. Participants highlighted that citizens are not aware of the streams management policy standards. All Sihlanzimvelo participants agreed that citizens are not knowledgeable at all. However, not all participants from municipality departments agreed that citizens are not knowledge and all municipality and consultants' participants said that community members do not understand the laws.

"The first mistake the municipality did was not to engage or inform the citizens that they will be people working in the streams because the community thinks we earn big monies when cleaning the streams. They need to be told that we are part of the same community and not outsiders. Even the municipality officials should address the community because community undermines us as co-operatives." *(participant 1, focus group).*

Williams *et al*. (2007) affirms that for an adaptive management of natural resources such as rivers framework and issues, a two-phase process of deliberative and iterative phases in adaptive management with every stakeholder involved is necessary since environmental variation is the most prevalent source of uncertainty and is largely uncontrollable and possibly unrecognized. Another participant said:

"*This is another loophole in the project, the Sihlanzimvelo co-operatives the community and even are not trained in doing mini-SASS, so that they have better understanding of what the impact improvement of cleaning these streams, that is what is it that they are improving*." *(participant 14, interview).*

Besides the fact that streams and rivers in this area have been associated with health and safety susceptibility and severity that include diarrhoea; cholera; malaria; TB; floods; air pollution severities just to mention a few (WHO, 1983; WHO, 2014; Sinanovic *et al.*, 2015). According to Meyer *et al.* (2007) sustainability requires public participation, social learning, capacity building and empowerment of the local public and that is without such there will be no sustainability.

5.10.1 Subtheme One. Citizens' are Knowledgeable Just Ignorant

In determining the impact of lack of knowledge on stream water quality management, the other participants however highlighted that, it is not the lack of knowledge that is the main cause of the streams condition, rather it is the citizens' poor attitude and ignorance.

Some respondents from the municipality officials perceived that citizens are knowledgeable but just ignorant.

> "*the community is being educated but it the laziness of the people, because when it comes to waste, citizens just throw it to the streams as this is the easiest thing to do. Also, when it comes to paying for legal sewer connections, people do not want to pay so they dispose on the streams." (participant 7, interview).*

According to Thunström, van Veld, Shogren and Nordström (2014) some people use ignorance as an excuse to reduce pro-environmental behaviour, ignorance significantly decreases the probability of buying carbon offsets as strategic ignorance significantly decreases the probability of buying carbon offsets and guilt of social pressure. According to Thunström et al. (2014) people decide on strategic ignorance of environmental harm and social norms even if they are negatively affected by environmental harm.

> *"Because of slums and it not because lack knowledge but they are ignorance, lazy and not willing to take their waste to the collection points, they refuse to take it there rather throw it on the streams." (participant 8, interview).*

UNICEF/WHO (2015) and White et al, (2015) agree that the surface water quality deterioration can be caused by slums, general waste and sewer pollution.

5.11 STAKEHOLDERS PERCEPTION ON STREAM POLICY ADHERENCE

The impact of policy is to promote healthy behaviour on citizens. From SEM or SES, local, national government departments and agencies is responsible for the policy level and its implementation and enforcement (Dahlberg and Krug, 2002). It is from this insight that the researcher was then interested in determining if the stakeholders lack of knowledge influences their behaviour in adhering to stream water quality management policies and promoting sustainability. Since the findings in the interview section, theme five also highlighted that most citizens are not knowledgeable about stream management policy standards.

5.11.1 Subtheme One. Policies on Stream Management are not Implemented and Enforced

The stakeholders were asked if in reality these policies on stream management are implemented and enforced. In respect stakeholder's view regarding the citizens' behaviour on stream water quality policy and practices adherence, a number of observations were made. All Sihlanzimvelo participants said that:

> "*community members did not believe in the policy because nobody is ever penalised or arrested*."

These findings are in line with that of Pride and Joy Consultants (2015) from eThekwini Municipality where citizens perceived eThekwini municipality to have poor performance in mitigating pollution of rivers and wetlands. The government officials admitted that they as the municipality have failed to implement and enforce these laws, as another participant continued to say

> *" Even if you say tell them about the laws or policies, these policies are not a priority to them*. *As we as municipality are failing to enforce these laws, impacts positive on disbelieve that such laws exist." (participant 3, focus group).*

According to the researcher, the authorities are perceived slacking from doing their job in enforcing such policies, then citizens may have a luxury not to abide to these laws associated with surface water management. This action agrees with Bagozzi and Yi (1993); Mohiuddin *et al*. (2018) who indicated that when there is poor formation of an intention of police that is caused by a gap between the intention and the actual action, then an individual's perception on how important that law is will determine if that will be abiding by it or not (Bagozzi and Yi 1993; Mohiuddin *et al*., 2018).

5.11.2 Subtheme Two. Implementation and Enforcement of these Policies is Difficult

In respect to stakeholder's view regarding policies not implemented and enforced. Stakeholders were further asked what they perceive as barriers in implementing and

enforcing these policies. Municipality departments indicated that implementing and enforcing these laws is a difficult task.

> *"When I summon a fine penalty to houses, which address should I send it to? Unless you see them littering there and there (participant 4, focus group).*

All participants agreed that it difficult to enforce these laws.

While WHO and UNICEF (2015) and WHO (2017) believes that one of society's greatest challenges in the twenty-first century is to ensure that freshwater ecosystems continue to provide services essential to human well-being over the long-term, in the face of multiple pressures. From literature though, if an individual perceived the barriers to be more difficult or costlier than the benefits, the likelihood of action is less. The researcher believes that policymakers perceptions that implementation of these policies is difficult the main barrier more than the implementation itself and that such perceptions need to be changed. OECD (2015) argue training and educating professionals is essential as professionals direct, influence other professional and make decisions in their workplaces work under, and to influence several institutions.

5.11.3 Subtheme Three. The Informal Houses Makes It Difficult for Stream Management Policies to be Implemented and Enforced

The stakeholders went further to indicate that while policies and laws can be used on formal houses due to their traceability, it is ineffective on slums as these are illegal dwellings with no address or accountability. Hence laws cannot be enforced with them.

> " *implementation is easy for built up area, where we know that that house number and the street name. citizens in the slums do not even have roads, so where do we send the letter to*?" *(participant 4, focus group).*

Everybody agreed.

Even though, the municipality departments perceive the implementation of stream water quality policies as difficult especially in the informal dwellings. According to White *et al*. (2015) values are attributes that people, or individuals perceive as

important, as positive attribute that they will uphold. However, the stakeholders especially the local authorities of this area as leaders of the management they should be setting an example, however, they seem not value or even understand how their lack of policy implimentation influence the stream water attributes and maintaining the streams water clean.

5.12 PERCEIVED BARRIERS

As part of HBM, individuals do encounter barriers that hinder them from promoting a healthy behaviour and reduces their health risks even though they sometimes are aware of the risks (White et al, 2013). This section discussed challenges associated with maintaining Umlazi Township streams clean. Participants were asked to offer comments on whether there are challenges they perceived to hinder stream water quality management in Umlazi. This question was discussed in the setting of focus group discussion by both Sihlanzimvelo and municipality departments. The focus group participants involved were the same group used in the above section.

From Sihlanzimvelo perceptions, barriers to management of streams was divided into three categories: citizens' actions as barriers, working condition as a barrier and, municipality departments as barriers. These highlighted barriers were validated by both citizens and municipality departments

5.12.1 Subtheme One. Citizens Bad Attitude Are Perceived as the Main Barrier

All Sihlanzimvelo participants indicated that the stream is used as a nappy depot to dump used nappies (pampers) and that this is one of their main challenges as these nappies are thrown at them sometimes while they are working.

> …" *They put faeces into plastics and throwing it into the stream. There is another lady who is sick and uses pampers daily then they throw these used pampers to streams, sometimes while cleaning, and everyday we have to pick this up". (participant 6, focus group)*

According to Mohiuddin et al. (2018) the stronger the individual's pro-environmental attitudes, the more likely the individual will engage in various pro-environmental behaviours. Again, the harmful threats received by workers is a sign that the community streams or even worse does not value the streams and is not happy with doing this stream cleaning. Sihlanzimvelo participants also indicated that citizens even threaten to harm them with knifes if they try to discipline them not to litter and say that participants should remove waste from DSW, especially during strike from DSW.

In validating these findings, municipality Roads department participants also perceived bad attitude and threats behaviour from the citizens is another barrier.

> "*This weekend we went to the Hostel to clean the stream and the attitude was bad. They told us" we do not want you here"! they told us that we are to volunteer. Saying we are driving nice cars and eating their money! Saying I am full of myself they wish I can get a lover who is infected with HIV*. *Can you imagine what challenges Sihlanzimvelo workers go through on a day to day from these people?" (participant 1, focus group).*

According to the researcher's view, citizen's bad attitude and behaviour can be as a result of effect of environmental pollution they live under on their daily lives. Such conditions can leave them with no hope let alone valuing nature as stated before such condition has been occurring for a long time. Environmental pollution or degradation increases stress that can make people more likely to engage in behaviour that has a negative impact on their health for example, smoking, risky behaviour, and unhealthy eating habits, illegal dumping (Beaudoin, 2011; Bryant et al., 2014; Flory, Hankin, Kloos, Cheely, & Turecki, 2009).

Although majority of the participants indicated bad attitude they receive from citizens, there were however those participants especially from Sihlanzimvelo that indicated that not all citizens are the same, that is, few citizens even offer them juice while they are working on stream showing appreciation of their work in the community.

5.12.2 Subtheme Two. Citizen's Mind-Set

Although the cooperative consultants confirmed that they evaluate the Sihlanzimvelo work of cleaned the stream every Monday but on Wednesday it like the Sihlanzimvelo co-operatives have not done anything even though the co-operatives work 8 hours a day from Monday to Friday. It is from this discussion that the Catchment and Roads participants indicated that citizens' mind-set is another barrier and these participants believe that citizens need education to change their mind-set and to instil that pro-environmental culture.

> "*Most people like, my colleague said are not interest in the environment and wasting their time but rather houses, electricity and water. They also say environment project do not have money they prefer electricity or housing project that have large stipends. Hence education can instil that culture to change their mind-set as to why." (participant 2, focus group).*

According to Rudiak-Gould (2013) terms such as "climate change" and "global warming" is perceived to be at the global scale rather than the personal impacts. Also, according to Hulme (2009); Swim et al., (2009) and Weber and Stern (2011) the daily and seasonal weather variation, obscurity and unpredictable data of climate change can make the issue easier for people to push aside, particularly when faced with other pressing life issues.

> "*Another issue they say they litter because they are creating job opportunities and say we will come and pick it up because there are people allocated for these jobs, not knowing that the budget used could be used for other project in the ward but now it constantly used for clean streams." (participant 2, focus group)*.

From the researcher's point of view, the citizens have poor understanding of the importance of clean streams and of the fact that it is not only the responsibility of the municipality to keep the streams clean. As such discussion should be incorporated in government environmental awareness campaigns. These observations are in line with Hill and Carroll (2009) who stated that water governance, represents the negotiation between society and government in effectively implementing socially acceptable

allocation and regulation by mediating behavior through values, norms and laws of both government and that of society (Hill and Carroll, 2009).

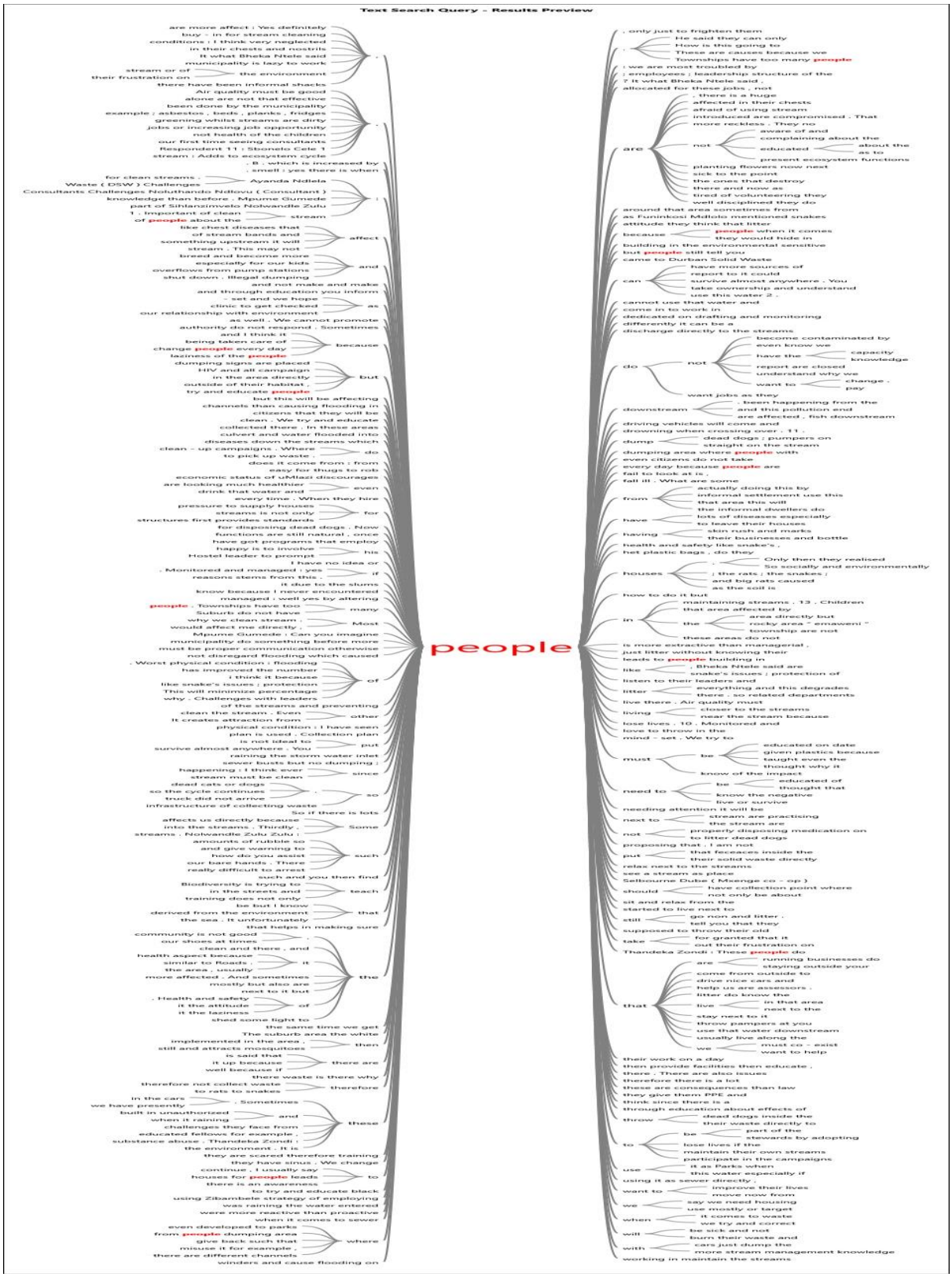

Figure 10. Perceptions of the main barrier

5.12.3 Subtheme Three. Working Conditions Are Not Safe

Sihlanzimvelo workers perceived working condition as another main barrier. Dead bodies of children, animals near and in the streams were encountered by the Sihlanzimvelo workers during work. Also, there was an issue of sewer bursts and dangerous animals like snakes associated with these working conditions due to small scope of the project.

> ” *Main problem is the working condition, the co-operatives workers face when they are working in these communities for example, these guys that are drug addicts “Whoonga”. These guys go and stay by the streams and making co-operatives workers unsafe as they mark them, threaten them and rob them of working tools”. (participant 1, focus group).*

Researcher view that streams were perceived as a centre of diseases and physical harm occurs for both Sihlanzimvelo workers and communities, instead of being viewed as a recreational area. Municipality participants perceived Sihlanzimvelo workers to be more in threats than them as departments as the co-operatives face such challenges on a daily basis as stated below

Another participant added that

> ” *So this thing is deeper than cleaning of streams but now substance abuse. Now issues of substance abuse must be addressed. These addicts now need to be told not to go to streams and rob co-operatives workers.” (participant 4, focus group)*.

Although Gwack, Lee, Kang, Chang, Lee and Hong (2012:208) indicated that acute health effect was associated with where and how long they worked for cleanup. The streams deteriorating conditions have encouraged the “whoonga” drug addicts from the community to threaten Sihlanzimvelo co-operatives on a day by day basis while they are working.

5.12.4 Subtheme Four. Community Members Undermine Both Sihlanzimvelo Workers and the Municipality Departments Itself

Contributing to unsafe working conditions both stream workers and consultants mentioned that the community undermines them as co-operatives, therefore municipality engagement in addressing the community can be useful in making working conditions better. The municipality participants were asked if they know about the Sihlanzimvelo unsafe working conditions and if so, if they have addressed it.

> "*We have responded before, there is a gentleman we use to work with there at Umlazi who is in charge of metro police station and used to be part of our meetings. He confirmed that it really difficult to arrest such people. He said they can only accompany us to go and give warning to such people, only just to frighten them and make people think that since there is a policeman maybe there will obey because they will be scared of being arrested". (participant 3, focus group).*

Everybody laughed at what the above participant was saying, and they all agreed that they are undermined.

Overall, people do not understand the role of the Sihlanzimvelo and the role of its members in cleaning up the stream as Sihlanzimvelo participants previously indicated that the first mistake the municipality did was not to engage or inform the citizens. This alone creates a challenge. This is because no matter how much effort is made by the programme; the outcome will not be effective without community understanding.

5.12.5 Subtheme Five. Municipality Causes Working Conditions to Be a Barrier

Although working conditions were categorized as the second main perceived barrier in keeping the Umlazi streams clean, municipality was perceived to be responsible for these poor working conditions. Challenges highlighted included low budget allocation in running this project. Further, the municipality was perceived to be lazy in doing it work and not able to provide necessary equipment for the Sihlanzimvelo project resulting in unsafe working conditions. The small scope of Sihlanzimvelo was also

highlighted as a barrier.

The Sihlanzimvelo co-operatives said they do not have enough resources to supply their workers with Personal Protective Equipment (PPE) every time due to low budget allocated to them by the municipality. The other main barrier of Sihlanzimvelo was multiple job functions like carrying wet waste for a long distance without the assistance of trucks since DSW does not pick up wet waste.

Participant 18 indicated during the interview that:

> *In other areas we cannot work due to safety and health risks when manhole has busted for example, therefore we cannot access the stream, we have to pick waste using our hands, even if we use proper PPE, sometimes PPE get toned apart because of thorns along the stream but in such areas you cannot even enter. Sometimes we ask the municipality to come and address the houses that do renovations along the streams especially when they are changing roofs and throw asbestos in the streams". (participant 18, interview)*

Gwack *et al.* (2012) state that the use of appropriate PPE such as mask can decrease the prevalence of acute physical symptoms believe that the use of appropriate waterproof suit reduces risks of toxic effects genotoxic effects and even heavy metal contamination and physical injuries. Such conditions can eventually affect their services according to the researcher.

Another participant added

> "*we have a challenge of changing workers every time due to unsafe working conditions and lack of providing them with PPE every two months, because when these workers decide to leave they take the PPE with them*. *(participant 12, focus group).*

Everyone agreed with this statement and clapped hands.

All Sihlanzimvelo participants and assessors agreed that they have a challenge of changing workers frequently due to working conditions they are working under. According to the researcher, the municipality need to improve the municipality need to improve the health and safety of the Sihlanzimvelo workers otherwise the key

employees will be lost, and this may result in competence skills being lost in the process. As Gwack *et al*. (2012) also emphasized that acute health effect was associated with how well the workers wore PPE yet, LMICs policies does not address this issue in their health system and that of population health concerns (Wright, 2015).

In response to this concern, all municipality departments acknowledged that scope and budget should be increased and that all the concerns of the Sihlanzimvelo workers as genuine concern and these they will consider. The municipality departments stated that it is true that one cannot recover the PPE once it's gone, it's gone and that for hygiene purposes you cannot use someone else's PPE.

5.12.6 Subtheme Six. Municipality Itself is a Barrier and not Proactive

It is important to measure public attitudes as it is possible for a municipality to be judged successful in managing programmes and complying with regulations, whilst the overall wellbeing of the community may not have improved. Understanding the barriers towards stream restoration will help improve citizens' knowledge, attitude and behaviour as there is a relationship between pollution due to illegal dumping and diseases.

In determining the stakeholder's behaviour in response to stream water quality policy and practices in Umlazi Township, KwaZulu Natal, South Africa. Municipality departments were categorized by Sihlanzimvelo workers as the third main perceived barrier on keeping the Umlazi streams clean. Sihlanzimvelo stakeholders were then asked whether the municipality does attend to the enquires and complains regarding stream water quality reported to them.

Sihlanzimvelo co-operatives said they have reported people that litter on stream, have you encountered such cases.

> "we *report these issues to the municipality, but nothing is done" "For example, big trees like banana tree that are found along the streams disturb us when working and need cutting but nothing is done.*" *(participant 3, focused group)*

Minnaar (2010:6) maintains that for accountability to occur in an organisation, continuous feedback on individual performance and organization must be determined and this is part of SA Constitution onTransformation of the Public Service (Notice376 of 1995).

> *" Yes, they do inform us that they report but we do not sure if they get response". (participant 1, focus group).*

Values are attributes that people, or individuals perceive as important, as positive attribute that they will uphold (White *et al*., 2015). Lack of accountability and interest on stream management of this area on municipality was observed as part of strategic ignorance by the researcher. Municipality must work hand in hand with Sihlanzimvelo workers, assessors and consultants as they are more on the field, assessors know more than them as municipality. Municipality must take us seriously because we encounter so many challenges as co-operatives such as dead dogs, sewer bursts our health is at risk.

Another challenge highlighted by participants was that the municipality fails to initiate and improve citizen's understanding on stream water quality management

> *"The first mistake the municipality did was not to engage or inform the citizens that they will be people working in maintain the streams because the community thinks we earn big monies. They need to be told that we are part of the same community and not outsiders cleaning. Even the municipality officials should address the community because community undermines us as co-operatives*." *(participant 1, focus group).*

As much as the community has been accused of their bad behaviour, the municipality has an obligation as civil servants to serve the community as according to the Constitution of South Africa (Act 108 of 1996). Section 195 (1) (c) of the Constitution "public administration must be developmental-oriented" and (e) that "people's needs must be responded to and the public must be encouraged to participate in policy-making". This means that municipalities must be democratic, responsive and accountable to the citizens. (RSA, 1996).

5.12.7 Subtheme Seven. Challenges Faced by DSW, Roads and Catchment Departments in Running Sihlanzimvelo Programme

During the group discussion on barriers in running Sihlanzimvelo project, participants also highlighted that as individual departments also face challenges. When participants were asked what these challenges are. Municipality participants also highlighted the need to expand the scope and include Human settlement as it difficult to run this project without proper communications of departments.

The challenges faced by DSW, Roads and Catchment department were perceived by participants to be similar and these challenges include lack of human settlement department involvement; Umlazi population size is greater than manhole capacity at present. Other participants viewed lack of human settlements department involvement in this project is a barrier on its own houses built by housing for citizens is often not safe due to high demand of houses by citizens.

> "*I have not seen Human Settlement as being part of Sihlanzimvelo.* Yet, *people will say, "we need housing" or is it going to affect, and certain things will be overlooked for example placement; ecological infrastructure that we have presently. (participant 1, focus group).*

From researcher's view citizens' ecological infrastructure is a not properly managed and are mostly closed to be flood plain. The impact of population growth and urbanization is an underlining cause of Silo mentality barrier and these challenges require town planning, housing departments as well. Otherwise, as Sihlanzimvelo consultants confirmed that manhole bursting every now and then releasing directly to the streams and rivers such challenges will not be resolved. As another participant added

> "*The manholes were not built for example, 10 households to connect to one manhole. The four roomed houses now have outside buildings connected to the same sewer pipes on that one manhole. You then find another new household in the area also connecting to the same manhole that is why we see these manholes bursting every now and then.*" (*Participant 8, focus group*)

As indicated before that poor health system governance practices result in population's needs and health spending priorities being compromised and demoted (El-Zein *et al*., 2014). These findings are confirming that there are old and inadequate infrastructure and poor maintenance DWS (2016) and this increases surface and drinking water quality risk of deterioration due to blockages, and collapses of infrastructure resulting into a major health and safety concern (USEPA ,1999).

The Silo mentality was another main barrier perceived by all municipality departments that makes Sihlanzimvelo project to be complex project as, it includes departments like: Roads; Catchment; Parks; Health and DSW but not all of these departments are active in the project. Climate change department briefly disussed it as their main challenge in running Sihlanzimvelo project.

5.12.8 Subtheme Eight. Challenges Faced by Climate Change Department

The participants indicated that even the municipalities do not work together, departments local, provincial and national do not work together. That they as sister departments they find themselves sometime telling the citizens not to use them as departments but refer the citizens to national as only national have a right to give them instructions.

> " *Our problem is Silo mentality. Whatever we do we it in our own Silo's and it difficult to communicate because there is no platform where we are able to discuss and align our objectives as departments*. *Barring in mind that we are equal as departments, so as sister departments therefore we have no powers to tell another department what to do and all another challenge." (participant 4, focus group).*

Nel and Driver (2015) maintains that challenges in government departments, there are also bureaucratic problems around complicated intra-departmental processes, which include a lack of communication between chief directorates, inaccessibility of information, an overload of rules and regulations and a lack of funding in certain areas. These issues limit the capacity of government employees to absorb and use new science products and tools, given the already stressful work environment within which

they function especial regarding the National Freshwater Ecosystem Priority Areas project of South Africa (Nel et al, 211:78). Another participant added,

> "*Moreover, it takes longer to get national involve in such things*". *Yes, it takes long. It like the issue of sand mining along the river poses. This is supposed to be DMR who is responsible for that, but DMR is far, it in Pretoria.*" *(participant 3, focus group).*

Also, most government departments and sub-units are understaffed, making it difficult for government employees to carry out their day-to-day operations (Nel and Driver, 2015). Such challenges agree with perceived challenges of participants. According to the researcher, it would better if such issues are tabulated at higher level like City Manager frequently and taken as one of the major priorities just like housing projects

Both department of climate change participants and Roads department perceived departments silo mentality as their main barrier.

> "*In the past we use to have quarterly meetings with all the departments where we discuss the program. If there is any need we call the department directly for example Catchment department assist the streams collapses, then will call them to come and check if they can put Gibions Road*." *(participant 1, focus group).*

Authorities thus have an obligation to ensure that every individual, particularly the poorest of the poor, is part of the decision-making mechanism regarding development (Swanepoel & De Beer 2011) due to inherent Constitutional rights that apply. Regardless of socioeconomic or cultural backgrounds, communities with high levels of social capital and community leadership experience the quickest recoveries after a disaster and the highest satisfaction with community rebuilding. Therefore, HBM external factors and that of TPB are part of behavioural change that can provide general guidelines of strong social pressure that could be considering persuasive communications (Fishbein and Ajzen, 2005). These social pressures include local leaders like ward councillors according to the researcher.

5.13 CUES TO ACTION

The participants perceived streams provide various benefits to the community provided it clean for example irrigation and swimming services. However, since the current condition of the streams was perceived to affect participants individually to the extent that result in susceptibility of diseases on especially when children playing near or swimming inside the stream water or even developing into health and safety risks/ severity as is the case with Umlazi children.Such that the worst physical condition and barrier for Sihlanzimvelo participants was them working on streams conditions and being exposed to dangerous waste items and animals.

According to Glanz *et al*. (2015) though, once the perceived barriers and benefits are established, there arise a need for cues to action. It is with these concerns that researcher wanted to understand what cues to action can mitigate these challenges associated with maintaining Umlazi Township streams clean. This question was discussed in the setting of focused group discussion by both Sihlanzimvelo and municipality departments (separately). The focused group participants involved were the same group used in the above section.

According to Burke (2016), cues to action are anything that triggers a decision to change behaviour. Burke, (2016) insists that the two categories of barriers and benefits discussed can lead to likelihood of action and determine if the action is worth it.

5.14 FINDINGS OF FOCUS GROUP

5.14.1 Attitudinal Change Cues to Action

The response from the focus group and that from the survey shared some similarities. All participants agreed that municipality engagement and education are the main tools that can change the attitude from bad to good. The overall, and as emphasised in other themes, more education must be implemented for the community and inform people these are consequences than law enforcement after training.

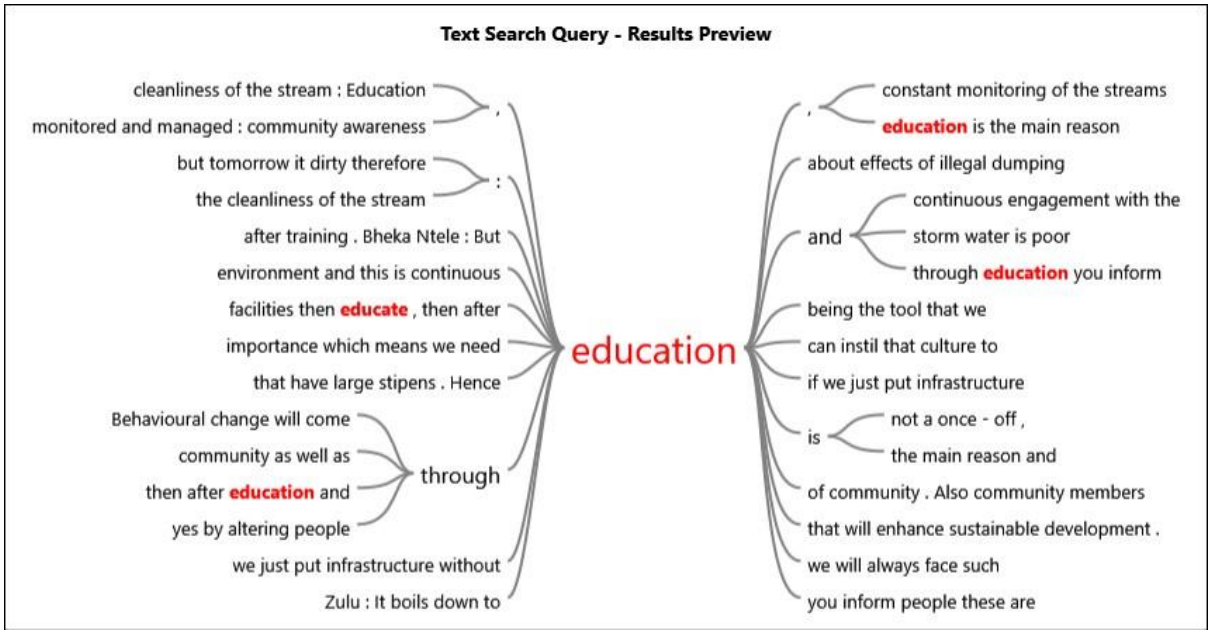

Figure 11. Summary of tools that help change attitudes

Educating citizens about the importance of environmental policies will bring knowledge improvement, attitudinal change and behavioural change towards stream management practices.

The response from the focus group shared some similarities. All participants agreed that municipality engagement and education are the main tools that can change the attitude from bad to good. The overall, and as emphasised in other themes, more education must be implemented for the community and inform people these are consequences than law enforcement after training. While Becker (1974) believes that action is taken through belief that disease will decrease, and that is a benefit in HBM. Other participants though believe that attitudinal change will come with time.

All the participants agreed that attitudinal change will come with time.

> *" Some will learn, some would not, some it takes time but again". (participant 3, focus group).*

However, participants believe that only some citizens will learn while others will not.

“Can you educate someone and tell them that they should not something and they learn from that? Can people from hostel change?” (participant 3, focus group).

The participants also mentioned that carrot approach implementation using incentives when they do good, this method discourages bad behaviour. One respondent mentioned that there were two approaches that can be used to gain attitudinal change. The ‘carrot’ and/or ‘stick’ approach. Carrot approach was more about incentives.

“Carrot approach-if you do good that what you will get but we discourage that a person gets an incentive for something they should be doing. Because it does not make sense because” I am helping you”! (participant 4, focus group).

Even though the municipality participants indicated that it everyones job to keep the streams clean the municipality participants, the researcher still perceive that municipality feels it is only citizen’s job to keep the streams clean because of lack of accountability from the municipality, lack of community engagement, lack of awareness campaigns and training. However, as mentioned earlier, water governance is the negotiation between society and government in effectively implementing socially acceptable allocation and regulation by mediating behavior through values, norms and laws of both government and that of society (Hill and Carroll, 2009). Not only does the municipality not provide necessary working material for the Sihlanzimvelo workers, moreover, from the researcher’s perceptive their attitude and mindset also need to change.

Another participant added that stick approach was another approach that can help change the attitude from bad to good according to the focus group participants.

“*the stick approach indicates that if an individual does not change their attitude and behaviour to good, they will face consequences and such law enforcement or natural disasters like floods affecting them”. (participant 4, focus group).*

All stakeholders agreed and believed that the reason why citizens continue to litter is because they are not penalised and are not even scared of not complying. Such insight from stakeholders agree with Smith and Strand (2008) that determinants of behaviour

are individual's attribute that influence behaviour can be positive and negative reinforcements. As stated earlier that, people that have little personal experience with a disaster are less motivated to take the warning seriously or even to seek further information (Barnes et al. ,2007).

5.14.2 Authorities knowledge

According to Glanz *et al*. (2015), even if the intention present is good, lack of proper knowledge can be a barrier to performing that action or behavioural change. Participants highlighted that they are not aware of the streams water quality and for this reason they will never advise children to play inside or near the stream waters. Another participant further indicated that they have no clue on stream water quality status as departments involved in streams.

> "*The department of environmental health were to assist in water testing however, no follow-up was done as to when do they test water. Currently water quality we do not know how it would affect them as there are no specific records what is in the water and do not know the results of the streams that is which ones are clean. Even if clean we do not know what happening upstream"*. *(participant 17, interview).*

According to Severtson (2012) knowing the water condition data could help participants identify personal risks and intensify a strong belief. Therefore, even though the intention of cleaning the streams is there, there is still lack of proper knowledge from the municipality participants.

Again, the researcher believes that the type of surface water quality data collection methodology and its interpretation have an impact on stakeholders' knowledge, attitudes and behaviour practices. The trend of water quality results in return informs other policy regulations of that area. Also, the successful implementation and abiding of those regulations depends on and is determined by stakeholders' perception of its importance.

5.14.3 Authorities Attitude

Although stakeholders' knowledge on health and safety susceptibility and severity of the current streams condition is there, however, according to the researcher's observation there is still no relationship between attitude and behaviour due to lack of intentions policy enforcement. The municipality departments perceive the implementation and enforcement of stream water quality policies as difficult especially in the informal dwellings.

Pahl-Wostl, Sendzimir, Jeffrey, Aerts, Berkamp and Cross (2007) in managing change toward adaptive water management through social learning found that lack of IWRM is a lack of knowledge on global water management concept and that this lack of IWRM is due to lack of policy implementation especially in the developing countries. As a result, although the departments perceive themselves to understand these laws yet, no action has been done. This can mean that authorities may not be perceiving stream water quality condition as health and safety susceptibility and severity that much, otherwise they would have changed their behaviour to minimise risks.

According to the researcher, as previously explained above that the municipality to a certain extent shows a positive attitude regarding streams cleaning and it maintenance and this has led to establishment of Sihlanzimvelo project. However, there still will be no relationship between attitude and behaviour due to lack of policy impact, that is even if there is positive attitude on authorities, that positive attitude will not lead to behavioural change because of lack of policy implementation.

Although White *et al*. (2015) insists that values are attributes that people, or individuals perceive as important, as positive attribute that they will uphold. However, the stakeholders especially the local authorities of this area as leaders of the management they should be setting an example, however, they seem not value or even understand how their lack of knowledge on water quality status and on intention of policies implementation influence the stream water attributes and maintaining of the streams water quality.

5.14.4 Authorities Behaviour

Strategic ignorance was another challenge that was highlighted throughout the study from both authorities and community members at large. According to Knocke and Kolivras (2007); Lee, Meyer and Bradlow (2009) individuals can ignore warnings or downplay signs and this make the information to be less effective. While, Hobfoll, Stevens, & Zalta, (2015) believes that another barrier to behavioural change can be that people may decide to purposefully ignore, deny the effects of climate change due to the complexity, uncertainty and fear it concept or so to reduce guilt of not complying.

In response to this concern, all municipal departments acknowledged that scope and budget should be increased and that all the concerns of the Sihlanzimvelo workers as genuine concern on their part and that these they will consider which included supply of additiaonal PPE.

Sihlanzimvelo participants during the interview also indicated that have a problem of accessing the streams at time such that they either hire tractor that will remove the stream bank sand that has collapsed due to these heavy waste materials or remove it with our bare hands.

> "*we are not provided with trucks to transport this waste plastic bags, the budget allocated to us is very small, we have to get transport and transport it for ourselves*. Also, *sand block channels and we have to remove it as it prevents the stream water flow. Can the municipality remove this sand for us please?" (participant 10, focus group)*.

