THE DYNAMICS OF A HYDROSOCIAL RELATIONSHIP. A CASE STUDY OF THE PINETOWN/NEW GERMANY INDUSTRIAL COMPLEX AND THE PALMIET RIVER.

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Submitted in partial fulfilment of the requirements for the degree of Master in Development Studies, in the School of Development Studies, University of KwaZulu-Natal, Durban, South Africa.

DECLARATION

I declare that this dissertation is my own unaided work. All citations, references and borrowed ideas have been duly acknowledged. It is being submitted for the degree of Master of Development Studies in the Faculty of Humanities, School of Built Environment and Development Studies, University of KwaZulu-Natal, Durban, South Africa. None of the present work has been submitted previously for any degree or examination in any other University.

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ABSTRACT

This study sought to explore the relationship between Industry located in the Pinetown/ New Germany Industrial complex and the Palmiet River. The objective of the study was to explore industry attitudes and perceptions towards water by studying the relationship between businesses located in the New Germany Industrial Complex and the Palmiet River, as well as external actors, processes and practices that regulate and govern this relationship. The hydrosocial cycle was used as the theoretical framework to guide this study as it better provided a space for a critical analysis of water and society; centring water to better understand the production of social power (Wittfogel 1957; Swyngedouw 1999; Linton 2010, Linton and Budds, 2013). Qualitative research methods such as in-depth interviews were utilized to gain insight from various stakeholders mainly; industry, the municipality and civil society.

This study revealed the intricate and structural internal connections between water and society. Which challenged the notion of a one-dimensional didactic relationship, rather it highlights how these two entities shape and remake each other continuously. Through this internal connection, they embody influences from various external actors, processes and practices, which change the context as well as the nature of this relationship. In its location at an industrial complex, the Palmiet River has enhanced, altered and fostered new relationships amongst and between stakeholders, with ecological infrastructure and climate change playing a significant role in connecting and facilitating these relationships. Broadly, the findings of the study found that the river can be understood as an integrator; it blurs the line between the formal and informal. It enmeshes the formal public spaces with the informal invisible spaces. True to the cyclical nature of water it connects the dominant socio-economic challenges back to the municipality and the state.

DEDICATION

Dolly, E. Ntini

I love you, mommy.

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Philippians 4: 13

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ACRONYMS

CFCs- Chlorofluorocarbons

CSO- Civil Society Organizations

PRP- Palmiet Rehabilitation Project

WB- World Bank

CHAPTER ONE

INTRODUCTION

1.1 Background and Rationale for the Study

Rivers play a vital role in helping us understand the relationship between water and society. Rivers transcend water provision and water management as they occupy a special space in communities (Strang 2006; 2014; Gibbs, 2010). People's relationships with rivers, and to an extent water, is socially constructed; they mean different things to different people at any given moment. Relationships with rivers and water are therefore influenced by politics, power, history and various other factors. For example, in South Africa, a country characterized by a history of vast economic inequality, socio-cultural exclusion and environmental racism, the historical and contemporary injustices are demonstrated in the provision and access of water to disadvantaged communities (Bond, 2002; Loftus, 2011). This construction of society has shaped the relationship between water and society (Bond, 2002). Water is often conceived as a means to economic ends and is indirectly used to exacerbate the exclusion of marginalized communities.

The relationship between rivers and industries is often one of the main spaces where the didactic relationship between water and society is maintained and sustained. The most common narrative describing the connection between rivers and industry often paints the relationship as bleak and exploitative. Industries are the polluters and rivers the dumping ground. This narrative is rooted in reality and there is ample evidence highlighting the role of industries as the biggest polluters and exploiters of water bodies such as rivers (see Brand et al 1967; Gleick 1993; Bond 2002; Alcamo et al 2003; O'Keeffe 2009; Wong et al 2007; Buono and Eckstein 2014). Industries also use the most water; 0.26 percent of global freshwater is stored in lakes

reservoirs and rivers (Alcamo et al 2003) and a significant portion of this water is used for economic activities and industrial processes.

Far beyond just providing water, rivers provide a variety of ecological infrastructure and ecosystem services which are critical for the survival of communities and the development of industries. They carry nutrients and sediments and are used as a living habitat by organisms (Rivers- Moore et, al. 2011). Rivers provide an abundance of ecosystem services and functions, they house "important biotic communities and species, reflect the environmental health of catchments, and are sites for important ecological processes such as migration of plants and animals, nutrient and detoxification" (O'Keeffe, 1986: iii). Rivers are also credited for shaping landscapes and providing beautiful landscapes and scenery. Rivers have multidimensional impact on human lives and the greater ecological community. Much like water, rivers have incredible significance in our communities and are the fabric of our societies and have attracted people and industries to congregate and build around them (Wong et al 2007). This often makes rivers spaces of development, conflict and competing tensions. Rivers carry and internalize the values and struggles of that society. The state of a river and the quality of the waters that flows through it can reveal the characteristics and the socio-economic status of society (Linton and Budds 2013), thus demonstrating the social nature of water.

This study builds on research conducted under the Palmiet Rehabilitation Project (PRP), a pilot project of the uMngeni Ecological Infrastructure Partnership (UEIP), which explored the use of ecological infrastructure as a means to attaining water security for the uMngeni Catchment and the city of Durban, in a context of high water insecurity, poverty and inequality. The PRP focuses on the various connections and governance approaches that emerge when multiple stakeholders, representing different sectors in society, engage and work together to address water security and climate change adaptation (Williams et al 2018). Climate change governance was used to frame this discussion, because issues of climate change, particularly climate change adaptation, require in depth analysis into the entanglement between socio-economic, political and ecological issues. The PRP project utilized the hydrosocial cycle as the theoretical framework to capture the experiences and realities of the different stakeholders, as it acknowledges and accommodates the political discourses around water and related issues such climate change, ecological infrastructure and more.

Whilst this thesis is influenced by the broader PRP project, it focuses specifically on the relationship between industry in New Germany and the Palmiet River. The impacts of industry on the environment are well documented (Naidoo, 2005; Moodley et al, 2014), however, further research is required about how industry or people who own and work in industry conceptualize and interpret their relationships and interactions with the natural environment. It is with this understanding and background that this study seeks to uncover the different ways industry in New Germany and the Palmiet River are mutually entangled (Linton and Budds, 2013). This will be done by studying and exploring this relationship and the other external actors, processes and practices that regulate and govern this relationship.

1.2 Problem Statement

The relationship between industry and rivers is also viewed and understood as one dimensional and directional. In this relationship industry often play the role of polluters and disturbers of rivers and the water that flows through industrial areas. This popular notion of viewing rivers and industries as separate but interconnected entities means that the dialectical relationship between rivers and industries is not adequately explored. This relationship becomes even more important in the context of climate change and water scarcity. This study seeks to understand how actors from industry conceptualizes their relationship with the Palmiet River, exploring the different ways industry in New Germany is "internally connected" (Linton and Budds 2013:04) to the Palmiet River. Ecological infrastructure and services provided by the river will be used to explore the social and material conditions of this relationship. Ecological infrastructure plays a vital role in the Palmiet Catchment as it has been identified as an important component to providing water in the context of climate change and water scarcity in Durban (Sutherland et al., 2017). Ecological infrastructure, through its multi-dimensional services, captures a number of socio-economic challenges with regards to engaging multiple stakeholders, concurrently. It is there for a useful lens in this study, as it will help us to better understand the challenges of addressing an issue which intersects and cuts across a number of different stakeholders, who are seeking to serve different and sometimes opposing agendas. According to SANBI "investing in ecological infrastructure requires collaboration among a range of entities, including, the state, the private sector, landowners and civil society, in order to be effective (SANBI, 2014: 07). In the context of this study, the role of ecological

infrastructure provides a lens in which to better understand the relationship between relationship between water and society and how it should be managed and regulated.

There is an awareness that industries and rivers are not politically neutral spaces, there are various laws, policies and discourses which influence industry and at the same time, rivers can act back on industry by reshaping policies and practices due to negative outcomes in rivers. This study also explores how these often conflicting and competing tensions overlap and influence the relationship between the river and industries.

1.3 Significance of Study

Whilst the relationship between industry and the environment is always discussed, there is often little qualitative research which documents and analyses how industry representatives conceptualize their relationship with the environment. This study will provide valuable insight into personal attitudes and perceptions about one critical aspect of the environment- the river and by default, water. This is important in a country like South Africa where the relationship between industry and the environment is highly discussed and scrutinized. It is also important as South Africa is considered a water scarce country, with climate change predictions showing more negative impacts on water (Dennis and Dennis, 2011). This study presents the views of industry, these can be helpful towards thinking about how to better intervene and work together to find a suitable and sustainable balance between social and economic development and the environment in South Africa.

1.4. Objectives of the Study

The aim of this study is to explore industry attitudes and perceptions about water by studying the relationship between businesses located in the New Germany Industrial Complex and the Palmiet River, as well as external actors, processes and practices that regulate and govern this relationship.

The research is designed to answer the following questions;

- What is the context within which the Palmiet River and the New Germany industrial area are situated (physical materiality, i.e. natural attributes of the river catchment and

physical characteristics of the industrial development, socio-economic and political context)?

- What are the attitudes and perceptions of industries in New Germany towards the Palmiet River, with a view to understand how they conceptualize water?
- How do the industries conceptualize the impact of climate change on their businesses?
- Identify external actors/ stakeholders (specifically street level bureaucrats and civil scientists) and how do they manage the relationship between industries and the river?
- How does the external context and the external actors impact the relationship between these two entities?
- What ecological infrastructure and services does the river provide for businesses in the area?

1.5 Thesis structure

The current introductory chapter presents the background and rationale for the study, along with the problem statement which inspired the inquiry into this particular topic. Furthermore, it presents the significance of the study as well as the overall aims and objectives of the research. Lastly it outlines the overall structure of the thesis.

The second chapter presents and reflects on literature pertaining to this research, using academic journals and various other sources of literature to compare and contrast findings and arguments from previous research. In this chapter, literature is reviewed to better understand and contextualize the hydrosocial cycle as a theoretical framework, as well as to outline main arguments of the theory and opposing critiques to present a balanced discussion about this field of study.

The third chapter presents a background of the study area. Offering a brief overview of the historical development of industry in Durban. Focusing on the influence of Modernist discourse in the development of Durban as an industrial city, with demarcated industrial Zones. Furthermore, the chapter, discusses the role different stakeholders in contributing to the pollution of the Palmiet River. The challenge of pollution has been acknowledged as one of the biggest challenges in the greater Palmiet Catchment area.