According to the researcher's view, the scope of Sihlanzimvelo can lead workers feeling stressed even depression as they feel they are being overworked, moreover, due to the current stream's deteriorating condition.

> "*The waste issue, I do agree with them. maybe we should include this in the next scope maybe by asking a truck from DSW allocated to co-operatives to help them collect this waste*. *They have to transport alien plants they removed from the stream using their vans as DSW is not involved in wet waste only solid waste and this wet waste is heavy, so they find themselves having many jobs to do. (participant 1, focus group).*

The findings from Rajan (2018) also confirms that the perception of sanitary workers there are risk factors associated with heavy workload and its impact on health and work and behaviour of the sanitary workers. Therefore, the authorities need to improve the working conditions for Sihlanzimvelo worker according the researcher otherwise, physiological health, mental health, health behaviours, related health and safety of Sihlanzimvelo would be greatly affected (Wong, Chan and Ngan, 2019).

From this theme thirteen of perceived barriers, the researcher's viewed authorities to practice strategic ignorance. Authorities although they are aware of challenges faced by co-operatives when cleaning the streams in this area, they continue not to provide them with necessary working tools. Authorities are also confirmed that they are aware of citizen's bad attitude of hitting stream workers with used nappies, yet, nothing has been done by the municipality departments involved yet. This from the researcher's point of view can be categorized as strategic ignorance from authorities' side as one municipality participant previously indicated that they were threatened at the Hostel even wished that they contract HIV.

In HBM, action is taken through belief that disease will be reduced and benefits will be maximised (Becker ,1974). From interviews and focus group discussion findings, the researcher's view was that there would be no attitudinal change from bad to good and that there would be no stakeholder's behavioural change towards stream water quality restoration practices because of the lack pro-environmental behaviour on stream water quality management policies and lack of intentions on policy enforcement and implementation.

6CHAPTER SIX

DATA ANALYSIS AND PRESENTATION OF THE QUANTITATIVE PHASE

6.1 INTRODUCTION

Since the research study applied the mixed method research design, quantitative methods were used to triangulate the qualitative findings. This is the second to last section of the study, where the community members of Umlazi township were the main participants in answering of all research questions from questions 1 to research question 5. The Covid-19 precautions were considered during the survey to prevent the spread of corona virus. Some of results from this survey method finding was extracted for inferential analysis.

6.2 SUMMARY OF SURVEY DEMOGRAPHIC INFORMATION

Table 28. Household demographics

	N	Minimum	Maximum	Mean	Std. Deviation
Household	190	1	16	5.33	2.953

The household demographic is given in Table 29. The minimum number of the household indicated was 1 while the maximum was 16. Overall, the mean household number was 5.33±2.9.

Table 29. Occupational status of head of household

		Frequency	Percent
Status	Unemployed	128	67.4
	Self-Employed	27	14.2
	Employed	35	18.4
	Total	190	100.0

The occupational status of the Head of household is given in Table 30. Majority 67.4% were unemployed, 18.4% indicated to be employed while 14.2% indicated they are self-employed.

Table 30. Highest educational qualification of head of household

		Frequency	Percent
Qualification	Primary	58	30.5
	Secondary	76	40.0
	Matric	43	22.6
	Tertiary	13	6.8
	Total	190	100.0

Table 31 indicates that 40% of the head of household holds secondary school level qualification, 30.5% holds primary level, 22.6% were matric holders, and 6.8% Tertiary degree qualification.

Table 31. Ethnicity

		Frequency	Percent
Ethnicity	Black (South African)	190	100.0

Table 31 indicates that all the respondents were Black (South African).

Table 32. Age group

		Frequency	Percent
Age group	18-24	30	15.8
	25-40	102	53.7
	41-65	54	28.4
	>65	4	2.1
	Total	190	100.0

The age group distribution of the respondents is given in Table 33. Majority 53.7% are within 25-40 years of age, 28.4% within 41-65 years of age, 15.8% within 18-24 years of age and only 2.1% above 65 years of age.

Table 33. Gender

		Frequency	Percent
Gender	Male	60	31.6
	Female	130	68.4
	Total	190	100.0

The gender of the respondents is shown in Table 34. Majority of the respondents were female 68.4% while only 31.6% were males.

Table 34. Living arrangements

		Frequency	Percent
Living arrangement	Living alone	26	13.7
	With family/friends	161	84.7
	In care	1	.5
	Other	2	1.1
	Total	190	100.0

Table 35 shows that the majority 84.7% living arrangement is with family/friends, 13.7% living alone, 1.1% living with others, and 0.5% in care.

Table 35. Type of tenancy

		Frequency	Percent
Tenancy	House owner	36	18.9
	Renting	17	8.9
	Living with family/parents	137	72.1
	Total	190	100.0

Table 36 shows that the majority 72.1% are living with family/parents, 18.9% are owner of the house, and 8.9% renting.

Table 36. Type of house

		Frequency	Percent
Type of house	RDP	64	33.7
	Informal dwelling	36	18.9
	four-roomed or formal dwelling	90	47.4
	Total	190	100.0

As shown in table 37, 47.4% type of house is a four-roomed or formal dwelling, 33.7% RDP, and 18.9% informal dwelling.

Table 37. House near the stream

		Frequency	Percent
Is the house near the stream?	Yes	105	55.3
	No	85	44.7
	Total	190	100.0

When asked if the house is near the stream, majority 55.3% answered yes while 44.7% answered no (Table 38).

Table 38. Number of years living in the area

		Frequency	Percent
How long have you been staying in this area?	1-5	14	7.4
	6-10	37	19.5
	11-15	46	24.2
	15-20	33	17.4
	25-30	38	20.0
	above 30	22	11.6
	Total	190	100.0

As shown in Table 39, 24.2% indicated to have lived in the area between 11-15 years, 20% indicated within 25-30 years, 19.5% indicated 6-10 years, 17.4% indicated 15-20 years, etc.

6.3 SURVEY PHASE DATA PRESENTATION

6.3.1 Knowledge About Health and Safety Susceptibility and Severity Associated with Stream Water Quality.

In validating the first research objective findings from qualitative phase of conducting an initial assessment of community knowledge about stream water quality policy and practices in Umlazi Township, KwaZulu- Natal, South Africa. This second section of the quantitative research first focused on knowledge about health and safety susceptibility and severity associated with stream water quality. Similar questions to that were asked in the interview phase of qualitative were asked to the community members.

6.3.1.1 Importance of stream cleanliness

To a large extent the portfolio of benefits will depend on how a stream or river is managed by it users. The citizens were asked: In their own opinion what is the importance of the clean stream in their neighbourhood as question one, figure 12. In validating the above qualitative finding of perceiving stream cleanliness as important, the same question was asked to citizens if they perceive importance of a clean streams. 77,4% of the citizens believes that clean streams are important (figure 12)

Citizens were then asked what the reason can be they perceive clean streams to be important. The following were reasons why stream cleanliness is important: with 30.5% citizens confirms that healthy community needs healthy streams and prevention of diseases and germs as the second main reason with 28.4% as the reason for stream importance. (figure 13). Respondents indicated healthy stream results into a healthy community, and this was the most highly ranked reason from respondents. This is logical and the water quality affects the health of the community. Prevent diseases and germs relating to the above, this was the second most highly ranked factor.

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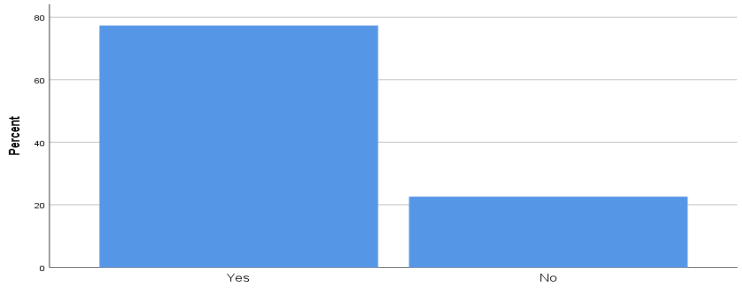


Figure 12. Indicating whether a clean stream is important

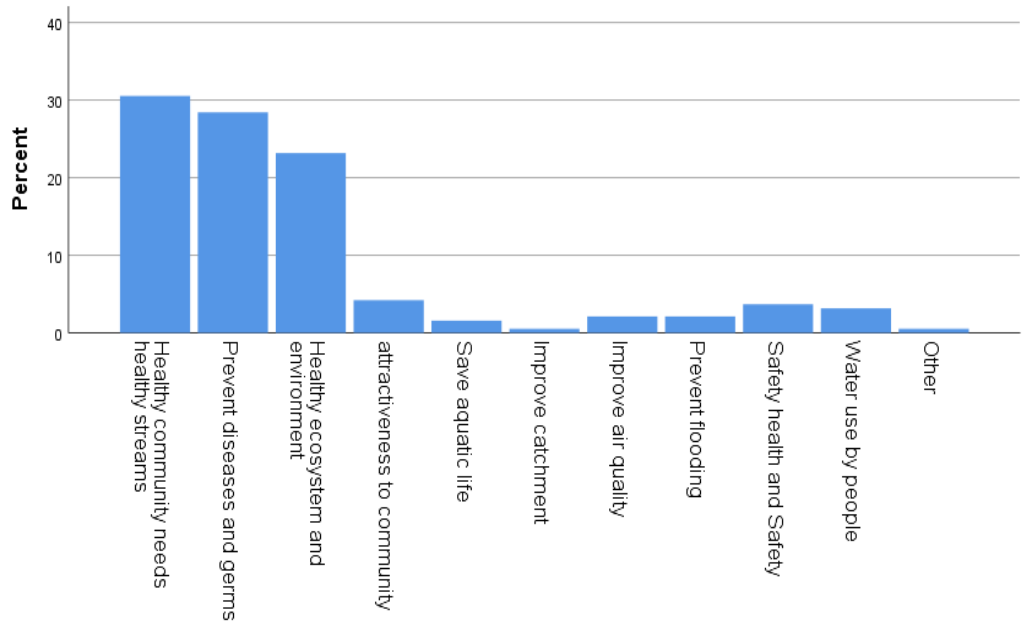


Figure 13. Why citizens feel clean streams are important

6.3.2 Current condition of the streams and it causes

Then citizens were asked: In their own opinion, what is the current condition of these streams. Majority of the citizens perceive the stream condition to be deteriorating with 48,9% of the citizens perceived the condition of the streams of Umlazi to be poor and 35,3% perceived it as worse and only 2.6 % considered the streams to be clean (Figure 14). In indicating the reasons that has led to this condition below, citizens were then asked what the cause of this current state could be? 30.0% majority said it the poor attitude of citizens; 22.6% believe because stream not cleaned; 13.2% indicated lack of education and knowledge as the reason 9.5% believe easy access to the stream (Figure 15).

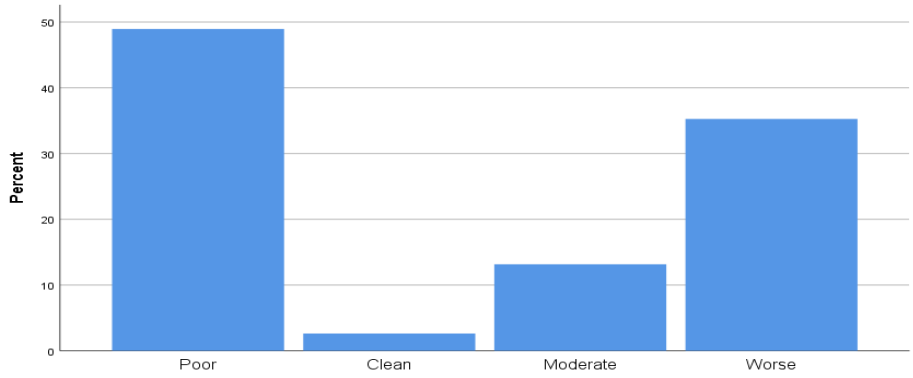


Figure 14. What is the current condition of the streams?

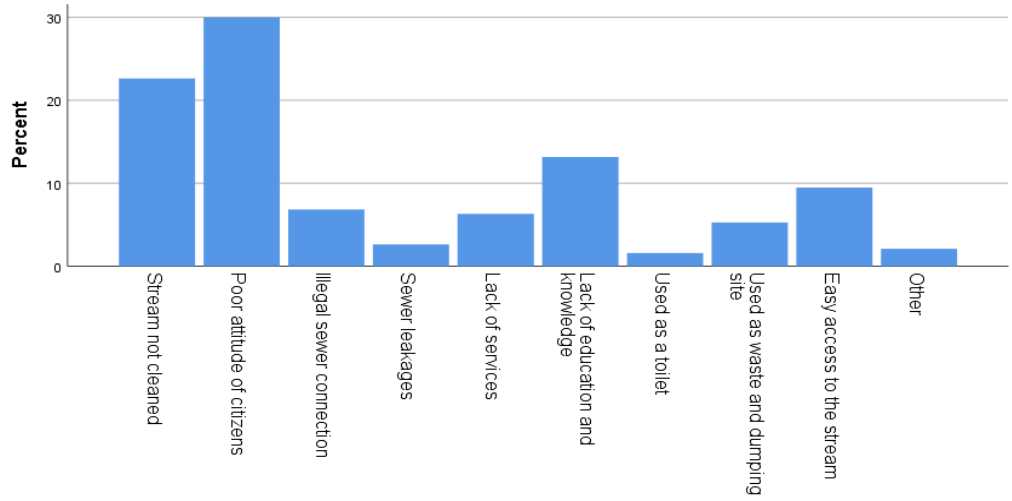


Figure 15. What led to these challenges?

6.3.3 For how long has poor stream condition occuring

After establishing the streams current condition to be health and safety hazards due to it poor condition, the citizens were asked how long has this reaction of stream deteriorating condition been happening in their neighbourhood. 62.1% indicated that ever since I started living here; 18,9% believed that from the time they were young, and 10.5% citizens said they do not know (Figure 16). Determing duration of such poor conditions confirms qualitative finding of how long and how unsafe the citizens and Sihlanzimvelo workers of this area have been.

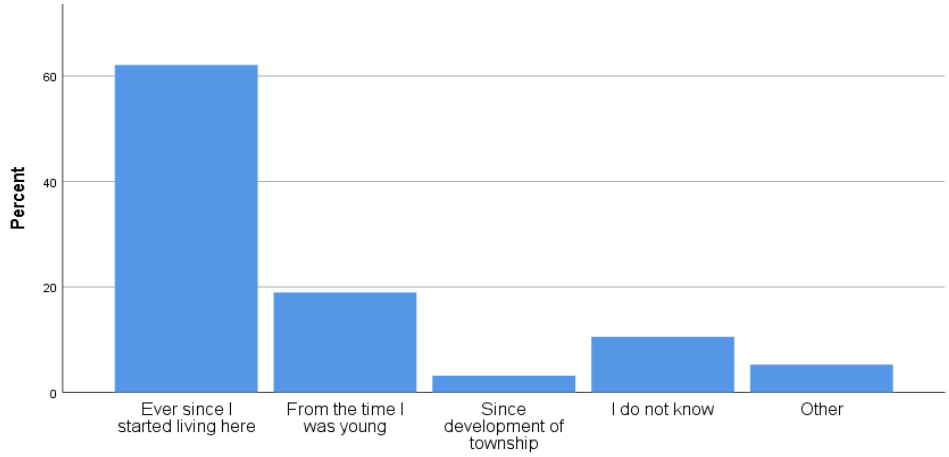


Figure 16. Indicating how long the citizens perceive this reaction has existed

6.3.4 The attribute of a clean stream

When citizens were asked to give their generic description of a clean stream, 24,7 % citizens believe that no debris is an attribute of clean stream; 24,2 % citizens believe clean water is, and 20,0 perceived no waste in water as an attribute for clean stream (Figure 17).

This, however, can mean 24,7 % of the citizens can use the stream water if there are no debris or litter without knowing if the stream water is clean and; 24.2% believes that clean streams is determined by clean water. These findings confirm the argument that unless stream or river testing is done community members are prone to risks associated with surface water as they have no knowledge.

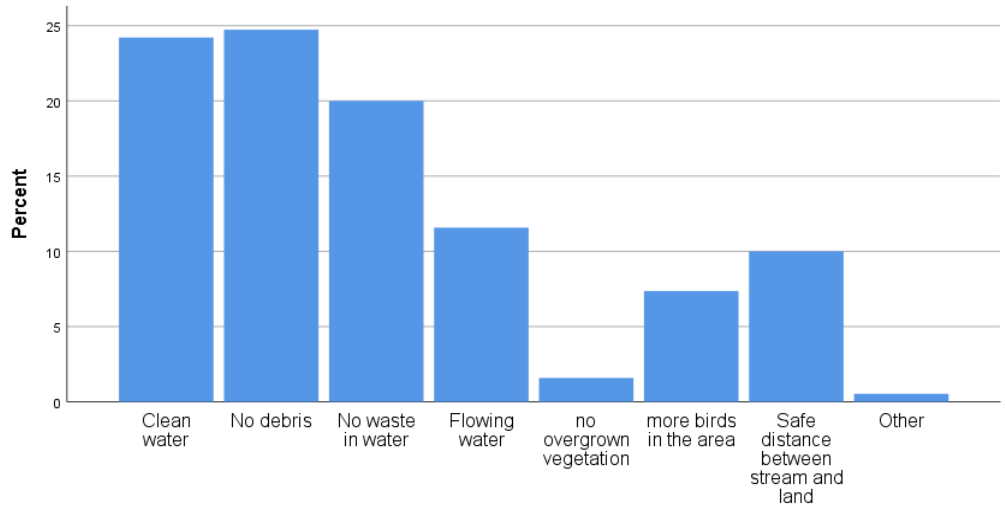


Figure 17. Showing citizens perception on the attributes of a clean stream

6.3.5 Current condition of the stream impact

When community members were asked to share their opinion as to whether the current deteriorating condition of the streams affects them as individuals, 27,4% of the citizens stated diseases as the main health and safety risks associated with stream ,14,7% perceived dangerous animals inside or near the streams, and 14,2 % citizens believe it robberies (Figure 18).

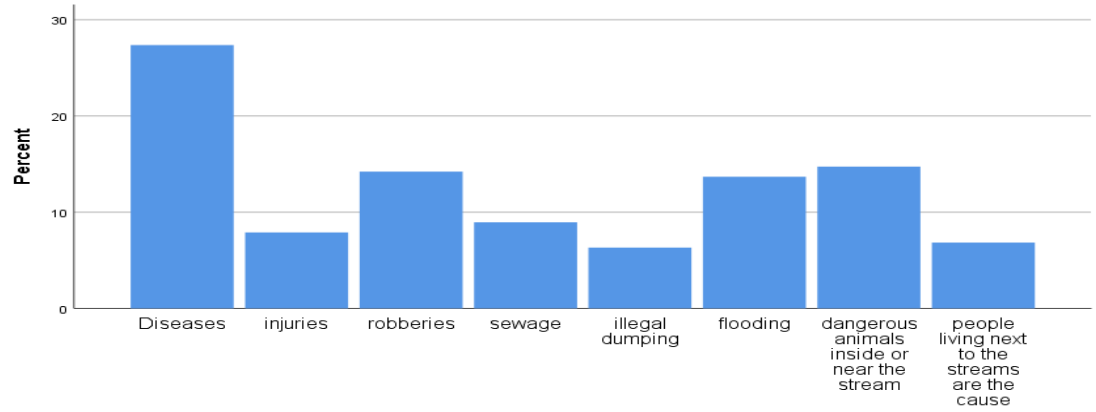


Figure 18 . Citizens perception on how current stream affects them as individuals

6.3.6 Offensive smell in streams

After determining that the streams poor condition has been occurring for a long time, citizens were asked if there is an offensive smell in the streams and if so, what is the cause of this smell. 77,4% confirmed that the stream has an offensive smell and 22,6% do not perceive any offensive smell on the streams (Figure 19).

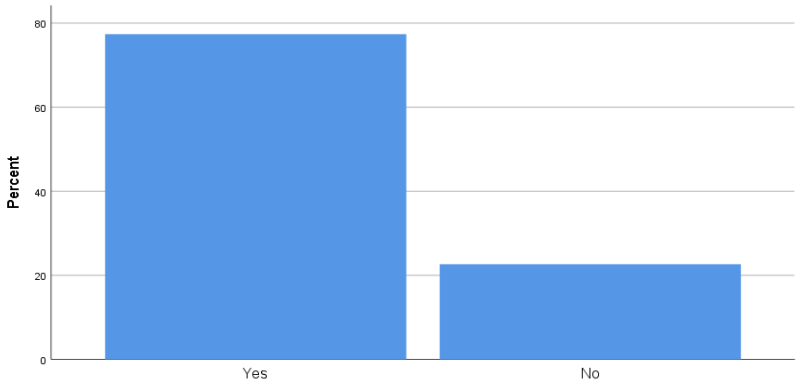


Figure 19. Perception of an offensive smell in the stream

6.3.6.1 Causes of the offensive smell

In validating the interview concerns of offensive smell in streams and it cause, citizens were asked what could be the cause of this offensive smell, 37,9% of the citizens stated nappies and faeces as the reason for the offensive streams in this area and specially 16,3% indicated sewer as the main cause. 29,5% citizens believe general waste was the reason for the smell (figure 20).

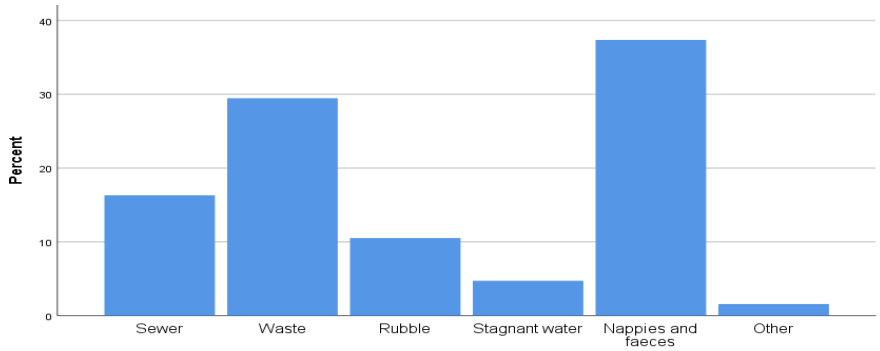


Figure 20. Causes of offensive smell in the stream

6.3.7 Risks of living near the streams

When citizens were asked if the perceive any risks in living near the streams, 74.2% confirmed that there are risks in living near the streams, 24.2% said no there are no risks and 1.6% said they do not know (figure 21).

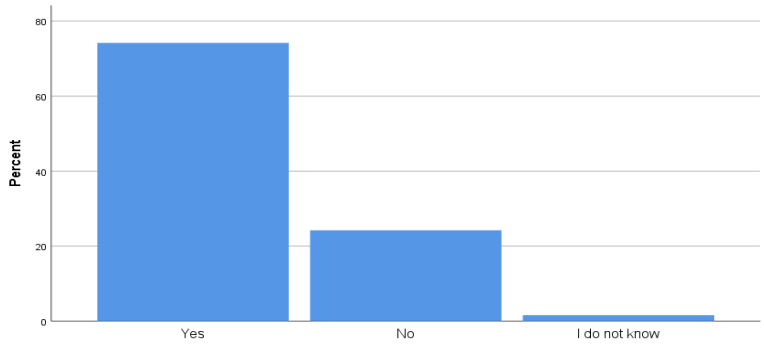


Figure 21. Perception on increased risks

6.3.7.1 Factors influencing Health Risks associated with Stream

In validating health risks concerns raised in the interview section, citizens were then asked to describe what are health risks associated with streams deteriorating condition be. 34.2% indicated cholera; 19.5% said diarrhoea; 18.9 % said malaria; 11.6% indicated skin rash on people and children; 10.5% citizens said TB and chest related diseases; 3.7 % indicated bilharzia and only 1.6% said it other diseases (figure 22).

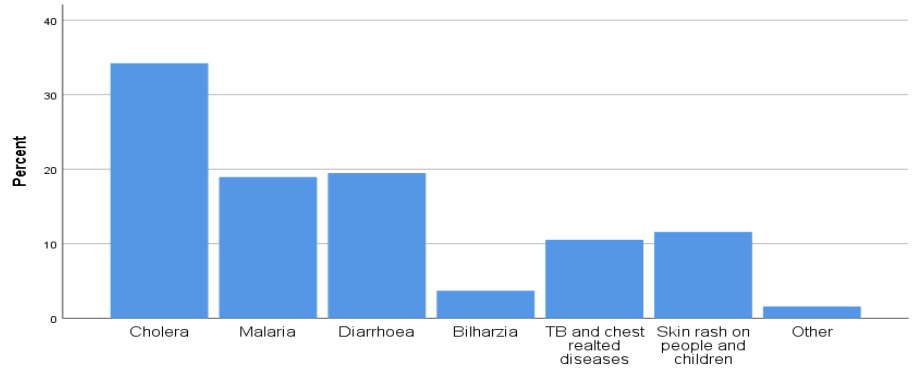


Figure 22. Perception on whether living next to streams increases health risks

6.3.8 What are these safety risks

Citizens were then asked, what can be these safety risks, 24.2 % indicated children in those areas do not have enough space to play; 17.9% indicated air quality and smell; 20.0% mentioned dangerous animals; 16.3% still insisted that it diseases; 13.7% said mosquitos; 7.4% indicated soil erosion and flooding as the reason and; only 0.5% said it other factors not indicated. As indicated earlier in the qualitative stage that children are at risk of getting diseases when they play near or inside the streams. Based on these findings, validated the above concerns that it not a good idea for children to use stream area as playground (figure 23)

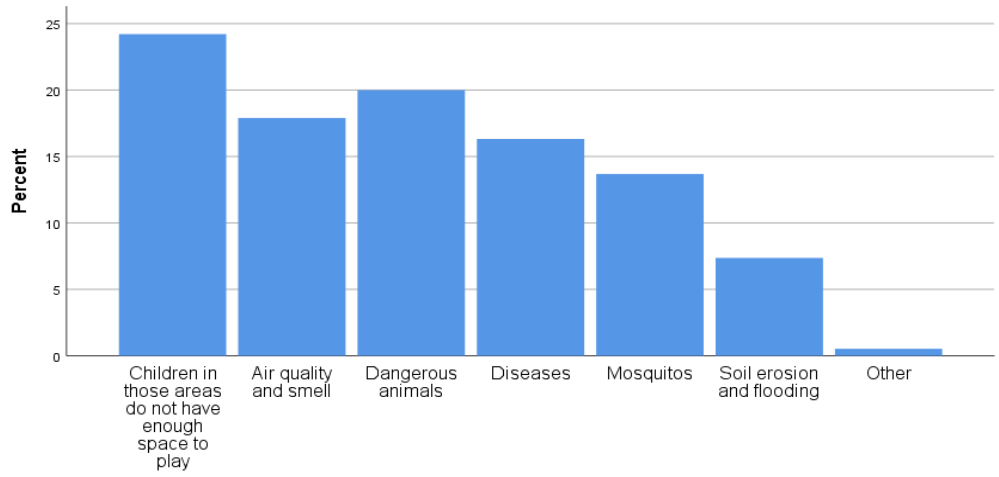


Figure 23. Showing why citizens near streams are more affected

6.3.9 The worst physical condition caused by the current stream condition

From HBM, there are conditions that individuals perceive as severe than others, in fact White *et al*. (2013) believe that if there is a susceptibility condition that is left untreated it can develop to severity. With these concerns, citizens were asked what physical condition they perceived can be caused by the streams current condition.

From findings, 38.9% citizens believe health, illness and injuries as the worst condition; 32.6% believe it waste and sewage; 22.1% perceived floods as the worst; 3.2% indicated extinction of wildlife and another 3.2% perceived economic and

sustainability depreciation as the worst (Figure 24). Health, illness and injuries, this was the most highly ranked condition. This includes the various diseases that are prevalent due to the stream condition. Diseases could affect people to a point where they could die or become incapacitated.

In the current study, citizens also do not seem to consider economic and sustainability depreciation associated with river or streams conditions that much as was the case with qualitative findings, that is irrigation of vegetables, drought, water pollution due to climate change is not as important as their health. As only 3,2% citizens that perceived economic and sustainability depreciation to be their worst concern.

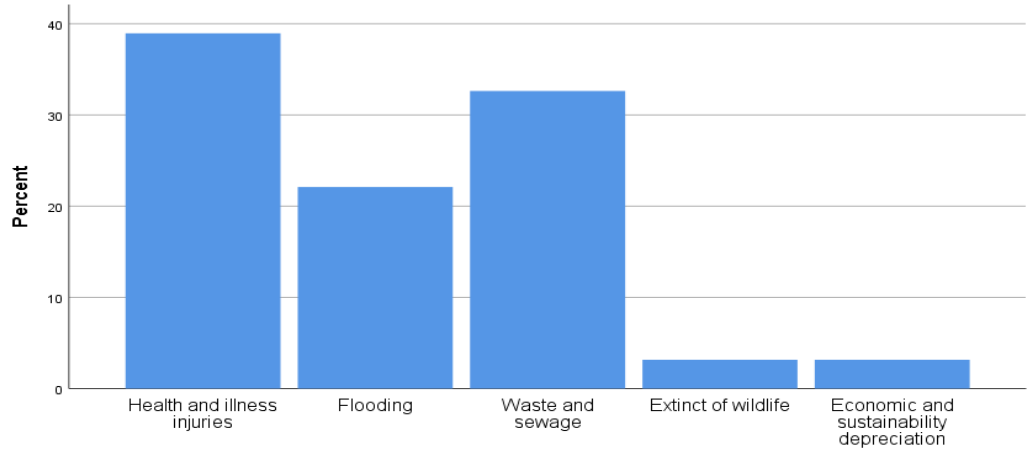


Figure 24. Perceptions on the worst physical conditions

6.3.10 Perception on children playing near or inside the streams in this area

As indicated earlier in the qualitative stage that children are at risk of getting diseases when they play near or inside the streams. Based on these findings, citizens were asked if they believe children do play near or inside the streams in this area. 60.5% citizens confirmed that they believe that children do play near or inside the streams; 38.9% said no and; 0.5% said they do not know if children do play near the streams or not (figure 25).

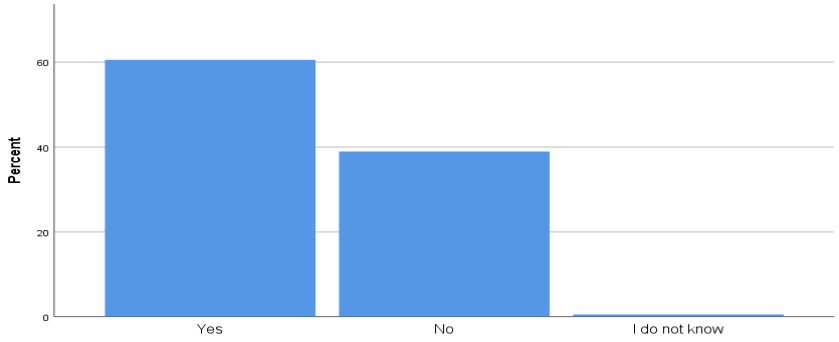


Figure 25. Whether children play near the stream

6.3.10.1 Are there any bad implications when children play with stream water

When citizens were asked if there are any bad implications on children when playing near or inside the streams.76.3% said yes, there are direct health and safety impact; 23.2% said no there are no impacts and 0.5% said they do not know (Figure 26).

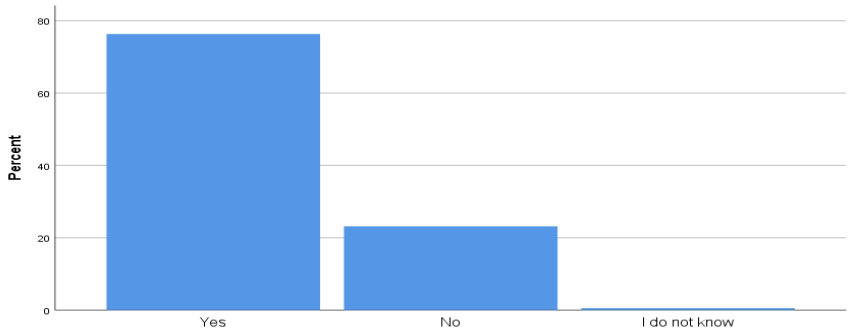


Figure 26. Perception on direct implications

6.3.10.2 Bad Implications When Children Play with Stream Water

When citizens were asked what can be these factors that can badly affect children playing near or inside the streams, the citizens confirmed the bad implications observed in qualitative phase. 45.8% indicated germs and bacteria; 21.6% indicated dangerous dumped items; 12.1% said drowning; 2.6% said dangerous animals; another 2.6% said physical danger; 4.7% citizens said skin rash; 8.4% indicated

diseases as the main factor; 1.6% said because children are left with less play area as their houses are situated along the streams and only 0.5 % believed it other factors but these they never revealed. (figure 27).

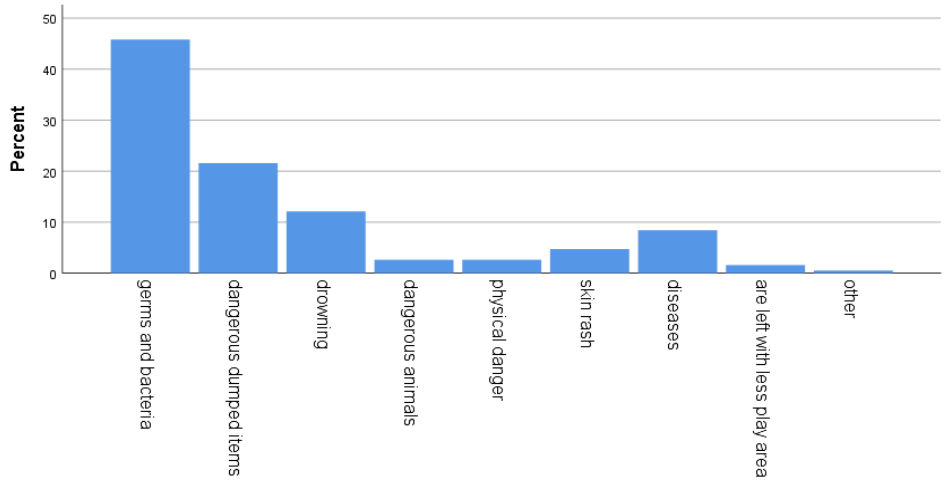


Figure 27. Indicating citizens' direct implications of polluted streams on children

6.3.11 Lack of knowledge on water quality status

In qualitative phase of this study, participants' knowledge on health and safety susceptibility and severity associated with the current surface water quality was broadly understood, but knowledge on the current stream water quality status was absent although the IWRM process of SA is suppose to use public participation process as building blocks to determine RQOs of the catchement (DWAF, 2004).Stakeholders did not know the contents of the water, yet they perceived such surface water to be used by citizens for various reasons for survival. It was with these reasons that the researcher decided to include the documents used to evaluate the surface water of the catchments in South Africa as the basis of the streams water quality status evaluation.

6.3.11.1 Citizens' knowledge on RQOs of their streams

During the qualitative study participants highlighted that nobody knows what is the streams water quality status of their neighbourhood. To confirm that even citizens are not knowledgeable on this, citizen were asked citizens were asked if they understand what is meant by RQO of their streams and if so, they were asked to explain further. 93,7% of the citizens argued that they do not know the status of their streams or rivers (Figure 23). This means that citizens cannot take advantage of status of their rivers if such rivers are in a good condition. Also, this means citizens cannot be not alert of the risks associated with river water quality (Figure 28). Moreover, only 5.8% believe that they know the meaning of RQOs, however were asked to explain further why they said so none explained.

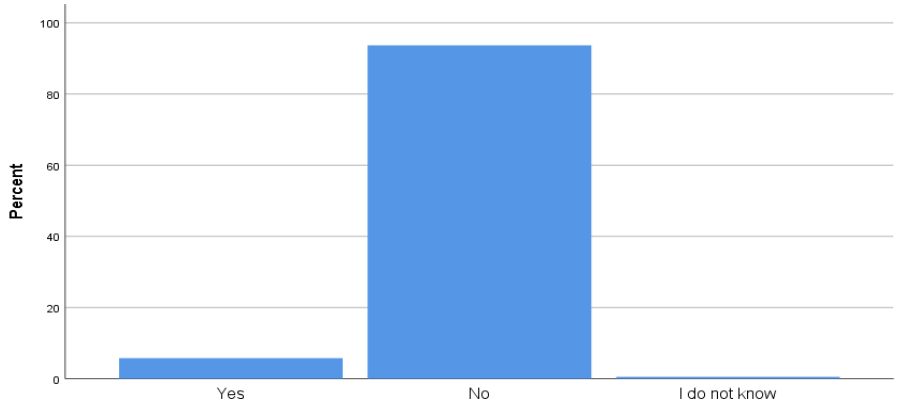


Figure 28. Indicating citizens' knowledge of RQOs of their streams

6.3.11.2 Citizens' knowledge on WQI of their streams

Also, citizens were asked if they understand what is meant by WQI of their streams and if so, they were asked to explain further. 74,7% of the citizens do not know what the water quality index is and how the knowledge of such can affect or help them as individuals. only 22.6% believe that they know the meaning of WQI (Figure 29), however when they were asked to explain further why they said so none explained.

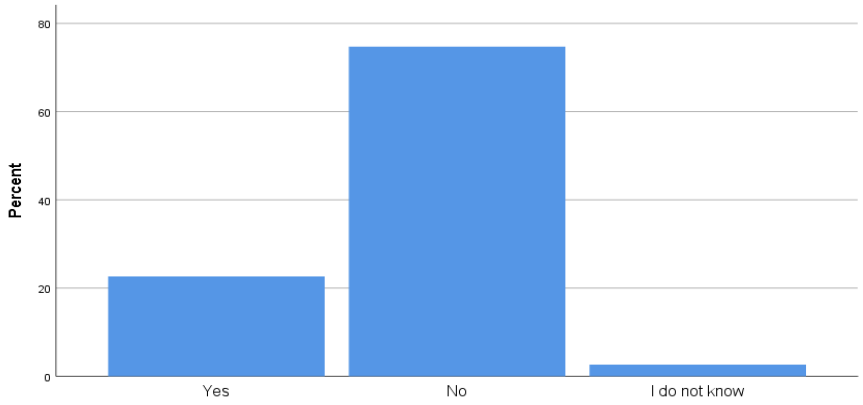


Figure 29. Indicating citizens' knowledge on WQI of their streams

6.3.11.3 Citizens' knowledge on WQI importance and awareness

Citizens were asked if they perceive knowledge on WQI and awareness as important in surface water related risks. 60,5% citizens did not perceive WQI as important in the awareness of surface water related disease, yet global research argues WQI to be an effective tool to communicate surface water quality to the community (Figure 30). Only 7.4% said yes it important, but when this 7.4 were asked to explain further why they said so none explained and; 32.1% indicated that they do not know (Figure 30).

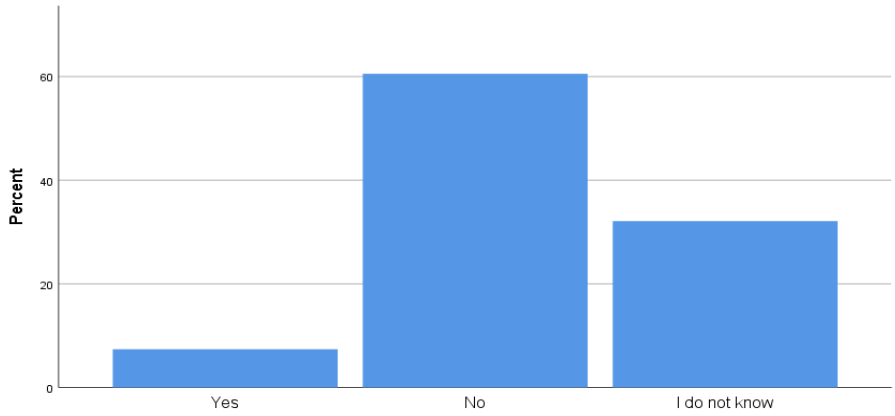


Figure 30. Indicating citizens' knowledge on WQI importance and awareness

6.3.11.4 Perception of citizens on streams water level

The researcher was also interested in knowing citizens' perception on streams current water level. Citizens were asked if they perceive the streams water level to has decreased over the years and to explain further their answer. 48,9% of the citizens stated that they do not know if the streams water level has decreased over the years, 25.8% said no it had not decreased and; 25.3% said yes it had decreased. (Figure 31).

The fact that citizens do not see the drought as an effect in South Africa's rivers, can be the reason why citizens' behaviour has not changed in the past even after the awareness about drought in this country has been discussed in the media platforms such as radio stations and televisions. As the majority of the citizens in the survey indicated that they do not know what meant by, RQOs and WQI moreover do not even know is current status of their streams and rivers and its importance (Figure 28, Figure 29 and Figure 30). Yet, the procedures that determines RQOs involves implementation, monitoring and continuously process review by the authorities (DWS, 2014).

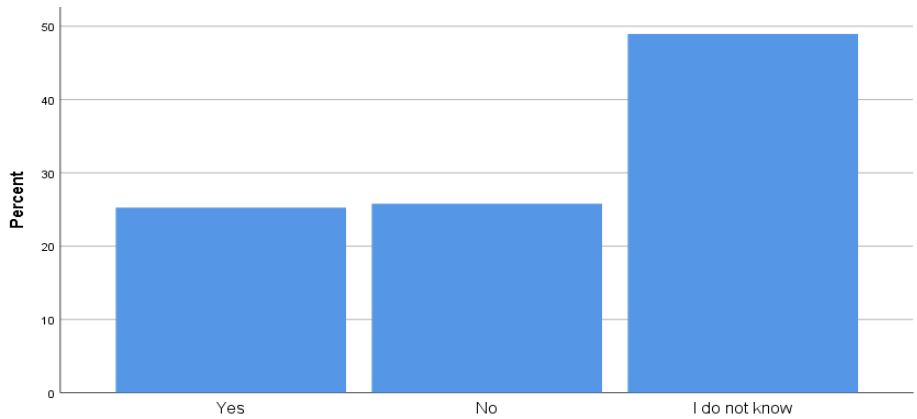


Figure 31. Showing the perception of citizens on streams water level

6.3.11.5 General knowledge of community on stream water condition

When citizens were asked of their opinion on what is the general knowledge of the community on stream water condition. 45.3% of participants believe that citizens are ignorant; 17.9% said they are knowledgeable and; 36.8% indicated that they need education (figure 32).

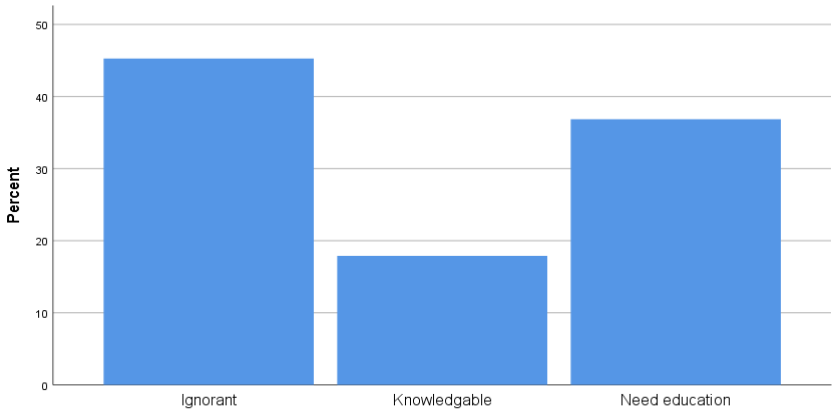


Figure 32. Showing citizens general knowledge on stream policies

6.4 PERCEIVED BARRIERS

As indicated earlier that perceived barriers are also considered as another important predictive health process, therefore assessing barriers such as buildings; lack of knowledge is important in reducing health risks according to SEM perception (Glanz *et al*.,2015; Shafer *et al*., 2017). In validating the perceived barriers findings observed in the qualitative phase, community members were asked indicate if there are barriers associated with keeping streams of this area clean and if so, what could be these barriers.

6.4.1 There Are Barriers Against Keeping the Streams Clean

When citizens were asked if there are barriers against keeping the streams clean, 69,5% of the citizens stated also that there are barriers in keeping the streams clean, however, 30.5 % believed that there are no barriers at all (Figure 33).

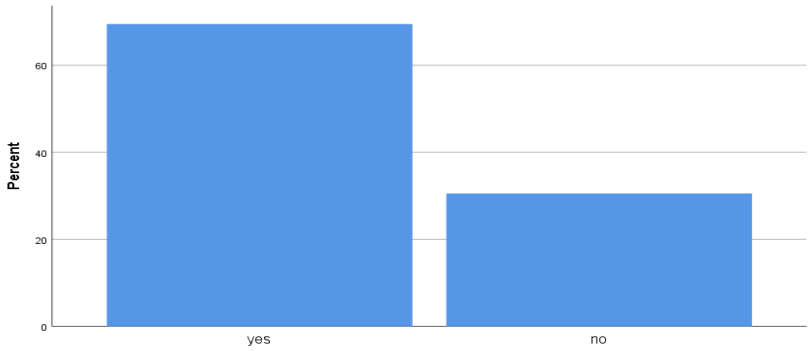


Figure 33. Indicating citizens' perception on barriers from keeping the stream clean

6.4.1.1 Citizens Perceived Barriers on Keeping Stream Clean

When citizens were asked what these perceived barriers were on keeping the stream clean. Majority of 36.8% perceived ward councillor not doing his or her job as the main barrier; 19.5% said population growth in the township; 12.1% said community do not care about laws; 11.1% said lack of proper leadership in the community; 3.7% indicated slums; 5.3 believe it is because of small scope of Sihlanzimvelo; 6.3% said it municipality departments lagging to respond; 3.7% indicated no supply of plastic bags; 0.5% believe it all the above mentioned factors and; 1.1% said it other factors not mentioned (figure 34).

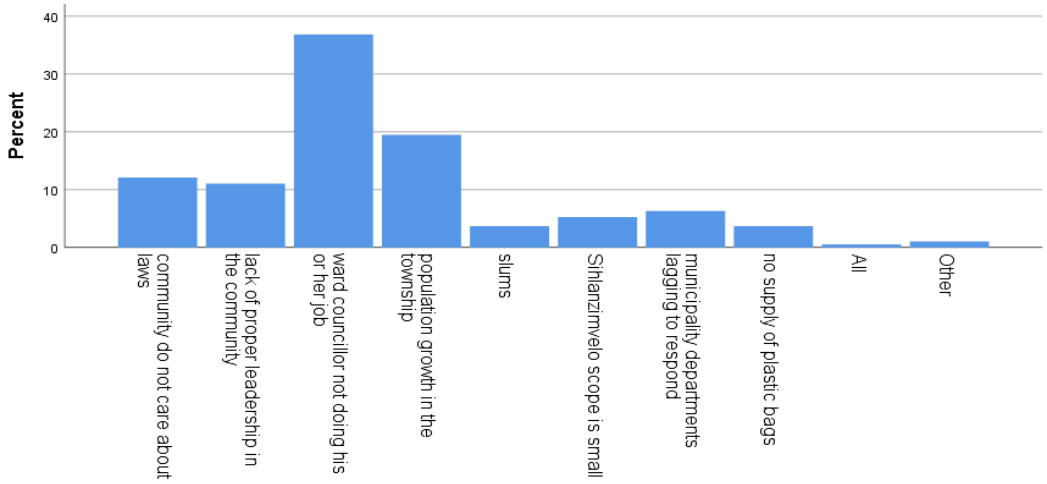


Figure 34. Citizens perceived barriers on keeping the streams clean

6.5 PERCEIVED BENEFITS

From the focused group discussion, participants perceived that streams and river provide benefits for their well-being. In validation of such, as previously stated, 77,4% of citizens confirmed that they perceive clean streams as important. From qualitaitive findings again stakeholders highlighted that streams condition is poor, this finding was validated by 48,9% of the citizens perceived the condition of the streams of Umlazi to be poor and 35,3% perceived it as worse in the survey. The alarming findings from the qualitative phase indicated that citizens continue to use stream water despite it deteriorating condition as they perceive streams to provide them benefits. It was with this concern that the researcher wanted to validate the use of stream water by citizens.

6.5.1 Stream Water Used for Irrigation Purposes

From qualitative findings, all the participants agreed that:" stream water can be a good source of irrigation provided the water is clean". It was from these findings that the researcher wanted to determine if citizens do use stream water for various reasons. The participants were asked if they perceptive citizens to be using stream water for irrigation and if so, citizens were asked to estimate the number of litres used per day

for such an activity. In validating of the qualitative findings, 53,7% participants indicated that they do not know if citizens use stream water for irrigation; 20.5% said no and; 23,7% said yes citizens do use it for irrigation (Figure 35).

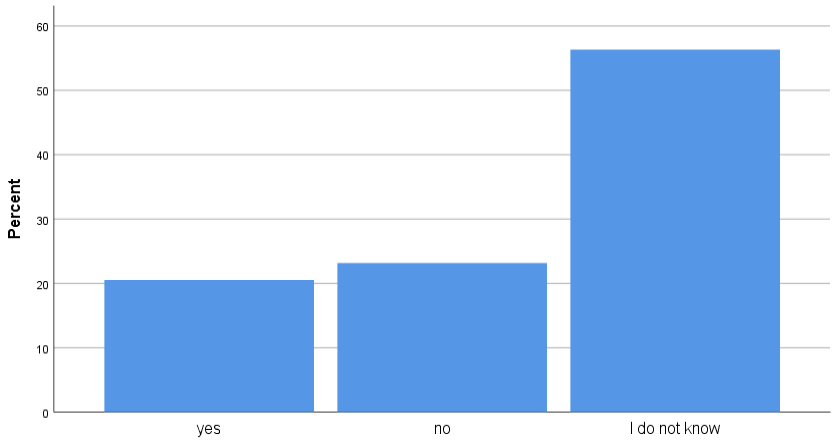


Figure 35. Perception of citizens using stream for irrigation

6.5.2 Estimated Number of Litres Used Per Day for Irrigation

The participants were further asked if they perceive citizens to be using stream water for irrigation and if so, citizens were asked to estimate the number of litres used per day for such an activity. 29.9% citizens further indicated that citizens use between 11-20 litres of stream water for irrigation and 20.9% believed that citizens use 20-50 litres per day (Figure 36).

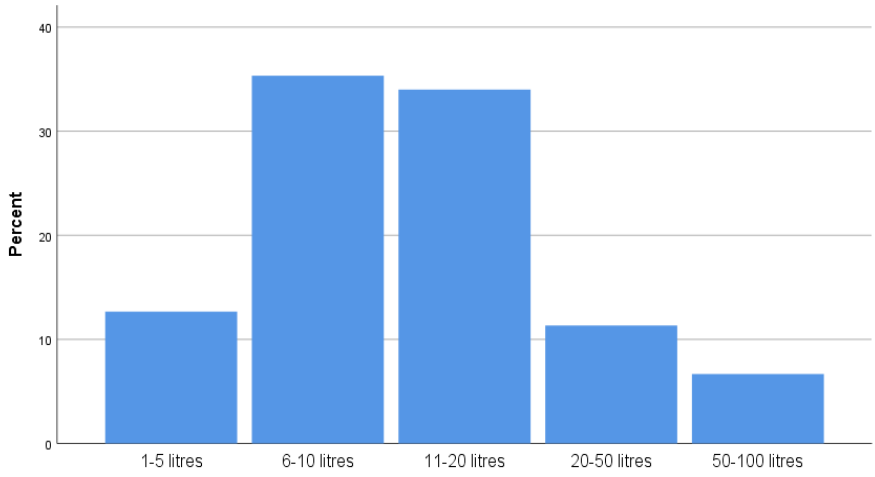


Figure 36. Perception on how many litres of stream water are used per day

6.5.3 Other Perceived Activities of Citizens in Using Stream Water

From qualitative findings it was found that citizens are still benefiting from stream water for survival, in validating this, 22,1% indicated fishing as the main activity; 22,6% participants who indicated swimming as the main activity (Figure 37).

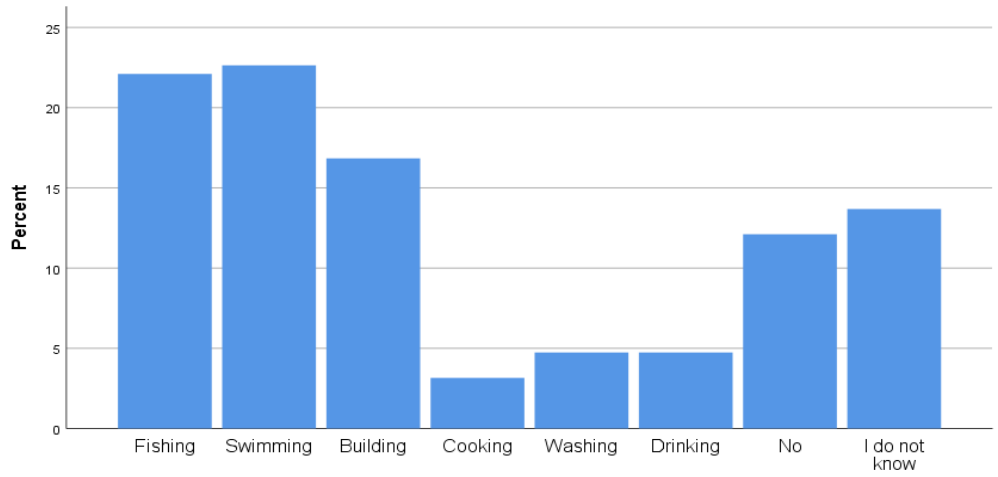


Figure 37. Perceived activities using stream water

6.5.4 Using Stream Water When There Is Water Supply Shortage in The Area

To further analyse the use of streams by the community, citizens were asked if there would use stream water for different activities when there is water supply shortage in the area.40,5% agreed that citizens will use stream water for the activities if there is water shortage (figure 38). Such findings are concerning considering the streams current conditions.

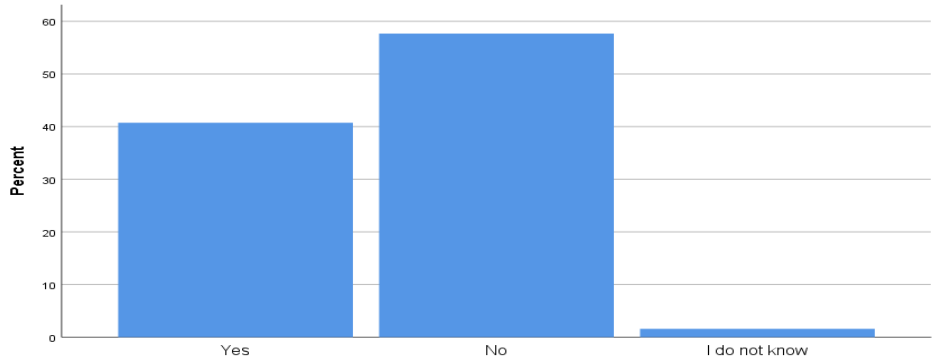


Figure 38. Perception on use of stream for activities when water shortage in supply

6.6 STAKEHOLDERS ATTITUDE

This section validates the second research objective findings from qualitative phase of conducting an initial assessment of community attitudes about stream water quality policy and practices in Umlazi Township, KwaZulu Natal, South Africa. When citizens were asked what the community's attitude regarding stream management is, the majority of the participants perceived citizens' attitude as a poor to an extent of threatning them and therefore considering this as a main barrier. There were however those that indicated that not all citizens are the same, that is, few citizens even offer them juice while they are working on stream showing appreciation. It is with this concern that the researcher wanted to validate such findings using survey.

In validation of the above findings, citizens were asked what is the general attitude of the community members on stream condition management. 29.5% respondent from the survey believe that the citizens attitude is negative, 9,5% said they do not care and 19,5 % believe that this attitude needs to be changed from bad to good; 17,4% respondents indicated that citizens have a positive attitude (Figure 39). Also, 9,5% indicated that people are constantly afraid of using stream water because of its contamination even if there is a shortage of water they do not even go near the streams (Figure 39).

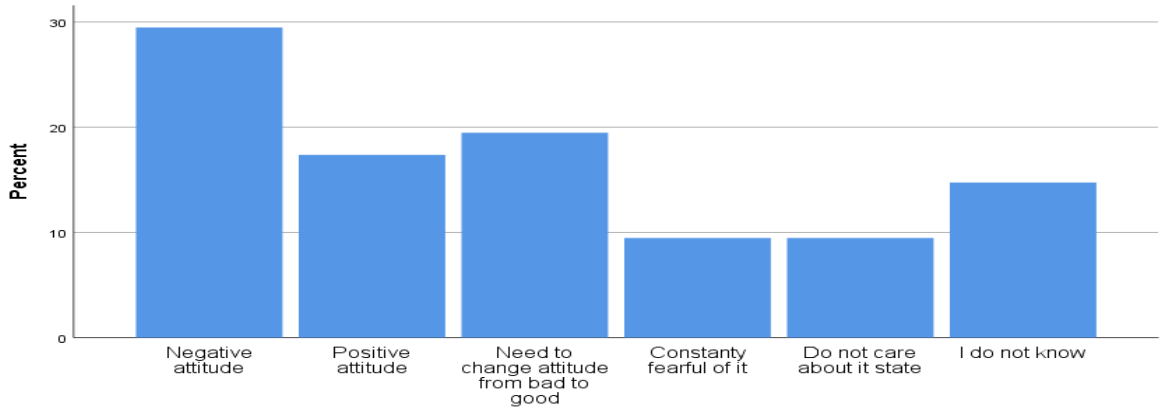


Figure 39. General attitude of community on stream condition

6.6.1 Government Training on Stream Water Quality Testing

As indicated earlier, that when people have knowledge and also know how to perform the behaviour, they will perform that action. Moreover, from literature it has been indicated that even if the individuals have positive attitude to perform an action but if they have no proper knowledge the action will not be performed. However, when citizens were asked if they have received any stream water quality testing from the government, majority of the citizens with 75,8% stated they have never received any training from the government (Figure 40).

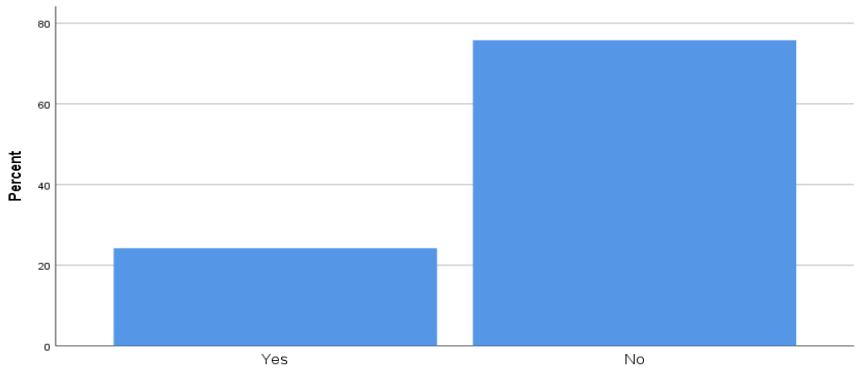


Figure 40. Indicating whether citizens received any stream water quality training from the Government

6.6.2 Who Is Responsible for Maintaining Stream Water Clean

In order to determine the citizens' responsibility attitude on maintaining streams clean. Citizens were asked who they perceive to be responsible for maintaining the stream water clean. 61,1% perceived both municipality and citizens as responsible for maintaining the streams clean, however, 25, 8% citizens perceived municipality as responsibility. Moreover, only 13,2% of the citizens perceived themselves as responsible (Figure 41).

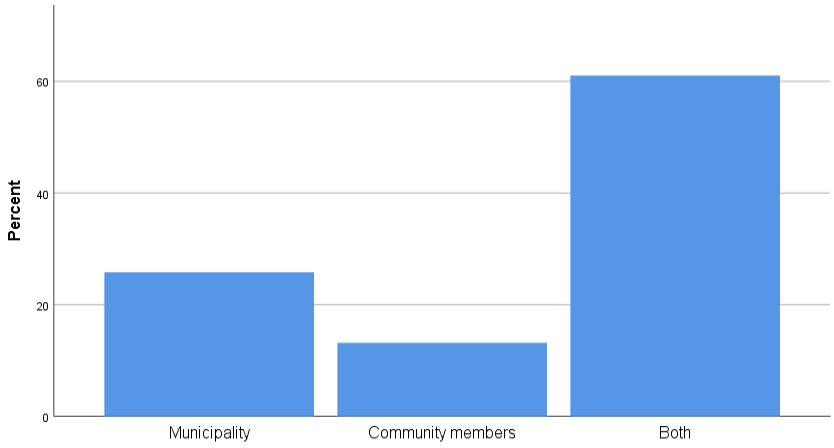


Figure 41. Perception on who is responsible for maintaining stream

6.6.3 Do Citizens Report Stream Challenges to The Municipality?

After obtaining the responsibility perspective on stream management, participants were asked if they report these challenges that relate to stream management to the municipality. 61,1% of the citizens' state that they do not report stream challenges to the municipality. Only 38,9% stated that they report these challenges (Figure 42). The reason why the majority of the citizens do not report these challenges could be because they do not see themselves responsible for stream management.

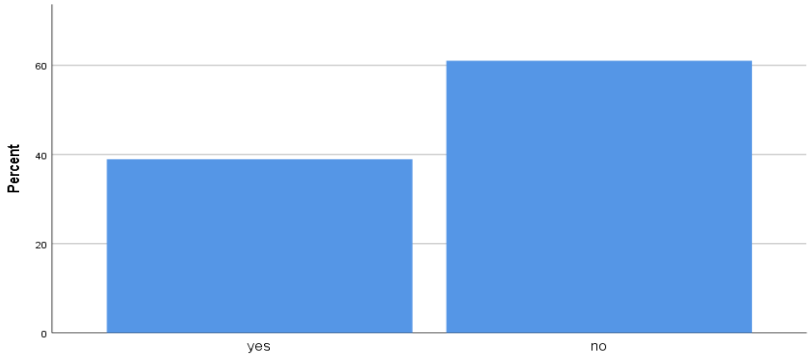


Figure 42. Whether citizens report stream challenges

6.7 STAKEHOLDERS PERCEPTION ON STREAM POLICY ADHERENCE

Not abiding by environmental law even after awareness of water scarcity increase caused by climate change again can be a sign of poor understanding of environmental consequences. These environmental consequences include health risks, floods, malnutrition, drought due to river vulnerability, therefore good understanding and adherence on these surface water quality policies is necessary.

6.7.1 Do Stakeholders Know and Understand Policies Associated with Stream Management

With the above enlightenment on environmental consequences, participants were asked if in their opinion the community understand the policies and laws that govern streams management. 65.8% of the citizens in the survey said that they do not know if the community understand the policies and laws that govern streams management. Only 9,5% citizens believed that community members know and understand these policies (Figure 43). From the 9,5% that said they understand and know these policies, when they were asked to state and elaborate some of these policies in a follow-up question, non-stated any policy.

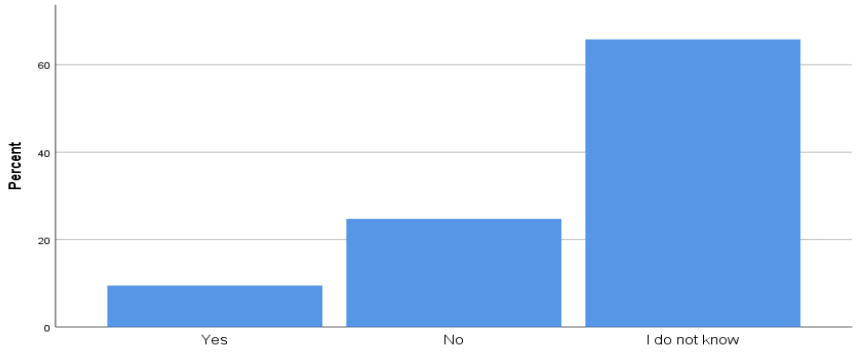


Figure 43. Communities knowledge on policy

6.7.1.1 Implementation and Enforcement of These Policies Is Difficult

According to the findings from interview policies and laws are not implemented and enforced in this area because it difficult to do so. Qualitative research also highlighted that implementation and enforcement of these laws can only be used on formal houses due to their traceability, it is ineffective on slums as these are illegal dwellings with no address or accountability.

In validating these findings, participants were asked if in their opinion the policies regarding stream water quality management are effectively implemented and

enforced. 66,3% of the citizens said they do not know if these policies are effectively implemented ad enforced and, 30,5% citizens believe that these policies are not effectively implemented and enforced and only 3.2% said yes, these laws are implemented and enforced (figure 44).

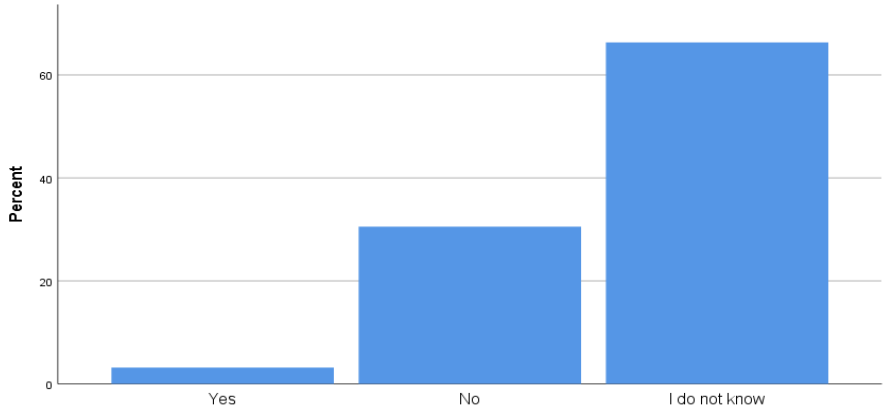


Figure 44. Perception on effective implementation of policies

6.8 STAKEHOLDERS BEHAVIOURAL PATTERNS

This section validates the third research objective findings from qualitative phase of conducting an assessment of community behaviours in response to about stream water quality policy and practices in Umlazi Township, KwaZulu Natal, South Africa. Participants were asked what the community's behaviour and practices in response to keeping the stream water quality policies and practices.

6.8.1 Citizens' Behavioural Pattern Towards Stream Management

As highlighted previously, the streams deteriorating condition in this area was perceived to be worse by other stakeholders while others perceived it to be poor. Based on these findings, the researcher was interested in determining what can the reason for such. According to HBM poor knowledge, attitude and behaviour of the individuals can be reason for environmental degradation. When citizens were asked to give opinion on what is the citizens' behaviour signs towards stream

management.16.8% moderately fearful of it; 16.8% constantly fearful of it; 16.3% seriously contaminate it; 14.2% moderately love, value and protect it; 14.2% constantly contaminate it; 11.6% constantly love, value and protect it and; 10.0% moderately contaminate it (figure 45).

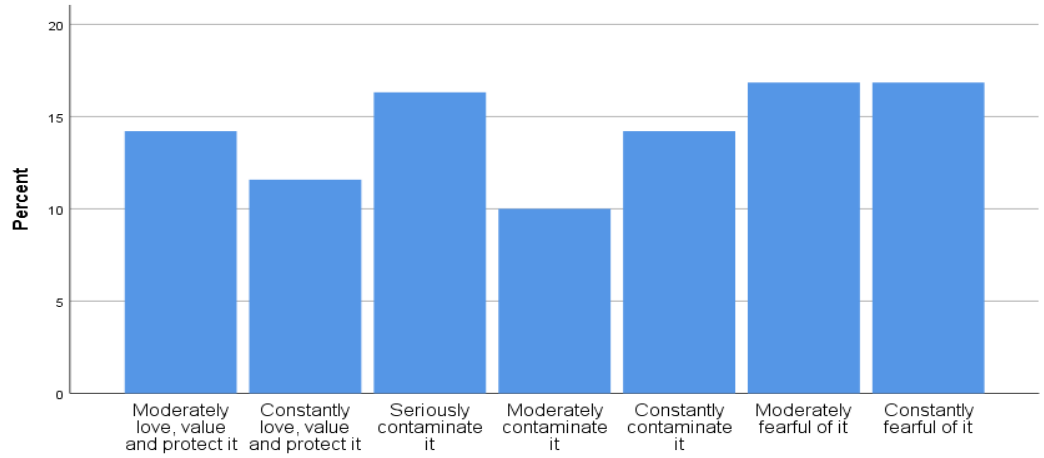


Figure 45. Showing behavioural patterns of the community

6.8.2 Implemented and Enforced Policies Changing the Behaviour Towards Stream Restoration Practice

When citizens were asked if in their opinion these stream water quality policies are effectively implemented and enforced in figure 44, only 3.2% said yes, these laws are implemented and enforced. It was with this concern that the researcher wanted to find out if the citizens behaviour will change if these policies are implemented. However, 63,7% participants indicated that they do not know if implemented policies will influence their behaviour towards a stream restoration practice and 22,1% said no the implementation of policies will influence them (Figure 46). This act may indirectly condone the community members to not perceive themselves as responsible for their own environment hence the citizens will not see a need to be accountable or even change their behaviour especially when it relates to illegal sewer connections that

release to the natural surface waters of streams and rivers as only 14,2% citizens said yes, their behaviour will change.

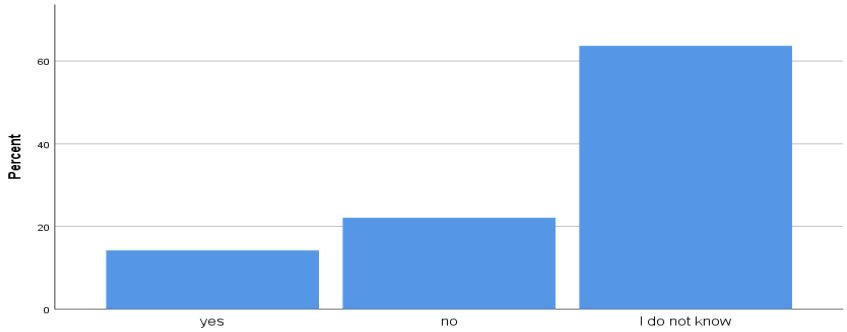


Figure 46. Perception of citizens' behavioural change if policies are effectively implemented and enforced

6.9 CUES TO ACTION

Freidson (1961) insist that cue, or a trigger to appropriate action or behaviour towards reducing susceptibility and severity of the condition can occur with event occurring for example, internal enlightening events such as interpersonal interactions or external events such as the impact of media communication or both.

6.9.1 Cues to Action on Streams Health and Safety Policy

The behaviour of individual depend on how that individual believes the action is beneficial to them and this process is termed likelihood of taking recommended preventive health action. Authorities at a policy level in South Africa have not yet considered the health susceptibility and severity aspect associated with using even small volumes of stream water for irrigation and other activities when streams are polluted in their regulations as yet. The current laws in place are indirectly allowing citizens to continue use stream water even with high health and safety susceptibility and severity. Therefore, evaluating surface water authorization to highlight health and

safety susceptibility associated with streams current condition must be considered to reduce risks.

6.9.2 Attitudinal Change Cues to Action

Throughout this study, participants have indicated that one of the main barriers in keeping the streams of uMlazi clean is poor attitude of stakeholders. From this concern, the researcher wanted to know what strategies can be used to improve stakeholders' attitude. When participants were asked what can be done to change citizens' attitude to change from poor to good. 32,1% of the citizens believed that the municipality engagement with community can help change the community's attitude to change (Figure 47).

22.1% perceived more education is needed in the townships as a solution; 15.8% perceived ward councillor doing his or her job as a solution; 15.8% said Sihlanzimvelo members increase as cleaning community system; 7.4% said more enforcement of policies by municipalities is a solution; 6.3% indicated that only disasters will change attitude and; only 0.5% felt that there are other factors except these ones mentioned, however from this 0.5% none of the participants described these factors (Figure 47).

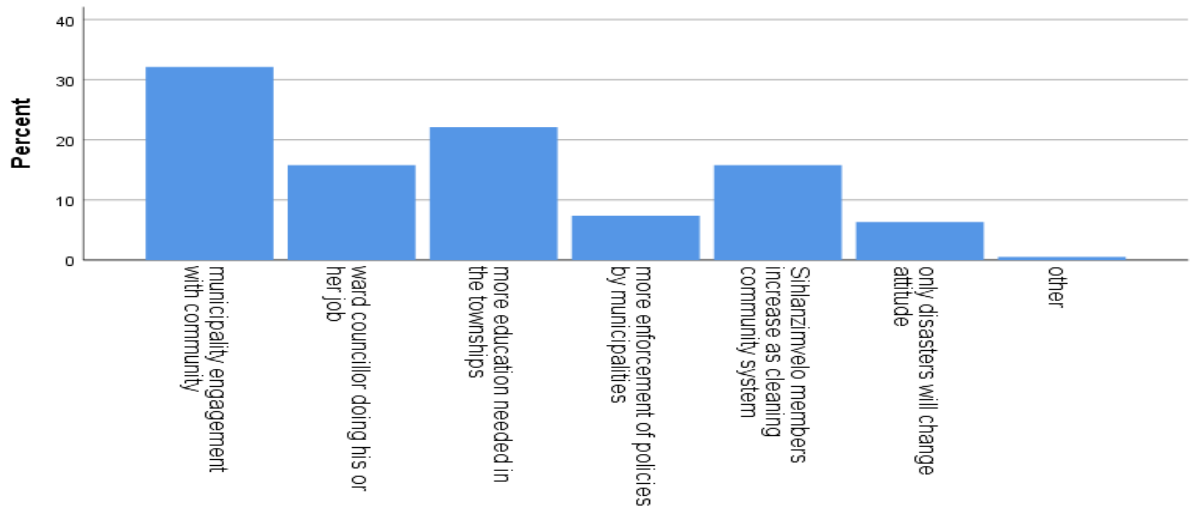


Figure 47. Citizens perception on how attitudes can be altered

6.9.3 Solutions on Stream Water Quality Policies and Laws Adherence

6.9.3.1 The Causes of the Ineffective Policies

The citizens were asked what could be the cause of the ineffective stream water quality policies? Majority of 25.3% said community do not understand the laws; 16.8% said it the lack of community members change in mind-set; 11.6% perceive that lack of ongoing monitoring and testing of water quality causes the stream policies to be ineffective; while 14.7% perceive lack of municipality departments support and accountability as a cause; 10.5% said it due to illegal dwellings that have no address; while 8.4% citizens said that it the lack of community engagement; 5.3% said the community do not care about the laws; 3.2% said it the lack of use of policy and laws enforcement; only 2.6% said it the Lack of current research on these issues in the township; 0.5% said it the lack of support from intergovernmental departments and ; another 0.5% said it other factors. (figure 48).