The fourth chapter presents discusses the research methodology employed to guide this study. It details the study design, research tools, as well as the type of analysis used to unpack and interrogate the data.

The fifth Chapter will present the findings of the study. The findings are detailed in a thematic manner, aligning them to the objectives of the overall study.

The sixth and final chapter of the thesis will be a detailed discussion of all the findings, illustrating how they compare or differ to previous research. Secondly, it presents the conclusion and final remarks. Lastly it presents suggestions for future research.

1.6 Summary

This chapter served as introduction to the research. It presented an overview of the background and rationale for the research. It also, detailed the aim and overall objectives of the research, outlining the broad research questions that will be answered as well as the significance of the study. Lastly, it presented the structure and organization of the thesis.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews and discusses how water and society has been conceptualized theoretically. Various sources of literature; such as academic journals, websites, policy documents and newspaper articles have been utilized to compare and contrast different theories and research that have informed discussions about the dynamic relationship between water and society.

The relationship between water and society has received increasing scholarly attention due to what seems to be a global shift in how water is discussed, defined and managed (Linton and Budds 2013). This shift can be attributed to the current socio-political, environmental and to some extent economic factors, which directly and indirectly influence the production of water and subsequently society (Ahlers 2010; Gibbs 2010). Some of the factors include climate change, issues of global water scarcity and quality, water and sanitation as well as challenges to water access and management (Swyngedouw 1999; Bond 2002). This study explores the relationship between industry and rivers and how the outputs of industry, including pollution and solid waste impact on rivers, exploring why this negative relationship has been established.

According to Linton and Budds (2013: 01), the increase in the desire to understand the relationship between water and society begins with acknowledging that "water management is not merely a technical field that can be addressed through infrastructure provision and scientific expertise, but a political one that involves human values, behaviours and organization". Acknowledging this premise allows for greater discussions about the social nature of water and forms the focus of this study, which explores how the relationship between industrial actors and rivers has been constructed. These discussions have implications on how we as society actually understand, talk and write about water, it allows for us to challenge what we thought we knew about water as well as question the ideologies and factors that have dictated and governed how we have constructed our relationship with water.

On a larger a theoretical scale, acknowledging the social nature of water infers a paradigm shift from regarding water as simply an object of social processes, to a nature "that is both shaped by, and shapes social relations structures and subjectivities" (Linton and Budds, 2013: 01). This means that studying the relationship between water and society seeks to do more than to simply understand the dynamics between society and water. It also investigates the shift away from traditional understandings of water; which often viewed water as just an object at the receiving end of social processes. Instead, moving towards more integrated and holistic understandings, which acknowledges the power and agency of water *to shape* and *be shaped* by society, thus highlighting the internal connection of water, social power and the ideological influences which shape water governance discourse (Swyngedouw 1999; Loftus 2001).

Linton and Budds position the hydrosocial cycle as a useful framework for exploring hydrosocial relationships, and they define it as "a socio-natural process by which water and society make and remake each other over space and time" (2013:01). The hydrosocial cycle can be understood as a framework which puts a human and political face to water, it "describes the process by which water is enlivened by human affairs, and human affairs are enlivened by water" (Linton 2008: 646). Furthermore, the hydrosocial cycle provides a space to fully explore the social dimensions of water and the role of different actors and processes in configuring their relationships with water, thus highlighting the role of water as an active agent of social change, as well as the dialectical relationship through which water and society interconnect and relate (Ridolfi 2014, Schmidt 2014). This theoretical approach is in contrast to studies grounded in the hydrologic cycle, which often adopted a one directional didactic approach to examining the relationship between water and society.

2.2. Characteristics of Water

Since the beginning of time water has been important for human survival and existence and raised curiosity about its nature, form and flow (Linton 2008, Linton and Budds 2013, Ridolfi 2014). The need to learn more and understand water and its various representations opened up new avenues of inquiry and analysis.

Before fully unpacking discussions about water and society, it is important to first focus on water itself; firstly, at what it is- the material properties, and secondly the various meanings and interpretations, the social construction of water. Water is considered one of the most important natural resources, similar to air, it is critical for the survival of all living beings

(Gleick 1993). In addition to being a life giving and sustaining source, water is often credited for its awe inspiring nature, and according to (Strang 2006) has inspired more poetry, art and literature than any other component of the environment.

There has been much curiosity and interest about the workings and flows of water. Most of the curiosity was based on wanting to find out what water was, where it came from and where it goes (Linton 2008; Ridolfi 2014). As this was early on in the inquiry into this substance, there were numerous interpretations, observations and hypotheses about the nature and origins of water.

Writings about the nature of water can be traced far back, however it was during the 17th century when scholars first began to critically theorize and evaluate existing theorizes of water and its circulation. Prior to the 17th century water was "recognized as the 'blood of the earth', and its flow was considered a subterranean, natural, divine, spiritual and theological affair" (Ridolfi, 2014: 20). As the years progressed there was a shift away from earlier theories, which were inspired by "observations of rainfall and river flow in the Seine basin, and on the idea of evaporation from the Mediterranean" (Ridolfi, 2014: 20), towards more scientific articulations of water. According to Linton and Budds (2013) this was a significant moment in studies about water as it encouraged and privileged the physical scientific over the social and mythical. The move away from religious and spiritual conceptualizations of water was significant as it enabled more scientifically rigorous research to dominate. This is the moment that many scholars argue that the studying of water as purely a scientific field isolated the social element in understanding, constructing and reproducing water (Linton 2008; Wilson 2014). As the pure science approach to understanding water dominated, discussions and the general discourse changed, and water was stripped of its many meanings and representations. It became a physical substance, which was controlled and regulated by hydrologists and engineers. Water became specialized, it was no longer spiritual and divine; instead it was explained by its scientific and material properties.

Water has many dimensions and characteristics to it. There is the formal chemical component, its material presentation which has been scientifically named H_2O due to its chemical composition of one Oxygen and two Hydrogen atoms joined together by covalent bonds. This chemical composition of water enables it to take various shapes and forms; it exists as liquid, solid (ice), gas and steam. It evaporates at a specific temperature, forms as precipitation under

particular conditions (Gleick 1993). These various forms of water demonstrate its diversity and its multidimensional nature.

Whilst there is only a single way to chemically describe and formulate water, there are numerous ways people socially construct water and its meanings. This is usually context specific and helps shape different perceptions and experiences of water. There is an emerging body of literature which documents these different experiences of water, focusing on "human mobilization and interrelationships with water. The mutual theme in this literature investigates 'water materiality', which seeks to understand or explain the role of biophysical and ecological characteristics in shaping 'human perceptions, discursive constructs and responses to water'" (Bakker, 2012: 617). This novel approach to writing about water, reveals the multi-dimensional nature of water, it demonstrates water as more than just a material object or commodity, it reveals water as "a non-substitutable flow resource essential for the life, ecological health, deep spiritual and aesthetic significance" (Bakker 2012: 618).

Strang (2006) explored shared cultural meanings and experiences of water amongst the Aboriginal people in Australia and a community of people living in catchment located in the South of England and uncovered that "at an individual level, they cannot survive for more than a few hours without ingesting and incorporating it. On a daily basis they are therefore confronted with inescapable evidence that it is integral to their own bodies, and constitutes the major part of their substance", further adding water is "integral to the composition of self and one's identity" (Strand, 2005: 99). Similarly, Gibbs (2010), posits that this approach to water can be used as a tool to deconstruct traditional and Eurocentric values of water. The arguments brought forward by Gibbs (2010) and Strang (2006) are important for this thesis, as the ethos of these ideas are similar to the manner in which water will be discussed and debated throughout the study.

2.3. Water shapes society

There is a large body of literature which documents and theorizes the relationship between water and society, more especially the different ways in which water connects people to the world around them (Wittfogel 1957; Swyngedouw 1997, 2006; Loftus 2005). Some of the early work which started analysing the interactions and relations between water and society can be traced back to Semple who wrote in 1911 about how water shapes and influences history. This type of work was important in shifting ideas about water as not just a natural commodity, but

rather demonstrated its agency, namely, the ability of water to impact on, and play a greater role in society, as well as the broader social dimensions of water, (Bakker 2003; Linton and Budds, 2013).

Research on the relationship between water and society has again increasingly become the centre of critical inquiry in academic scholarship (Fonstad 2013; Ridolfi 2014). As the interest in these subject increases, more scholars are evaluating the various components and intricacies to this relationship focusing on areas such as; climate change and water (Dennis and Dennis 2011), sustainable water governance models (Wilson 2014; Norman et al 2012). This increase in the study of the relationship between water and society has brought about dynamic and interesting collaborations between scientists in different fields (Sutherland et al, 2017). These collaborations can be attributed to advancing theory and illuminating previously unknown information.

2.4. Rivers

Rivers have played a pivotal role in reflecting the dynamic role between water and society and can be used as an illustration of how rivers and water are used to shape and develop societies (Postel and Ritcher, 2003). For many centuries' rivers have been at the centre of human evolution as well as the development of communities, and societies at large. For the purposes of this study, the Palmiet River will be used an entry to the New Germany Industrial Complex. Multitudes of the great civilizations of the world started alongside rivers from the ancient Mesopotamians who built the first urban settlements alongside the Tigris and Euphrates River, the ancient Egyptians who formed communities along the River Nile, as well as early Chinese societies who lived along the Valley of the Yellow, commonly known as the "mother" river (Postel and Richter 2003, Wong et al 2007). This behavior has been carried over into contemporary society, great cities, some of the largest metropolises have been built around rivers; Rotterdam, London, Montreal, New York City, Shanghai, Tokyo, Hong Kong and many other great and small cities (Postel and Richter 2003). The cities share another characteristic other than being strategically located near a river. They are also some of the richest cities in the world, and this can be attributed partly to their location near a river.

Once it was established that water was indeed critical to the establishment and advancement of communities and on a large-scale society, attitudes toward water shifted and it became central to not shaping but also organizing society (Swyngedouw 2004, Bakker, 2013). This means that the function of rivers and water expanded beyond the biophysical, the benefits of these were enhanced and harnessed to organize communities socially and politically, it became means to social power (see Swyngedouw, 1999). This was done primarily through the design and popularization of the hydrologic cycle (Linton 2008, Loftus 2011). This shift in attitude towards the role of water laid the groundwork and can be prefaced to the design and development of the theoretical conceptualization of the hydrologic cycle (Linton, 2008), which plays a critical role in how water is constructed globally.