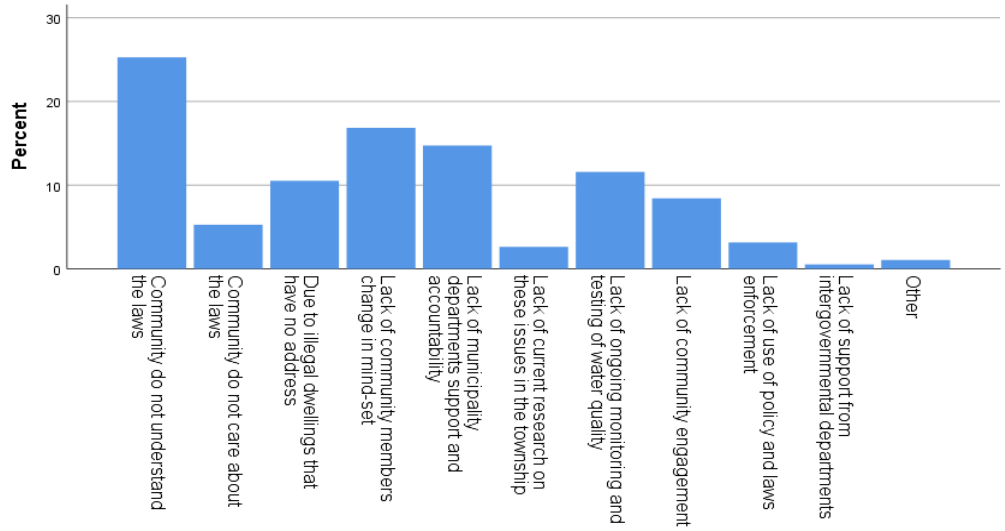


Figure 48. Participants perceptions on causes of ineffective policies

6.9.3.2 Strategies to Be Used to Improve Stream Water Quality Policies and Laws Implementation or Enforcement

Solutions on stream water quality policies and laws implementation or enforcement is necessary especially because policies influences health behaviour of individuals. Therefore, in determining how can the stream water quality policies and laws be implemented or enforced. Citizens where asked what their opinion on solution of improving these laws.

Majority of 26.3% citizens said through cooperation and compliance; 21.6% said education and awareness about policies; 20.0% perceive that compliant systems need to be used by community members; 8.9 % believe community needs to take ownership; another 8.9% believe that municipality departments need to be dedicated; 5.3% said ongoing monitoring and testing of water quality; 3.7 % believe the use of policy and laws enforcement; another 3.7% believe that it other factors not included in this question and only 0.5% said proper use of river banks can be the solution in improving stream water quality policies and laws implementation and enforcement. (figure 49).

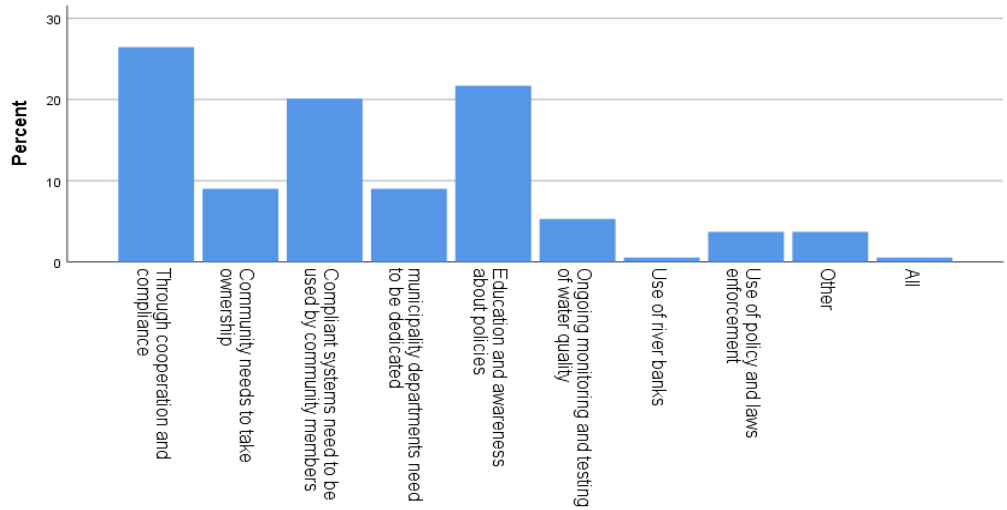


Figure 49. Citizens perception of water quality policies

6.9.4 Improving Self-Efficiency of Stream Water Quality Testing

Throughout this study it has also been highlighted that community members do need to be educated. In validating the shortage of training of citizens regarding stream water quality policies and management. Citizens were asked if they perceive to have any ability to conduct stream water quality of their area. 48,8% indicated that they do not have the ability to conduct stream water quality and 32,1% said they are moderately equipped and; only 19.5% citizens agreed that they are able to conduct the stream water quality in their area (Figure 50).

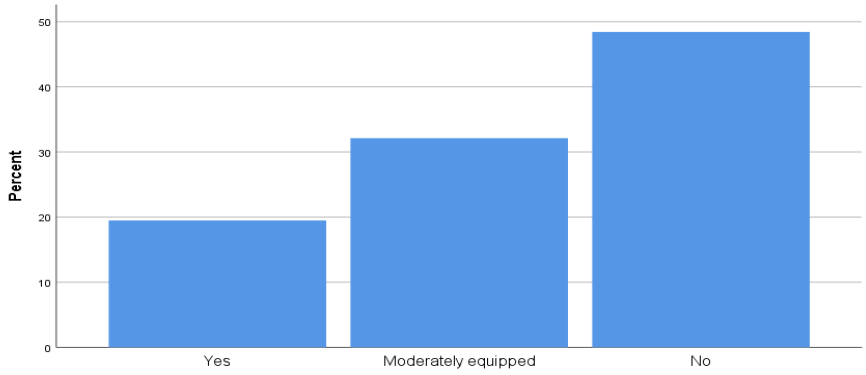


Figure 50. Ability of citizens to conduct water quality

6.9.4.1 Strategies to Be Used to Improve Water Quality of the Stream

In validating some of the concerns raised during the focus group discussion on working conditions due to streams poor water quality. Citizens were asked what their opinion on what strategies can be used to improve water quality of the stream. Majority of 36.8% indicated that an increase scope of Sihlanzimvelo employees scope can be a solution to improving water quality of the streams; 17.4% indicated removal of large trees and vegetation maintenance; also 17.4% perceive addition of more bins and waste removal as solution; 9.5% citizens said sewer system maintenance improvement; 7.4% believe allocation of better housing and space that is not near the

streams ; 6.8% said more involvement of human settlement department and; 4.7% said it other factors not included in the question (figure 51).

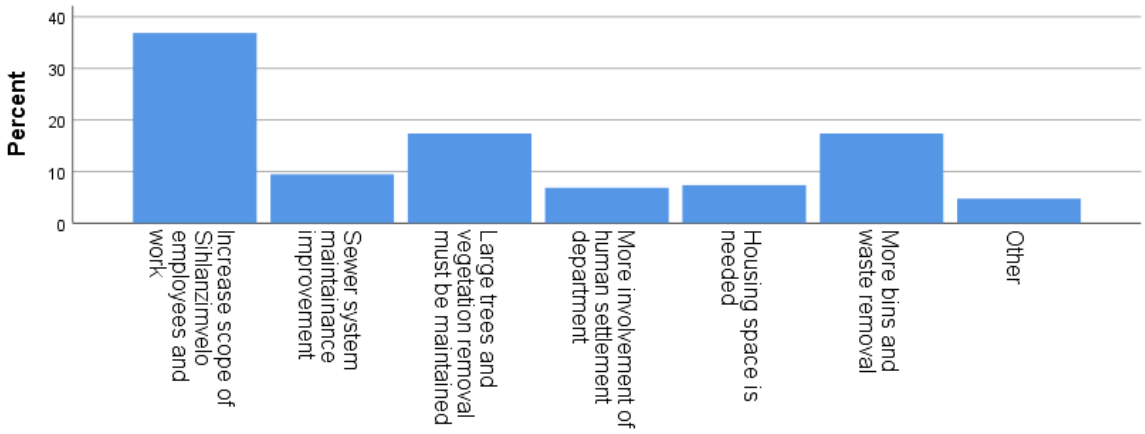


Figure 51. Opinions on improving water quality

6.9.5 Municipality Capability of Solving Stream Water Quality Challenges

In light of the above statement, participants were asked to indicate whether they believe municipality is capable of solving such challenges and, if not, why do you think municipality fails to solve these challenges. 43,7% of the citizens believe the government is capable of solving such challenges in this study (Figure 52), still 33,2% citizens though believe that through the help of others municipality can solve these problems (Figure 52).

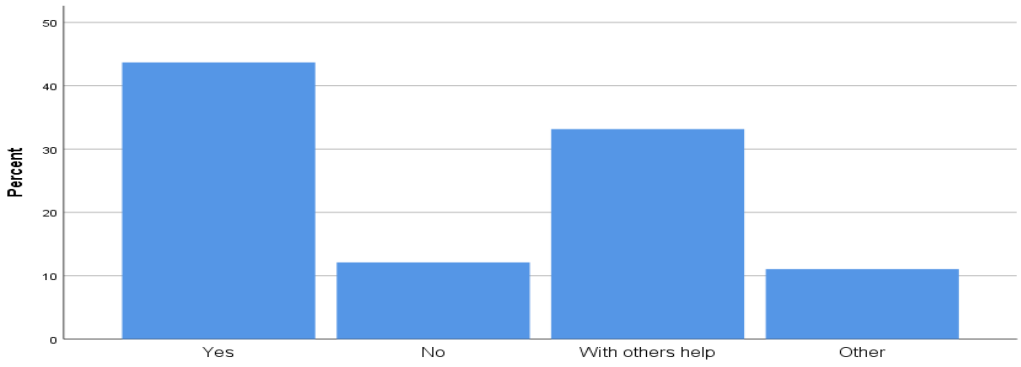


Figure 52. Municipality solving stream challenges

6.9.6 Municipality Initiative That Threats and Manages Streams Will Improve Citizens' Knowledge

Citizens science is a tool used by natural scientist in improving community's knowledge, attitude and behaviour towards a better management of nature as previously explained. In adaptive management of surface water, many scholars believe in using community organizations that focuses on environmental issues as an efficient method if educating the community. With this understanding the researcher wanted to know if there are any existing municipality initiatives that deals with treatment and management of the streams in this area. As this would assist in evaluating surface water authorisation to highlight health and safety susceptibility associated with streams current condition.

Citizens were asked if they know any existing municipality initiatives that treat and manage streams, and if yes, what are they. 69,0% of the citizens argue that they are no any existing municipality stream initiatives that also manage the streams and only 0,5% said they do not know if there is any initiative. Only 30,5% stated that they know the existing initiative. The 30,5% in the follow up question indicated Sihlanzimvelo as the only existing initiative they know (Figure 53). Few focus group participants though indicated Green corridor, and few indicated that Parks and recreation as another, but they were not sure how Parks department operate.

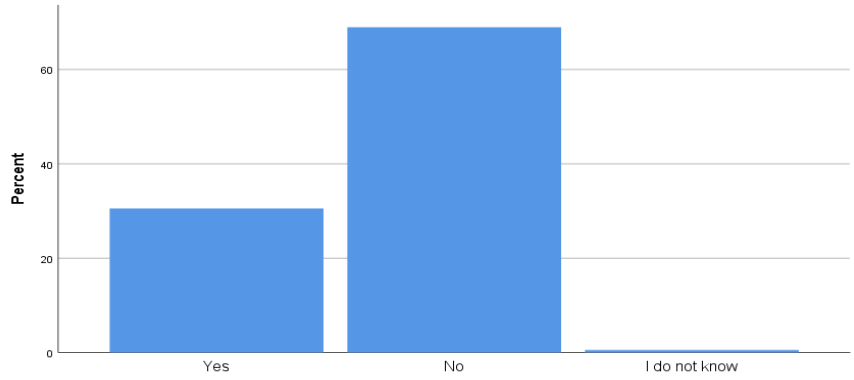


Figure 53. Citizens knowledge of municipality stream initiatives

6.9.7 Strategies to Be Used to Improve Management System That Can Be Used in Health Risks Monitoring

One of the major challenges highlighted by participants on stream management was poor stream management that has consequences of health susceptibility and severity on individuals near the streams; on those that use streams water and; on those cleaning these streams. It is from these concerns that researcher wanted to find solutions that can improve the health risks by using better management system.

Citizens were asked what is their own opinion on what management system that can be used in health risks monitoring. Majority of 43.2% citizens perceived cleaning is the only solution; 11.1% said community needs to take ownership; 7.4% perceived use of policy and law enforcement as solution; 6.8% said compliant systems need to be used by community members; another 6.8% believe that education and awareness is a solution; another 6.8% believe that a better use of river banks is a solution; 5.8% said municipality departments need to be dedicated; another 5.8% said ongoing monitoring and testing of water quality; other 5.8% of citizens believe it other factors not mentioned (figure 54).

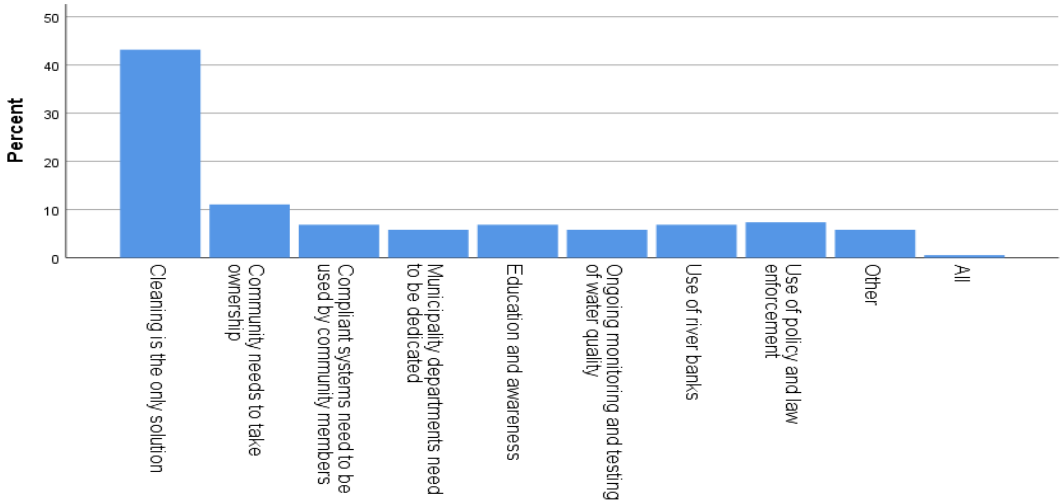


Figure 54. Citizens opinion on monitoring health risks

6.9.7.1 Presence of Environmental Community Based Programme in The Neighbourhood

The presence of community based environmental programme helps to better facilitate and evaluate the community-level outcome; enhances social capital; community capacity; economic impact of job creation; trust between public, scientists, and land managers. In line with these statement, citizens were asked if know any environmental community-based programme in their neighbourhood. 62,1% of the citizens did not know any environmental community-based programme in their neighbourhood; 30.5% said that there are environmental community-based programme and, 25,8 % citizens said there are no environmental community-based programme (Figure 55).

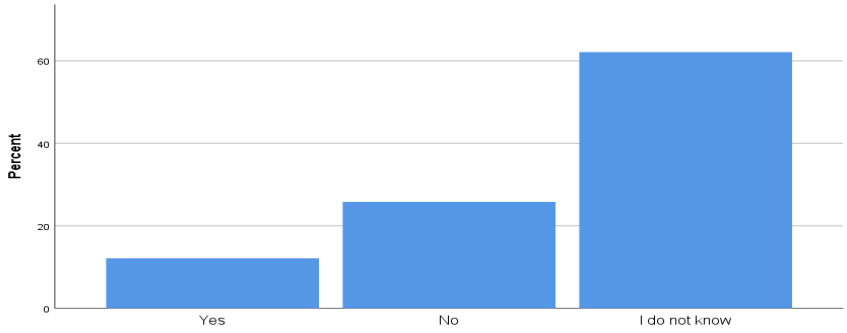


Figure 55. Umlazi community based programme

6.9.7.2 Are Community Based Programmes Active and Impactful in This Area?

The learning program outcomes at a community-level should be specific, measurable, attainable, relevant, and timely. The researcher then wanted to find out if the existing the community-based programme are active and impactful or not from those participants who indicated that there is an environmental community-based programme. When citizens were asked this question, 62.1% said they do not know the community-based programme not active and impactful; 32.6% citizens said the

community-based programme not active and impactful and only 4.7% said confidently yes that the community-based programme is active and impactful (figure 56).

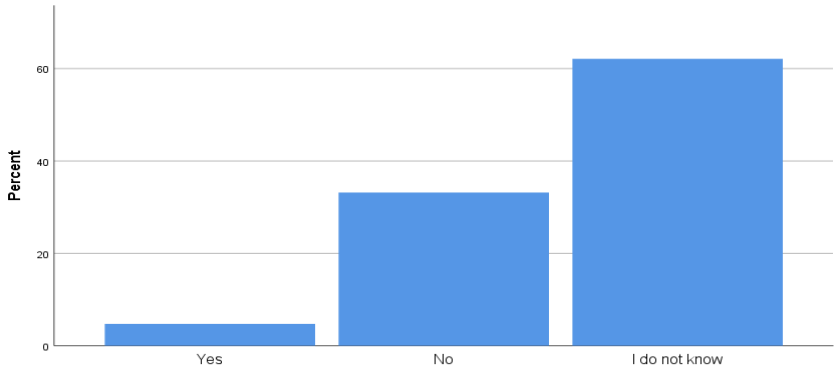


Figure 56. Active community based programme

6.10 SURVEY FINDINGS

6.10.1 Demographics

From the demographic's summary of this study, there are more females than males and less percentage of the elderly in this area. According to Stevenson *et al*., (2016) women's health well-being and that of elderly are related to water challenges have caused insecurity, anxiety and depression is more prevalent. Even though the percentage of the eldely in this area is low, however, from White *et al.* (2013) even a small percentage of citizens' exposure to susceptibility and severity is concerned as a threat and need to be addressed. As perceived susceptibility is defined as the risk at which person thinks or feel they are facing due to the condition or disease at a given time and that if the individual feels that the risk of getting that particular disease is great, they are assumed to change their behaviour (Severtson ,2012).Therefore from the demographics of this area the citizens behaviour should be a pro-environmental one considering the fact that from the findings citizens were aware of their health and safety suspectibility and severity associated with streams current condition.

6.10.1.1 Living Arrangements

76.3% of citizens believed children are more vulnerable to health and safety risks (figure 26) but instead they continue to use the stream and benefit from its water for various activities including children swimming. According to Weine, Ware, Hakizimana, Tugenberg, Currie, Dahnweih and Wulu (2014), the support of family and close connections is particularly important for children. Parents are likely the most central source of support for children during trauma and adversity, and children are at higher risk of long-term physiological and mental health stress burdens when parents themselves suffer acute levels of distress (Weine *et al*., 2014). Cunsolo Willox, Stephenson, Allen, Bourque, Drossos, Elgaroy, Kral, Mauro, I., Moses, Pearce, MacDonald and Wexler (2014) reported that spending time with family and friends helps protect the mental health of youth enduring the impacts of climate change on their land and environment. Parents and caregivers also serve as buffer against trauma and protect children from neglect and abuse by providing necessities, such as shelter and food (Kousky, 2016).

Also, majority of 72,1% citizens indicated that they live with their parents and friends (table 36) and 84.7% (table 35) but still lack knowledge regarding policies that govern stream management. However, according to Lazarus, Jimerson and Brock (2002) children look to parents and other caregivers as models in managing their emotions. Effective coping strategies should be taught during this time, such as encouraging children to talk about the event or turning to other resilient communities that have endured natural disasters and recovered (Lazarus *et al*., 2002). Parents are role models are especially important following natural disaster events. Also, the National Scientific Council on the Developing Child (2015) found that children and youth optimize resilience during adversity if they have the help of non-caregiver role models, such as teachers or coaches.

6.10.2 Survey

In validating the first research objective findings from the qualitative phase of conducting an initial assessment of community knowledge about stream water quality policy and practices in Umlazi Township, KwaZulu- Natal, South Africa. To collaborate these findings between question 1 and question 2 findings, 77,4% of the citizens believe that clean streams are important (figure 12) and majority of the citizens perceive the stream condition to be deteriorating with 48,9% of the citizens perceived the condition of the streams of Umlazi to be poor and 35,3% perceived it as worse (figure 13). Although there was generally good knowledge on stream health and safety risks from the citizens as 74.2% believe that there are risks in living near the streams (figure 21) and; 77,4% believe the stream has an offensive smell (Figure 19). The above acknowledgment of stakeholders on health and safety risks however their persistent use of these contaminated streams and not reporting the challenges of poor streams conditions highlighted citizens' strategic ignorance. To further confirm these findings, 29.9% citizens indicated that citizens use between 11-20 litres of stream water for irrigation and 20.9% believed that citizens use 20-50 litres per day (Figure 36) and, 60.5% of citizens that believe that children do play near or inside the streams (figure 25).

Furthermore, although Prisby *et al*. (2008); Redline and Gold (1994), agree with White *et al*. (2013) that males, children and elders are more susceptible to health and safety risks than females. However, women's health well-being related to water challenges have caused insecurity, anxiety and depression is more prevalent (Stevenson *et al*., 2016). With majority of the respondents were female 68.4% (table 34) and with 2.1% participants that were above 65 years old (table 33). Psychological illness in SA citizens is evident, as indicated earlier, SA anxiety group reports 40 000 phone calls on its suicide helpline since January 2019 (Govender, 2019), it is therefore of great importance to perceive clean streams management as one of the natural resources that supply water supply since SA is faced with water insecurity. Moreover, middle-to-low educational status and unemployed females were additional risk factor for psychological distress. Guglielmucci *et al*. (2015). 67,4 % of the household head

occupational status of the citizens was unemployed can make citizens to be more vulnerable and more dependent on natural resources even if there are health and safety risks involved (table 30).

Besides water insecurity, as White *et al* (2013) insist that even a small percentage of citizens' exposure to susceptibility and severity is concerned as a threat and need to be addressed. However, the aspect of susceptibility on children of Umlazi is more evident as these children has the highest diarrhoea even though there are running taps in most households of this area. Addressing the above concern of individual's and more especially children's high susceptibility especially in uMlazi area**,** majority of the citizens with 60,5% believed that children play inside the streams (figure 25). This again could be interpreted as strategic ignorance from citizens' side because although 76,3% citizens admitted that they are health and safety risks implications when children playing near or inside the stream (Figure 26).

6.10.2.1 Citizens Knowledge

In HBM, even if a positive intention exists for a specific behaviour, it is still possible that if an individual lacks the necessary knowledge and skills to perform that behaviour, this can prevent an individual from performing the behaviour (Glanz et al., 2015).

In determining what is the status of stream water quality across streams in Umlazi Township and; what is the community's knowledge about stream water quality policy and practices in Umlazi Township. Although participants' knowledge on health and safety susceptibility and severity associated with the current surface water quality was broadly understood, however knowledge on the current stream water quality status was absent. Stakeholders did not know the contents of the water, yet they perceived such surface water to be used by citizens for various reasons for survival. In validating these findings, participants indicated that they do not know policies associated with stream water management for example up to 93,7% of citizens said they do not know what is meant by RQOs and WQI, yet guidance of these facts help in decision-making

of how stream water will be used by the community and maintained (figure 28, figure 29 and figure 30). The RQOs and WQI contain water quality status data of that particular surface water, knowledge and understanding about such information can improve citizens' knowledge on how to protect both streams ecosystem and their wellbeing to such that they also benefit social, economic and strategically (Nel and Driver, 2015; DWS, 2014; Parker and Oates, 2016).

According to Frick et al. (2004) self-regulation systems set goals and defined procedures for goal attainment, and which lead to specific action plans are generated in contexts of self and the social system. These system refers to self-knowledge and social factors used to draw conclusions about a disease and deciding a symptom reflects illness or age requires reference to the self and what it means, to an extent where a person's feeling of adequacy to perform a new behaviour. Unfortunately, 75,8% majority of the citizens stated they have never received any training from the government regarding stream water quality testing (Figure 40). While, almost 50% of citizens perceived themselves as not being able to conduct stream water testing in their area (Figure 48). Such findings indicated that majority of citizens of uMlazi lack self-efficacy due to lack of training and feedback from the authorities regarding water quality status and are not in the position of improve and monitoring goals of SDGs. (Gollwitzer and Sheeran, 2006). As indicated ealier that knowing the water condition data could have helped participants with higher arsenic levels had stronger beliefs about identifying personal risk (Severtson *et al*., 2008).

6.10.2.2 Policy Impact

Besides the fact that the General Authorization (GA) and Water Use Licence Authorization (WULA) is mainly focused in maintaining the river's health and not much on people's health. Other environmental policies regarding polluting the environment are also not enforced by authorities, such as Section 24 (a) that state that everyone has a right to an environment that is not harmful to their health or well-being. As the municipality stakeholders indicated that implementing and enforcing such laws is difficult.

According to NWA (Act 36 of 36), GN 538 of 2016, other Umlazi areas allows up to 8 litres per second for 40 000 cubic metres per year (DWS, 2016). Sithebe (2017) highlighted though that using uMlazi streams and river water for irrigation poses major impact on the health and wellbeing of the community due to faecal pollution especially next WWTW.

Yet, GA of South Africa for industrial activity or a waterworks allows up to 2000 cubic meter disposal of wastewater a day into an on-site or off-site slurry ponds and irrigation with wastewater from slurry ponds under specific conditions under GN 665, Act of 1998 of Section 21e (DWA,2013). For irrigation and other activities, a maximum of up to 2000 cubic meter per year with abstraction rate of 1 litre per second taken may be taken at any time during the whole year for some areas of Umlazi (DWS, 2016).

Moreover, stakeholders confirmed the usage of streams for different reasons throughout the study indicate health and safety susceptibility and vulnerability on citizens hence policies need to be evaluated. Therefore, in order to maximise these perceived benefits of streams usage, poor behaviour and attitude of authority towards the role of policy impact, its implementation and enforcements role needs to change, and this change will eventually change citizens' attitude and their behaviour, as indicated by Delzendeh *et al*. (2017) that education and policy implementation are the tools in changing negative environmental behaviour of stakeholders.

6.10.2.3 Citizens Attitude

Liu and Guo (2018) indicated that people who are less responsible environmentally can be measured with the reality of their society where the environment is worsening, and there are unendingly environmental incidents happening. Harring *et al*. (2017), Tjernström and Tietenberg (2008) believes that the public attitudes are important attribute as it governs environmental policy choice. However, in figure 42, 61,1% of the citizens' state that they do not report challenges associated with streams condition to the municipality although they are aware of these challenges (figure 33). Figure 39 confirmed citizens' poor attitude towards the stream management as 29.5% respondent from the survey believe that the citizens attitude is negative, 9,5% said they do not care and 19,5 % believe that this attitude needs to be changed from bad

to good when there were asked what is the general attitude of the community members on stream condition management.

Also, citizens may be tempted to shift the responsibility to other people and decide not to be accountable and responsible. Although they have indicated that they directly use stream water for varies activities. Majority of 43.2% citizens perceived cleaning is the only solution; 11.1% said community needs to take ownership (figure 54).

6.10.2.4 Citizens Behaviour

When citizens were asked if policies are effectively implemented and enforced, 63,7% participants indicated that they do not know if implemented policies will influence their behaviour towards a stream restoration practice and 22,1% said no the implementation of policies will influence them (Figure 46). Although Section I and J 151 of NWA (Act no.36 of 1998) is against illegal sewer connection flowing into surface water and section 21 states that prevention of pollution arising from illegal discharge and stormwater contamination in urban areas needs to be controlled by local authorities (King *et al*., 2018). This act may indirectly condone the community members who do not perceive themselves as responsible for their own environment hence the citizens will not see a need to be accountable or even change their behaviour especially when it relates to illegal sewer connections that release to the natural surface waters of streams and rivers as only 14,2% citizens said yes their behaviour will change. Otherwise, Allan and Pahl-Wostl (2013), maintains that climate change and water security challenges for adaptive water management cannot be solved.

As previously mentioned that people who have less pro-environmental behaviour can be measured with state of the environmentcondition detorirating, and with unendingly environmental incidents happening. 40.5% indicated that streams are being contaminated by citizens; 33.6% fear the streams and; only 25.8% feel that citizens care and value the streams (figure 45). From these survey findings citizens are perceived have poor attitude and to be posses less pro-environmental behaviour.

6.11 TRIANGULATION

6.11.1 Findings of Interview on Health and Safety Knowledge

In determining the first research objective findings from qualitative phase of conducting an initial assessment of community knowledge about stream water quality policy and practices in Umlazi Township, KwaZulu- Natal, South Africa. Theme 1 and 2 of the interview sections indicated that clean streams are important; that streams current condition is poor and that citizens do use streams and its water for different reasons such as irrigation, swimming for example despite knowing the streams current condition of health and safety susceptibility and severity, and for this reason some participants perceived the citizens to be ignorant.

In validating this first research objective findings from qualitative phase, question 1 and 2 of survey findings confirmed with, (figure 12) and; majority of the citizens perceive the stream condition to be deteriorating with 48,9% of the citizens perceived the condition of the streams of Umlazi to be poor and 35,3% perceived it as worse (figure 13). Although there was generally good knowledge on stream health and safety risks from the citizens as 74.2% believe that there are risks in living near the streams (figure 21) and; 77,4% believe the stream has an offensive smell (Figure 19). However, 29.9% citizens indicated that citizens use between 11-20 litres of stream water for irrigation and 20.9% believed that citizens use 20-50 litres per day (Figure 36). The above acknowledgment of stakeholders on health and safety risks yet continuing to use these contaminated streams and not reporting the challenges of poor streams conditions highlighted citizens' strategic ignorance.

USGCRP (2016) maintains that health impact must be understood whether direct and indirect. Therefore, according to the researcher's observation both authorities and citizens are perceived to possess a strategic ignorance behaviour as they know streams current condition. As both qualitative and quantitative phase of this study, participants' knowledge on health and safety susceptibility and severity associated with the current surface water quality was broadly understood,

6.11.1.1 Findings on streams water quality status knowledge

However, in determining what is the status of streams water quality across uMlazi Township and; what is the community knowledge about stream water quality policy and practices in Umlazi Township. Knowledge on the current stream water quality status was lacking in both qualitative and quantitative findings. Qualitative participants of Sihlanzimvelo and municipality departments indicated that that although they are working on stream management however they themselves did not know the contents of the water and have not done any water quality analysis and training on it, yet they perceived such surface water is used by citizens for various reasons for survival. In validating these findings, majority of the citizens with 75,8% stated they have never received any training from the government regarding stream water quality testing (Figure 40). Moreover, almost 50% of citizens perceived themselves as not being able to conduct stream water testing in their area (Figure 48). To confirm further that citizens are not knowledgeable water quality status of their stream, citizens were asked if they understand what is meant by RQO of their streams, 93,7% of the citizens argued that they do not know the status of their streams or rivers (Figure 23).

From the demographics of the qualitative phase though, all participants that are involved in stream management of uMlazi believed that they have enough skills to manage the streams. Such lack of skills is a contradicting statement of theories as from HBM, adaptive management and SEM, these theories encourages that the participants involved in river management should be skilled with water testing skills as well. According to the researcher, the participants do not see the importance of streams water quality data and testing even though they have worked in stream management for such a long time.

6.11.2 Findings of the Focus Group

6.11.2.1 Attitude findings

On the second research objective findings from qualitative phase of conducting an initial assessment of community attitudes about stream water quality policy and

practices in Umlazi Township, KwaZulu Natal, South Africa. All qualitative participants indicated that implementing the laws is difficult. Also, particiticants in the qualitative phase indicated citizens' violent behaviour on hitting the Sihlanzimvelo workers with pampers and threatening them with weapons when they try to discipline the citizens. From the researcher this was viewed as social disapproval and bad attitude regarding stream water quality policy and practices in Umlazi Township, KwaZulu Natal, South Africa. In validating the second research objective findings from qualitative phase, when citizens were asked what the community's attitude regarding stream management is, only 17,4% respondents indicated that citizens have a positive attitude (Figure 39). Also, 40.5% indicated that streams are being contaminated by citizens; 33.6% fear the streams and; only 25.8% feel that citizens care and value the streams (figure 45). This indicated social disapproval as majority of citizens agreed that they pose bad attitude and that citizens are responsible for streams contamination.

6.11.2.2 Ward Councillors as barrier in keeping streams clean findings

In determining the barriers associated with keeping the streams of Umlazi clean both citizens and municipality departments perceived ward councillors as a major barrier. From the focused group, the stakeholders perceived that ward councillors have a different Agenda**.**

> "*As councillors have their own agenda, they want you to get a political buy-in for stream cleaning, people listen to their leaders and do not want to act against their leaders will be because they depend on him or her for resources. The council needs a workshop first to why we clean stream*." *(participant 3, focused group).*

The stakeholders' concerns are in line with that of Swanepoel and De Beer (2006) who argue that to ensure that change agents and development organisations adhere to a social learning process approach, change agents must be sent to communities with an "empty agenda". In other words, they should approach the public with "empty slates", ready to instil the culture of the learning process in them.

To validate this finding, when citizens were asked what were these perceived barriers on keeping stream clean, majority of 36.8% perceived ward councillor not doing his or her job as the main barrier (figure 34) agreeing with Mchunu (2012) that the ward councillors contribute to the decline in satisfaction levels.

6.11.2.3 Policy implementation and evaluation findings

From SEM or SES, local, national government departments and agencies is responsible for the policy level and its implementation and enforcement (Dahlberg and Krug, 2002), however this too was lacking as indicated by the qualitative participants, instead such task of law enforcement was perceived to be difficult by authorities. This kind of attitude from the authorities according to HBM, where the barrier is greater than the benefits will result in no health behaviour practice of policy implementation although the impact of policy is to promote healthy behaviour on citizen. In validating these findings, only 3.2% said yes, these laws are implemented and enforced as 66,3% of the citizens said they do not know if these policies are effectively implemented and enforced (figure 44).

6.11.2.4 Behaviour findings

In determining the third research objective findings from qualitative phase of conducting an assessment of community behaviours in response to about stream water quality policy and practices in Umlazi Township, KwaZulu Natal, South Africa. Participants were asked what the community's behaviour and practices in response is on keeping stream water quality policies and practices. The researcher wanted to the determine the stakeholder's behaviour in adhering to stream water quality management policies and promoting sustainability towards stream restoration practice. The municipality stakeholders were perceived to practice strategic ignorance as they were aware and had knowledge of the citizens' health and safety susceptibility and severity associated with the current streams condition, but no attitudinal change was observed by the researcher. No educational nor water quality testing initiative was

conducted by authorities with the community members although they perceived citizens to use the stream water. Authorities also acknowledged that no policies regarding streams management were implemented and enforced and even indicated that trying to implement such policies would be difficult. Therefore, knowledge about health and safety risks did not change or influence attitudinal and behavioural change of authorities towards streams restoration. Such findings agree with Delzendeh *et al*. (2017) that education and policy implementation are the tools in changing negative environmental behaviour of stakeholders.

In validating these findings, when citizens were asked if their behaviour would change if these stream water quality policies are effectively implemented and enforced, 63,7% participants indicated that they do not know if implemented policies will influence their behaviour towards a stream restoration practice (Figure 46). Such findings indicate that even if there is enough knowledge on health and safety risks, if the attitude is bad, there will be no behavioural change. It was then perceived that stakeholders' knowledge on susceptibility and severity did not change their attitude and behaviour in adhering to stream water quality management policies and promoting sustainability towards stream restoration practice. To further determine if there is any existing relationship between knowledge, attitude and behaviour of the stakeholders towards stream restoration, inferential analysis was conducted below.

6.12 INFERENTIAL ANALYSIS DISCUSSION

This is the last subsection of the analysis. The inferential analysis is extracted selected stakeholders' knowledge, attitude, policy and behaviour perceptions questions on from the survey method.

The knowledge section (part 1) included **10** close-ended questions with three possible answers, **"yes"**, "**no" and "I do not know".** These questions focused on knowledge regarding health and safety susceptibility and severity associated with stream water quality and stream management policy standards knowledge questions (Table 40). For evaluation, a scale ranging between good and poor percentages answers. Citizens that scored" good" knowledge was 47,9% and 52,1% scored "poor"

knowledge (Table 40.1). **The attitudes section** of the questionnaire (part 2) aimed to determine the perception of citizens' responsibility and the ability to conduct stream water quality testing and its management (Table 42). Attitude section contained 3 questions that required 2 levels of answers, **"Yes",** and **"No" and on some question it** required 3 levels of answers, **"Yes", "No" and "Both".** Citizens that scored" good" attitude was 32,6% and 67,4% scored "poor" attitude. **The policy section** of the questionnaire (part 3) aimed to determine the perception of citizens on policy knowledge and understand of laws governing stream or river management, and the perception on implementation, enforcement and evaluation of these policies (Table 43). Policy section contained 2 questions that required 3 levels of answers, **"Yes"**, **"No",** and **"I do not know".** Citizens that scored" good" policies were 14,7%; 59,5% scored "poor" policies and 25,8% was scored as fair (as the coding was between 1.4 and 2). **The behaviour section** of the questionnaire (part 4) aimed to determine the citizens stream water usage patterns and how policies influence their behaviour towards a stream restoration practice (Table 44). Behaviour section contained 3 questions that required 3 levels of answers, **"Yes"**, **"No"** and **"I do not know".** Citizens that scored" good" behaviour were 12,6% and 87,4% was scored as "poor" behaviour.

6.12.1 Knowledge on Policy, Health and Safety Susceptibility and Severity

In order to establish the level of health and safety susceptibility and severity knowledge that is associated with stream water quality and stream management policy standards knowledge, a scale ranging between good and poor percentages on participants' response. Citizens that scored" good" knowledge was 47,9% and 52,1% scored "poor" knowledge.

6.12.1.1 There Is a Relationship Between Knowledge and Policies

This study shows that there is a relationship between knowledge and policies with r=.438*, p=0.000. According to Gelcich *et al*. (2009) knowledge of perceptions can be used to understand acceptability of conservation initiatives by different stakeholders

and help identify problems and challenges associated with such programmes or policies. This study results agrees Cinner (2007) that knowledge perceptions may help illuminate potential ways of 'fine tuning' the intention of the existing practices and policies or finding novel solutions to the challenges facing aquatic conservation and management and conservation. Also agrees with Gelcich *et al*. (2005) that understanding the knowledge perceptions of the community can help predict their behaviour towards a new policy or conservation programme before it is implemented in theory.

6.12.1.2 There Is No Correlation Between Knowledge and Behaviour

This study indicates that there is no significant correlation between behaviour and knowledge r=-0.003 p=0.968 (table 41). It shows that individuals who have a high level of knowledge does not necessarily mean their behaviour will change. Citizens' knowledge towards policies that govern the stream management is poor as indicated in question number 17, 18 and 19 .93.7% citizens indicated that they do not know what is RQOs of their streams and rivers (question 17). Lack of knowledge on citizens is impacted by the lack of skills, knowledge accuracy of data from the professionals on stream and river management.

In table 45 of this study again, show knowledge (-0.145) had an inverse influence towards behavior change. These results confirm that of Ajzen, Joyce, Sheikh, and Cote (2011) in study 1 where, environmental knowledge had no effect on energy conservation, and in study 2 where, alcohol knowledge was unrelated to drinking behaviour. Such disappointing correlations may result from an inappropriate focus on accuracy of information at the expense of its relevance to and support for the behaviour. However, these findings are not in line with that of Alies (2019) findings that show the existence of a moderate correlation between knowledge and behaviour of river pollution ($r = 0.401$, $p = <0.0001$) that individual's high level of knowledge contributed to a positive behaviour**.** The findings of parallel studies conducted by Hines, Hungerford, & Tomera (1987) on a meta-analysis related to environmental

behaviour showed that the correlation between knowledge and behaviour of the environment is r = 161.

Lack of Proper Knowledge Causes No Behavioural Change

However, according Ajzen *et al*. (2011) it is only when well informed can we then act effectively to produce desired outcomes. This article of faith is frequently invoked to explain a wide range of detrimental lifestyle behaviours. Uninformed or misinformed, people eat an unhealthy diet and don’t exercise enough, engage in unsafe sex, abuse drugs and alcohol, fail to protect themselves from the harmful rays of the sun, and pollute the environment.

Table 39. Assessment of citizens' knowledge regarding stream management practices

Statement	Yes	No	I do not know
Q1. In your own opinion, is there any importance of the clean stream	**147 (77.4%)**	**43 (22.6%)**	
Q8. Is there an offensive smell in the stream?	**147 (77.4%)**	**43 (22.6%)**	
Q10. In your own opinion does living near the stream increase risks associated with stream conditions	**141 (74.2%)**	**46 (24.2%)**	**3 (1.6%)**
Q15.Do you feel there are any direct implications of polluted streams on children	**145 (76.3%)**	**44 (23.2%)**	**1 (0.5%)**
Q17.Do you know what is meant by River Quality Objectives (RQO) and it status of your river or stream?	**11 (5.8%)**	**178 (93.7%)**	**1 (0.5%)**
Q18.Do you know what is meant by Water Quality Index (WQI) status of your river or stream?	**43 (22.6%)**	**142 (74.7%)**	**5 (2.6%)**
Q19**.**In your own opinion is WQI criteria more important for the citizens' awareness on water related disease instead of RQO in this country.	**14 (7.4%)**	**115 (60.5%)**	**61 (32.1%)**
Q20. Do you feel the streams have less water than in the past years?	**48 (25.3%)**	**49 (25.8%)**	**93 (48.9%)**
Q22.In your own opinion, are there any challenges or barriers in keeping the stream clean	**132 (69.5%)**	**58 (30.5%)**	
Q41.Do you know any existing municipality initiative that treat and manage streams?	**58 (30.5%)**	**131 (69.0%)**	**1 (0.5%)**

Table 40.1 Level of knowledge of citizens on health and safety susceptibility and severity associated with stream water quality and stream management policy standards knowledge

Knowledge					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Good	91	47,9	47,9	47,9
	Poor	99	52,1	52,1	100,0
	Total	190	100,0	100,0	

Table 40. Correlation between knowledge, attitude, policies and behaviour

Correlations						
		Attitude	**Behaviour**	**Policies**	**Knowledge**	
Attitude	Pearson Correlation	1	0,027	0,115	.522**	
	Sig. (2-tailed)		0,715	0,113	0,000	
	N	190	190	190	190	
Behaviour	Pearson Correlation	0,027	1	.259**	-0,003	
	Sig. (2-tailed)	0,715		0,000	0,968	
	N	190	190	190	190	
Policies	Pearson Correlation	0,115	.259**	1	.438**	
	Sig. (2-tailed)	0,113	0,000		0,000	
	N	190	190	190	190	
Knowledge	Pearson Correlation	.522**	-0,003	.438**	1	
	Sig. (2-tailed)	0,000	0,968	0,000		
	N	190	190	190	190	
**. Correlation is significant at the 0.01 level (2-tailed).						

6.12.2 Citizens Attitude Perception

In order to establish the level of citizens' attitude perception on their responsibility and their ability to conduct stream water quality testing and its management, a scale ranging between good and poor percentages on participants' response. Citizens that scored" good" attitude was 32,6% and 67,4% scored "poor" attitude.

Citizens poor attitude was rated as the highest reason that led to this condition with 29.5% (Figure 39). 45.3% majority of citizens indicated citizens' ignorance towards stream water quality management policies (figure 32).

6.12.2.1 There Is a Relationship Between Attitude and Knowledge

Analysing the association between knowledge and attitude of citizens on stream water quality management using Chi Square test, the results showed there was significant differences ($p < 0.05$) between knowledge about health and safety susceptibility and severity and citizens attitude on stream water quality management (question number 1. These finding are in line with to ul Haq, Hassali, Shafie, Saleem, Farooqui and Aljadhey (2012) findings that, better knowledge gain can lead to positive attitude.

6.12.2.2 The Citizens' Environmental Disapproval Attitude Although There Is Fair Knowledge

In this study, however, despite the relatively good level of knowledge (with 47,9% good and 52,1% bad), the percentage of citizens' good attitude was relatively low (with 32,6% good and 67,4% bad). These results agree with the findings of Suparmi, Desanti and Cahyono (2015) where there was a good knowledge of PKK (a community organization whose members) mothers' household mothers on food colorant but poor attitude about food colorant of PKK mothers in Penggaron Lor Village. According to Thunström *et al*. (2014) this can also be due to citizens' environmental disapproval attitude that can lead to bad behaviour.

6.12.2.3 Lack of Proper Knowledge Causes No Attitude Change

Although almost the all participants with 76.3% agreed that polluted streams have direct impact on children (question number 15) and 45.8% perceived germs and bacteria as the main implication (Figure 27). The attitudes questions that was to determine the perception of citizens' responsibility and the ability to conduct stream water quality testing and it management in question 29, 31. Although 61.1% of the citizens perceived both municipality and citizens to be responsible for stream maintenance (in question 30) yet only 38.9 % citizens report the challenges regarding stream management to the authorities (in question 31) and 75.8% do not have the ability to conduct stream water quality testing (in question 29). These findings agree with Ajzen *et al*. (2011) that it only when well informed individual that can act effectively to produce desired outcomes.

6.12.2.4 There Is No Relationship Between Attitude and Policies

There is no relationship between attitude and policies r=0.115 and p=0.113. According to Ajzen (1988) intention is interpreted as a transition between the cognitive and evaluative components of attitude and behaviour and intentions are direct functions of both individual and social related variables. Figure 55 in this study showed that 62.1 % indicated that there do not know if there is a community-based organisation and 25.8% indicated that there is no organization in the neighbourhood. In figure 56 of this study also, 62.1% citizens indicated that there they do not know if there the community-based organisation is active while 33.2% perceived the community-based organization in their neighbourhood as inactive and not impactful to the environment. According to Ajzen *et al*. (2011) poorly informed, people fearfully avoid members of outgroups, investors succumb to ‘‘irrational exuberance,’’ and a nation's leader embarks on misguided policies then individuals act beyond detrimental lifestyles.

Strategic ignorance on authorities can be the cause of no relationship between attitude and policies for authorities as indicated in the triangulating section of this study. In question 41 of this study, 69.0% indicated that there is no municipality initiative and 0.5% said they do not know. Only 30.5% confirmed that there is a municipality initiative

that treat and manage streams. This can be due to strategic ignorance. According to Thunström *et al*. (2014) such a behaviour can be perceived as strategical ignorance (partially) from the fact that they were able to perceive the streams as dangerous and not in a good condition due to human activities.

6.12.2.5 There Is No Relationship Between Attitude and Behaviour Due to Lack of Intentions-Policy Enforcement

From this study, the correlation between attitude and behaviour showed no correlation with r=0.027, p=0,715. According to Kraus (1995) attitude shows high significance when the intentions are present as variables of attitude and are stable, certain, accessible, affective-cognitive consistency and direct experience with r=.39, higher when corresponding levels of specificity in the attitude and behaviour measures q=.47 and low on no experience like non students as subjects q=.17. Intentions can be in the form of policy formulation, implementation, enforcement, evaluation. These findings agree with that of Alias (2019) that show the existence of a weak correlation between attitudes and behaviour of river pollution (r = 0.315, p = <0.0001). The findings of Fah & Sirisena (2014) also show that there is a weak correlation between attitudes and behaviour as literacy environmental dimension (r = .224).

In a review of 12 studies, Lam and Chao (2003) found greater intentions to demonstrate pro-environmental behaviour. Intention is interpreted as a transition between the cognitive and evaluative components of attitude and behaviour (Ajzen, 1988) and intentions are direct functions of both individual and social related variables namely attitude toward the act, a personal evaluative response, and subjective norms, the social information available and the perceived social pressure to behave. Moreover, intentions mediate the influences of attitudinal variables on behaviour totally so that no direct path from attitude to behaviour is hypothesized. As mentioned above, both attitudes toward the act and subjective norms are based on cognitive information so that the model is interpreted as a sufficient representation of attitude-behaviour relationships, since all possible external influences on intentions and behaviour are thought to be totally mediated by the formulation processing that underlies attitudes and subjective norms (Ajzen & Fishbein, 1980).

6.12.2.6 Lack of Knowledge from Authorities Can Be the Cause of No Relationship Between Attitude and Policies for Authorities

Lack proper of information on the authorities' side could have been the cause for question number 17, 18, 19, question number 29, figure 53 and figure 56 results, as indicated by Ajzen *et al*. (2011). Ajzen *et al.* (2011) that the beyond detrimental lifestyles, when poorly informed, people fearfully avoid members of outgroups, investors succumb to ''irrational exuberance,'' and a nation's leader embarks on misguided policies. In figure 50 of this study, only 19.5% citizens agreed that they are able to conduct the stream water quality in their area.48.8% respondents indicated that they do not have any ability to conduct stream water quality and 32.1% believe that they are moderately equipped.

The findings show that individuals who have an optimistic attitude toward the issue of river pollution also contribute to positive behaviours. Subsequently positive correlation indicates that the individual has a high level of knowledge on the issue of river pollution indirectly will form a responsible behaviour towards the environment and such knowledge was lacking in this study.

Table 41. Assessment of citizens' attitude regarding stream management practices

Statements	**Yes**	**No**	**I do not know**
Q29.Have you ever received training on stream water testing from the government?	46 (24.2%)	144 (75.8%)	
Q31. Do you report to the municipality these stream challenges you face?	74 (38.9%)	116 (61.1%)	
	Municipality	**Citizens**	**Both**
Q30. Who do you think is responsible for maintaining stream water clean?	49 (25.8%)	25 (13.2%)	116 (61.1%)

Table 42.1 Showing the attitude perception of citizens' responsibility

Attitude					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Good	62	32,6	32,6	32,6
	Poor	128	67,4	67,4	100,0
	Total	190	100,0	100,0	

6.12.3 Citizens Perception on Policy Measures

In order to establish the level of citizens' policy knowledge and understand of laws governing stream or river management, and the perception on implementation, enforcement and evaluation of these policies, a scale ranging between good and poor percentages on participants' response. Citizens that scored**" good"** policy was 14,7%, 59,5% scored **"poor"** policy and 25,8% was scored as **"fair"** policy (table 43).

6.12.3.1 There Is a Relationship Between Behaviour and Policies

To achieve behaviour change that is sustainable barriers must be lowered or even removed across community and society at large (White *et al*.,2015). As stated earlier, barriers to healthy behaviours is a combination that reinforces efforts at all levels that includes individual, interpersonal, organizational, community, environment and, public policy (White *et al*, 2015). While, Bancalari and Martínez (2017) believe that policy solutions that can reduce exposure to faecal pathogens from open defecation and can emphasised the local data collection.

The findings from this study indicate that behaviour is significantly correlated to policies r=.259** p=0.000 (table 41). Since intention is interpreted as a transition between the cognitive and evaluative components of attitude and behaviour (Ajzen, 1988), intentions are direct functions of both individual and social related variables. Attitude toward the act, a personal evaluative response, and subjective norms, the social information available and the perceived social pressure to behave. Both attitudes toward the act and subjective norms are based on cognitive information so that the model is interpreted as a sufficient representation of attitude-behaviour relationships, since all possible external influences on intentions and behaviour are thought to be totally mediated by the formulation processing that underlies attitudes and subjective norms (Ajzen & Fishbein, 1980).Policies are external influences that are meant to shape social information that is available and the perceived social pressure to behave on all stakeholders.

Yet policies according to Harring *et al.* (2017) should be guided by professional knowledge, skills and environmental data especially that of surface water, however these professional attributes were limited, not accurate and not implemented in this study and this could have resulted in figure 46 and question 35, 24 and 27 promoted these behavioural findings (table 44). Where about 22.1% indicated that policy implementation will not influence their behaviour while 63.7% said they do not know if policy implementation and enforcement will influence their behaviour towards stream restoration practices (question 24). As a result, the behaviour section aimed to determine the citizens stream water usage patterns and how policies influence their behaviour towards a stream restoration practice, highlighted that 87,4% citizens have

“poor” behaviour (table 44.1) due to more than 60.0% of citizens who do not understand policies and do not believe thst these policies are implemented and enforced (table 44).

Table 42 Citizens adherence to policies

Statement	**Yes**	**No**	**I do not know**
Q32.In your own opinion, do community members know and understand policies and laws governing stream or river management	18 (9.5%)	47 (24.7%)	125 (65.8%)
Q33.If yes, are these policies effectively implemented and enforced	6 (3.2%)	58 (30.5%)	126 (66.3%)

Table 43.1. Citizens policy and governing laws knowledge

Policies					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Good	28	14,7	14,7	14,7
	Poor	113	59,5	59,5	74,2
	Fair	49	25,8	25,8	100,0
	Total	190	100,0	100,0	

6.12.4 Citizens Behaviour Perception on Stream Management and Restoration Practices

As indicated above that there is a correlation between behavior and policies. In order to establish the level of citizens' behaviour towards stream water usage patterns and on how policies influence their behaviour on stream restoration practice, a scale ranging between good and poor percentages on participants' response. Citizens that scored" good" behaviour was 12,6% and 87,4% scored "poor" behaviour.

The F-test showed revealed a significant difference in the model. The regression coefficient ($r=0.300$; $p<0.01$) suggests a weak causal relationship in the predicted model. The beta coefficients (0.168) for policies suggest it has the biggest influence in predicting behavioural change towards stream restoration. The coefficient of 0.085, however, indicates a poor predictor for the attitude; while knowledge (-0.145) had an inverse influence towards behaviour change. Equally relevant, the R^2 values measured suggests that there is a weak explanatory power (9%) for the predictors in the model. Moreover, it can be seen that both polices, and knowledge contributed to behaviour prediction.

The findings from this study show that knowledge, policies and attitude are predictors for environmental behaviour with the $p=0.001$. These findings agree with Karpudewan, Ismail and Roth (2012) who indicated knowledge and attitudes that make up a predictor of environmental behaviour directly. Also, Alias (2019) found that knowledge and attitudes related to the behaviour of river pollution, collectively, the two variables act as factors that contribute to the formation of the behaviour of river pollution Bancalari and Martínez (2017) also believe that policy can reduce exposure to faecal pathogens from open defecation and can emphasise the local data collection. However, if there is no intention from authorities to implement and enforce river management policies and in developing water conservation programs, encouraging community based environmental programmes, then policies as a predictor will not be able to predict behavioural outcomes (Aarts *et al*., 1998; Fielding *et al*., 2012; Gregory & Di Leo, 2003; Ouellette & Wood, 1998).

6.12.4.1 No Community Organisation Is Due to Poor Information

Ajzen *et al*. (2011) maintain that when poorly informed, people fearfully avoid members of outgroups, investors succumb to ‘‘irrational exuberance,’’ and a nation’s leader embarks on misguided policies then individuals act beyond detrimental lifestyles.

Table 43 Assessment of citizens’ behaviour towards stream management practices.

Statements	**Yes**	**No**	**I do not know**
Q24.In your own opinion, do citizens use stream water for irrigation	**45 (23.7%)**	**43 (22.6%)**	**102 (53.7%)**
Q27. In your own opinion, will citizens use stream water for the activities if there is water shortage or supply in the township	**77 (40.7%)**	**109 (57.7%)**	**3 (1.6%)**
Q35.If these policies are effectively implemented and enforced, will these influence your behaviour towards a stream restoration practice	**27 (14.2%)**	**42 (22.1%)**	**121 (63.7%)**

Table 44.1. Stream water usage behaviour

Behaviour					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Good	24	12,6	12,6	12,6
	Poor	166	87,4	87,4	100,0
	Total	190	100,0	100,0	

Table 44 Regression analysis of variables

Predictor	F-value	P-value	R	Beta coefficients	R Square	Predicted
Attitude	6.114	0.000	0.300	0.085	0.09	Behaviour
Policies				0.168		
Knowledge				-0.145		

Table 45 Behaviour change required

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	0,582	3	0,194	6,114	.001[b]
	Residual	5,903	186	0,032		
	Total	6,485	189			
a. Dependent Variable: Behaviour						
b. Predictors: (Constant), Knowledge, Policies, Attitude						

6.13 CONCLUSION

The findings from this study indicated poor predictor for the attitude; while knowledge had an inverse influence towards behaviour change. The improved knowledge, attitude and behaviour towards the stream restoration practices will also improve air quality, due to odours being reduced as illegal dumping is reduced. Prevent flooding, if the streams are cleared of litter, waste, and debris, this will promote better flow with no blockages. This will then prevent flooding. Safety, health and safety can improve

especially when the vegetation is maintained and prevent dangerous animals from lurking as well as other related dangers.

Since poor surface water quality is associated with lots of diseases that is currently affecting the socioeconomic, health and safety of humans, improving the surface water will require all stakeholders improved knowledge, attitude and behaviour towards the stream restoration practices, helping to enhance social; economical and also strategical benefits of stakeholders as they continue to use these streams for various reasons. However, to experience an impactful behavioral change toward stream restoration practices in Umlazi Township, KwaZulu Natal, South Africa, the findings indicated that policy must be implemented and enforced as it had the highest beta coefficients with 0.168 for policy adherence on stream water quality practices on behaviour. Improving these attributes will help enhance social; economical and also strategical benefits and requires input of professionals' skills in providing accurate and updated local surface water quality data necessary in implementing and enforcement of surface water management related policies that will benefit the local citizens as well that is currently lacking and not understood by community members.

The next chapter addressed the last research objective of the study, it focuses on developing a knowledge, attitude and behaviour modification framework / recommendations that support stream water quality restoration practices. The next chapter features a presentation of the proposed model that can be useful in mitigating the highlighted health and safety risks associated with streams current condition but maximise social; economical and also strategical benefits.

7CHAPTER SEVEN
THEORY DEVELOPMENT

7.1 INTRODUCTION

In Chapter five and chapter six the presentation of results, data analysis and interpretation were discussed. Findings from the mixed method research analysis in chapter five highlighted the following challenges.

The current river framework models, theories and programmes variables used to mitigate the surface water scarcity and pollution is not easily understandable to the citizens surrounding the streams and rivers. Throughout the study, participants indicated that they do not know policies associated with stream water management for example up to 93,7% of citizens said they do not know what is meant by RQOs and WQI, yet guidance of these facts help in decision-making of how stream water will be used by the community and maintained. The RQOs and WQI contain water quality status data of that particular surface water, knowledge and understanding about such information can improve citizens' knowledge on how to protect both streams ecosystem and their wellbeing to such that they also benefit social, economic and strategically (Nel and Driver, 2015; DWS, 2014; Parker and Oates, 2016).

Although almost stakeholders perceived the stream current condition as a threat to their health and safety with 48,9% of the citizens perceived the condition of the streams of Umlazi to be poor and 35,2% who said the stream condition was in worse a condition. Citizens' behaviour and attitude highlighted social disapproval towards clean stream management, because about 40,5% continue to contaminate the streams and Sihlanzimvelo workers attested that they have experienced bad behaviour from citizens, citizen would throw nappies at them at time when working, yet 76.3% of participants indicated their concerns of children being more vulnerable to health and safety risks.

Findings also indicated that 29.9% citizens use between 11-20 litres of stream water for irrigation. 20.9% believed that citizens use 20-50 litres. 25.1% believed that citizens use stream for swimming purposes, followed by 19.3 % that perceived stream water is used for building purposes. The above acknowledgment of stakeholders on health and safety risks however persists in using these contaminated streams and not

reporting the challenges of poor streams conditions highlighted citizens' strategic ignorance.

Moreover, there was strategic ignorance from the local and national authorities. Although, the beta coefficients (0.168) for policies suggest it has the biggest influence in predicting behavioral change towards stream restoration. Yet, findings indicated that there is still a lack of consistency on surface water quality policy implementation and enforcement methodological variations by professionals and this was verified by municipality participants of this study who agreed that the policies are not implemented and that they perceive policy implementation and enforcement as difficult (Pappenberger & Beven, 2006; Dabrowski, Baldwin, Dabrowski, Hill & Shadung ,2017). According to Patterson (1983) a theory though should provide explanation and deep understanding of actual events, behaviours, or the meaning making activities of stakeholders and respondents; and should be accepted by professionals and stakeholders who co-constructed the theory.

Guided by these challenges, this chapter attempts to develop the theory with the aim to mitigate these challenges and improve stakeholder knowledge, attitudes and behaviour toward stream restoration. As stated before, chapter addressed the last research objective of this study, focuses on the developing a knowledge, attitude and behaviour modification framework / recommendations that support stream water quality restoration practices. The chapter will begin with the overview of science, in the development of this theory framework as science is a fundamental foundation of theory development with its role to systematic and organized body of knowledge (in any area of inquiry that is acquired using "the scientific method").

The chapter will than discuss the role of scientific methods in organizing scientific knowledge. Since the process of scientific knowledge requires it to be guided by finding the actual knowledge through experiment and logical observation (research) when developing the theoretical framework, highlighting the relationship between theory and research. Following on from the last chapter, the current chapter pulls to develop the theory guided by attributes of good theory as indicated that theory developed should be understandable, should provide explanation and deep understanding of actual events, behaviours, or the meaning making activities of

stakeholders and respondents; and should be accepted by professionals and stakeholders who co-constructed the theory (Patterson, 1983).

Further to this, methodological challenges and strengths of the proposed theory developed will be discussed as part of theory development evaluation. The last section of this chapter will focus on the proposed specification framework for current study; the purpose of our conceptual framework; the purpose of our conceptual framework; unexpected issues that are looked at within the framework; limitations / cautions about the use of the theory and conclusion.

7.2 SCIENCE, SCIENTIFIC RESEARCH AND THE SCIENTIFIC METHOD

7.2.1 Science

Science refers to a systematic and organized body of knowledge in any area of inquiry that is acquired using “the scientific method”. This systematic body describes and explains natural phenomena through observation and experimentation. The purpose of science is to create scientific knowledge. Theories and observations are the two pillars of science (Bhattacherjee, 2012).

According to Kroeze (2019) natural science and social science are the two broad branches of science. Natural science is the study of objects or phenomena that exist in nature, such as light, matter, the earth, celestial bodies, or the human body. Social sciences can be classified into disciplines such as psychology that is, the science of human behaviours, sociology (the science of social groups), and economics (the science of firms, markets, and economies) (Bhattacherjee, 2012).

7.2.1.1 Basic and Applied Science

Basic sciences, also known as pure sciences, are those that describe the most fundamental objects and powers, as well as their interactions and the rules that regulate them. Applied sciences, also known as practical sciences, are fields of study

that extend scientific knowledge from the fundamental sciences to a physical setting. Both basic and applied sciences are required for human development. Applied sciences, on the other hand, cannot advance on their own and must depend on fundamental sciences to do so. Of course, because of their practical value, industry and private businesses prefer to concentrate more on applied sciences, while universities research both fundamental and applied sciences (Greene *et al*., 1989).

7.2.1.2 Scientific Research/ Knowledge

7.2.1.2.1 Scientific Knowledge

According to Bhattacherjee (2012) The method of discovering real information by experiment and observation is known as scientific knowledge. Scientists arrive at their conclusions by logical and rational steps. These conclusions are reached by observation, theories, theory, rules, and inference. Scientific knowledge refers to a generalized body of laws and theories to explain a phenomenon or behaviour of interest that are acquired using the scientific method. Theories are systematic interpretations of the underlying phenomenon or behavior, while laws are observable patterns of phenomena or behaviors. According to Carey and Spelke (1996) arriving at scientific laws or theories is through a process of logic and evidence. The only two foundations on which scientific understanding is built are logic (theory) and evidence (observations). In science, theories and observations are interrelated and cannot exist without each other. Theories give meaning and significance to what we see, and observations aid in the validation or refinement of existing theories or the creation of new ones. Other methods of acquiring knowledge, such as faith or authority, cannot be considered science. According to Carey and Spelke specific systems of knowledge provide one potential mechanism of theory development and conceptual change (Carey and Spelke 1996).

Internal and external resources, which are implied and explicit, explanation and definition of climate, are divided into scientific knowledge. The problem's complexity allows one to deal with information not through an algorithm, but rather through a

collection of rules that clarify the relevance and practices (Curtis & Curtis, 2011). The three characteristics of scientific understanding, according to Bhattacherjee (2012), are empirical, logical, and systematic. Deductive reasoning is turned into a hypothesis, then a theory, and eventually rules. These can be attained by studying the fundamental concepts of inference, variable, parameters, and function types.

7.2.1.2.2 Scientific Research

According to Mackinson and Nøttestad (1998), the integrate the knowledge involves several stages. By gathering all the fundamental requirement, assumptions and laws (scientific knowledge). Scientific knowledge is what we learn from the scientific process which involves experiments and data collection. Scientific research is the process of data collection to investigate and explain the phenomenon. Scientific research operates at two levels: a theoretical level and an empirical level. According to Silvermann (2000) The theoretical level is concerned with creating abstract concepts and interactions between those concepts in order to construct "theories" about natural or social phenomena. While the empirical level is concerned with putting theoretical principles and relationships to the test to see how well they represent our observations of experience, with the ultimate aim of improving theories. A theory becomes more developed over time so that it better suits the observable facts, and science matures (Garca, 2018). Moving back and forth between theory and findings is a constant in scientific study. Scientific analysis necessitates the use of both theory and findings. For example, making inferences solely based on findings while ignoring theory is not considered legitimate scientific research (Garca, 2018).

There are two types of scientific inquiry: inductive and deductive. A researcher's aim in inductive research is to derive theoretical principles and patterns from observed evidence. Generalisations are extracted from observations of specific events through the inductive approach (Wallace,1971).

7.2.1.3 Research Strategies to Theory Development

According to Cooper and Schindler (2008) the goal of scientific research is to discover laws and propose theories that can explain natural or social phenomena, or in other words, build scientific knowledge. However, this knowledge may be imperfect or even quite far from the truth. Therefore, the progress of science is marked by our progression over time from poorer theories to better theories, through better observations using more accurate instruments and more informed logical reasoning.

Scientific laws or theories is through a process of logic and evidence. The only two foundations on which scientific understanding is built are logic (theory) and evidence (observations). Theories and findings in science are inextricably linked and cannot exist without one another. Theories provide context and significance to what we see, and observations aid in the validation or refinement of existing theories or the creation of new ones (Garca, 2018).

The aim of deductive analysis is to put theory-based principles and patterns to the test using new empirical evidence. Theory testing is through the deductive approach (Wilson,2010). As a result, inductive research is often referred to as theory-building research, whereas deductive research is referred to as theory-testing research. It's worth noting that theory-purpose testing is not only to test a theory, but also to refine, develop, and expand it.

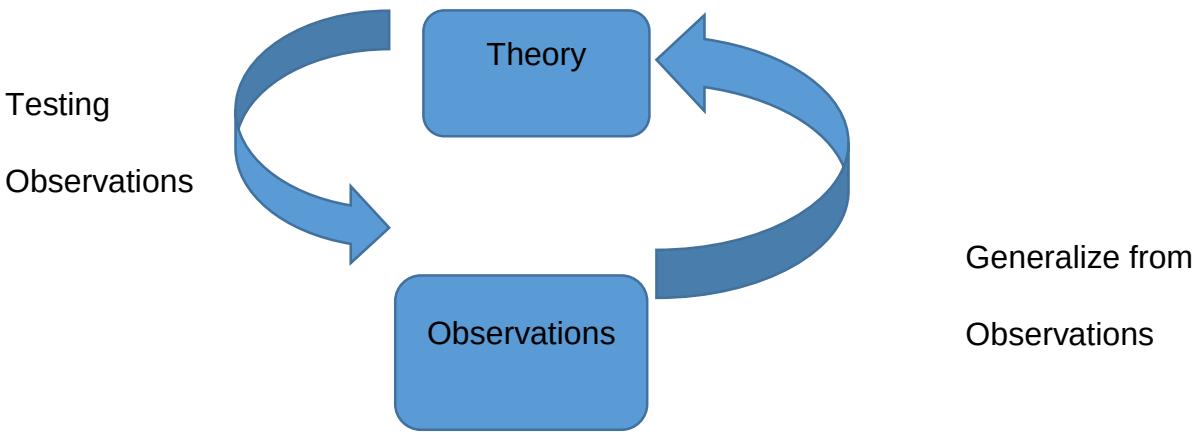


Figure 57. Cycle of science showing the complementary nature of inductive and deductive research (Wallace, 1971)

According to Clarke (2007) When there are few prior hypotheses or interpretations, inductive (theory-building) research is more useful, while deductive (theory-testing) research is more effective when there are multiple competing theories of the same phenomenon and researchers want to know which theory works better and under what conditions.

According to Bhattacherjee (2012) it is crucial to realize that both theory-building (inductive research) and theory-testing (deductive research) are important for scientific progress. It is to better to view the cycle of science as an iteration between hypothesis and evidence leads to more accurate interpretations of the phenomena of interest and more accurate hypotheses important for the advancement of science.

7.3 THE DEFINITION AND NATURE OF THEORY

Kivunja (2018) defines theory as a set of interrelated constructs (concepts), definitions, and propositions that present a systematic view of phenomena by specifying relations among variables, with the purpose of explaining and predicting the phenomena.

According to Wacker (1998) a theory is defined as an ordered collection of assertions about a generic behavior or structure that is presumed to hold true over a wide range of specific instances. Others define it as a statement of relationship between units observed or approximated in the empirical world (Bacharach,1989). According to Chilisa and Kawulich (2015) a term theory has different meaning depending on the discipline. Silvermann (2000) provides the motivation for research. In social science, a theory is the use of theoretical frameworks to study and interpret social structure and phenomena within a particular school of thought. According to Wacker (1998), a theory must have four basic criteria: conceptual definitions; domain limitations; relationship-building; and predations. Theories are conceptual basis for understanding, analysing, and designing ways to investigate relationships within social systems. a theory can help guide the development of your framework (Wacker ,1998).

Since, it has been established that theory contribute to the research study. Kivunja (2018) further attest that theory contributes to theory first as a paradigm, in which theory plays an important role in understanding the research design. Theory defined a paradigm as “a representation of a way of thinking that is shared by scientists in solving problems in their fields, to represent commitments, beliefs, methods, outlooks and that are shared across a discipline” (Chilisa & Kuwilich 2015). Second, theory as a ‘lens' from which we can gain a better understanding of the circumstances or events under investigation. The third way, theory as knowledge. Theory as a theory is concerned with the metaphysical constructs that make up our social existence as we know it, or ontology; it also looks at what we accept as the truth of that reality, or epistemology; and, finally, it looks at the tools we use to analyze these backgrounds, or methodology; and the means we use to collect facts, or methods (Gay & Weaver 2011; Chilisa & Kuliwa 2015).

Glanz, (2017) attest that as a partnership of agreeing thinking that has evolved over time, theory is commonly used to describe certain circumstances and events in society. The role of a theory in social research varies depending on the methodologies and techniques used to perform the study. Theory is defined as “a system of ideas formulated with the intention to explain a certain phenomenon” It can also be described as a collection of principles that guide practice (Oxford dictionary 2018). According to Kivunja (2018) theory is characterized by its ability to clarify why such things occur or do not occur, as well as provide a basis on which we can base our behavior.

Theories in the social sciences can help organize information, understand what has already been observed and why it happened, and also highlight knowledge gaps (Ragsdell, West & Wilby 2002). Theory aids analysis by assisting us in determining which data is important to the study and which data is not (Mngadi, 2018). Theories assist us in constructing structures for the creation of schools of thought and the formulation of ideologies. Ideologies become a mirror through which we can see the universe. According to Barrow (1993) theoretical developments in social studies are actively taking place. As a consequence of a rapidly evolving world, ideas that can no longer justify the realities of the modern world are either challenged to modernize and change or ignored by academia and society.

The theoretical framework may be rooted in a specific theory or theories and these are expected to be validated in relation to specific events, issues, or phenomena. Kivunja (2018) argue that a theoretical framework is used to limit the scope of the relevant data by focusing on specific variables discuss how a single idea can develop into a theory, as well as how theories evolve and adapt to changing circumstances. It will also examine the various levels of theories, with a particular emphasis on meta theory and grand theories. Where appropriate, relevant social science theories, primarily political science theories, will be used to illustrate the various levels of theories (Kivunja ,2018).