2.5. The Hydrologic Cycle

The hydrologic cycle is a theoretical framework, accompanied by diagram designed and made popular by US born hydrologist R. Horton in 1931 (see Figure 1 below). The hydrologic cycle, which is commonly known as the 'water cycle' explains flow of water, from start to end. In his work Horton described the hydrologic cycle as "the natural circulation of water on, in and over the earth, a process that occurs independently of human involvement" (Linton and Budds 2013:02). It is important to note that concepts of a hydrologic cycle precede Horton. According to Linton (2008) earlier versions of the water cycle can be traced back to the 19th century. However, it was this version which was reproduced and popularized globally.

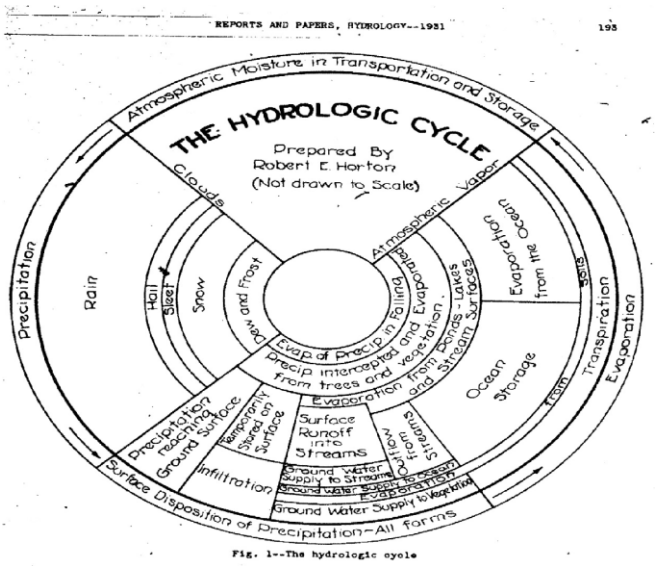

Figure 1: *The Hydrologic Cycle as first presented by R.E Horton in 1931*

Image copied from Linton and Budds (2013: 03).

Primarily at its most fundamental level, the water cycle documents the production and distribution of water. It serves to illustrate the various stages of water and how water is both simultaneously and continuously recycled in a circular manner around the earth, moving from the sea to land and into the atmosphere (Linton 2008, Graham et al. 2010). The water cycle is made up of five (5) stages; evaporation, condensation, precipitation, infiltration and runoff. Through these five processes water is constantly moving and reconfiguring around the earth, "Water vapour condenses to form clouds, which result in precipitation when the conditions are suitable. Precipitation falls to the surface and infiltrates the soil or flows to the ocean as runoff. Surface water (e.g., lakes, streams, oceans, etc.), evaporates, returning moisture to the atmosphere, while plants return water to the atmosphere by transpiration" (www.nasa.gov).

Coming from a past and context were the origins and movements of water were considered a mystery or articulated in spiritual and religious discourse; the hydrologic cycle demystified water. It revealed the various natural process which allowed it to flow and nourish the earth. In addition, the cycle illuminated the leading role of water in regulating the climate, cooling the earth's temperatures (Tundisi et al, 2015). It provided insight as to how the different countries globally could manage water in order to meet the demand and mitigate issues of scarcity and preventable droughts.

Furthermore, the hydrologic cycle provided a level of predictability to the often mysterious and untameable nature of water. This enabled for more comprehensive water governance strategies and policies (Tundisi et al, 2015). However, it seems like the pros and cons were two sides of the same coin; were on one hand the hydrologic cycle was celebrated for re-introducing the flow and flux of water to public consciousness and discourse. And on the other it also cemented the study of water as purely scientific, natural and apolitical; a perfect cycle completely void of social impact and human imprint.

2.6. Criticisms of the Hydrologic Cycle

One of the biggest critiques against the hydrologic cycle was the fact that it conceptualized and represented water activity in a uniform and 'rational manner' (Budds 2013; Ridolfi 2014). In the hydrologic cycle the flow and circulation of water is presented as cyclical, with little to no

acknowledgement of the various external actors and processes that influence and inform this cycle.

According to Linton (2008), the purely scientific depiction of water, completely void of human activity in the production of water reflected the era in which the cycle was designed. The Hydrologic Cycle was designed around the time of The Great Depression, one of the biggest financial crises in the history of the world. Governments turned to scientific, mathematical and statistical methods to fix the economy. The same approach was suggested for water management. According to Linton (2008: 636), "hydrologic science had established a mathematically structured representation of the water process as a self-contained and dynamic mechanism, one like the economy, was readily taken up by the State as a discursive objective". Additionally, the Great Depression expanded the role of the State in managing and controlling natural resources. As argued by Linton (2008: 636), "the political circumstances of the Depression allowed what Donald Worster (1985) described as 'an immense ballooning of the State' in terms of its capacity to account for, represent and assume control of the nation's natural resources, water in particular" (page 279). The involvement of the state solidified the entry of the role of water in politics and governance.

The scientific approach as a form of state management can be linked to the second critique of the hydrologic cycle. Social scientists argued against the clear absence of social or human contributions to the production and reproduction of water (Linton and Budds 2013; Loftus 2011), because the hydrologic cycle as illustrated and presented by Horton (1931) excluded people and the role of society in the production and reproduction of water. The process of water production is illustrated and explained in an untouched cyclical manner. To support his design, Horton and other hydrologists emphasized the absence of humans in the cycle. He defined the hydrologic cycle "as the natural circulation of water on, in and over the earth, a process that occurs independently of human involvement" (Linton and Budd, 2013: 02). In a similar vein another hydrologist Maidment (1993) described the hydrologic cycle as "an immense water engine fuelled by solar energy, driven by gravity, proceeds endlessly in the presence or absence of human activity" (1993: 13). Both these definitions explicitly express the lack of human involvement in the circulation of water. This view positions humans outside of the cycle, thus making them modifiers or disturbers of the 'natural flow of water'. According to Linton and Budds (2013), this positioning enabled hydrologists and the state to reduce the agency of water as well as control and regulate water through scientific methods and technologies.

The hydrologic cycle utilized more technical expertise and managerial bureaucratic approaches to water management and governance. This approach shapes the response of many water users in society today, who do not take personal responsibility for their relationship with rivers and water supply, they see this as the technical responsibility of city engineers and water officials, as will be explored in this study. This approach has been instrumental in the exercising social power and shaping specific waterscapes. The rise of technocracy, which Budds (2013) contends is a "component of neoliberal thought, based on the idea that policy should be directed by technical expertise instead of partisanship" (2009: 421), perpetuated the role of scientists, engineers and various other technical experts to make administrative decisions based on scientific facts and knowledge. Thus, technocracy moulded the relationship between water and society to meet certain political objectives.

According to Budds (2013), the shift towards a more technocratic management/ governance was intended to fulfil 'neoliberal economic reforms' (the author was writing specifically in the Chilean context), which sought to reduce the role of the state in both the economy and society. He argues further that the reforms made were not simply technical, their intentions were far grander in that "they contributed towards a wider political objective held by technocrats: that of spearheading successful economic social reforms that would consolidate their own political power and place them as the strongest contenders to form the government following the eventual dictatorship" (page 421).

The hydrologic cycle was further used a vehicle to advance political agendas, for example state control of water as a means to control and organize society, through water governance laws and policies (Gandy 2002). This had a direct and indirect influence on how water was defined and managed in the mainstream. Water was used as an object for human consumption and development, perpetuating a didactic interactions and relations with water and other natural resources. The U.S. federal government benefited greatly from the hydrologic cycle. Linton (2008) argues the hydrologic cycle appeared at a "propitious moment" for water in the US as the federal government was about to begin a massive "fluvial manipulation" program, one of the biggest in American history, possibly suggesting the hydrologic cycle was designed to assist the State in its fluvial management programs.

Substantive evidence exists (See Swyngedouw 1999, 2007; Bakker 2008, 2013) which documents the social dimension of water, focusing mainly on the role of the State in

manipulating nature, particularly water, to advance and achieve certain socio-economic agendas and political projects. Through a detailed historical analysis Swyngedouw *(*2007:10*),* demonstrates "how Spain's hydrosocial modernization process after the civil war became a deeply and very specific scalar geographical project" by exploring the different ways the State utilized water sources and policies to transform the country's hydraulic environment in order consolidate and expand political power.

The Spanish government under the leadership of Franco developed and utilized specific water policies to change the socio-economic conditions in Spain. Swyngedouw (2007) details the various water policies and the context in which they were developed and the outcomes they sought to achieve. These were twofold – firstly, "Franco's ideological-political mission was predicated upon national territorial integration, the eradication of regionalist or autonomist aspirations and a concentrated discursive and physical process of cultural and material national(ist) homogenization" (2007:07). Secondly, "the production of the techno natural material infrastructures of this modernizing programme was predicated upon re-scaling the 'networks of interest' on which Franco's power rested from a national visionary to an internationalist geo-economic and geopolitical imagination, articulated through Spain's integration in the US-led Western Alliance" (Swyngedouw 2007:07). This brief account of Spain's hydraulic transformation exposes the institutionalization and politicization of water and its agency to achieve political objectives which have direct impact on society at both a micro and macro scale.

In a similar vein, Bakker (2013) presents a historical analysis of the "evolution of the World Bank's (WB) policies on the Urban Water Supply Networks from 1960 to the late 1980's" (2013: 280). Highlighting the paradigm and ideological shifts within the World Bank, which supported governments to exploit water as a tool to advance its global development agenda, which aimed to expand the "biopolitical power of developmental states" (2013: 280). Similar to Spain, governments worked in collaboration with the WB who used water to form political alliances and maintain hegemonic control.

Supplementary critiques of the hydrologic cycle exposed the flaws of its design and conception, which privileged a westernized view of water. According to Linton (2008) the design of the hydrologic cycle is not a realistic representation of global water; "by representing water as a constant cyclical flow, the hydrologic cycle establishes a norm that is at odds with the hydrologic reality of much of the world. Misrepresenting the hydrologic experiences of vast

numbers of people" (page 639). Further elaborating that privileging Western ideals of water erases other hydrologic realities and experiences, therefore making the hydrologic cycle vulnerable to exploitation for imperialist motives and agendas.