Since the essence of science is constant, ideas must be adaptable as well. Theories are formulated within some disciplines. Theories in the social sciences should be changed to suit the changing needs of the environment and to meet modern social research criteria. The phase of theory formulation starts with a theory or theories that are empirically tested. When testing theories empirically, current knowledge, experience, and/or observation are used.

The empirical test can result in a hypothesis, allowing for further investigation. Some theories are confirmed and others are dismissed at this stage, and the theory is then modified to incorporate improvements based on research findings (García ,2018).

7.4 RELATIONSHIP BETWEEN THEORY AND RESEARCH

According to García (2018), the natural and social sciences are inextricably connected to a significant shift. This shift is marked by a split in the reasoning used to comprehend and describe the world's phenomena, or, in some cases, the world itself. This fundamental shift in the scheme or logic of thought, which can be thought of as a (cognitive) paradigm, should be seen as a prerequisite for the advancement of any explanation or hypothesis that claims empirical validity (Garca, 2018). García (2018) believes that a theory is a logical construction to explain a given phenomenon, which departs from some assumptions, stating concepts and how and why these concepts interrelate with each other to understand a phenomenon.

According to Gawronski and Bodenhausen (2015) The relationship between theory and analysis can be visualized graphically using the Wheel of Science or Cycle of Science presented in Figure 57 above showing the major components. The Wheel of Science is meant to reflect the process which seeks, develops, and finds truth or knowledge. In this wheel, the researcher can start the process at any point: hypotheses, research/observation, generalizations/deductions, or theory. Data collection is than conducted, observations made, generalizations produced, and finally, either confirm or refute the hypothesis, or propose a revision. When research findings do not support a theoretical claim, the theory can need to be modified to account for the new research findings/generalisations.

Teddlie and Tashakkori (2009) believes that if the researcher started with a theory, research will lead to the theory's expansion and development. Theories serve as a unifying framework for conducting research. Without hypotheses to direct study, a discipline's research risks becoming a jumbled mess of disconnected experiments that fail to create an integrated understanding of a discipline like human communication.

7.4.1 Ontology Approach

As stated earlier by Chilisa and Kuliwa (2015) that theory, as a paradigm, is concerned with the metaphysical concepts that make up our social existence as we know it, or more precisely, ontology, which examines what we accept as the truth of that reality (Gay & Weaver 2011; Chilisa & Kuliwa 2015).

According to Ito, Gimenez and Junior (2019), the clarification, not the interpretation, is the primary feature of science philosophy. Philosophers in this field are concerned with topics such as the concept of science, the interpretation of logical structure, theories, processes, and the implications of scientific investigations (Klemke, 1998). Consequently, Gimenez and Junior (2019), argue that theory building is one of the most important goals of science, and that assessing the theory-building process is an important feature of science philosophy. The first step in this direction is to create a suitable lens through which to examine the theory-building process in strategic management.

As Klemke (1998) insists that there are a number of questions concerned with the paradigm. Since the aim of this study is to determine policy impact and stream water quality practices on knowledge, attitudes and behaviour toward stream restoration practices in Umlazi Township, KwaZulu Natal, South Africa. Therefore, the nature of this research focuses on ontology. As ontology looks at the core beliefs that a person has about the social world and how it interacts with other people. There are social realities that individuals believe exist outside of humanity's conceptualization and perception of them, and there are social realities that people with unique social, cultural, and historical contexts believe are social constructs.

Since, this study also borrowed the ontological approach in the theoretical framework level where the theoretical framework is rooted in three specific theories. These theories, however, are expected to be validated in relation to specific events, issues, or phenomena. Again, using the ontological approach according to Merrington, Hanchard, Wessels, Pidd, Rogers, Forrest, Higson, Smits, Townsend and Yates (2019) is ideal categorising and sorting out data that may be in large quantities. Agreeing with, Quine, (1951) who described ontological emergence to have the ability to develop between theories that have the same extension but different intensions, and between theories that have both different extensions and intensions. ‘Ontology' in the simple sense of ‘the ontology of a scientific theory that is the area of operation that a theory defines, according to a given meaning.' This domain of application is a part of the empirical world (Merrington *et al*.,2019)

7.4.2 Role of theory in Epistemology

As earlier indicated that epistemology approach investigates at what individuals accept as the truth of that reality and lastly it looks at the research methodology, that is which means are employed to investigate or to gather evidence these backgrounds (Gay and Weaver ,2011; Chilisa & Kuliwa 2015).

Epistemology is the study of human knowledge's origins, processes, and foundations. Science has a logical relation between the theoretical and practical way of treating methods, which leads to cause and effect, which is known as coherence. As a result

of the need for methodology and specialization, science has been divided into various disciplines (Greene et al., 1989). However, this does not occur in the real world. In fact, scientific knowledge is just one type of knowledge. The epistemology purpose is to question what strategies and how to make reliable and valid knowledge. According to Creswell (2015) epistemology concentrate on the relationship between measurable circumstances and sense perception. The final collection of epistemological questions are those that are concerned with the research method or tools, these questions ask how we can collect data to test the theories used in the study.

According to Scotland (2012) in social science, there are two types of models: qualitative and quantitative. The aim of a qualitative analysis is to comprehend social phenomena through investigations and perceptions of the meanings associated with them; the primary goal is to make sense of the social world. The main concepts are subjectivity or rather perceptions, the development of a hypothesis during and after the analysis, and the inductive method (Pierce, 2008). Inductive studies begin with the gathering of relevant data, followed by data analysis and the discovery of similar patterns, and finally the formulation of a hypothesis based on the data. The aim of a quantitative analysis is to test a theory made up of variables that can be calculated in numbers and analyzed using statistical methods to see if the predictive generalization of a theory is right or rather accurate. This approach is also associated with deductive methods, and it is associated with positivist and/or post positivist paradigms. Its core concept is objectivity; the hypothesis is specified before the analysis, and the aim of research is to validate the theory (Perce, 2008). A deductive approach is used to formulate a hypothesis based on a previously developed theory. It begins with a researcher's interest in a social theory and progresses to data-driven inferences. The research will change its emphasis from a wider to a more oriented approach. The researcher looks at what other researchers have found, reads about current hypotheses, and then tests the theory that arises from those theories (Blaikie, 2009).

Where theories can be used as a lens of understanding, the researcher will examine established theories that attempt to explain how various aspects of the world function, particularly those that are related to the research topic. The goals may be to update, adapt, and validate an established theory, or to create a new theory or to link conceptual frameworks. Conceptual frameworks can be understood as “a writing or visual representation that explains either graphically or in narrative form the main

things to studied – key factors, concepts or variables – and the presumed relationship among them" (Miles & Huberman 1994). The conceptual framework is usually formulated after the literature review in quantitative research; it provides the basis and context for the entire analysis based on the literature review, and it is more likely to be updated at the study's end (Rivitch & Riggan 2017). In qualitative study, the conceptual framework is created after the literature review and then refined as the participants' perspectives and problems are interpreted and analyzed (Rivitch & Riggan 2017).

In certain cases, the researcher can opt to use a combination of methods. The use of both qualitative and quantitative analysis approaches is referred to as mixed methods research. Both qualitative and quantitative techniques are used simultaneously in concurrent mixed methods, while in sequential mixed methods, the latter tells the former or vice versa (Chilisa & Kuwilich 2015). As illustrated in figure 57, iteration between theory and evidence that leads to better explanations and hypotheses of the phenomenon of interest. Using Mixed methods research (MMR) in answering ontology since MMR has more advantages than using qualitative or quantitative independently.

7.5 BUILDING BLOCKS OF THEORY

Whetten (1989) identifies three elements that make up a theoretical contribution: (1) What are the variables that affect a specific phenomenon? (Constructs); (2) 'how,' referring to the manner(s) in which the relevant factors interact; and (3) 'why,' elucidating the mechanisms justifying the relevant factors' selection and cause-effect relationships (propositions). Sutton and Staw (1995) argue that these building blocks in the interpretation of a phenomenon, is an intuition that goes beyond common sense. According to Quine (1951) these blocks arise gradually as a result of researchers' collaborative efforts, which are expressed in papers and book publications, as well as discussions at conferences and seminars, resulting in consensus-based expertise.

Whetten (1989) believes constructs, propositions, reasoning, and boundary conditions or assumptions are the four building blocks of a theory (Bergdahl and Bertero, 2016). Constructs is the first building block that capture the "what" of theories that is, what

concepts are important for explaining a phenomenon. According to Bergdahl and Bertero (2016) are abstract ideas decided at a high level of abstraction and chosen specifically to explain the wonder of interest Weight and age are examples of unidimensional constructs; personality and community are examples of multidimensional constructs. These must be quantifiable abstract constructs that are called variables (Bergdahl and Bertero, 2016).

According to Whetten (1989) describe propositions as the second building block that is the “how”, that is how are these concepts related to each other. Shoemaker, Tankard, Lasors (2004) defines as the affiliations hypothesised in light of deductive logic, there is a relationship between constructs. Propositions should be testable, and if they are not supported by empirical evidence, they should be dismissed. (Bergdahl and Bertero, 2016). Propositions, including constructs, are stated at a theoretical level and must be tested by comparing the relationship between quantifiable variables of those constructs. Hypotheses are the analytical plan of propositions expressed as relations between variables (Whetten, 1989).

According to Shoemaker et al. (2004) the third building block is logic represents the “why” that is, why are these ideas associated, and what are boundary conditions/assumptions examine the “who, when, and where” that is, what conditions will these ideas and relationships work in. Sutton and Staw (1995 perceive logic as the "why" and acts like a "glue" that connects the theoretical constructs and emphasizes the significance and importance of the connections between them Logic is often concerned with the interpretation at the heart of a theory. Propositions will be specially named, self-assertive, and useless without logic, and they will be unable to be tied into a long-lasting set of propositions that is at the heart of every theory (Mollah,2019)

Assumptions or boundary conditions is the fourth and the last is the building block of theory Inspects the "who, when and where." All theories are constrained by assumptions about time, space, values, and boundary conditions, which determine where the theory can and cannot be related (Bhattacherjee, 2012). According to Quine (1951) Boundary conditions that govern where the principle can and cannot be implemented, as well as assumptions about values, time, and space. All of a theory's implicit assumptions, which shape the theory's limits, must be fully understood before it can be used or checked. Unfortunately, theorists seldom explicitly state their implicit

assumptions, resulting in frequent misapplications of theories to problem situations in research.

7.6 GOOD THEORY

Berger and Zelditch (1993: 23-24) believes that a good theory should be made up of well-defined principles that are both functional and implementable. Clear and precise hypotheses are the hallmarks of good theories. A good theory should be straightforward, but simplicity is delicate, and we must exercise caution when developing simple theories. Since the world is so complicated, over-simplification can cause a theory to lose its meaning and validity. A good theory should be plausible, logically consistent, and believable. A degree of testability and falsifiability should be present in every good theory (Berger and Zelditch ,1993).

Van de Ven (1989) suggests that a good theory should be both useful and true, that it should go beyond establishing empirically measurable trends and thus be able to predict and explain, that its usefulness should be measured by its potential to—advance expertise in a scientific discipline or field, direct research toward critical questions, and enlighten the profession—and that it should clarify and link levels of reference, account for time, and implement new concepts that either correct shortcomings or complete existing theories.

Neuman (2000) stated that “methodology is what makes social science scientific”. It's important to differentiate it from research methodology, which refers to the analytical methods used to carry out a study (Sim, 1998). Research methodology as part the scientific method are tools used to testability and falsifiability good theories (Berger and Zelditch ,1993). Since the scientific method as a building block of good theory allows researchers to evaluate pre-existing hypotheses and prior observations independently and impartially, as well as subject them to open discussion, changes, or improvements. Therefore, a good theory must satisfy four characteristics.

- **Replicability**: Others should be able to reproduce or duplicate a scientific study independently and come up with similar, if not identical, findings.

- **Precision**: Theoretical principles, which are often difficult to quantify, must be described precisely enough that others can use them to measure and evaluate the theory.

- **Falsifiability**: A theory should be described in such a way that it can be refuted. Theories that can't be tested or refuted aren't scientific theories, and any knowledge that can't be tested or refuted isn't scientific knowledge. A hypothesis that is vaguely defined or whose premises are not precisely quantifiable cannot be verified, and therefore is not empirical. Even though psychoanalysis may have practical usefulness in treating some forms of illnesses, Sigmund Freud's theories on psychoanalysis fall into this category and are therefore not considered a "theory" (Heron, 1996).

- **Parsimony**: Scientists must always consider the easiest or logically most economical explanation when there are several explanations for a phenomenon. This is known as "Occam's razor" or "parsimony." Scientists are prevented from following unnecessarily complicated or outlandish hypotheses of an infinite number of ideas and relationships that may clarify a little bit of anything but nothing in particular by parsimony (Reason 1996).

Good theory is a way of thinking about problems and how to solve them. They are organized in a systematic, logical, and sequential manner, with a strong cause and effect principle in place. A good theory is a thorough, informative, and systematic examination of something or a phenomenon in order to learn something new about it or to examine it from a different angle (Lincoln, 1985).

7.7 CRITERIA OF EVALUATION

According to García (2018) there are eight criteria of evaluation namely: ability to falsify (testability); description accuracy and power; prediction accuracy and power; scope parsimony (simplicity); internal and external consistency; heuristic (utility); and time test

- **Ability to Falsify (Testability)**, (Kuhn, 1970), argued that hypotheses must be testable, that the intensity of the testing must differ, and that the outcome of the testing must be a refutation or confirmation of the theory. Theory verification, according to Kuhn (2012), can be accomplished by comparing two opposing theories and choosing the one that best matches the evidence.

- **Accuracy and Power of Explanation** is an explanatory theory is one that attempts to explain a phenomenon. Explanatory theories are often contrasted, with a new hypothesis being proposed as a substitute for an older theory on the basis of having a more accurate explanation—of fitting the available proof (Kuhn, 2012). The capacity of the new theory to more clearly clarify any element of the phenomanon normally serves as evidence.

- **Accuracy and Precision of Prediction**, García (2018) believes the specificity of a theory refers to how well it predicts phenomena such as people's reactions to a particular communication behavior.

- **Scope** according to Kuhn (2012) represents the range of phenomena or contexts that a theory may describe or predict. The more extensive the theory's reach, the more important it is considered. The better a hypothesis is, the more it describes or predicts (Mollah ,2019).

- **Parsimony (Simplicity)** according to Mollah (2019) rather than being complicated, grand theories are often basic. Maintaining the simplicity of a theory

improves its utility in providing reasons for what occurs as well as making reliable forecasts or successful plans.

- **Internal and External Consistency** Gawronski and Bodenhausen (2015) internal consistency is defined as the degree to which a theory is self-consistent, meaning that its arguments are logically connected. Internal consistency is determined mainly by analyzing the reasoning used to connect the variables and principles that make up the theory's statements and propositions. Consistency can also be attributed to the language used in the theory. The degree to which a theory matches with other theories is known as external consistency (Kuhn, 1970). This is one of the most difficult qualities to spot in theories because it necessitates a thorough analysis of the theory in question as well as a working knowledge of other theories (Merton, 1957).

- **Heuristic (Utility)** is the usefulness or applicability of a theory. In general, it represents the extent to which other academics have been able to apply the theory. The scope and ability to predict and/or describe a hypothesis are directly related to its usefulness. By questioning if what is expected or explained is noteworthy, utility adds a qualitative dimension to these qualities (Gawronski and Bodenhausen, 2015)

- **Test of Time**, Mollah (2019) believes theories vary in terms of how long they have been around.

While, Gawronski and Bodenhausen (2015) in Patterson (1983), presented the following in applied disciplines, there are eight standards for determining "good" theory. Importance, precision and clarification, parsimony and simplicity, comprehensiveness, operationally, empirical validation or proof, fruitfulness, and practicality are the parameters that reflect a traditional (empirical-analytical) perspective of theory building evaluation (Gawronski and Bodenhausen, 2015).

- **Importance** of theory should be significant and have some relevance to life or real behaviour “(Patterson, 1983). A theory should provide explanation and deep understanding of actual events, behaviours, or the meaning making activities of stakeholders and respondents; and should be accepted by professionals and stakeholders who co-constructed the theory (Lincoln & Lynham, 2007).

- **Precision and Clarity** according to Lincoln and Texas (2007) of a theory should be understandable, internally consistent and free from ambiguities”

- **Parsimony and Simplicity** of a theory means that is the theory should be understandable to the general community that are not part of the scientific community narratively elegant, and conceptually rich, provocative and evocative (Lincoln and Texas, 2007).

- **Comprehensiveness** of a theory should be complete, including all known data in the local, regional field” (Lincoln & Lynham, 2007)

- **Operationality**, a theory can be useful to both professionals and common people in the sense that it suggests ways of being in the world or ways of changing one's circumstances in certain context” (Patterson, 1983; Lincoln, 1985; Lynham & Torraco, 2002).

- **Empirical Validity or Verification** addresses the concepts that a theory must be supported by experience and experiments, showing that observation, and some element of socially constructed life. Furthermore, developing both new social scientific knowledge, and new respondent learning (Gawronski and Bodenhausen, 2015).

- **Fruitfulness** addresses the aspect of theory as being capable to lead to predictions that can be tested and leading to the development of new knowledge (Lynham & Torraco, 2002).

- **Practicality** of a theory should be useful to practitioners in organizing their thinking and practice by providing a conceptual framework for practice and to the ordinary people in the sense that they propose new ways of being in the world or new ways of changing one's circumstances in a specific context, as well as high organizational performance (Lincoln, 1985)

7.8 STRENGTHS OF THEORIES USED IN A PROPOSED THEORY FRAMEWORK

Since this study aim is to determine policy impact and stream water quality practices on knowledge, attitudes and behaviour toward stream restoration practices in Umlazi Township, KwaZulu Natal, South Africa. Therefore, this research attempted to focuses on ontology approach using mixed method approach for integrating and triangulating different data sets and seeks to achieve scientific knowledge for the proposed theory framework (Heyvaert, Maes, & Onghena, 2013). Ontology looks at the central beliefs about the social environment and its relationship to individuals that a person holds. Ontological emergence to have the ability to develop between theories that have the same extension but different intensions, and between theories that have both different extensions and intensions (Quine,1951).

As Berger and Zelditch (1993) argued that a good theory should be made up of well-defined principles that are both functional and implementable. Clear and precise hypotheses are the hallmarks of good theories. A good theory should be straightforward, but simplicity is delicate, and we must exercise caution when developing simple theories. Since the world is so complicated, over-simplification can cause a theory to lose its meaning and validity. The theory development framework proposed attempted to be as practical as possible highlighting the importance of every

stakeholder's input and commitment towards attaining the goal of stream water quality restoration. The framework proposed took into account all levels of ecological models (individual; relationship; community; societal and; policy level) which usual lack the specificity about the most important hypothesized influences, but instead puts a greater burden on health promotion professionals to identify critical factors for each behavioural application. Therefore, this proposed framework is based on the concepts of HBM; SEM and adaptive management models constructs as part of triangulation approach allow for greater validity without a critical understanding of how different datasets interact, instead of using one theory.

In river management adaptive model argue that policymakers often perceive uncertainty analysis as a lot of even unnecessary work (Pappenberger & Beven 2006) though uncertainty occurs natural in policymaking. Again, adaptive management is influenced by people's role; believes and by change in policies. Therefore, the use of HBM fully explains the believe, knowledge and attitude of individuals in the study however this model lacks contextual factors as mentioned by Dreibel *et al.* (2013). Where a wide range of employees of the municipality and water management services were identified as part of the target population and this broad range of potential participants that required that a varied repertoire of participant recruitment strategies be used to minimise the potential for participant non-responsiveness but reduce uncertainties.

The HBM can help explain and predict health behaviours by measuring health beliefs; perceived susceptibility (likelihood of health problems like diarrhoea for self and close others); perceived severity (how serious is diarrhoea or polluted stream water); perceived benefits (pros of donating clean stream water), and self-efficacy (confidence that individual could keep stream clean if she or he wants to). Once perceived barriers and benefits have been identified, prompts to action are required, which may include exposure to a media message encouraging health action and clean stream water donation. SEM as intervention since it directly speaks to the environment, therefore SEM application can maximise IWRM and ESS benefits approach (White *et al.*, 2015).

Combining HBM and SEM is important in this study because in public health, behaviour is influenced by individual-level attributes of HBM includes beliefs, knowledge and attitude by conditions which people live important attribute or

determine of stakeholder's involvement (White, 2012). While SEM studies the interaction of human and the environment health behaviour resulting in behavioural change through knowledge of the population is influenced by altering physical environment (like restoration of stream) and improving conditions in which people live in yielding better public health outcomes are created through behavioural change (White *et al*., 2015). Involvement of all related stakeholders in this proposed framework will eventually reduce high uncertainties associated with the river management adaptive model argued by policymakers. The use of this proposed framework where all stakeholders are involved can capture the diversity of viewer interactions to the fullest extent possible (Johanson & Glow, 2015).

7.9 LIMITATIONS OF THE THEORIES USED IN A PROPOSED FRAMEWORK

Although the framework followed these guidelines of developing theory however, there were some limitations. The proposed framework although it dependent on citizens' knowledge, attitude and behaviour, however, it driving force is mainly dependent on the local and national authorities' actions, their effectiveness in policy implementation and enforcement. All theories used to develop this proposed framework agree that policy implementation is at a national level of the country cascaded to the local government, therefore, lack of previous experience and evidence of application of policy implementation and enforcement from these institutions can serve as shortcomings since the authorities' participants argued they have not even implemented the policies as yet.

7.10 PROPOSED SPECIFICATION FRAMEWORK FOR CURRENT STUDY

Rivers and streams flows connect people, places, and other forms of life, inspiring and sustaining diverse cultural beliefs, values, and ways of life. However, streams are heavy polluted mainly by humans, and humans are sick and also at risk to be sick especially children in the urban areas. According to Liu *et al*. (2016) and Bardsley *et al*. (2013) up to 1.8 billion people relied on unsafe water and were therefore at

increased risk of developing water-borne illnesses. The township of uMlazi, Durban South Africa is not immune to such health and safety susceptibility and severity. The infrastructure of this area has allowed majority of citizens of this area to have access clean water from the taps at home or from standpipes and flushed toilets. Despite the awareness campaigns initiatives of water scarcity in the country, rivers and stream water quality continues to deteriorate mainly due to human activities. In this area children under the age of 5 years were highly infected with diarrhoea disease; diarrhoea is a surface water-related disease usually present with *E. coli* contaminants despite the fact that this is one of the developed areas (DHPKZN, 2015). Umlazi continues to have a challenge of illegal sewer connections that flows directly to the streams. The stakeholders affected by these activities seems to less informed on the impact their behaviour has on the whole ecosystem and their survival as humans that continues to be threatened by water scarcity, floods and diseases. Parker and Oates (2016) believe SA river conservation programmes do not have a clear direction as to the question of 'what kind of social, economic, or strategic results does the program aim to support, and how can these be monitored'. This could have led to authority's lack of commitment on environmental law enforcement to mitigate this condition (Pride and Joy Consultants, 2015). Therefore, to fully comprehend the links between river health, ecosystem resources, and the numerous benefits and threats to society, a large amount of evidence from various disciplines must be assessed.

7.10.1 Strategic priorities that relate to the identification of benefits and risks factors associated with streams managements (utilisation) in urban townships

All stakeholders including local citizens must be aware of health and safety susceptibility associated with streams management. SA has relied on RQOs of the catchment classification and NCMP data policy to determine the maintenance of that catchment (DWAF, 2006; DWAF, 1996; RSA, 1998; DWS, 2018a; DWS, 2018d). The use of RQOs for surface water does not reflect the reality of the current use of rivers and streams in urban areas. According to the RQOs of urban areas, rivers and streams are mainly used for agricultural purposes (DWS,2018a). Yet, the studies indicated SA

rivers to be highly threatened such that estuaries of Embokodweni and Isipingo were closed due to high contamination of *E. coli* on the Isipingo River and Estuary were receiving raw sewage at rates ranging from 3.67 to 6.7 ML/day. (Pillay, 2013; Nel and Driver, 2015; McLean, 2016) and uMlazi River E. coli was up to 720 000 due to broken sewers in uMlazi township (Dicken, 2002; Sithebe, 2017). This shows that not all stakeholders especially the local citizens are aware of health and safety susceptibility associated with streams management.

7.10.2 All Stakeholders must be Involved in Identification of Benefits Associated with Streams Management.

Involving all stakeholders in the determining river health status through water quality testing such as using miniSASS; allowing them to be part of meetings and of decision making can help even local citizens to be active in being stewards of their local rivers and streams as they are aware of the benefits it brings. This will increase the adoption of water conservation behaviours, extension professionals should reinforce the behaviours they want people to continue by specifically targeting and providing support for people who engaged in landscape water conservation in the past especially in urban areas of developing countries (Anderson *et al*., 2019). All stakeholders must be involved in identification of benefits associated with streams management. Since rivers have the ability to benefit society in a variety of ways, including promoting key livelihood activities and economic sectors, fostering social connections and spiritual well-being, and contributing to strategic goals like food, energy, and water conservation, poverty reduction, and climate resilience. (Parker and Oates, 2016). Contributing to linkages between societal benefits and river health (Liu and Guo, 2018).

7.10.2 Training of Citizens on miniSASS and Improving Citizens Science is Necessary.

The type of surface water quality data collection methodology and its interpretation have an impact on stakeholders' knowledge, attitudes and behaviour practices. The

trend of water quality results in return, informs other policy regulations of that area. Also, the successful implementation and abiding of those regulations depends on and is determined by stakeholders' perception of its importance. There is a lack of guidance on interpretation of variables other than faecal bacterial indicators. As indicated earlier that about 64% of SA citizens said they do not see the need to change their behaviour even though there is water scarcity (van der Vyver, 2014). The participants were not able to make the connection between these areas and sustainable development.

Nel and Driver (2015) confirmed that seventy-nine percent of the respondents showed concern with the safety of the river as an issue. River safety included the presence of dangerous animals, polluted water, a lack of swimming ability (Cele, 2015). Also, the identification of macroinvertebrates poses perhaps the biggest problem to the miniSASS user, particularly in differentiating between mayflies, damselflies, and stoneflies. This may result in unreliable results if the general public is adding the data themselves making training of citizens necessary (CDM Smith, 2016).

7.10.3 Translation of RQOs Terminology to an Easier One is Needed.

A concentration on the issues that matter most to all decision-makers, as well as the use of terminology they understand, would be much more beneficial than a sole focus on river health or even ecosystem services. South Africa has developed the RQOs as a tool that aims at the sustainability of river and stream but also look at the social and social benefits of the community. Yet this brilliant RQQs application is not known by citizens. Citizens can be at a risk of being victims of streams unacceptable condition ratings from the PES or from RQOs or could be the overexploitation of the threatened species or could be polluting the streams with other human activities that can either affect them health wise or effect or pollute the species (Nel and Driver, 2015; DWS, 2018a). RQOs of Umlazi and Embokodweni rivers at a tertiary catchment level of Mvoti to uMzimkhulu WMA indicated that E. coli and coliforms to meet recreational use targets (DWS,2018a). Yet, Health River Programs have not yet included E. coli results

in their local river and streams, this affect the interpretation of these environmental measures by the community members. The community members can unknowingly interpret their local RQOs as safe and at an acceptable range, yet the opposite is true (Dicken, 2002, Sithebe, 2017). Nel and Driver (2015) also argued that individual ecological condition indicators used by DWS to assess the PES of rivers in 1999 and again in 2011 is more difficult to communicate with the target audience such as national politicians or civil society that are not experienced in river ecological condition and spatial analysis still used to date as part of RQOs (DWS, 2018a; DWS, 2018d).

7.10.4 Feedback to all Stakeholders is Important to Minimise Stream Water Quality Deteriorations.

Transparency and participation in decision-making processes are essential for addressing equity problems and promoting the interests of disadvantaged or marginalized communities to those in positions of power and influence is required otherwise, ambiguity of uncertainty increases as stated in FSB influence role (Bandura ,1977). In the framework that highlight complexity in relationships between river health and societal benefits, constant feedback will play a big role where there are number of uncertainties. Overexploitation of ecosystem resources, such as fisheries, has a detrimental impact on river health, and can lead to negative ecosystem destruction if not carefully controlled. In turn, the wider governance context, which is increasingly changing, determines the management and usage of river ecosystems and their services. The likelihood of future socioeconomic transition trajectories is high uncertain (Stankey *et al*., 2005). As the iterative decision-making approach is usually used due to a lack of information on river management well suited for uncertainties like environmental variations (Virapongse *et al*., 2016).

7.10.5 Strategic Priorities that Influence Environmental Policy Compliance as Applied to the Constitution and each RQOs of the Local Rivers

Policy makers should be fully aware of the opportunities cost and trade-offs involved in stream water quality restoration practices. Policymakers, on the other hand, are often unaware of the opportunity costs and trade-offs involved, as well as the alternatives available, such as investing in more "normal" solutions. According to WHO (2018), the lack of data on virtually all aspects of water quality and wastewater management, especially in developing countries, is one of the challenges in monitoring SDG Target 6.3 indicators. In both the public and private sectors, reliable data should provide social, economic, and environmental benefits because they can underpin activism, promote political engagement and investments, and inform decisions making in al level improving SDGs targets (IRP, 2019). Targets and goals need to be tracked and evaluated using a collection of global metrics, but each country must identify its own national goals for wastewater treatment and water quality (UNEP, 2016). A noted earlier, also SA river conservation programmes does not have a clear direction as to the question of ‘what kind of social, economic, or strategic results does the program aim to support, and how can these be monitored ‘and this need to be improved (Parker and Oates, 2016).

7.10.6 Accurate and Updated Scientific Data in the Local Area to Avoid Data Duplication is Needed

Rivers bring individuals, places, and other modes of life together, inspiring and preserving a wide range of cultural traditions, values, and lifestyles. The definition of environmental flows provides a basis for better understanding and promoting mutually beneficial relationships between river flows and people (Anderson *et al*., 2019). Accurate and updated scientific data in the local area is needed to meet global indicators. Since there is a gap in policy implementation even when using the international recognized models like IWRM and ESS to mitigate global threats of water scarcity and pollution. SA uses the IRMW approach in river management is at the National scale of 1:500 000 which does not consider local rivers; hence this approach

is not effective in uMlazi rivers. SA also uses, South Africa's NSSD uses SDG as guideline for its strategic benefits in the implementation of healthy stream water restoration to improve sustainable development. However, this NSSD that is more equivalent to the ESS approach lacks environmental data. Moreover, data-driven approaches are moreover criticized for lacking theoretical foundations (Operations Phakisa, 2014; DEA, 2014; DWS, 2017).

7.10.7 Accurate and Updated Scientific Data at the Local Area is Essential for Disaster risk reduction

According to Rowes and Smithers (2018) and Rabba *et al*. (2018), catchment measurement for floods and water resources is poor or non-existent in SA. Lack of knowledge or correct information of river or stream inflow can help in predicting disease spread in case of outbursts or flood disaster that is if the river or stream is too polluted. Citizens can be advised to relocate from that risk area. Such data lack of network of tiny streams that feed into tributaries that are not reflected in the 1:500 000 river network used in SA (Nel and Driver, 2015). Rowe and Smithers (2018) and Buytaert *et al*. (2014) assert that the application of the flood model and perception of stakeholders, citizen science of lack of knowledge on water consumption must be improved.

As stated previously that SA's stakeholders' perception on flood risks, water consumption and scarcity is poor misunderstood by citizens in citizen science (Buytaert *et al*., 2014; Rowe and Smithers ,2018). Therefore, WQI approach must be improved and show transparency to all citizens (Rodda *et al*. ,2016). Public buy-in and awareness are highly recommended by participants to impact stakeholder's perception, belief, and attitude. Lack of information on floods and drought impact at a local level can cause a role's ambiguity between balancing between public rights and obligations versus responsibilities (Rodda *et al*., 2016).

7.10.8 Reduction of Silo Mentality within the Municipality Departments and Government is Required

Parker and Oates (2016) maintain that despite their ability, rivers are frequently used to achieve a limited set of goals, to the detriment of river health and other human needs. This is largely due to the fact that river and ecosystem management has continued to occur in silos, with weak cross-sectoral cooperation and a lack of coordinated planning, and has often been motivated by political expediency, resulting in suboptimal results. Allan and Pahl-Wostl, (2013), Nel and Driver (2015) believes that most efforts have concentrated on the issue of water quantity, ignoring other primary river health characteristics, and most approaches have failed to address mounting anthropogenic pressures on rivers of a local level participants. As stated earlier, these challenges are caused by bureaucratic problems around complicated intra-departmental processes in government departments which include a lack of communication between chief directorates, inaccessibility of information, an overload of rules and regulations and a lack of funding in certain areas (Nel and Driver ,2015). Although DWS (2017) maintains that water quality despite receiving less funding, scientific support, and public interest, is just as vital for meeting basic human and environmental needs. On the plus side, researchers and practitioners are calling for reform, and multi- and transdisciplinary approaches, including the creation of new decision-support methods, are becoming more common (DWAF, 2004; RSA, 1998; DWAF, 1996; DWS, 2017).

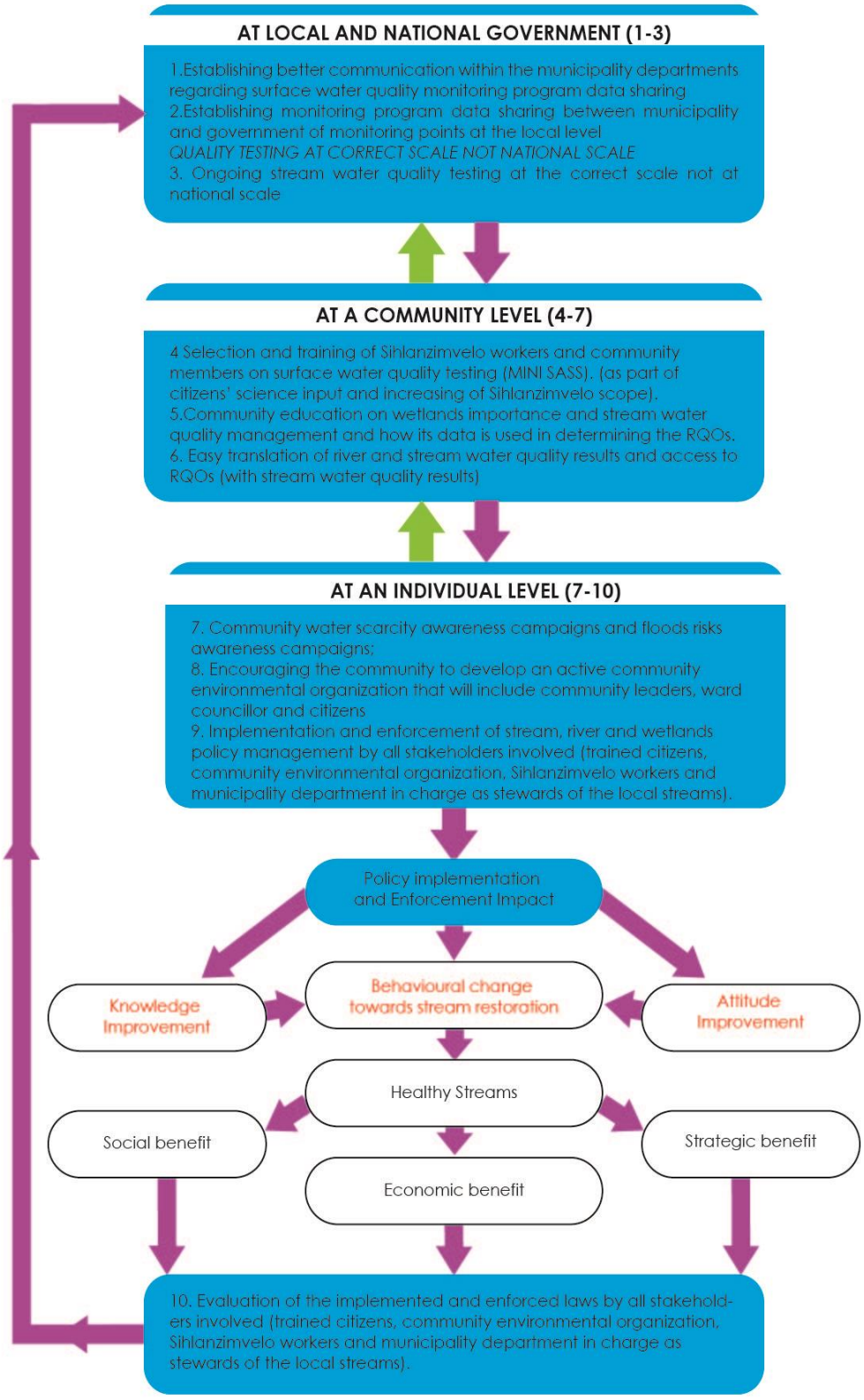
7.10.9 RQOs must be Implemented and Evaluated by Putting Humans at the Centre of the Framework

The report from DHPKZN (2015) confirmed that 2 175 children under the age of 5 years old were admitted due to diarrhoea disease in the uMlazi and Ngonyameni area in 2011 and this number increased to 2 716 in 2015. While DWS (2018a) agreed that there is deficient implementation of RQOs, that the RQOs currently have no guidelines for the implementation of RQOs. Therefore, the policymaking and priority of development programs need to consider the existing situation, condition, characters,

and local potentials that are reflected from their environmental carrying capacity (Harring *et al*., 2017).