The hydrologic cycle successfully co-opted the field of hydrology and carved a narrow view and application of water resources. This narrow approach to the understanding of water was useful for the advancement of state agency and policies (Swyngedouw 1999; Linton and Budds 2013; Bakker 2013). In this one-dimensional view of water, water is utilized by the state as a tool to achieve development goals, and thus managed as a technical resource requiring the skills of engineers, planners and other specialists (Linton 2008). However, there is a paradigm shift in how water is understood, an increasing realization that water is "entangled with other ecological processes and human society" (Linton and Budds, 2013: 03) and therefore that this needs to be reflected in how water is managed and constructed in society. This is essentially an acknowledgement of water's social dimension which demands a holistic approach to hydraulic management and governance.

The holistic approach to water governance, goes beyond talks of 'integration', which according to Linton and Budds (2013), can be understood as "integrating cultural, ecological and economic aspects of water and calls for the inclusion of all relevant stakeholders in the decision-making process" (page 3). In fact, the authors argue that the very notion of integration further compartmentalizes water *and* society, as it reinstates the idea that these two entities are separated. In contrast, the hydrosocial cycle highlights the interwoven dialectical relationship between water and society, which is facilitated by hydrosocial hybridity.

2.7. Shifting the paradigm: towards a hydrosocial cycle

The dynamic nature of our society requires a more multidimensional conceptualization of water. A conceptualization in which water is viewed as more than just the material H_2O, one which allows for the social and political elements of water to be explored. There is growing consciousness in documenting the political, social, ecological and economic manifestations of water (Strang 2006; Wong and Brown 2008; Gibbs 2010). In political and economic terms, the presence and absence of water is understood to be dictated by financial flows and global capital. From water privatization to the construction of dams and pay-as-you-go water meters- all of these economic and financial systems dictate whether people access water or not (Bond 2002; Bakker 2003; Loftus 2011, Ridolfi 2014). This dimension also speaks to the various external

actors, processes and practices that govern hydrosocial relationships, which will be explored in more detail later in this thesis.

The hydrosocial cycle is a direct response to the short falls of the hydrologic cycle and presents alternative ways to conceptualize water and society (Ridolfi 2014). The hydrosocial cycle was designed to challenge the presentation of the hydrologic cycle as a neutral scientific idea, void of any political influences, many of the proponents of the hydrosocial cycle vehemently argued against this misrepresentation (Linton and Budds 2013), stating it was misleading and in fact the hydrologic cycle severed certain political objectives. Those primary objectives being; diminishing the agential role of nature and its ability to shape and organize society by recreating it to fit into a specific narrative in which it can be manipulated and exploited for human consumption, under the guise of development (Bakker 2013; Linton 2008), as well as to advance the position of hydrology as a framework and science most suitable and accurate for understanding global water. This was problematic for the reasons already discussed above.

2.8. The Hydrosocial Cycle

The hydrosocial cycle was conceptualized to illustrate a more realistic representation of the water cycle (Linton 2008, Linton and Budds 2013, Bakker 2013). This conceptualization borrowed from various schools of thoughts, theories and ideologies. The hydrosocial cycle is a result of a collaboration between various philosophies and research (Swyngedouw 2012; Ridolfi 2014). These different perspectives laid the theoretical foundations for the hydrosocial cycle and therefore accounts for the various material and socio-political definitions and experiences of water.

Exploring the social nature of water has served as the foundation for the development of the hydrosocial cycle theory. The idea of a hydrosocial cycle has been around for at least a decade (Swyngedouw 2007, Schmidt 2014) made popular by scholars in geography and political ecology, however there is no single definition of the term. Linton and Budds (2013) define it as “a socio-natural process by which water and society make and remake each other over space and time” (page 01). Ridolfi (2014) elaborates and describes it as a concept “which interrogates both the physical and socio-political nature of water”, she further adds “by employing this concept, through the lens of Urban Political Ecology, they have showed how water is closely linked to social, political, cultural, and economic systems and how they govern different flows of water through societies, shaping the formation of urban environments” (page 15). This is the

definition that will be used in this paper to understand and explain the hydrosocial cycle. This definition is the most suited for this research because it provides an appropriate framework, as it allows for nuance and context, which are critical in investigating the relationship between water and society, through exploring the relationship between industry in New Germany and Palmiet River.

Water is often presented as a tool to achieve specific outcomes, and seldom is the role of water as an agent of change and influence documented. This is one of the unique characteristics of the hydrosocial cycle. To begin uncovering the agential role of water in society, we have to consider water as living, in the sense that water "internalizes social relations and politics as opposed to being merely the object of politics" (Linton and Budds, 2013: 02). Presenting water as an active part of society breaks down the segregation between 'water' and 'society'. It removes the dualistic constructs of the relationship between water and society and shifts towards a more integrated and relational centred approach. It is through this relational approach that we can begin to understand how water and society make and remake each other, and thus better understand the socio-political and power relations that are embedded in water.

In material terms, water and society cannot be isolated as traces of anthropogenic influence are evident through various types of pollution. According to Wong et al (2007) the world's greatest rivers are suffering under the weight and destruction caused by humans. This demonstrates how global water bodies literally have and contain human imprints (Linton and Budds 2013), water pollution, expanding economies, growing populations, specifies and climate change amongst other things, directly impact on rivers and water (Shiklomanov 2000; Wong et al 2007; Flu et al 2014; Buono and Eckstein 2014). Similarly, anthropogenic pollution has been identified as one of the biggest challenges in the Palmiet Catchment (Naidoo 2005, Moodley et al. 2014, Palmiet Nature Reserve.net), and the leading cause of decreasing biodiversity and deteriorating water quality in the Palmiet River.

2.8.1. Relational-Dialectics and Water

Relational and dialectic theory is often is linked to Karl Marx who combined economics, sociology and philosophy to explain the organization of society. According to Linton (2010) "dialectics sees the world as a fundamentally constituted of processes, relation and change" (2010: 25). The seminal works of Semple (1911) and Wittfogel (1957) are often credited for applying ideas of relational-dialectics into understanding the intricate relationship between

water and society and more specifically the role of water as a political tool utilized by the state to centralize society (Swyngedouw 1999; Bakker 2003; Linton 2008; Loftus 2011; Bannister 2013; Budds 2013).

According to Marx there is a constant tension struggle between humans and nature. Humans are constantly and actively seeking to escape the limitations and constraints of nature (Marx 1971). Through this constant struggle the characteristic of human society and nature are altered and transformed, thus reconfiguring the relationship (Swyngedouw 1999, Bond 2002; Linton 2010; Bakker 2012; Bannister 2013). This basic principle of relational dialectics has been extrapolated to the inquiry into the relationship between water and society and begin to illuminate the social and political nature of water.

2.8.2. Hybridity

The concept of hybridity is present in discussions about water and society as it is one of the first theoretical concepts employed to challenge traditional, mutually exclusive articulations of the 'nature and society' debates. Rooted in Marxism, the theory of hybridity has advanced the main arguments which form the theoretical underpinnings of hybridity which can be summed as; a) highlighting the internal relationship between nature and society, b) disputing conventional articulations of nature and society as mutually exclusive entities, c) proposing instead a shift towards looking at the internal relations between nature and society and finally, advocating for the acknowledgement of 'social nature', 'socio ecology', 'social nature' and other similar terms to articulate the complex and dynamic relation between nature and society (Linton and Budds 2013) . These themes have been particularly relevant in studies concerned with understanding the relationship between water and society and they will be employed in this study on the relationship between industry and the river in the Palmiet Catchment.

Swyngedouw (1999) further advocated the idea of understating water relationally by arguing that there is an internal connection between water and society. The idea of understanding water and society as internally connected as opposed to externally has been termed *"hybridity"*, Swyngedouw defined it as "a thing like appearance that is part natural and part social and that embodies a multiplicity of historical-geographical relations and processes" (1999, p 445) and similarly in (Swyngedouw 2004) looking specifically at water, "water is a 'hybrid' thing that captures and embodies processes that are simultaneously material, discursive and symbolic" (2004: 28). Linton and Budds (2013) expand the term to *"Hydrosocial Hybridity"*. Hybridity

"implies a shift from thinking of relations between things such as the impacts of humans on water quality - to the relations constituting things - such as the cultural, economic and political processes that constitute the particular character of water" (Linton and Budds 2013: 04). Hybridity challenges traditional notions of dualistic thinking about water and society, as two isolated components or entities, rather it posits that both are yields and agents of socio-natural change.

2.9. Hydrosocial Cycle Waterscapes

The hydrosocial cycle allows for diverse waterscapes, as opposed to the 'one size fits all' approach of the hydrologic cycle. According to Budds and Hinojasa (2012) "waterscape represents a useful framework to approach the multiple processes and dynamics that mediate water over space and time, in a way that avoids the limitations of thinking about water in purely material terms, analysing water issues according to traditional spatial scales, and accepting hierarchical forms of institutional administration as given (2012: 120). In a similar vein, Loftus (2005) writing specifically in the context of Durban, South Africa explains a waterscape as "a networked entity -the system of pipes, purification works dams that link city's people", he continues "the waterscape is better understood as a complex of relationships, processes and struggles. It should be understood as something dynamic and changing – in a material way, as the networks expands to outlying settlements; and in a political way, as balance of power shifts from group of people to another" (2005: 03). Hydrosocial waterscapes unveil the politics that make up and constitute water within a society.

Rattu and Véron (2015) unpack the politics of tap water in Switzerland and discover a political waterscape, one in which there were intricate interactions and overlaps between the water sector and the two dominant types of governmentality in 1850 and 1950, and how they influenced Swiss water networks, ideologies about sanitation as well the overall organization of society.

Similarly, although already briefly aforementioned, Loftus 2005 uncovers complex hydrosocial relationships in the South African (Durban) waterscapes. A waterscape where water is site for power struggles, and positioning. The South African waterscape still carries the burdens of South Africa's unjust apartheid past. South Africa is said to be the most unequal country in the world as it possesses the highest Gini-coefficient (Bosch et al 2010). The inequalities in South Africa go beyond just the economy; they permeate all sectors of society

and trickle down to the provision of basic services such as water and sanitation. Bond (2002) provides an example of the inequality regarding the provision and access to water in early democratic South Africa. “Only 25 percent of the water sold in Gauteng in 1995 by Rand Water- comprising 41 percent of the Vaal River System’s supply- was bought by low income consumers, while 36 percent went to middle- and upper-income consumers, 24 percent to industry, and 15 percent to large mines” (Bond 2002: 243).

The waterscapes sought to demonstrate real world applications of the hydrosocial cycle, and although they are context specific, they all demonstrate the political nature of water and how it shapes and informs society. Additionally, they reveal that this relationship is not stagnant or fixed, rather these entities continue to reproduce each other over space and time. With the aid of various actors and processes, hydrosocial relationships are continuously being reconfigured and forming unique waterscapes.

2.10. Summary

The hydrologic cycle has been positioned as a tool to help better understand the water cycle. However, through its design it alienated the role of society in shaping and influencing the production of water. Additionally, the water cycle limited our understanding of water. As a result, of the alienation, the role of society was minimized and thus the true and multidimensional nature of water was underexplored. Through vigorous exploring of the relationship between water and society, the political nature of water and unique waterscapes emerged, informing new theory and discussions about not only the relationship between water and society, but also about the internal nature of this relationship. Understanding water and society as internally connected allowed for a more complex and dynamic analysis of water and allows for more diverse understanding of water governance. This aided in discovering new meanings and experiences of water beyond its material composition. The result of these discoveries and inquiries into the relationship between water and society brought about a paradigm shift towards a hydrosocial cycle, a water cycle which acknowledges and interrogates the social as well as the political nature of water.

CHAPTER THREE

BACKGROUND TO STUDY AREA

3.1 Introduction

This study is a single embedded case study (Yin 1981), looking to understand the relationships and dynamics between industry and the Palmiet River, located in the Pinetown/ New Germany industrial Complex. This location is relevant because it contains many of the elements dynamics between industry, natural environment in Durban eThekwini and Pinetown/ New Germany industrial complex.

This chapter will describe the location and context of the study area. Firstly; it will outline the physical location of the city, as well as highlight the socio-economic characteristics of Durban. . Secondly, it will briefly outline the history of the expansion of industry in Durban. Focusing on the modernist discourse which shaped the design of Durban as an industrial city. As well as highlight the significance the role of ecological services in supporting the expansion of Durban, as an industrial city.

3.2 Durban and eThekwini Municipality

Figure 2: Satellite image of Durban, East coast of South Africa

Durban is located in the East Coast of South Africa (29°53'S 31°03E), in the province of KwaZulu-Natal (Freund, 2001). It is the third populous city in South Africa after Cape Town and Johannesburg; with a reported population of 595 061 (Statistics South Africa, 2013). Due to its bustling tourism sector, Durban is also referred to as "South Africa's Playground" (SouthAfrica.net).

Durban is commonly referred to as "eThekwini", this is also the official name of the local government- eThekwini Municipality, which is responsible for managing and governing the city (Roberts, 2008). The eThekwini municipality has made substantial efforts to make the city profitable as well as environmentally safe, and this has been evident over the recent years as the municipality has been active in building resilience against the looming threats of climate change, and its well documented impacts on the provision of water in the region (Roberts, 2008).

One of the most prominent features about Durban, is that it accommodates one of the biggest and busiest ports in the Southern Hemisphere. This makes Durban a major key player in the overall economy to the country. Durban is South Africa's second biggest industrial complex, after Gauteng (eThekwini Municipality, 2003). The port enables the country to engage in international trade, facilitating South Africa's ever-expanding export and import trade (Valodia 1999, eThekwini Municipality 2003). In addition to trade through the port, Durban is known for its manufacturing, especially clothing and textile (Prinsloo, 1996) and over the years industry in Durban has diversified and now includes a petrochemical sector (Roberts, 2008).

3.3 Modernist Plans: A Brief History of Durban

The Port has played a vital role in the creation of Durban as an industrial and competitive economic hub. According to Scott (2003), modernist discourse greatly influenced the design of the city of Durban. The focus of modernist planners was to design cities that encouraged and enabled industrialization. The modernist design of Durban was further enabled by the intermingling interests of the local and national State and Industry. Modernist discourse not only influenced the design of the city of Durban, it also worked as a tool to organize the social and economic landscape of the city.

Too a large extent Durban has kept the original design and invested in developing the different industrial zones, across the city. Zoning was one of the practical methods in which modernist designs were implemented (Scott, 2003). To date, the city of Durban has zones demarcated specifically to accommodate industry and manufacturing, namely; Clairwood, Mobeni, Isipingo/ Prospecton, Umgeni, Pinetown, New Germany/ Westmead areas (see: The eThekwini Municipality Industrial Land and Land Strategy Development, 2014).

Scott Brown (1964) expands on some of the critical factors that led to the development of Durban as one of the biggest industrial zones in South Africa, mainly the role of ecological infrastructure and the services it provided in making Durban conducive for industrial expansion. Prior to 1914 small commercial businesses began to grow around Durban and the port. Before World War One, Durban was a commercial port city much of the small businesses were near and surrounding the port. As the industrial potential of Durban was realized, the once small Durban Borough, was expanding its boundaries. Small industrial nodes began forming in areas such as Congella, Isipingo, Wentworth, Merebank, Umbilo, Jacobs. In 1920 the area of Clairwood and Maydon Wharf were slightly more developed as industrial nodes. During this period the industrial capacity of Durban was expanding, and even more industrial nodes were identified, one of the areas was located South of the Umbilo River; and this was because of its accommodating flat topography which is suitable for industries, close to the harbour, and close to townships, which served as 'cheap labour reserves' for industry. According to (Prinsloo, 1996 and Valodia, 1999), the abundant of labour was one of the biggest sources of attraction to the Pinetown, New Germany area.

3.4 Pinetown/ New Germany and The Palmiet Catchment

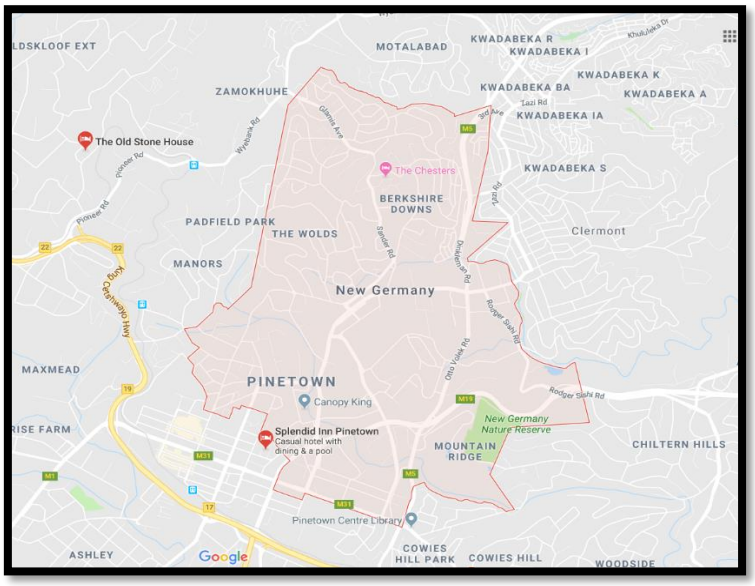

Figure 3: Map of New Germany

This study was conducted in the Pinetown, New Germany area which is located in the Inner West part of the city Durban, KwaZulu-Natal. Pinetown, New Germany is an urban area which comprises of industry residential areas and the Palmiet Nature Reserve. The Pinetown, New Germany area which is heavily industrialized is considered an important economic hub for the city of Durban and the broader eThekwini Municipality. The greater Pinetown and New Germany areas were given 'Brownfields' status by the Municipality's *Industrial Land Study and Land Strategy Development team*; "Brownfields – areas that are zoned for industrial use, serviced and developed but are deteriorating and therefore not attracting the development that should be expected and may as a result be experiencing increased vacancy rates i.e. are in need of intervention to retain and attract development" (The eThekwini Municipality Industrial Land and Land Strategy Development , 2014: 19).

The Palmiet Catchment, an urbanized catchment is located 15 km Northwest of Durban. It is 26 km long, the river flows from Kloof and it enters Umngeni through Springfield (du Preez and de Villiers, 1987; Naidoo, 2005; Moodley et al, 2014). Additionally, within the Catchment there is the Palmiet Nature Reserve, however only 6 km's of the river is within the reserve. Majority of the river flows amongst and in between factories and private residential areas. The geological composition of the Palmiet catchment consists of Table Mountain sandstone in

central and western parts of the catchment, with Dwyka, Ecca and alluvium formation in the eastern parts (du Preez and de Villiers, 1987).

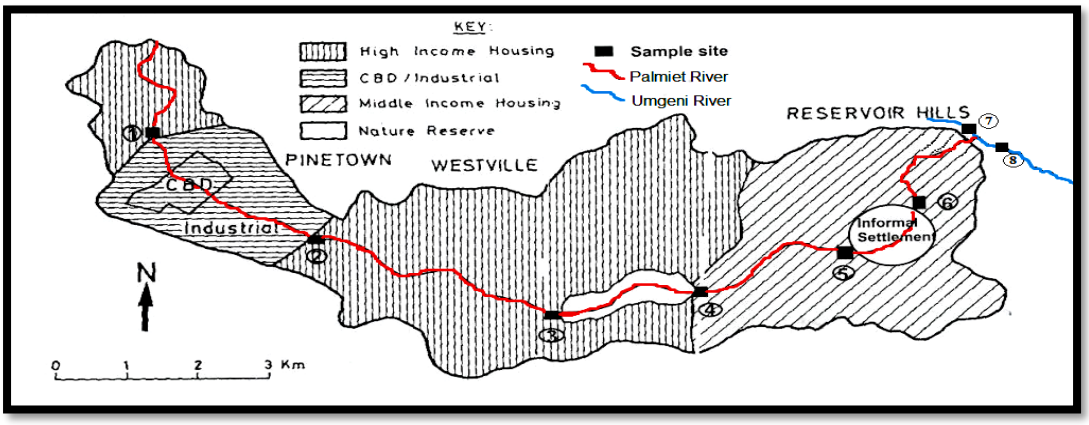

Figure 4: Map showcasing demarcated land use in the Palmiet Catchment (Moodley et. al, 2014).

The residential homes range from high income to informal settlements and are situated along the catchment, with industries located in the upper parts of the catchment. The area was considered a high to medium income area and was historically only reserved for white residents, post 1994 the area became racially integrated. According to (Statistics South Africa 2011 census); 48.67% of the residents of New Germany were black, 33.15 % white, 12.30 % Indian or Asian, 4.46 % coloured and 1.42% who identified as other.

Although only 6 km of the Palmiet River flows through the nature reserve, the Palmiet Nature Reserve is an important part of the catchment. Firstly, it lends it name the entire catchment and is named after the *Prionium Serratum* plant (Palmiet Nature Reserve). However due to excessive pollution the plant is no longer present in the catchment. Secondly the Palmiet Nature Reserve is important because it serves as a conservancy for the various plant and bird species which can be found in the catchment.