7.10.10 Encouraging Community Organization Formulation

Development of community organization is essential as stated by Thunström *et al*. (2014) both internal pressure (“guilt”) from causing harm to the environment as well as external pressure to conform to the social norm for pro-environmental behaviour. Therefore, Hobfoll *et al*. (2015), some of the resilience measures that should be considered include community based environmental organisation that will enhance the ability of a person and a community to cope with, grow through, and transcend adversity.



. **Figure 58. Proposed Framework Development**

The proposed framework model: the first 9 steps are part of knowledge objective for authorities. The implementation and enforcement of these policies are intentions of the authorities. Then begins the first knowledge objective for citizens (which will include stream water quality testing and awareness, miniSASS). This must be followed by citizens' intentions (community organizations formation). Then attitude change objective. Then behavioural change objective will occur. Then behavioural changed must be monitored by all (step 11 of the framework). Since attitude cannot be correlated significantly with behavioural change unless intentions (policies) are included. Unless proper knowledge is given, no desired behavioural change will occur (especially in terms of police adherence) (Ajzen *et al*.,2011). This will eventually improve the relationship between policies and knowledge, resulting in health streams that can benefit all stakeholders socially; economically and also strategically. Where social benefits that make a difference in the lives of individuals and societies, as well as society's proper functioning (Fisher *et al*., 2014). Economic benefits can overlap to social well-being that contribute to the country's economy and create jobs (Parker and Oates, 2016). Strategic benefits contributing to poverty reduction and economic development, the water-energy-food security nexus, disaster risk reduction (DRR), and climate resilience are some of the issues that need to be addressed.

7.11 RELATING TO EXISTING UNDERSTANDING

The framework with the multi-disciplinary approach of including all stakeholders involved in RQOs achievement attempt to cross the gap between two disciplines: ESS and their valuation, with an emphasis on ecologists and environmental economists, and IWRM, or water protection approaches, which engineers and other water sector practitioners prefer by using HBM; Adaptive management and SES model. To understand how and by whom gains are realized, rely on the social sciences and political economy thinking. On a practical level, recognizing that putting the human at the centre of the study would have influence over decision-makers would be beneficial and will focus more on reduction of water scarcity and pollution as opposed to putting ecosystems at the centre of the investigation which would cause to have less power with decision-makers than a focus on social and economic outcomes.

As stated earlier, theory should provide explanation and deep understanding of actual events, behaviours, or stakeholders' and respondents' meaning-making activities; and it should be agreed by experts and stakeholders who co-constructed the theory (Patterson, 1983). Using theories that are clear and understandable, internally consistent and free from ambiguities to all stakeholders can allow local citizens to be useful part of scientific research tool between theory development and research; participate in making informed decision making Lincoln & Lynham, (2007); in the reducing in uncertainties; reducing the health and safety susceptibility and severity associated with stream current condition in their community as they understand the impact of their behaviour towards stream water quality restoration practices (White *et al*., 2013).

7.12 PURPOSE OF THE CONCEPTUAL FRAMEWORK

There is a gap in natural resources policy implementation and enforcement particularly that of surface water protection and usage globally yet, there is strong evidence that behaviour and environment are responsible for over 70% of avoidable mortality (Institute of Medicine, 2001). The interplay of acts that improve wellbeing is better understood at the group level, in terms of how people live, what influence they have over their health conditions, and how this is promoted at a community level (White & Nanan ,2008). Lack of planning, dirty crowded street and lack of public health services at a community level cause health risks and eventually affect the economic and social policies.

Since river policymakers are tasked with a variety of duties, some of which are at odds with one another. They must devise strategies that will last a long time. In their policies, they need to find a compromise between the needs of various actors and multiple river functions such as navigation, drinking water supply, environmental development, recreation, and flood risks. Flexibility is important in fitting the initiative to particular settings, that is, avoid one-size-fits-all assumptions, at the monitoring and assessment stage This will aid implementers in better understanding how contextual variables like politics, sociocultural norms and values, and the fiscal climate will affect anything from replicability and adaptation to potential success of scaling-up (Yamey ,2011).

However, there is a gap in policy implementation even when using the international recognized models like IWRM and ESS to mitigate global threats of water scarcity and pollution. SA uses the IWRM approach in river management is at the National scale of 1:500 000 which does not consider local rivers; hence this approach is not effective in uMlazi rivers. Moreover, the IWRM that is suppose to use public participation to determine RQOs of the local rivers is less understood by local citizens as indicated in figure 23. SA also uses, South Africa's NSSD uses SDG as guideline for its strategic benefits in the implementation of healthy stream water restoration to improve sustainable development. However, this NSSD that is more equivalent to the ESS approach lacks environmental data. Moreover, data-driven approaches are moreover criticized for lacking theoretical foundations (Operations Phakisa, 2014 and DEA, 2014).

This chapter's conceptual framework is focused on the scoping analysis, specifically recent developments when considering ecosystem processes and roles, as well as human well-being (Parker and Oates, 2016). The framework is the product of the evidence's organization of the impact policy on humans' knowledge, attitude and behaviour towards stream water quality restoration practices that eventually impact the provide a tool for further study and program design by presenting interactions between river health and societal benefits in an open format. Although recognizing the nuances of these relationships, they are represented in relatively simplistic terms. Much more information can be added to the conceptual diagram on knowledge, attitude and behaviour; specific streams benefits, was illustrated in the in chapter two to chapter five.

The framework attempt to reconcile two disciplines: ESS and their valuation, with an emphasis on ecologists and environmental economists, and IWRM or water protection approaches, which are preferred by engineers and other water sector practitioners, by employing HBM; adaptive management, and the SES model. To understand how and by whom gains are realized, rely on social science research and political economy analysis. On a practical note, acknowledging that placing human at the centre of the analysis will have power with decision-makers and will focus more on reduction of water scarcity and pollution as opposed to placing ecosystems at the centre of the analysis which would cause focusing on social and economic consequences has less clout with decision-makers.

7.13 ADVANTAGE OF THE PROPOSED FRAMEWORK

Stakeholders training on stream water quality testing and interpretation of relevant RQOs and WQI terminology for citizens especially will help improve relevant stream data in return allow citizens improve their knowledge, attitude and behaviour towards streams restoration.

7.14 UNEXPECTED ISSUES THAT ARE LOOKED AT WITHIN THE FRAMEWORK

Lack of previous experience and evidence of application of policy implementation and enforcement improvement from these institutions can serve as shortcoming since the participants from municipality argued they have not even implemented these policies as yet.

7.15 DISADVANTAGE OF THE PROPOSED FRAMEWORK

Application of policy implementation and enforcement will take time due lack of relevant data; lack of previous training and experience from all stakeholders as indicated in chapter 5 and chapter 6. This will prolong the surface water quality restoration of streams that is currently deteriorating at a fast past and affecting all stakeholders' social; economic and strategic benefits.

7.16 LIMITATIONS / CAUTIONS ABOUT THE USE OF THE THEORY

A full the political economy examination. The context in which the program is being introduced will help determine who the powerful players are and what their interests are, as well as the role that access and entitlements play in allowing various groups to

benefit from the river and the consequences for how benefits are distributed.as ward councillors were perceived to have their own agenda.

7.17 FURTHER DEVELOPMENT BY FUTURE RESEARCHERS

The evaluation of impact of current streams water quality results in RQOs determination; and in the sustainability of streams ecosystem. The evaluation of impact of current streams water quality on the air quality of the area.

7.18 CONCLUSION

River ecosystem management needs a more inter-disciplinary approach and reclaiming the "water market" from the periphery to the centre of attention policymaking. Local stakeholders especially the citizens are more attached and easily affected by the streams condition and changes. Therefore, more investment on understanding the perspective of local stakeholders regarding the importance of maintaining the streams clean in their community, this must be followed by the initiatives to improving stakeholders' knowledge, attitude and behaviour in restoring the stream water quality before policy makers design programmes that deals with closing the gaps between IWRM and ESS. The surface water protection and usage policy implementation and enforcement can be effective and addressed thereafter.

The following chapter presents the literature review's conclusions and guidelines, as well as the primary research findings.

8CHAPTER EIGHT

CONCLUSION AND RECOMMENDATIONS

8.1 INTRODUCTION

This final chapter offer a summative overview of the entire study and provides a chapter-by-chapter summary and discussion of key observations, debates and issues that warrant further exploration. A consideration of limitations of the study, findings, and recommendations for future empirical work will be made. The primary aim of the study was to carry out an analysis of the influence of policy and water quality practices on identified stakeholders' knowledge, attitudes and behaviour toward stream restoration practices in Umlazi township, KwaZulu Natal. To achieve this purpose, the researcher employed a sequential mixed method design mixing both quantitative and qualitative research (or data) in a single study or series of studies to understand a research problem. The study also aimed at developing a knowledge, attitude and behaviour modification framework / recommendations that support stream water quality restoration practices. Thus, a model framework on the impact policy on humans' knowledge, attitude and behaviour towards stream water quality restoration practices as outlined in chapter 7.

Within the proposed mixed method study, data was collected via a Three-Phase empirical study, as illustrated above. This included data collection will be followed by a combination of individual interviews and focus group discussions (Phase 1) which explored the perceptions of purposively sampled community members, employees of the water management and waste management departments about their knowledge, attitudes and behaviours as they relate to stream water management and how their health beliefs may impact behaviour. This phase included individual interviews (n=25) and focus group discussions (n=2). Phase 2 which involved a quantitative self-complete questionnaire administered via a combination of door to door and online survey formats (n=190). Phase 3 involved model /framework development in the corrective-framework

Umlazi has double disease burden of TB and diarrhoea, moreover, the socio-economic status of Umlazi is not good and susceptibility is closely linked to socio-economic status and has the most adverse effects in South Africa's impoverished communities (SSA, 2011; DHPKZN, 2015; SSA, 2016b). Regarding stakeholder's

knowledge on health and safety risks and susceptibility, almost stakeholders perceived the stream current condition as a threat to their health and safety and 48,9% of the citizens perceived the condition of the streams of Umlazi to be poor and 35,2 said the stream condition was worse. Majority of the stakeholders believed that citizens still continue to contaminate the streams directly and indirectly through illegal dumping, illegal sewer pipes that discharge directly to the stream, yet, citizens still use streams for various purposes such as building, irrigation and children swimming purposes.

From the findings, few citizens seem to value the stream water quality restoration as they may not identify themselves with nature as they are less dependent on it when it comes to water supply of drinking and household activities because of water and sanitation infrastructure available since this is a township however they rather concerned about the streams condition due to their health concerns as this was the case with both focus and interview findings the main fear was people's health not because of the environment. However, citizens failed to perceive that their behaviour and human activities contribute to their well- being both health and safety wise.

Authorities have acknowledged that they have not implemented, and enforced laws related to surface water management and perceived implementing these laws as a difficult task. Citizens indicated that they do not fully understand the laws that govern surface water management. Also, the majority of community members said they do not see the need to change their behaviour even if the laws are implemented and enforced. All stakeholders agreed that there is no data related to stream water quality in this area.

In addressing this gap the framework development, lack of consistency on surface water quality policy implementation and enforcement methodological variations by professionals in ESS and IWRM gap; impact of ESS or stream benefit knowledge on citizens; lack of pro-environmental behavioural impact on IWRM and; environmental social disapproval attitude and behaviour impact on IWRM were discussed using HBM, SEM and adaptive management models as theoretical foundation for the highlighted findings of this study.

8.2 THE PURPOSE OF THE STUDY

The aim of this study was to determine policy impact and stream water quality practices on knowledge, attitudes and behaviour toward stream restoration practices in Umlazi Township, KwaZulu Natal, South Africa. By conducting an initial assessment of identified stakeholders' knowledge about stream water quality policy and practices; conducting an initial assessment of identified stakeholders' attitudes about stream water quality policy and practices; assessing the identified stakeholders' behaviours in response to about stream water quality policy and practices in Umlazi Township, KwaZulu Natal, South Africa. Lastly, developing a knowledge, attitude and behaviour modification framework / recommendations that support stream water quality restoration practices.

8.3 RESEARCH DESIGN

Since this study aim is to determine policy impact and stream water quality practices on knowledge, attitudes and behaviour toward stream restoration practices in Umlazi Township, KwaZulu Natal, South Africa. Therefore, this research attempted to focuses on ontology. As ontology looks at the individual's core values about the social environment and its relationship to other individuals. Ontological emergence to have the ability to develop between theories that have the same extension but different intensions, and between theories that have both different extensions and intensions (Quine,1951).

Interviews and focused group tools were used first to collect data of the municipality departments and Sihlanzimvelo participants under the heading of exploratory design. The benefit of using interviews as a research method was that it allowed for more in-depth testing of research theories as well as insights into the attitudes and behaviors of those interviewed (McMillam and Schumacher, 2010). For focused group, Freitas et al. (1998) believes that focus group discussion research tool is vital to understand about what people think, feel and how they behave when supplied with information and the findings from this exercise can be used to formulate prevention programs. The

survey method was used on community members in this study to validate the interview and focus group findings. Questionnaires as a research instrument designed to test attitudes and perceptions of subject evaluated or researched (Pilapil-Pelones, 2011). This study was limited to simple random and stratified probability sampling. Lastly, the model /framework development was conducted a set of recommendations.

8.4 SUMMARY OF KEY RESEARCH FINDINGS

8.4.1 Demographic information

8.4.1.1 Qualitative Demographic information

The demographic data was not directly pursued as part of data collection of the study. However, the quantitative data obtained gave the researcher an overview of the profile of the participants' knowledge, attitude and behaviour towards stream restoration practices. The different municipality stakeholders all were graduates in engineering fields and some in education and environmental studies with more than 5 years' experience in their departments and in being part of Sihlanzimvelo projects. While the Sihlanzimvelo participants were all Umlazi residents, mostly the owners of the co-operatives that also had more than 5 years' experience in stream management of their area.

8.4.1.2 Survey Demographic information

All the participants were black South Africans, 53,7% participants between the age of 25-40 years with 67,9% being females. 47,4% participants live in four-roomed or formal dwelling only 18,9% participants that live in the informal dwellings. Majority of 72,1% of these participants are living with their parents and 55,3% that live near the streams. 55,3% of the participants live near the streams. 24,2% of the participants have lived in this area between 11-15 years, followed by 20,0% that have lived in this area above 30 years and 19,5% that have lived in this area between 6-11 years. stayed in this area more (Figure 52 to figure 62).

Poor knowledge, attitude and behaviour of citizens towards stream restoration practices yet, 67,4 % of the household head occupational status of the citizens was unemployed can make citizens to be more vulnerable and more dependent on natural resources even if there are health and safety risks involved. According to Maldonado, Colombi and Pandya (2013) communities with a shortage of capital, both physical and financial, are more vulnerable to climate change. Although indigenous communities' residents are often reliant on natural resources to make a living and live in area that is geographically vulnerable (Cunsolo *et al*. 2014). Climate change has the potential to impact nutrition and food safety by lowering crop yields and reducing the amount of food available, since families lose income, food quality is reduced, distribution networks are disrupted, and access to food is reduced (Ziska, Crimmins, Auclair, DeGrasse, Garofalo, Khan, I. Loladze, Pérez de León, Showler, Thurston, & Walls, 2016).

Although, 72,1% citizens indicated that they live with their parents and friends, yet they indicated that 76.3% that believed children are more vulnerable to health and safety risks but instead they continue use the stream and benefit from it water for various activities even children swimming. According to Weine *et al*. (2014) though, the support of family and close relationships is especially important for children.

Stakeholders were adults yet majority lack knowledge regarding policies that govern stream management, yet Lazarus *et al.* (2002) emphasized that after natural disaster events parents and caregivers are suppose to be role models and have more knowledge than their children.

8.4.2 Qualitative findings

8.4.2.1 Knowledge

8.4.2.1.1 Professionals lack of local and current water quality data of streams and rivers put stream workers at health and safety risk

According to Severtson *et al*. (2006) knowing the water condition data could help

participants with higher arsenic levels had stronger beliefs about identifying personal risk. Yet, all Sihlanzimvelo participants, assessors and consultants highlighted that they have not received any training of stream water quality testing although, they work in the streams daily and put their lives in danger on a daily basis as they do not even know how dangerous the water quality of the streams they are working on since they do not have any results of stream water quality, no knowledge of how to test the water quality of the streams they are working on. This lack of local current water quality data was verified by the municipality departments. Therefore, lack of consistency on surface water quality and lack of policy implementation and enforcement methodological variations by professionals in ESS and IWRM gap put those working at the streams more at risks of contracting diseases and being physical dangers.

According to William (2011); Nel and Driver (215) monitoring of streams and rivers is not functional at a local level as there is a shortage of data at this level. Highlighting the impact of lack of consistency on surface water quality methodological variations by professionals that contributed to gap between ESS and IWMR water security concepts.

8.4.2.2 Attitude

8.4.2.2.1 Citizens bad attitude and mind-set shows social disapproval towards environmental restoration

From Sihlanzimvelo perceptions, barriers to management of streams was divided into three main theme categories: citizens' actions as barriers, working condition as a barrier and, municipality departments as barriers. These highlighted barriers were validated by municipality departments participants. Both Sihlanzimvelo and municipality departments highlighted that citizens poor behaviour was as a result of citizens' poor attitude, mind-set and poor knowledge. Hence, people or citizens were perceived as the main barrier against maintaining streams clean, as they continuously contaminate the streams directly and indirectly. All Sihlanzimvelo participants indicated that the stream is used as a nappy depot to dump nappies (pampers) and that this is one of their main challenges as these nappies are thrown at them

sometimes while they are working. Hence when workers are trying to clean, they are attacked by getting nappies thrown at them as previously explained. Participants indicated that citizens even threaten to harm them with knifes if they try to discipline them not to litter and say that participants should remove waste from DSW, especially during strike from DSW". Catchment and Roads participants believed that for citizens to change their mind-set education to instil that culture and change their mind-set is required as citizens say they litter because they are creating job opportunities. Moreover, the community members were observed to undermine both Sihlanzimvelo workers and the municipality departments itself.

8.4.2.3 Behaviour

8.4.2.3.1 Authorities Strategic Ignorance Behaviour Practice

Knowing about water related risks without implementing and enforcing laws to mitigate these risks will not encourage behavioural change, instead can be considered as strategic ignorance practice, since ignorance is a state of denial (Douglas, 1986). Municipality departments were perceived to be responsible for most of these working conditions, as they were perceived to be lazy and lagging in resolving the reported issues, and these findings were all acknowledged by the municipality departments. Included in the challenges faced by Sihlanzimvelo workers include dead bodies of children, animals near and inside the streams were encountered by the Sihlanzimvelo workers during work. Also, there was an issue of sewer busts and dangerous animals like snakes associated with these working conditions due to small scope of the project. That due to these conditions they have a challenge of changing workers every time due to unsafe working conditions and lack of providing them with PPE every two months, because when these workers decide to leave, they take the PPE with them.

Streams were perceived as a place where diseases and physical damage occurs affecting both communities and the Sihlanzimvelo workers. Moreover, not knowing the stream water quality status of these streams, we work under is even a great challenge that create more panic and stress (Neria & Schultz, 2012). The Sihlanzimvelo co-operatives said they do not have enough resources to supply their workers with

Personal Protective Equipment (PPE) every time due to low budget allocated to them by the municipality. The other main barrier of Sihlanzimvelo was multiple job functions like carrying wet waste for a long distance without the assistance of trucks as DSW does not pick up wet waste. Municipality departments as perceived as responsible for most of these working conditions, as they were perceived to be lazy and lagging in resolving the reported issues. Despite knowing these conditions, municipal department have not done anything to reduce risks, not even educating community surface about water quality on how it impacts IWRM. While, IWRM is important in regulating social demands and pressures on resources or water security. Even though in SA the procedures that determines RQOs involves implementation, monitoring and review the process continuously must comply with IWRM practices which requires standardization of water quality (DWS, 2014).

8.4.2.3.2 Authorities Lack of pro-environmental behavioural impact on IWRM

A theory should provide explanation and deep understanding of actual events such as water security, behaviours, or the meaning-making activities of stakeholders and respondents; and it must be accepted by practitioners and stakeholders who collaborated on the theory's creation (Patterson, 1983). Yet, municipality participants perceived policy implementation and enforcement as difficult, although policy implementation is a required tool in methodological variations on professionals to mitigate natural resources degradation (Pappenberger & Beven, 2006; Dabrowski et al., 2017).

Gawronski and Bodenhausen (2015) believe it is important to use theories that are significant and have some relevance to life or real behaviour (Patterson, 1983). Yet authorities have not taken any initiative to do educational campaigns that address and link surface water management to current water security of the country is lacking resulting to poor impact on IWRM. Although, the beta coefficients (0.168) for policies suggest it has the biggest influence in predicting behavioral change towards stream restoration. However, the current river framework models, theories and programmes variables used to mitigate the surface water scarcity and pollution is not easily understandable to the citizens surrounding the streams and rivers. This behavior from

authorities highlight a lack of pro-environmental behavioural on IWRM since authorities are aware about water related security risks but have not indicated any intentions to implement and enforce laws to mitigate these risks.

8.4.2.3.3 Silo mentality and poor communication behavioural practice within local and national government departments

Although municipality departments were perceived as the third main barrier against keeping the streams clean. However, there were also challenges faced by each department in running Sihlanzimvelo Program. The Silo mentality and lack of communication between departments was the main barrier perceived by municipality departments that makes Sihlanzimvelo project to be a complex project as it includes departments like: Roads; Catchment; Parks; Health and DSW, but not all of these departments are active in the project. Catchment municipality participant also highlighted that ward councillors have their own agenda and want municipality officials to get a political buy-in for stream cleaning. The participant believe that people listen to their leaders and do not want to act against their leaders will be because they depend on him or her for resources.

Forceful placement of informal settlement and slums were perceived as a barrier, as the demand for new housing grows at a rate faster than houses that can be provided by local government. This make it hard for them as active participants as of Sihlanzimvelo to have effective results on managing streams. Therefore, involvement of all departments such as Human Settlement is crucial during the inception of the projects especially on the environmental sensitive areas and this is currently limited.

8.4.3 Quantitative Findings

8.4.3.1 Knowledge Perception

8.4.3.1.1 Citizens have a good knowledge understanding on health and safety susceptibility and severity associated with stream current condition

Since, Umlazi has double disease burden, moreover, the socio-economic status of Umlazi is not good while diarrhoea susceptibility is closely related to socioeconomic status and has the most negative consequences in deprived societies in South Africa (SSA, 2011; DHPKZN, 2015; SSA, 2016b). From susceptible and severity of diseases findings, participants perceived: Cholera; *E-coli*; Malaria; Diarrhoea; Bilharzia; TB and chest related diseases; Skin rash on people and children as main diseases. Other risks besides diseases that were associated with streams current conditions included: floods; dangerous animals like snakes; mosquitoes. The worst perceived risks extinct wildlife; being sick to death; Vibrio pathogens in fresh water, surface water and food causes human health and economic losses. Therefore, knowledge of stream water quality is important to those affected by it is important as knowledge even in the form of education is one of the good tools in changing negative environmental behaviour of students in a school community (Farrow, Grolleau & Ibanez, 2017).

The streams current condition was perceived as a threat to citizens' health and safety, 48,9% of the citizens perceived the condition of the streams of Umlazi to be poor and 35,2 said the stream condition was worse.76.3% citizens believed children are more vulnerable to health and safety risks and 74.2% believed that citizens that live near the streams are more prone to risks associated with stream conditions than this that are far. According to Morii et al (2008) health issues like mental status depression and cardiac arrest within 30-60 minutes occurs with exposure to sewer gas concentrations above 500 ppm. Moreover, those with asthma or respiratory conditions such as chronic obstructive pulmonary disease (COPD) are more vulnerable to poor air quality. Yet, 77,4% also believed the stream has an offensive smell and, sewer illegal connection and pampers, were the main factor of bad smell emanating from the river. However, the exposure to sewer gas can cause the health and safety severity.

8.4.3.1.2 Citizens have poor self-efficiency regarding stream water quality testing

Regarding the knowledge about stream water quality status and ability to do the water testing, however, 75.8% participants believed that citizens do not have the ability to conduct stream water quality testing. The findings highlighted that there is an inversely relationship between knowledge and behaviour. The inverse relationship was mostly influenced by stream water quality management knowledge and it's adhering policies, not from health and safety susceptibility and severity on humans with majority of participants of 74,2% that agreed they are other health and safety risks besides diseases to those that live near the streams.

Moreover, there were no community organisation in this area, and this could be as a result of poor information. According to Ajzen et al. (2011) maintain that People distrust members of outgroups, investors succumb to "irrational exuberance," and a nation's leader embarks on misguided policies when they are ill-informed then individuals act beyond detrimental lifestyles. As, 68.9% indicated that there is no municipality initiative and 0.5% said they do not know. Only 30.5% confirmed that there is a municipality initiative that treat and manage streams. From this 30,5% Sihlanzimvelo project was the only mentioned initiative by the survey participants.

8.4.3.1.3 Citizens have poor knowledge regarding stream water quality status of their area

Up to 93,7% of citizens said they do not know what is meant by RQOs and WQI, yet guidance of these facts helps in decision-making of how stream water will be used by the community and maintained and highlight the water quality of that particular surface water. Yet, Delzendeh *et al.* (2017) maintains that both education and policy implementation are the tools in changing negative environmental behaviour of students in a school community. However, the self-efficiency and water quality testing knowledge is lacking in this community.

8.4.3.1.4 Citizens have poor knowledge on policies regarding streams management policies of their area

Although stakeholders' perception is important because it determines if there might be a gap between intention such a policy formulation and adhering to that regulation which is the actual action will be closed (Bagozzi & Yi, 1993). From the findings, 65.8% of the citizens in the survey argued that they do not know if the community understand the policies and laws that govern streams management. Only 9,5% citizens believed that community members know and understand these policies (Figure 30). From the 9,5% that said they understand and know these policies, when they were asked to state and elaborate some of these policies in a follow-up question, non-stated any policy. Bagozzi and Yi (1993); Mohiuddin *et al*. (2018) maintains proper formulation of intentions by proper planning, accurate details and indication of proper start date of that action can decrease gap between intention and actual actions.

8.4.3.1.5 Poor formulation of policy implantation and enforcement resulted in lack of behavioural change towards stream restoration

Although, the beta coefficients (0.168) for policies suggest it has the biggest influence in predicting behavioural change towards stream restoration. only 3,2% citizens confirmed that policies are effectively implemented ad enforced. 66,3% of the citizens said they do not know if these policies are effectively implemented ad enforced and, 30,5% citizens believe that these policies are not effectively implemented and enforced. Agreeing with Pride and Joy Consultants (2015) findings from eThekwini Municipal Services where citizens perceived poor performance of the eThekwini municipality in limiting pollution of rivers and wetlands with average of 3.19 from the community's assessment.

Furthermore, 63,7% survey participants indicated that even if these policies are effectively implemented and enforced, they do not know if these policies would change their behaviour towards stream restoration practise and, 22,1% said no the implementation of policies will influence them, only, 14,2% said that enforced laws will

change their behaviour. Lack of consistency on surface water quality policy implementation and enforcement methodological variations by professionals in ESS and IWRM gap contributing to the attitude and behaviour of citizens. Poor formulation of policy implantation and enforcement resulted in lack of behavioural change towards stream restoration.

8.4.3.1.6 Lack of proper knowledge causes no behavioural change

However, according Ajzen *et al.* (2011) we can only function efficiently to achieve desired results if we are well educated. This article of faith is frequently used to justify a variety of harmful lifestyle choices. People consume an unhealthy diet and don't exercise enough, indulge in unprotected sex, misuse drugs and alcohol, refuse to protect themselves from the sun's harmful rays, and pollute the environment because they are uninformed or misinformed. From the findings, 29.9% citizens believed that citizens use between 11-20 litres of stream water for irrigation. 20.9% believed that citizens use 20-50 litres. 25.1% believed that citizens use stream for swimming purposes, followed by 19.3 % that perceived stream water is used for building purposes. Therefore, establishing the level of health and safety susceptibility and severity knowledge associated with stream water quality and stream management policy standards knowledge, Citizens that scored" good" knowledge was 47,9% and 52,1% scored "poor" knowledge.

8.4.3.2 Attitude

8.4.3.2.1 Citizens have bad attitude

When participants were asked the reason that led to this stream poor condition, citizens' poor attitude was rated as the highest reason that led to this condition with 30%. Also, ignorance towards stream water quality management was considered to be the attitude citizens with 45.3% instead of poor knowledge with 17.9%. 29.5% believe that the citizens attitude is negative and 19.5 % believe that this attitude needs to change from bad to good. 40,5% participants perceive that citizens are responsible for the poor condition of the streams at Umlazi, citizens were perceived to continue to contaminate the streams and exposing themselves in health and safety risks. As a

result, the beta coefficients of 0.085, indicated that indeed attitude is a poor predictor in predicting behavioral change towards stream restoration and need to be improved.

8.4.3.3 Behaviour

8.4.3.3.1 Citizens Strategic Ignorance behavioural practice

Yet, 40,5% participants perceive that citizens continue to contaminate the streams and exposing both themselves and 76.3% that believed children are more vulnerable to health and safety risks, moreover, citizens continue use the stream and benefit from it water for various activities even children swimming. Since internal pressure (“guilt”) from causing harm to the environment should trigger an individual to obey laws that will make them develop a pro-environmental behaviour (Thunström et al, 2014). As stated earlier, such a behaviour of continuing to litter even though knowing the risks can be perceived as strategical ignorant (partially) from the fact that they were able to perceive the streams as dangerous and not in a good condition due to human activities (Thunström *et al.*, 2014). From the inferential findings, there was a relationship between attitude and knowledge. Knowing about water related risks without changing the attitude will not mitigate these risks and will not encourage behavioural change. Moreover, only 38.9 % citizens indicated that they report the challenges regarding stream management to the authorities although, 61.1% of the citizens perceived both municipality and citizens to be responsible for stream maintenance.

8.4.3.4 Policy Impact

8.4.3.4.1 There are no stream water policies in place

Perceived benefits of taking action and likelihood of action occurs when one accepts susceptibility provides a force leading to action. Knowledge and experience influences direction that the action takes and influenced by effectiveness of in reducing the health and safety susceptibility and safety threat. Then a benefit to change would increase health on individual ‘s level, however, there are other factors that can influence action existing like social pressure. Yet, 65.8% of the participants argued that they do not

know if the community understand the policies and laws that govern streams management. Only 9,5% participants believed that community members know and understand these policies. Gawronski and Bodenhausen (2015) though believe it is important to use theories that are significant and have some relevance to life or real behaviour "(Patterson, 1983). According to Morowatisharifabad et al. (2012) people's behaviour and intentions about healthy behaviours depend on their beliefs, values and knowledge in cooperated by both TPA and HBM.

8.4.3.4.2 Poor formulation of policy implantation and enforcement resulted in lack of behavioural change towards stream restoration

Although, the beta coefficients (0.168) for policies suggest it has the biggest influence in predicting behavioural change towards stream restoration. However, lack of consistency on surface water quality policy implementation and enforcement methodological variations by professionals in ESS and IWRM gap have caused lack of behavioural change towards stream restoration as there was a poor formulation on policy implantation and enforcement. As much as the community has been accused of their bad behaviour, the municipality has an obligation as civil servants to serve the community as according to the Constitution of South Africa (Act 108 of 1996). Section 195 (1) (c) of the Constitution "public administration must be developmental-oriented" and (e) that "people's needs must be responded to and the public must be encouraged to participate in policy-making". This means that municipalities must be democratic, responsive and accountable to the citizens.

8.4.3.4.3 Citizens will not change their poor behaviour towards stream restoration even if the laws against their behaviour are in place

66,3% of the citizens do not know if these policies are effectively implemented ad enforced and, 30,5% citizens believe that these policies are not effectively implemented and enforced. Further to this, 63,7% of the citizens do not know if their behaviour will change even if these policies are effectively implemented and enforced

and, 22,1% citizens insist that their behaviour will not change even if these policies are not effectively implemented and enforced. Pahl-Wostl, Sendzimir, Jeffrey, Aerts, Berkamp and Cross (2007) in managing change toward adaptive water management through social learning still lacks IWRM concept which is a water management global knowledge and implementation, and this eventually hinders policy impact in the developing countries (Pride and Joy Consultants, 2015). A new generation of water management practitioners trained in participatory system design and implementation is urgently needed (Pahl-Wostl *et al*.,2007). 26,3% citizens also indicated that the policies can be implemented and enforced through cooperation and compliance; 21,6% believe that education and awareness about policies and; 20,0% complaints systems need to be used by community members can be the solution (Figure 33).

8.5 RECOMMENDATIONS

8.5.1 Municipality have to improve their skills

Tortajada and Joshi (2014) found that there is a lack of ability, attitude, resources, skills and competency to comply with water legislation, standards and guides. There is a lack of enforcement of legislation and standards due to the lack of ability, attitude, resources, skills and competency. Yet, people in authority play a key role in fostering students' beliefs, attitudes, values and behaviours about sustainable water consumption. Therefore, professionals in the water sector needs to be improved as local government is a sphere that is closest to grass-roots to ensure the attainment of sustainable, democratic and developmental local government, in line of the Constitution of the country. Skills gaps have been identified in South Africa, according to studies, approximately 10% of qualified engineers in the water sector who work for local government.

8.5.2 Government incompetency on knowledge and water policy compliance must include authorities being aware of local benefits

This will help authorities change their perception on viewing policy implementation and enforcement as a difficult task.

Since, individuals intend to have a certain behaviour when they evaluate it positively (Burke, 2016). Therefore, authorities should consider viewing policy implementation as Constitution biding and doable task necessary to reduce diseases associated with poor streams conditions. Otherwise, authority's current behaviour and attitude will enable citizens not to adhere to these laws.

8.5.3 Policy makers should be fully aware of the opportunities cost and trade-offs involved in stream water quality restoration practices

This can be achieved thorough the accurate and updated scientific data in the local area that must be shared by centrally shared by authorities at a local and national level to avoid data duplication. This will reduce silo mentality barrier within municipality departments and lack of communication. This strategy will reduce the lack of coordination between chief directorates, inaccessibility of records, an abundance of rules and regulations, and a lack of funding in some areas are among the bureaucratic issues surrounding complicated intra-departmental processes.

8.5.4 Authorities strategic priorities that influence environmental policy compliance must be applied as stipulated in the Constitution

These must include adherence to RQOs of the local rivers and streams implementation, enforcement and continuously evaluation and monitoring even at a local level on policy compliance (Act no 36 of 1998). The National Water Act (NWA) identifies activities that have impacts on water resources in terms of quantity and quality. Such activities are referred to as water uses (Section 21 of the Act). According

to Section 22, Water Use Activities are only permissible when the Minister has granted a water use authorization (DWS, 2014 and DWS, 2015). Also, because the procedures that determines RQOs involves implementation, monitoring and review the process continuously as all water resources are protected in order to secure their future and sustainable use (NWA, 1998; DWS, 2014).

8.5.5 Municipality have to improve the WWTW compliance audits

Since, citizens use stream water for irrigation. Umlazi area allows individuals to use up to 8 litres per second of surface water without triggering any authorization leaves community members susceptibility and vulnerable to health and safety risks as they can use the stream water for irrigation for example without any formal supervision. Therefore, improvement of the poor compliance tests audits is a barrier that must be addressed by WWTW. These include WWTW that are not licenced and that has almost full capacity as all sewage pipes for new developments are connected to same sewage line of the same WWTW and require improvement.

8.5.6 Authorities to consider evaluating surface water authorization laws to highlight health and safety susceptibility associated with streams current condition

The fact that majority of community members did not see the need to change their behaviour even if the policies are implemented and enforced. Therefore, authorities need to consider evaluating surface water authorization laws to highlight health and safety susceptibility associated with streams current condition. As participants perceived that the reason the community does not believe in the policy of no litter is because no one was ever penalized or even arrested due to the fact that these policies are not implemented.

8.5.7 Creation of environmental community-based organization that will include ward councillors to be part of the committee

This will aid both the community and authorities to get a platform to discuss issues in a formal manner. The citizens will be able to report the challenges to the right channel and get a chance to do a follow-up on those issues. Moreover, the involvement of ward councillors will help them to be more hands on the current environmental issues faced by both community members and the municipality. This will in the process change their perceptions and different agendas they were perceived to have had by both citizens and municipality.