Pollution is credited as the biggest threat to the Palmiet Catchment. The source of the pollution is mainly industrial effluents, with an average of 10.45 pollution incidents reported between January and November 2016 (Naidoo, 2018). however old municipality infrastructure, such as old pipes, drainage and sewerage systems, tend to overflow and exacerbate the pollution in the catchment; coupled with illegal dumping of waste generated from private residential areas

along the catchment. These anthropogenic factors have contributed to the decline in the quality and presence of biodiversity in the greater catchment.

3.5 Summary

This chapter provided a brief overview of the city of Durban and the history of industry. It was provided some background information of the study area, highlighting some of the socio-economic demographic characteristics of the area. Then, discussed the role of pollution as a threat to the Palmiet Catchment and the environmental systems which help maintain the health of the river and the catchment.

CHAPTER FOUR

METHODOLOGY

"The term methodology refers to the way in which we approach problems and seek answers. In the social sciences the term applies to how research is conducted. Our assumptions, interests and purposes shape which methodology we choose" (Taylor et al. 2016, p 03).

4.1. Introduction

This chapter outlines and describes the methodology of the research. This chapter will explain the research setting, data collection methods, sampling techniques and data analysis employed to conduct the study. Furthermore, this chapter will discuss limitations of the study, ethical considerations and address matters of validity, reliability and rigor.

4.2. Methods

Qualitative research methods were utilized for data collection, sampling, and data analysis. Qualitative research seeks to probe and investigate how people construct the world and their experiences (Brooks- Gordon et al 2010). Therefore, qualitative research methods were most suitable for this research because the study is exploratory in nature and thus needed in-depth, first-hand information as opposed to quantitative data and statistical analysis (Baxter and Jack 2008).

4.2.1. Interviews

Data was obtained through semi structured in-depth interviews. The use of interviews as a form of data collection aligns itself to the constructivist research paradigm. This study is influenced mostly by the constructivist approaches to research. According to a range of authors (Guba and Lincoln, 1994; Guba and Lincoln 2005, Baxter and Jack, 2008), with regards to questions of methodology, the constructivist approach proposes that the truth and reality are subjective and are socially constructed, therefore generating knowledge is collaborative effort between researcher and participants. The constructivist research philosophy is 'relativist' and acknowledges that there are multiple realities or lived experiences and that these realities are constructed and shaped by various factors and institutions. The constructed realities are localized and specific to individuals, however; there are elements which are common between

individuals and cultures. The constructed realities are “not more or less true in the absolute sense, but simply more or less informed and/ or sophisticated” (Guba and Lincoln, 1994:111).

According to Turner (2010), open-ended interviews are useful because they provide structure and consistency. All participants are asked the same set of questions. However, the open-ended nature of the questions also allows for participants to speak freely about their personal experiences. This enables the researcher to further probe and explore new themes that may arise from the discussion or ask participants for more detailed information. Thus, standardized open-ended interviews combine the benefits of informal conversations, with the use of structure to guide the discussion in order to yield topic specific information.

Quantitative research methods are often considered superior and are seen as the gold standard in scientific and academic research. There are still wide perceptions that only quantitative research is able to produce rigorous and valid research outputs (Baxter and Jack, 2008). However, there is growing acknowledgement of the short falls of quantitative research. The main issue being the lack of depth from quantitative data sources. Whilst they are beneficial for helping set the context in terms of understating broader issues and phenomena, they are often unable to provide detailed and data (Smith 2015). Qualitative research is as important and is able to produce detailed information that help researchers to better understand the context and various other factors that influence data and research outputs.

4.3. Sampling

As this was a qualitative case study, non-probability sampling methods were utilized to select participants and more specifically, purposive sampling was adopted. Purposive sampling enables the researcher to select respondents based on the theoretical knowledge and understanding of the research and that respondents most relevant to the study are included in the final sample (Turner 2010). Non-probability sampling does not allow for generalization of results.

A few steps were taken to identify and select the most suitable participants. Firstly, Google Maps was used to get an aerial view of the land, river and all the businesses surrounding it. Secondly, I organized two field trips and drove along the river in Pinetown and New Germany. The purpose of these field trips was to verify the initial information obtained from the google search, identify the businesses which were closest in proximity to the river as well as collect

contact information in order to communicate with the business about the study. Once all the names and contact details of the businesses were collected and compiled, I emailed and phoned all the businesses on the list. However, there was no feedback or correspondence. I organized a second field trip to Pinetown and New Germany, and this time around I went door to door talking to employees about the study.

The second field trip proved more effective and I managed to get a few interviews. From then onwards, the snowball method was used to obtain participants, as some business owners referred me to other business people in the area, similarly with participants from the municipality. Snowball sampling, also known as chain sampling, "is an approach for locating information-rich key informants" (Patton, 1990: 176). Some of the business owners even went to the extent of phoning on my behalf and used their position to secure participants for me to interview. This does create some bias in the sampling as this then means that the participants knew each other and were connected, and perhaps had similar mindsets and ways of approaching their businesses, but this was the only way I could break into the network of industry actors.

Table 1: Respondents Interviewed

Name of Respondent	**Date and Venue of Interview**	**Organization**
Respondent 1	*10 December 2015* Pinetown Water and Sanitation Municipal Offices	eThekwini Water and Sanitation (Pinetown). He is employed as the Water quality Officer.
Respondent 2 Respondent 3	*10 December 2015* Pinetown Water and Sanitation Municipal Offices	eThekwini Water and Sanitation (Pinetown)
James	*10 December 2015*	Manufacturing

	Place of work	
Lee	*29 February 2016* Palmiet Nature Reserve	Civil Society
Andrew	*27 June 2016* Place of work	Manufacturing Director
Valerie	*27 June 2016* Place of work	Owner Auto Design and Installation Company
Tracy	*27 June 2016* Place of work	Receptionist Motor repairs workshop
Samantha	*27 June 2016* Place of work	Secretary Car Wash
Niel	*27 June 2016* Place of work	Owner Motor repair workshop
Penny	*27 June 2016* Place of work	Administrator, Motor repair workshop
Jack	*26 May 2016* Place of work	Regional Manager Chemical company

In accordance to the University of KwaZulu Natal ethics committee recommendation; the names of participants, who requested anonymity (see appendix 3- participants informed consent), have been changed, Pseudonyms were used instead. All identifying information such as specific name of organization, has also been removed.

4.4. Data Collection

Standardized open-ended interviews were used to collect data. Interviews were recorded and transcribed. The length of the interviews was determined by the participants as they were typically busy individuals. Two sets of interview guides were developed (Appendix A) for businesses. The focus of this interview guide was to understand how industries interact with the river and their relationships with the different stakeholders who are responsible for the river and water in the area. The second interview guide (Appendix B) focused on understanding the perspective of other stakeholders and key informants who work interact with businesses with regards to water and other issues.

Data was collected on a diverse group of stakeholders, consisting of; ten business people who worked in businesses located in the Pinetown and New Germany industrial complex. Businesses whose premises were physically in close proximity to the River were selected. Two group interviews were conducted with members of the eThekwini Water and Sanitation Unit, Pinetown division. One member from 'River Watch' a civil society organization was interviewed.

4.5. Data Analysis

Data from the recorded interviews was transcribed and analysed thematically. Codes were generated from the data using an inductive bottom up approach (Gehman et al 2017). This helped identify patterns and relationships emerging from the data, which was further grouped into themes. Braun and Clarke (2006) advocate for thematic analysis in qualitative research as this of type analysis is useful in summarizing the main features of the data and it provides for in-depth descriptions of the data. Moreover, it can provide and generate 'un-anticipated insights' (page 97) which can shed new light and knowledge on the relations in the hydrosocial cycle.

4.6. Validity, Reliability and Rigor

It is often difficult to measure validity, reliability and rigor in qualitative research, as these types of concepts and tools used to assess this were developed for quantitative research methods. Qualitative research is unique and the results from such studies cannot be generalized

for the entire population (Spencer et al 2003). However, Guba and Lincoln (1994) developed robust criteria that can be used to ensure qualitative research of good quality and reliability. The paradigmatic underpinnings of the research are critical in ensuring reliable research (Morrow 2005). This study follows the constructivist approach to research, this type of research approach, the data collection methods and analytic tools are crucial in ensuring reliability and trustworthiness of the research and the results obtained.

Using standardized open-ended interviews eliminates researcher bias as the detailed information provided by the participants becomes difficult to manipulate, especially when working with many respondents (Turner 2010). The constructivist approach to research acknowledges that researchers have their own biases, ideas and beliefs before conducting interviews and the same can be said for participants. Therefore, it is critical to triangulate the data in order to minimize individual biases and perceptions which may distort the data (Patton 1990). For this study different stakeholders where interviewed; including employees from the municipality and civil society, in addition to the targeted business owners. This ensured that diverse perspectives and realities were accounted for and allowed one to compare and contrast responses.

Interviews were recorded and transcribed - this also served as a measure to check against data manipulation and misinterpretation. As stated by Shenton "steps must be taken to help ensure as far as possible that the works findings are the results of the experiences and ideas of the informants, rather than the characteristics and preferences of the researcher" (2004: 72).

Furthermore, to ensure rigor and to strengthen the validity of the study, in the findings chapter extracts and direct quotations from the interviews are used to demonstrate participant's responses and reflections (Shenton, 2004; Fereday and Muir-Cochrane, 2006). This is paramount for demonstrating confirmability which confirms trustworthiness in research.

Participants were given the option to see the finalized dissertation, this is known as "the process of member checks, a method sometimes used to validate participants responses to a researcher's conclusions about them" (Fereday and Muir-Cochrane, 2006:82). A number of the participants welcomed this option and requested the dissertation via email. Member checks also serves to ensure rigor and validity as participants can challenge misinterpretation of their responses.

4.7. Limitations of the study

One of the main limitations of the study is due to its qualitative design and therefore the results from the study cannot be generalized for the population (Guba and Lincoln 1994). In addition to study design limitations, finding willing participants was a great challenge. The data collection period was 7 months. It was difficult finding business owners and employees who were willing to give interviews during work hours, a number of potential participants mentioned that they could not take time off their workday. Weekends were also not a viable option because participants were away from work and it was time reserved for personal activities.

Due to the nature of the questions asked in the interviews, it was a concern that some business owners might feel compelled to exaggerate their relationship with the river or under report their impact on the river.