The environmental community-based organisation will also change community' a bad attitude and behaviour perceptions towards Sihlanzimvelo workers and towards municipality and reduce illegal dumping. The citizens through engagement with relevant municipality departments will learn that living in a clean environment is a necessity not a luxury and that it is as important as fighting for a house allocation because it affects their wellbeing and that of their children and their children future. Therefore, protecting nature is important as we all benefit from it and cannot live without it.

8.5.8 The environmental community-based organization created must include and evaluate the following objectives

Educating citizens about health and safety risks associated with streams current conditions, this will help citizens to be hands on in being stewards of the surface water reservations as citizens are more affected by mismanagement of this natural resource; Conduct frequent surface water quality testing check-up’s at a more local level using a smaller scale. The scope should also include social, economic and strategic benefits associated with these streams. Training certain citizens and Sihlanzimvelo workers on water quality testing of streams. Evaluate if community training on how to interpret RQOs and WQI is conducted also explaining why these RQOs and WQI are important for the citizens and nature itself. Making sure that the updated accurate local rivers

water quality and benefits data information is accessible to citizen. This information will also get to be shared in those environmental community-based organisation meetings and feedback be liaised to the authorities. In return, this will help in designing the tailor-made laws that have measurable and attainable standards and goals and; Implementing and enforcing laws that governs streams and river management. Without laws there is no easy way to measure, trace, evaluate the progress.

Investing in research and development of natural resources in the populated dense areas. This will help researchers to analyse, evaluate other natural resources effect on the stream and river management frequently and advise authorities in time before irreversible degradation and extinction occurs. Also, the health and safety issues that has resulted in Umlazi being affected heavily by diseases like TB and diarrhoea can be mitigated through thorough research and community engagement.

8.6 THE UNIQUE CONTRIBUTION MADE TO THE RESEARCH AREA

Although Morowatisharifabad *et al*. (2012) state that people's behaviour and intentions about healthy behaviours depend on their beliefs, values and knowledge in cooperated by both TPA and HBM. From this study though, policy impact was the greatest influence of behavioural change towards stream restoration more than knowledge and attitude. Therefore, policy makers need to put more effort on policy implementation and enforcement, and this must start at a local level. Policy makers design programmes that deals with closing the gaps between IWRM and ESS. The surface water protection and usage policy implementation and enforcement can be effective and addressed thereafter. Sustainable river ecosystem management necessitates a more multidisciplinary approach and the reclaiming of the "water market" from the margins to the centre of policy-making. Local stakeholders especially the citizens are more attached than anticipated since it is a township and easily affected by the streams condition and changes.

8.7 SCOPE AND LIMITATIONS OF THE STUDY

The gatekeeper approval for this study from eThekwini municipality department of Environmental health was not been granted. This department indicated that the Executive felt that there is a need for them to focus and develop internal policies before they are in a position for researchers to investigate this topic. The department of Climate Change and Protection only joined the discussion on the focus group phase as they were initially not included in the identified stakeholders but are part of Sihlanzimvelo project.

Also, the study was based on research of residents of Umlazi Township and is such any emergent findings may not be generalizable however, they will provide transferable observations that may help to inform corrective practices across a range of provinces within South Africa. The study also serves a Potential function a study which others would replicate within their provinces and as such, could have further value than is immediately apparent. The study has been conducted as a cross-sectional enquiry and more reliable insights could have been facilitated through conducting this as a longitudinal study over a period. It noted too, that the study was conducted by single research with limited resources and this also limited the study. A wide range of employees of the municipality and water management services were identified as part of the target population and this broad range of potential participants was required that a varied repertoire of participant recruitment strategies be used to minimise the potential for participant non-responsiveness.

8.8 CONCLUDING REMARKS

From literature, surface water contamination is mostly associated with diseases and other physical dangers, this study's findings confirmed the same, most participants perceived health and safety risks and susceptibility to be more on Sihlanzimvelo workers, on those that live near the streams and on children. Few citizens seem to value the stream water quality restoration as they may not identify themselves with nature since they are less dependent on it when it comes to water supply of drinking

and household activities because water and sanitation infrastructure is available since this is a township. The streams are rather heavy polluted to the extent that there is an offensive smell coming from it, streams are not protected, this will not secure their future and sustainable use even that of the ecosystem in general. Instead, from the data collected, stakeholders are rather concerned about their health and safety.

Citizens knowledge, attitude and behaviour indicated social disapproval towards stream restoration. Citizens were perceived as one the main reason for the current poor stream condition of the streams portraying social disapproval through their activities of polluting the streams and continuously threatening Sihlanzimvelo workers, yet, they continue to use stream water for various activities. 47.6% participants believe that the citizens are just ignorant of the stream condition, while 38.0% believe that citizens need education on stream condition status. From the interviews and focus group discussions with municipality departments, all participants agreed that there are no awareness campaigns on stream water quality testing; that the communities have no knowledge on stream water quality testing and as a results communities are not active in stream management; that there are no policies implemented and enforced regarding the stream or river management. Although the impact of policy suggested it has the biggest influence in predicting behavioural change towards stream management restoration that could indicate that authorities are strategic ignorant.

Stakeholders concerns about their health and safety can be improved through knowledge, attitude and behaviour improvement towards the stream restoration practices, in return this improvement will improve air quality as illegal dumping will be reduced. If the streams are cleared of litter, waste, and debris, this will promote better flow with no blockages in return, prevent flooding and promote the use of water and stream areas for various purposes.

Therefore, involving citizens in the IDP and RQOs is vital as the community is benefiting from the streams. As Ajzen *et al*. (2011) mentioned that it only when well informed can we act effectively to produce desired outcomes. Therefore, lack of proper

knowledge causes no behavioural change, instead encourages strategic ignorance on both authorities and citizens and will not discourage social disapproval from the citizens even if citizens and authorities are aware of policies governing stream water management. The national; local authorities' departments and professionals' skills input is therefore crucial in determining the accurate and updated local stream water quality data. The updated data plays a role in influencing policy and water quality practices on identified stakeholders' knowledge, attitudes, and behaviour toward stream restoration practices. Since the beta coefficients for policies also suggest it has the biggest influence in predicting behavioural change towards stream restoration. Indicating that there is a huge policy impact and stream water quality practices on behaviour toward stream restoration practices in Umlazi Township, KwaZulu Natal, South Africa.

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APPENDICES

Appendix A:Ethical Clearance

DURBAN UNIVERSITY OF TECHNOLOGY MANAGEMENT SCIENCES:
FACULTY RESEARCH ETHICS COMMITTEE (FREC)

19 May 2017

Student No: 16524881

FREC No: 19/17FREC

Dear Ms N Xaba

PHD IN MANAGEMENT SCIENCES (BUSINESS ADMINISTRATION)

TITLE: AN ANALYSIS OF POLICY IMPACT AND STREAM WATER QUALITY PRACTICES ON KNOWLEDGE, ATTITUDES AND BEHAVIOR TOWARD STREAM RESTORATION PRACTICES IN UMLAZI TOWNSHIP, KWAZULU NATAL, SOUTH AFRICA

Please be advised that the Faculty Research Ethics Committee has reviewed your proposal and the following decision was made: Ethics Level 2

Approval has been granted for a period of two years, after which you are required to apply for safety monitoring and annual recertification. Please use the form located at the Faculty. This form must be submitted to the FREC at least 3 months before the ethics approval for the study expires.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the FREC according to the FREC SOP's.

Please note that ANY amendments in the approved proposal require the approval of the FREC as outlined in the FREC SOP's.

Yours Sincerely

Prof JP Govender

Prof J Govender
Chairperson: FREC

Appendix B: Gatekeepers letter

Pod I, Second Floor, Intuthuko Junction, 750 Mary Thiphe Street, Umkhumbane, Cato Manor, Durban 4001,
Tel: 031 322 4513, Fax: 031 261 3405, Fax to email: 086 265 7160, Email: mile@durban.gov.za, Website: www.mile.org.za

For attention:
Chair; Ethics Committee (Faculty of Public Management)
Department of Management Sciences
Durban University of Technology
Durban
4001

5 August 2016

RE: LETTER OF SUPPORT TO STUDENT NTOKOZO AMANDA XABA, STUDENT NUMBER 16524881 GRANTING PERMISSION TO USE ETHEKWINI MUNICIPALITY AS A CASE STUDY

The Engineering Unit of eThekwini Municipality and the Municipal Institute of Learning (MILE), have considered your request to use eThekwini Municipality as a research study site leading to the awarding of a Doctoral degree in Public Management entitled: "Stream water quality in Townships: - A Mixed-Method analysis of the impact of policy and water quality practices on community knowledge, attitudes and behavior toward stream restoration practices in Umlazi Township, KwaZulu Natal, South Africa

We wish to inform you of the acceptance of your request and hereby assure you of our utmost cooperation towards achieving your academic goals; the outcome which we believe will help our municipality in the long run. In return, we stipulate as conditional that you present the results and recommendations of this study to the related unit/s on completion.

It is our understanding that Ms Xaba will be supported by Mr M. Tomlinson from eThekwini Municipality in the research study.

Wishing you all the best in your studies.

Head : Engineering Unit
eThekwini Municipality

5/8/16

Date

Head: eThekwini Municipal Academy
eThekwini Municipality

Appendix C: Letter of Information

LETTER OF INFORMATION

Dear Sir/Madam

I am a Doctoral student at the Durban University of Technology conducting research study titled: Stream water quality in Townships: - A Mixed-Method analysis of the impact of policy and water quality practices on community knowledge, attitudes and behaviour toward stream restoration practices in Umlazi Township, KwaZulu Natal, South Africa. My study aims to better understand community knowledge, attitudes and behaviour about stream water quality and I believe that Ethekwini municipality employees and Umlazi citizens have invaluable contributions to make in this conversation and survey.

I am requesting your permission to be able to approach Municipality departments involved and Umlazi citizens to seek their consent to participate in the study. As expected, my study will have ethical clearance from the University and has been designed to ensure protection of all participants.

Participation in this research is completely voluntary. All information provided through participation will be kept confidential. There are no known or anticipated risks to the participation in this study.

Thank you in advance for your co-operation in my research.

Yours Sincerely

Ntokozo Xaba

Appendix D:Consent Form

CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Ntokozo Xaba, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _____,
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

_____	_____	_____	_____
Full Name of Participant	Date	Time	Signature / Right Thumbprint

I, Ntokozo Xaba herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

_____	_____	_____
Full Name of Researcher	Date	Signature
_____	_____	_____
Full Name of Witness (If applicable)	Date	Signature

Appendix D: Interview Schedule

Section A: Work Experience

Please indicate your answer with a tick

1. What is your age?

20-29years	
30-39 years	
40-49 years	
50-59 years	
60 years and over	

2. What is your Gender?

Male	
Female	

3. Educational level

Matric	
Certificate	
Diploma	
Degree	
Post Graduate	
Other	

4. Length of service

1-5 years	
6-10 years	
>10 years	

5. Please indicate your department or company

Environmental Health	
Ethekwini Roads and Storm Water	
Ethekwini Coastal Stormwater and Catchment	
Durban Solid Waste	
Sihlanzimvelo	

6. Position within the company

General Workers	
Middle Management	
Senior Management	
Sihlanzimvelo	
Other	

7. How long have you been part of Sihlanzimvelo Project?

0-2 years	
3-5 years	
6-9 years	
More than 10 years	

8. How long have you been part of Stream Management?

0-2 years	
3-5 years	
6-9 years	
More than 10 years	

1. Please describe the nature of your position role in your department:

……

2. Do you feel you have necessary skills to perform your job in stream management?

……..

3. What other types of Project of stream management you know

……

Interview questions

1.In your own opinion, Importance of stream cleanliness

2.In your own opinion, Current Condition of the streams and it causes

3.In your own opinion, what can you describe as the attribute of a clean stream

4.In your own opinion, what is the current condition of the streams affects individuals

5.In your own opinion, there is an offensive smell in stream and if so what is the cause of this smell

6.In your own opinion, what are the risks of living near the streams

7.In your own opinion, are there any other health and safety risks other than diseases associated with living near the stream

8.In your own opinion, what is the worst physical condition caused by the current stream condition

9.In your own opinion, do citizen children playing near or inside the streams in this area, if so, are there any negative impact caused by this

10.In your own opinion, do citizen know and understand stream management policy standards

Appendix E: Focus group discussion Schedule

Section A: Work Experience

Please indicate your answer with a tick

9. What is your age?

20-29years	
30-39 years	
40-49 years	
50-59 years	
60 years and over	

10. What is your Gender?

Male	
Female	

11. Educational level

Matric	
Certificate	
Diploma	
Degree	
Post Graduate	
Other	

12. Length of service

1-5 years	
6-10 years	
>10 years	

13. Please indicate your department or company

Environmental Health	
Ethekwini Roads and Storm Water	
Ethekwini Coastal Stormwater and Catchment	
Durban Solid Waste	
Sihlanzimvelo	

14. Position within the company

General Workers	
Middle Management	
Senior Management	
Sihlanzimvelo	
Other	

15. How long have you been part of Sihlanzimvelo Project

0-2 years	
3-5 years	
6-9 years	
More than 10 years	

16. How long have you been part of Stream Management?

0-2 years	
3-5 years	
6-9 years	
More than 10 years	

1. Please describe the nature of your position role in your department:

……

2. Do you feel you have necessary skills to perform your job in stream management?

……..

3. What other types of Project of stream management you know

……

Focused Group Questions

1.In your own opinion, do citizens know water quality status of their nearby streams

2.In your own opinion, are there barriers against keeping the streams clean, if so what can these be

3.In your own opinion, what is the citizens' attitude towards stream management??

4.In your own opinion, what is the citizens' behaviour towards stream management?

5.In your own opinion, what are the cues to action to reduce the challenges?

Appendix F: Questionnaire

Section A: Demographics

1. Household demographics

Number of Adults in the Family ☐

2. Occupational status of Head of Household

Unemployed ☐

Self-Employed ☐

Employed ☐

3. Highest Educational qualification of Head of House-hold

Primary ☐

Secondary☐

Tertiary ☐

Job title (if employed): - _____

4. Ethnicity:

Black South African ☐

Black African☐

Indian South African ☐

Coloured South African ☐

Asian ☐

White South African ☐

Other ☐

5. Age:18-24 ☐

25-40☐

41-65 ☐

>65 ☐

6. Gender:

Male☐

Female ☐

7. Living Arrangements:

Living alone ☐

With family/friends ☐

In care ☐

other ☐

8. Type of Tenancy

House owner ☐

renting ☐

Living with family/parents ☐

9. Type of house

RDP☐

Informal dwelling ☐

four-roomed or formal dwelling☐

10. Is the house near the stream

Yes ☐

no ☐

11. How long have you been staying in this area?

0>1☐

1-5☐

6-10 ☐

11-15☐

15-20☐

25-30 ☐

above 30 ☐

Section B: Survey questions

1.In your own opinion, is there any importance of the clean stream

yes ☐ no ☐

2.If yes, why do you feel this way?

Healthy community needs healthy streams ☐prevent diseases and germs ☐ healthy ecosystem and environment☐ attractiveness to community ☐ save aquatic life ☐ improve catchment☐ improve air quality☐ prevent flooding☐ safety ☐ health and safety ☐water use by people ☐ other

3.What is the current condition of streams of Umlazi

Poor ☐ Clean ☐moderate ☐worse☐

4. What do you believe led to develop these problems?

Streams not cleaned ☐ poor attitude of citizens ☐ illegal sewer connection☐ sewer leakages ☐ lack of services ☐ lack of education and knowledge ☐ used as a toilet ☐ used as waste and dumping site☐ Easy access to the stream ☐other☐

Why do you feel this way?

5.How long has this stream condition been happening

Ever since I started living here ☐ from the time I was young☐ since development of township☐ I do not know☐ other☐

6.In your own opinion what are the properties or attributes of clean stream

Clean water ☐no debris and litter ☐ no waste in water☐ flowing water ☐ no overgrown vegetation ☐ more birds in area☐ safe distance between stream and land☐ other ☐

7.Do you feel there are any factors influencing health and safety risks associated with stream

diseases ☐ injuries ☐ robberies☐ sewage ☐flooding☐ dumping ☐ dangerous animals inside or near the streams ☐ people living next to the stream are the cause ☐ other☐

Why do you feel this way?

8. Is there an offensive smell in the stream?

yes ☐ no☐

9. In your own opinion what causes smell in the stream?

sewer ☐ waste ☐ rubble☐ stagnant water ☐nappies and faeces☐ other ☐

Why do you feel this way?

10. In your own opinion does living near the stream increase risks associated with stream conditions

yes ☐ no☐ I do not know☐

11. What type of diseases are more associated with stream management?

cholera ☐ malaria☐ diarrhoea☐ bilharzia ☐TB and chest related diseases☐ skin rash on people and children ☐ other☐

Why do you feel this way?

12. If yes, why do you feel that citizens that live closer are more affected this way?

Children in those areas do not have enough space to play ☐ Air quality and smell ☐ dangerous animals ☐ diseases☐ mosquitos ☐ soil erosion and flooding ☐ other ☐

13.What is the worst physical condition that can be caused by the current stream condition?

Health and illness injuries ☐flooding ☐ waste and sewage☐ extinct of wildlife ☐ economic and sustainability depreciation ☐ other ☐

Why do you feel this way?

---

14. In your own opinion do children play inside the stream or with stream water

Yes ☐ no ☐

15.Do you feel there are any direct implications of polluted streams on children

yes☐ no☐

16. If yes, what can these be?

Gems and bacteria ☐ dangerous dumped items ☐ drowning☐ dangerous animals ☐physical danger☐ skin rash ☐ diseases ☐ are left with less play area ☐ other ☐

Why do you feel this way?

17.Do you know what is meant by River Quality Objectives (RQO) and it status of your river or stream?

Yes ☐ no☐

If yes, can you explain how it affect you as an individual?

18.Do you know what is meant by Water Quality Index (WQI) status of your river or stream?

If yes, can you explain how it affect you as an individual?

19.In your own opinion is WQI criteria more important for the citizens' awareness on water related disease instead of RQO in this country.

Yes ☐ no ☐

can you further explain why you say so?

20. Do you feel the streams have less water than in the past years?

Yes ☐ no ☐ I do not know ☐

can you further explain why you say so?

21.In your own opinion, what is the general knowledge of the community on stream water condition

ignorant☐ knowledgeable ☐ need education ☐

22.In your own opinion, are there any challenges or barriers in keeping the stream clean

yes ☐ no ☐

23. What causes these challenges?

Community do not care about laws ☐Lack of proper leadership in the community ☐ ward council not doing his or her job ☐ population growth in the township ☐ slums ☐ Sihlanzimvelo scope is small ☐ municipality departments lagging to respond☐ no supply of plastic bags ☐ all

24.In your own opinion, do citizens use stream water for irrigation

yes ☐ no ☐ I do not know ☐

25. .If yes, how many litters do you think they use per day

5-10 litres ☐ 11-20 litres ☐ 20-50 litres ☐ 50- 100 litres ☐ 100 litres >

26. In your own opinion, do citizens use stream water for the following activities:

fishing ☐ swimming ☐ building☐ cooking ☐ washing ☐ drinking☐ No ☐ I do not know ☐ other ☐

27.In your own opinion, will citizens use stream water for the activities if there is water shortage or supply in the township:

Yes ☐ no ☐

28.In your own opinion, what is the general attitude of the community on stream water condition

negative attitude☐ positive attitude☐ need to change attitude from bad to good ☐ Constantly fearful of it ☐ Do not care about it state ☐ I do not know ☐

29.Have you ever received training on stream water testing (from the government)?

Yes ☐ no ☐

30.Who do you think is responsible for maintaining stream water clean?

Municipality ☐ community members ☐ both ☐

Why do you feel this way?

31.Do you report to the municipality these stream challenges you face?

yes☐ no ☐

32.In your own opinion, do community members know and understand policies and laws governing stream or river management

yes ☐ no ☐ I do not know ☐

Please give one example of these policies

_____

_____

33.If yes, are these policies effectively implemented and enforced

yes ☐ no ☐ I do not know ☐

Can you give one of these policies that is currently implemented

_____

_____

34. In your own opinion, what is the behavioural patterns of the community on the stream water condition

☐ moderately love, value and protect it ☐ constantly love, value and protect it ☐ seriously contaminate it☐ moderately contaminate it ☐ constantly contaminate it ☐ moderately afraid of stream water ☐ Constantly fearful of it ☐

35.If these policies are effectively implemented and enforced, will these influence your behaviour towards a stream restoration practice

yes ☐ no ☐ I do not know ☐

can you further explain why you say so?

_____

_____

36.In your own opinion what can be the cause of the ineffective policies

Community do not understand the laws ☐ Community do not care about the laws ☐ due to illegal dwellings that no addresses ☐ lack of community members change in mind-set☐ lack of municipality departments support and accountability ☐ lack of

current research on these issues in the township ☐ lack of ongoing monitoring and testing of water quality ☐lack of community engagement ☐ lack of use of policy and laws enforcement ☐ lack of support from inter-governmental department☐ other ☐

37.Do you think you have the ability to conduct the stream water quality in your area?

Yes ☐ moderately equipped ☐ no☐

If no, what can be the reason

38.Do you feel the municipality can solve these problems?

yes☐ no ☐ with others help☐ other ☐

39. If not, why do you think municipality fails to solve this challenges

Lack of proper infrastructure ☐ward council not doing his or her job ☐ population growth in township☐ slums ☐ Sihlanzimvelo scope is small ☐ municipality departments lagging☐ silo mentality

40.If the attitude need to change, how can this be done in your own opinion

Municipality engagement with community☐ ward council doing his or her job ☐ need for more education in township☐ more enforcement of policies by municipality ☐ Sihlanzimvelo members increase as cleaning community system ☐ only disasters will change attitude ☐ other

41.Do you know any existing municipality initiate that treat and manage streams?

yes☐ no☐

If yes, what are these initiatives

42.Is there any environmental community based programme in your neighbourhood?

Yes☐ no☐ I do not know ☐

43.If there is an existing environmental community based programme in your neighbourhood, is it active and shows impact in environmental

Yes☐ no☐ I do not know ☐

Please elaborate your answer

44.In your own opinion, how can these laws be implemented or enforced

Through cooperation and compliance☐ community needs to take ownership ☐ compliant systems need to be used by community members☐ municipality departments need to be dedicated ☐ education and awareness about policies ☐ ongoing monitoring and testing of water quality ☐use of river banks ☐ use of policy and laws enforcement ☐ other ☐

45.In your own opinion, what can be management system that can be used in health risks monitoring

Cleaning is the only solution☐ community needs to take ownership ☐ compliant systems need to be used by community members☐ municipality departments need to be dedicated ☐ education and awareness ☐ongoing monitoring and testing of water quality ☐use of river banks ☐ use of policy and laws enforcement ☐ all ☐ other ☐

can you further explain why you say so?

46.In your own opinion, what strategies can be used to improve water quality of the stream?

Increase scope of Sihlanzimvelo employees and work ☐ sewer system maintenance improvement☐ large trees and vegetation removal must be maintained☐ more involvement of human settlement department ☐ housing space is needed ☐ more bins and waste removal☐ other ☐

Appendix G: Table 2: Review table

AUTHOR	DESIGN/SAMPLE SIZE	RESEARCH OBJECTIVES	RESULTS
De Young, R. (1984). Motivating people to recycle: The use of incentives, Greece	N=375 households	To understand more deeply which factors motivate consumers to engage into Recycling Behaviour.	Knowledge and recycling attitudes showed relationships with recycling behaviour to reduce environmental pollution. Motivation was the most powerful factor in behaviour prediction Social incentives another type of motivation
Patil, S.R., Arnold,B.F., Salvatore, A.L., Briceno, B., Ganguly, S., Colford Jr., J.M. and Gertler, P.J. (2014). The Effect of India's Total Sanitation Campaign on Defecation Behaviours and Child Health in Rural Madhya Pradesh: A Cluster Randomised Controlled Trial. India	Structured questionnaires; observations; sampling and testing of drinking water; child anthropometry and specimen (stool and blood) testing. n= 630 households Baseline measures of sanitation conditions, behaviours, and child health (May–July 2009), and revisited households 21 months later (February–April 2011) after the programme was delivered.	To measure the effect of the Total Sanitation Campaign (TSC) implemented with capacity building support from the World Bank's Water and Sanitation Program in Madhya Pradesh on availability of individual household latrines (IHLs), defecation behaviours, and child health (diarrhoea, highly credible gastrointestinal illness [HCGI], parasitic infections, anaemia, growth).	41% adult men or women households still practiced daily open defecation although intervention villages that had improved sanitation The main reasons for daily open defecation were culture, habit, or preference for defecating in open followed by inadequate water availability. The intervention did not improve child health measured in terms of multiple health outcomes (diarrhoea, HCGI, helminth infections, anaemia, growth).
Jordan, R. C., S. A. Gray, D. V. Howe, W. R. Brooks, and J. G. Ehrenfeld. 2011. Key issues and new approaches for evaluating citizen-science learning outcomes, Canada	N=82 participants trained for three days over two years' programme	1.To determine whether participants without experience in plant identification and with little knowledge of invasive plants increased their knowledge of invasive species ecology; 2.To determine whether participation increased knowledge of scientific methods, and; 3.To determine whether participation affected behaviour.	Little change in behaviour regarding invasive plants due to lack of understanding as scientific goals, educational goals; The motivation of participants were not clearly defined during program design and even after participation
Niitsu, T., Takaoka, K., Uemura, S., Kono, A., Saito, A., Kawakami, N. and Shimizu, E. (2014). The	A cross-sectional mail-in survey using random sample, conducted for 11 months after the disasters.	To investigate the impact of a dual-disaster (earthquakes and radioactive contamination) on the prevalence of psychological distress in a landlocked city within the Tohoku area, Japan.	48% associated with psychological distress due to House damage as a result of

psychological impact of a dual disaster caused by earthquakes and radioactive contamination in Ichinoseki after the Great East Japan Earthquake.,Japan.	The K6 was used to determine psychological distress.		earthquakes and radioactive contamination Middle-to-low educational status and unemployed females were additional risk factors for psychological distress.
Morowatisharifabad, M.A., Momayyezi, M. and Ghaneian M.T. (2012). Health Belief Model and Reasoned Action Theory in Predicting Water Saving Behaviors in Yazd, Iran	Random cluster sampling N=200 heads of households. questionnaire tested using descriptive statistics, simple correlation, hierarchical multiple regression.	To explain water saving behaviours in Yazd, Iran on the basis of Health Belief Model and Reasoned Action Theory.	Health Belief Model constructs, with the exception of perceived severity and benefits, is more powerful than Reasoned Action Theory. HBM a framework for educational interventions in improving water saving behaviours
Liu ,S. and Guo, L. (2018) .Based on Environmental Education to Study the Correlation between Environmental Knowledge and Environmental Value ., China	Survey on 360 students	To determine a relationship between environmental education; environmental knowledge and, environmental value	The findings showed, positive correlations between: environmental education and environmental knowledge; between environmental knowledge and environmental value, and between environmental education and environmental value.
Van der Merwe-Botha, M. (2009). South Africa	Working Paper of selected, relevant and multidisciplinary viewpoints from leading South African experts.	1.To provide a qualitative and strategic perspective on water quality and its relationship to the economy, urban challenges and sustainable productive capacity. 2.To test the hypothesis that “good water quality is a vital component of good economic growth” 3. To determine the critical links and synergies between good water quality and good economic growth relationship.	Socio-economic environment of the structure of the economy and behaviour of its actors, reflect and influence natural and cultural legacies and policy choices; Poor education of society (does not have required skills to understand and manage public services effectively). R45 billion drop in economy (due to national water quality and quantity in South Africa in 2008 challenges).

Van Liere, K. D., and Dunlap, R. E. (1981). Environmental concern: Does it make a difference how it's measured? Washington State	N=806 residents using telephone listings, questionnaires collected via mail	To determine the degree to which different types of measures of environmental concern produce consistent results.	Sociodemographic of education 20%, age 60%, sex 40%, political ideology 33,3% had the most consistent relationship with environmental concerns or measures such as pollution and population; Poor education can act as a barrier of pro-environmental behaviour and no significance in residence. Environmental concern measures are not all equivalent that is
Sershen, S., Rodda, N., Thor-Axel, S., Schmidt, S., Dent, M., Faizal. B. Hanke, N., Buckley, C. A., Fennemore, C. (2016). Water security in South Africa: perceptions on public expectations and municipal obligations, governance and water re-use. South African	An interdisciplinary Water Security Colloquium, A selected group of water professionals from academia, civil society and local government focus group.	To determine the 'solutions and recommendations'.	Developing the ecological infrastructure that protects both quantity and quality of water and building strong partnerships among all stakeholders
Vining J, Ebreo A. 1992. Predicting recycling behavior from global and specific environmental attitudes and changes in recycling opportunities.	Surveys of households conducted at three different points in time	To investigate specific recycling attitudes and recycling behaviour that occurred as recycling opportunities increased over time.	Persons living in communities with fewer recycling opportunities were more likely to say that inconvenience influenced the level of their recycling behaviours
Virapongse, A., Brooks,S., Metcalf, E. C., Zedalis, M.,Gosz, J., Kliskey,A.and Alessia,L. (2016). A social-ecological systems approach for environmental management. United States (U.S.)	Literature reviews using transdisciplinary approaches and resilience objectives for environmental management:	To bridge the gap between theory practice by defining a framework for a Social-Ecological Systems (SES) approach to environmental management in the U.S. through synthesis of literature and presentation of real world examples and challenges	Translating of environmental theories into practice is lacking due to lack of knowledge on professionals and citizens. Defining a proper framework such as SES can help reduce the gap between theory and practice and be useful tool for future sustainability Integration of both social and biophysical components can

			help reduce the gap between theory and practice Communities can benefit from adaptive co-development knowledge to inform and improve environmental decision-making practise.
Caren B. Cooper,Lincoln R. Larson,Kathleen Krafte Holland,Rebecca A. Gibson,David J. Farnham,Diana Y. Hsueh,Patricia J. Culligan,Wade R. McGillis (2017). Contrasting the Views and Actions of Data Collectors and Data Consumers in a Volunteer Water Quality Monitoring Project: Implications for Project Design and Management. New York City	kayak-based Citizen's Water Quality Testing (CWQT). data collectors (n = 40) and consumers (n = 24)	To compare the characteristics, perceptions, and behaviours of those collecting and using CWQT data (data collectors) and those solely using the data (data consumers).	Data collectors and consumers trusted volunteer-collected data more than government-collected data, with informing decisions about conservation and recreation purposes and; Both groups had equally potential to likely undertake a suite of conservation behaviours.
Das, M. and Ramalingam, M. (2019). Does Knowledge Translate into Action? Impact of Perceived Environmental Knowledge on Ecologically Conscious Consumer Behavior. India	Self-administered questionnaire from business school students Partial Least Square Structural Equation Modeling (PLS-SEM) approach was used to analyse the data.	To examine whether the perceived environmental knowledge translates into action between Perceived Environmental Knowledge and Ecologically Conscious Consumer Behaviour	Consumer with high and average environmental concern has increased level of ecologically Conscious Consumer Behaviour compared to consumer with low level of environmental concern.
Overdevest, C., C. Huyck Orr, and K. Stepenuck. 2004. Volunteer stream monitoring and local participation in natural resource issues. Wisconsin	N=155 volunteers in this group using the survey. non-equivalent groups, quasi-experimental design	To evaluates whether increased learning, local political participation, and more extensive social networks are related to participation in a volunteer stream monitoring project in Wisconsin	Participation in a volunteer stream monitoring increased as volunteers learning about stream monitoring increased, indicating a community capacity to address environmental problems as increase the political participation, personal networks, and feelings of community connectedness among volunteers,

			participation in a volunteer stream monitoring increased
McCormick. S. (2012). After the cap: risk assessment, citizen science, and disaster recovery. British	Qualitative interviews, ethnographic observations, and video data were collected within five months of the spill. The data was collected from local social movement organizations, grassroots groups, spill workers, fisherman, local residents, scientists, and government representatives for Petroleum spill in the Gulf Coast.	To examine how crowdsourcing is used as a new form of citizen science that provides real time assessments of health-related exposures.	Crowdsourcing is a new form of citizen science allows a broader range of participation and the detection of a broader range of impacts helping to demonstrate how citizen science relates to risk assessment processes and affects disaster recovery and long-term response. Without overcrowding, it is difficult to specifically outline the policy impacts of any social movement.
Muhammad Mohiuddin, M., Mamun, A.A .I, Fazal Ali Syed,F., Mehedi Masud, M.M., and Su, Z. (2018). Environmental Knowledge, Awareness, and Business School Students' Intentions to Purchase Green Vehicles in Emerging Countries. Malaysia	Stratified random sampling on face-to-face interviews business students'	1.To measure the effect of environmental knowledge and awareness on students' attitudes toward the environment. 2. simultaneously determine the effects students' attitudes, subjective norms, and perceived behavioural controls on their intentions toward green vehicles and perceived behaviour.	Environmental knowledge and awareness have a significant influence on business students' favourable attitudes toward green vehicles; There is a significant between attitudes, perceived behavioural controls, and intentions to purchase green vehicles was observed.
Nurwidodo, N., Al Muhdhar, M. H. I., Rohman, F., Iriani, D., Herlina, H., and Fausan, M. M. (2019). Building proenvironmental behavior among school community of Adiwiyata green school. Malang City.	in-depth interview, directed observation, and documentation as well as triangulation. The data analysed by means of content analysis	To describe the patterns of building pro-environmental behaviour among school community of Adiwiyata green school in Malang City.	The policy has positive impact on building pro-environmental behaviour when used as part of school policy for external support and physical environment to raise and reinforce pro-environmental behaviour to change attitude and not just in the classroom The effectiveness of strategic energy framework depends on the significant attempts in enacting behavioural and attitude changes among people.

De Young, R. (1986). Some psychological aspects of recycling: The structure of conservation satisfaction, Michigan	300 questionnaires distributed to single-family homes randomly selected.	Explores the structure of satisfactions people derive from behaving in an environmentally responsible manner	People gained satisfaction from acting in ways that make a difference and from helping to bring order to the world Understanding of why people bother to conserve resources may be improved by the personal satisfactions like frugality and participation Engaging in both recycling and reusing materials was due to a need to feel satisfaction a necessary part of human psychological well-being and not a luxury
Hampson, D.I., Ferrini, S., Rigby,D. and Bateman, I.J. (2017). River Water Quality: Who Cares, How Much and Why ?, Norwich	Survey	To examines the relationships between ecological and recreational sources of value, in order to allow decision makers to better understand the consequences of adopting	Different users have different values, anglers prioritised ecological quality, while swimmers and rowers favour improved recreational opportunities.
Pino,G., Toma, P., Rizzo,C.,Miglietta,P.P., Peluso,A.M. and Guido,G.(2017). Determinants of Farmers' Intention to Adopt Water Saving Measures: Evidence from Italy. ,Italy	150 Italian farmers	To establish how farmers can be encouraged to adopt irrigation water saving measures	Favourable attitudes towards water saving measures and public bodies influence farmers' intentions to adopt water saving measures. Farmers' innovativeness and water footprints has a significant influence on their adoption intentions.
Chaudhary, A. K., Warner , L.A., Lamm ,A. J., Israel ,G.D., Rumble ,J.N. and Cantrell, R. A. (2017). Using the Theory of Planned Behaviour to Encourage Water Conservation among Extension Clients., Florida	rrigation users (N = 1,063) using hierarchical linear regression models.	To examine the relationship between several variables, including attitudes, subjective norms, perceived behavioural control, personal norms, demographic factors, and past behaviours, on intention to use good irrigation practices	Subjective norms influences intention to engage in landscape water conservation, and past behaviours and personal norms improved the prediction. Extension professionals should incorporate subjective norms into water conservation programs to improve perceptions of peers' practices.

			Personal norms were strong than subjective norms. Residents who feel a personal obligation to conserve water may be more open to information related to water conservation; Residents who feel a personal obligation may be more likely to act, even in the absence of social support.

Annexure

Academic and manuscript Editing Services.

To Whom It May Concern:

Date: 20/11/2020

Re: **Doctor of Philosophy in Business Administration:** Title: - **An analysis of policy impact and stream water quality practices on knowledge, attitudes and behaviour toward stream restoration practices in Umlazi Township, KwaZulu Natal, South Africa.**

Client name: Ntokozo Amanda Xaba

This serves to confirm that the above identified doctoral thesis was edited and finalised by SS and SV Academic and manuscript Editing services for language and format adherence in line with the Harvard (version 6.1) manuscript formatting requirements.

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Dr Sunil Sagoo

Director “SS & SV Academic and manuscript editing services.