The snowball method was efficient in helping me get participants for the study, however it also created a bias as many of the respondents I interviewed belonged to the 'River Watch Group' or knew each other from other environmental committees. This skewed the data in the sense that the people interviewed have similar perceptions and attitudes about the river and water.

4.8. Ethical considerations

Ethics for the study was granted by the University of KwaZulu-Natal Humanities and Social Sciences Research Ethics Committee. Prior to all interviews, information pamphlets- explaining the aim and objectives of the research, questionnaire and informed consent (Appendix C) were emailed to participants. One the day of the interview, the informed consent was discussed and signed. Participants agreed to be recorded and had the option of pseudonyms and whether they wanted a soft copy of the dissertation. Abiding by the ethical guidelines set by the University also ensured reliable research and data. One way to ascertain that data is collected ethically, is to employ tactics which help ensure honesty in informants when collecting data. This includes ensuring that respondents approached are informed of their rights

to refuse participation in the study and are willing to take part in the study freely (Shenton 2004).

4.9. Summary

The aim of this study is to understand industry attitudes and perceptions of Industry in New Germany towards the Palmiet River, and the external factors, actors and processes which influence and regulate this relationship. This chapter addressed issues of methodology, and detailed the research design, sampling methods, data analysis. Moreover, the chapter discussed matters of validity, rigor and reliability as well the limitations to the study and lastly the ethical considerations. This chapter is building of the previous reviewed literature to provide a theoretical analysis, in order to explain the finding and results in the next chapter.

CHAPTER FIVE

FINDINGS

5.1. Introduction

This chapter presents the findings of the study. To contextualize the chapter, it is important to note the purpose of the study, which is to understand the hydrosocial relationships in the Palmiet River catchment, with a specific focus on the Palmiet River and the Pinetown/ New Germany industrial complex. In this context, relationships refer to the way in which stakeholders are connected to each other and to the river through their interaction with the river. In this study these relationships are understood primarily through the lens of the industries, with additional perspectives from adjacent stakeholder which add nuance to our understanding of hydrosocial relationships.

The data from the study indicates that hydrosocial relationships in the Pinetown/ New Germany industrial complex are dynamic and complicated. The presence of the river plays a central role in the formation and navigation of relationships between industry and other stakeholders. In this delicate balance of tensions and interests (self or otherwise), spaces for engagement and innovative collaborations are formed.

5.2. Stakeholders

The study forms part of the Palmiet Rehabilitation Project (PRP). "The Palmiet Rehabilitation Project (PRP) was established as a pilot study of the uMngeni Ecological Infrastructure Partnership (UEIP) to explore the value of using ecological infrastructure as a means to promote water security in a city with high levels of inequality and poverty which is threatened with persistent droughts and floods", (Sutherland et al., 2017: 01). Whilst the project collaborated with a number of interested and affected stakeholders in the catchment, a critical issue identified in the PRP has been the lack of participation of industry representatives in the governance arena that has been constructed as part of the PRP. This study therefore focuses on the relationship between industry and the river and the reasons for the absence of industry stakeholders in the PRP (Williams et al 2018). Industry plays a significant role in impacting on and improving the state of natural environment globally. This research contributes to this body of knowledge by shedding light on how industry conceptualizes its relationship with the Palmiet River. It also helps us to understand how industry navigates its relationship with

various stakeholders in the catchment, mainly; the municipality, private citizens and civil society organizations, and in turn how those relationships and their unique configurations shape and reproduce relationships with the river.

The findings of the study are presented and categorized thematically. Some of these themes are aligned with the objectives of the research, whilst others emerged during the process of data analysis. Firstly, the data findings identify some of the stakeholders who are present and active in the catchment, primarily through the perspective of the industry. Secondly, it outlines the attitudes and perceptions of industry towards to the Palmiet River. Thirdly, it demonstrates industry's understanding of climate change and climate change adaptation strategies.

5.2.1. Industry

The findings of this research have allowed for better understanding of industry. Industry is often positioned on the outside of research focusing on environmental issues. They are identified as a great threat to the environment and as the greatest contributors to irreparable ecological damage and mass exploiters of natural resources (Bond 2002; Asthana and Asthana, 1998). This was due to the unchallenged models of production and economic growth. The natural environment and economic development are perceived as two sides of the same coin, were one could not be achieved without the depletion of the other, and industries have demonstrated a tendency of leaning towards profit and economic growth at the expense of the environment. However due to globalization and an increase in advocacy for environmental rights through trade treaties, policies and legislation, the interlinkages between the environment and economic development were mainstreamed (Zhu and Sarkis 2004; UNEP, 2014). This inspired an ideological shift towards more sustainable pathways to economic growth and development. The green economy was proposed as one pathway to sustainable "green" growth (Rogge et al, 2001). As it was able to articulate the need for economic growth, which in many developing countries is linked to social development, as well as make a case for green and clean technology, which helped reduce environmental destruction (Babonea and Joia, 2012). This allowed for more collaboration between the private sector and the state to find solutions which would encourage greater socio-economic development and economic resilience (UNEP, 2011).

It is within the context of these ongoing tensions and collaborations that the Palmiet River is situated, materially and theoretically. The Palmiet River contains the evidence of the prioritization of profits over natural environment as indicated by the high levels of pollution

that are emitted by industry into the river. One can trace the anthropogenic impacts on the river all along the catchment (Naidoo 2005, Moodley et al 2014). However, the findings from this study also show the complex nature of industry, illustrating that industries are not monolithic, there are a number of obstructing and enabling factors that govern the relationship between industry and the Palmiet River.

Landlords were identified as having a significant influence in the relationship between businesses and the river by one industry representative. The majority of industry respondents were tenants who were renting the premises to operate their businesses; landlords thus emerged as the 'middle-people' who to a degree facilitate the relationship between business owners and the municipality. By their positioning as the 'middle-people', landlords influence or alter the relationship between businesses and the municipality. They acted as a buffer between certain municipal departments and the businesses who rented their premises, especially when it came to matters of communication:

> *"We don't really communicate with them [the municipality]. We actually rent from (landlord) so they are our landlords, so everything and anything related to water goes through to our landlord. Anything that has anything to do with water relations goes through them" - (Tracy, Receptionist, industry, 27 June 2016).*

> *"As far as the electricity, the water is concerned that is handled by the landlord. So we don't have much to do on that side of things"- (Andrew, Director, industry, 27 June 2016).*

> *"I think it is the landlord, does all of that because we are just tenants, we don't, they do all of that"- (Samantha, Secretary, industry, 27 June 2016).*

Out of all the respondents from industry, only one owned their premises. The business previously operated in the Pinetown area, which is not far from their new premises in New Germany. According to Valerie, it was cheaper to buy the building and operate in New Germany. As the sole owner of operating premises in the sample, Valerie offered some insight albeit limited into the interactions between the municipality and landlords:

> *Not that I have noticed. We did have a bit of a blockage and they did come and sort that out. Some storm water drain was blocked in our property and they came and sorted that out. We don't see a lot of them- (Valerie, Business Owner, industry, 27 June 2016).*

Landlords play an important role in helping us understand the dynamics of hydrosocial relationships in the new Germany industrial complex because they are lodged in between businesses and the municipality. This is important for two reasons; firstly, their position as 'middle people' puts them and the municipality as the main custodians of water. This excludes businesses from direct engagements about water issues. This indirectly makes water an administrative issue.

Secondly, the focus of the relationship between landlords and the municipality is centred on easily regulated resources such as piped water, metered electricity and building maintenance. This creates a hierarchy in the prioritization of water sources in the New Germany Industrial Complex; it enforces a dichotomy of 'formal' and 'informal' water. Water that is contained within formalized structures; piped water, taps is managed regularly and with efficiency (formal). Water that is 'outside', such as the river, is reduced to being informal, it exists outside of consistent management. Whilst efforts are being made to manage and regulate the river, they are not as consolidated and consistent.

5.2.2. The Municipality

Industry reported mixed reactions when asked to describe their relationship with the municipality. A number of factors seem to influence whether they regarded their relationship as positive or negative. These factors being; interpersonal rapport with municipal staff members, feedback with regards to complaints, tip-offs or general inquiries. Additionally, a few respondents reported being unhappy with the relationship with the municipality as they felt that the municipality is also responsible for polluting the river by its outdated infrastructure which often releases sewerage into the river.

With regards to their experience and overall relationship with the municipality, some businesses felt they had a good relationship with the municipality, characterized by reciprocal communication and transparency:

> *I have a good relationship with them, whenever I try something new, I phone the powers that be…we have a good relationship in that I take advice from him and over and above our audits, I invite him for audits to come and see what we are doing so that he can carry that forward to other people, and also he brings his knowledge if other businesses are doing things differently "why do you try it like this", so we have a good relationship with the municipality, by means of a professional relationship, you know advise, both*

ways, we try something new, he sees something else that may work or may not work with us, we try it (James, 29 February, industry, 2016).

For other businesses, the relationship was often mediated by the landlords, making them a barrier to more in-depth engagement with the municipality:

They (municipality) come once a month and do their check-ups but it is always through the landlord. If there are any issues from our side, they ask us, but it is always through (landlord)"- (Tracy, Receptionist, industry, 27 June 17).

We don't have it at all. We are renting premises here. So, there is a landlord to do all of that. If there are any problems, we call the landlord (Penny, Administrator, industry, 27 June 2016).

Other stakeholders described their relationships as poor, due to the lack of communication and follow ups from the municipality. Furthermore, they also highlighted the role of the municipality as a polluter through its outdated infrastructure and systems:

"No, I think we have a poor relationship. Because we don't often get any feedback. So, when we have got a problem with the river, we report it and we never hear the outcome, we never hear if someone has been prosecuted for polluting the river or if they have found the person responsible. And many times, we believe it is actually the municipal sewerage that is being dumped in the river. That's biggest of all the problems that is biggest factor affecting the river. They have designed their sewerage systems, so that if they fail, they dump all their sewerage straight into the river. Which I think is a very poor design, I think they should have designed it with some other system, when it fails that it didn't just use the river as a dumping ground" (Valarie, Property owner, Industry, 27 June 2016).

The municipality is trapped as the worst offender when it comes to polluting the river and damaging aquatic habitats with unintended consequences of dated design and construction" (Lee, Civil Society, via email, 26 January 2016).

Similarly, representatives from the municipality also expressed their own perspective and experiences of their relationships with businesses:

We have got good relationship with most of the industries, its maybe 20% of the industries maybe the smaller ones that give us a lot of problems. Generally, we have a good relationship with most of them (Respondent 1, Municipality, 10 December 2015).

We normally meet at the site but we don't have a relationship, but I know most of them because when they find a problem, that this building does not comply with sewage policy and can harm the river, they normally call us but we don't work close to them, for them it's just that they inspect buildings (Respondent 1, Municipality, 10 December 2015).

The municipality is a central stakeholder with a more regulatory responsibility and can be regarded as the gatekeeper of the Palmiet River. The municipality has standard operating procedures which facilitate and guide stakeholder engagements. The data suggests representatives from the municipality who work directly with stakeholders, developed 'softer' interpersonal relationships with stakeholders especially with members of the business sector. This has been critical in building trust and improving compliance to municipal regulations. Transparency and friendly engagement from the municipality challenges negative perceptions of the municipality as the enemy which seeks to 'catch' and 'fine' businesses for lack of compliance. Although the relationships between the municipality and businesses is not without it challenges. Open and transparent forms of engagement seem to yield more positive outcomes.

Business who felt supported by the municipality were eager to explore and adopt water safe practices in their production processes. This affirms emerging literature and research (Reid and Taylor 2000; 2003, Dobson 2003, Wolf et al 2009,) which advocate for more investment in behavioural change policies to control harmful environmental practices. Representatives from the municipality ascribed to this idea in their practice which was inspired by an awareness that for a number of businesses, fines were seldom a barrier against polluting the river or contravening environmental legislation. Dobson (2003) argues against heavy reliance on financial means such as sanctions and fines to punish harmful businesses practices, as they are not effective in reducing environmental and ecological damage.

5.2.3. Civil Society

Another active stakeholder identified by industry is River Watch, an independent Civil Society Organization (CSO) working on reducing pollution and improving water quality in the Palmiet

Catchment. According to industry, the presence of River Watch as a third party or 'middle person' seems to have improved relations between some businesses and the municipality:

> *Initially it [relationship] wasn't that good because we didn't have much contact. Since joining Palmiet [River Watch] we have had quite a bit of contact with them, and they are making an effort to communicate with business owners specifically to look at the pollution control of the Palmiet. So, I have had something to do with them and they are helpful, sometimes it's the question of communication but they are getting better and they are working with us, so it is nice (Andrew, Director, industry, 27 June 2016).*

River Watch is also credited for its efficient and systematic communication and reporting,

> *And also, what use to happen in the past and is improved now with the Palmiet River Watch is that we only used to get complaints once a day. Past the industrial areas and the pollution is already in residential areas by then its long gone and they would have to trace it back to industries and it quite difficult. But we now have some of the industries complaining and we can pick it up quite quicker (Respondent 1, Municipality, 10 December 2015).*

Amongst other platforms River Watch uses social media to enhance and improve reporting between stakeholders, mainly WhatsApp. The WhatsApp group is open to the public. River Watch draws its members from the local community members and has a number of groups which includes representatives from the municipality and businesses. According to Lee the founder of River Watch, the WhatsApp group was created in response to the lack of coordinated communication between the municipality and the public, which resulted in confusion and under reporting of spillages, sewerage pump breakages and other pollution accidents. Lee designed a reporting system which helps eliminate confusion and guessing when it comes to identifying polluters.

> *We got a couple of WhatsApp Group and telephone lists and SMS's so it's just a matter of using whatever platform. Ideally WhatsApp has proven to be useful. So put it on WhatsApp so people upstream respond and if there are gaps then we fill it in with phone calls and SMSes so people are not rushing around, they just looking out the window or walking down to the river and saying "it's clear here" and then you know where the problem starts and each person who reports in give their reference point along the river*

from 0 up to 22 kilometres, so you can see where the problem stops and starts. So I am sitting and watching and I see it's at "5 km" and I know I that I am downstream so I know I not going to expect it later and if I am upstream I can look out and say "yes it's also here" (Lee, Civil Society, 29 February 2016).

Whilst the main intention of River Watch is to reduce pollution in the Palmiet catchment, the organization has been wedged in between businesses and the municipality and finds itself in the role of mediator repairing and establishing relationships between stakeholders.

5.2.4. Informal River Users- "Homeless people"

An external stakeholder identified mainly by industry and to some extent the municipality are individuals they identified as "homeless people" who use the river as a source of shelter and water.

As I showed you, the pollution every day from homeless living in the river bathing themselves in the river, stolen goods found on the river. So, we try and clean that out as much as we can but its labour intensive, we can't employ somebody full time to do it, ourselves. (James, Production Manager, industry, 28 February 2016).

Later on, in the interview, the issues of homelessness and the river arises again, however in this context the issue is highlighted as part of the broader socio-economic issues facing the municipality and the country.

Manpower to police it…there is manpower but who will pay for it you see. The manpower is there, many people are looking for jobs … But it needs to be policed more strictly, there has got to be more severe … um I don't know the wording … how do you tell a homeless guy, who has got nowhere else to bath, 'don't bath in this river here' … how do you tell a guy that has nowhere else to go? (James, Production Manager, 28 February 2016).

In a similar vein, representatives from the municipality also expressed concern about the informal use of the river. The main issue being the utilization of the river and water for informal employment activities and how these impact on municipal infrastructure, such as storm water drains.

We have the cardboard ladies who wet the cardboards and pieces of paper and plastic get washed off … that ends up in the river … and we have the guys that are stripping wires etc. for metal and they burn it next to the river and all the plastic and everything that they don't use they dump in the river (Respondent 2, municipality, 10 December 2015).

We going to have a lot of problems with these metal collectors… what do we call them scrap metal collectors, because we don't know how they can be regulated. Because those people that take the metals will find a place to burn it, and they do it along the stream of the river, I don't know why but they burn it before they take it to scrap yard (Respondent 1, municipality, 10 December 2015).

The notion of 'homeless' people in the context of the Palmiet Catchment is complex and requires further interrogation, as the catchment comprises of private households of various socio-economic status along, with the Quarry Road informal settlement located at the bottom of the catchment, as well as a number of other informal settlements in the catchment. Whilst they may be considered homeless by industry representatives, some of these individuals are residents of the Palmiet community. Urban Informal settlements are often highly marginalized and segregated from society, even though they become a great part of African cities. People end up in informal settlements for various reasons mainly; the shortage in housing, unemployment and rapid urbanization. This segregation exacerbates vulnerability to poverty and inability to access basic services and infrastructure, which leads to the use of the river in order to meet demands for water, shelter and other services.

The use of river water and surrounding spaces to prepare for recycling for cash schemes to contest unemployment, highlight the 'dual economy', which is used to describe the presence of both and formal and informal economic activities, especially in developing countries such as South Africa. Proponents of the dual economy theory demonstrate that there is often strong linkages between these two sectors and they influence each other in a number of ways (Davies and Thurlow, 2010; Valodia and Devey, 2012). In attempting to better understand hydrosocial relationships, the idea of strong linkages between the formal and informal sector can be extrapolated to expand on the interconnected nature of water and society as suggested by Linton and Budds (2013). Although 'informal' communities exist outside the formal structures of society, their interaction with the river disrupts the formal structures which exclude them,

by enforcing a response when the remains of cardboard or rubble from stripped wire cables end up blocking storm water drainage systems.

5.3. Relationship building processes - The River Clean-Up

River Watch contributed greatly in improving stakeholder relationships and involvement in the Palmiet Catchment, through its intervention of initiating and leading the River 'clean-up'. This process facilitated engagement and collaboration between industry and the municipality. The clean-up was an event in which businesses located near the river got together and cleaned up the river. This include removing alien invasive plants, shrubs and trees; planting more indigenous trees, removing waste and pollution. Through these processes industry became more involved in the maintenance of the river.

> *Lee approached us as asked what sort of impacts it is [the river] having on our business and the biggest thing was crime. That was the drive in the area, he was the influence behind the whole area I think coming into to play. Informing us of the negative impacts we are having because of the river problem. Yeah, we knew but we didn't really take it in. (James, Production Manager, industry, 28 February 2016).*

> *No, we within the Palmiet River Watch, Lee actually came up here for an unrelated incidents, I got to meet Lee and Lee saw that we were cleaning up the river, so we partnered up with Palmiet River Watch… we are part of the Palmiet River Watch even though there is limited funding, because we funded it ourselves. (Jack, Regional Manager, industry, 26 May 2016).*

The advocacy of River Watch allows us to better understand the role of Civil Society and its contributions to the arrangement of hydrosocial relationships. Suhudira and Nagendra (2013) illustrate through a case study of Bangalore, the powerful role of civil society in influencing government to prioritize environmental issues. Civil society is often conceptualized as existing between the State and the Private/ Domestic sector, operating in the 'in-between', yet also free from influence and interference from surrounding sectors (Swilling and Russell, 2001). However, the positioning, composition and functions of CS have always been contested. Beginning with ideas of CS as completely isolated from the State, influenced by assumptions that both sectors operated independently with conflicting objectives. Progressing to more complex ideas which closely interrogated the overlaps and relationship between both spheres

(Petras and Veltmeyer 2001; Sat Obiyan 2005; Obadare 2011). This challenged notion of a clear separation between the two and focused on the linkages which were ignored previously. Finally, Gramsci offered a distinct reading of CS and its relationship with the State (Loftus 2001). According to Buttigieg, "Gramsci regarded civil society as an integral part of the state; in his view, civil society, is far from being inimical to the state, it is in fact is most resilient constitutive element" (1995: 04), essentially arguing that the relationship between CS and the State is ambiguous, and that CS functions to secure State hegemony. However, this is not necessarily negative, it enhances the ever-present theme of entanglement between the formal and informal water in the New Germany industrial Complex. Through their constant monitoring, reporting and documentation of the state of the river, River Watch has made matters of the river more mainstream; it has propelled informal water to the forefront, and connected it to formal municipal structures and Industry.

5.4. Industries Attitudes and Perceptions of the Palmiet River

The study also sought to understand industry's perceptions of the Palmiet River. The attitudes were influenced by assessing perceived advantages or disadvantages of being located within close proximity to the Palmiet River.

5.4.1. Advantages

Whilst the river was praised for its aesthetic value, respondents from the business sector did not acknowledge the aesthetic value of the river as a service.

> *It's just aesthetics, it lovely, it brings beautiful birds. It doesn't help our business at all but it's lovely having nature right here in your doorstep.* (*Valerie, Business Owner, industry, 27 June 2016).*

> *I just think it's nice having the birds and the trees and a little bit of nature around you. As opposed to just a plain industrial type of thing. (Andrew, Director, Industry, 27 June 2016).*

Additionally, respondents emphasized the recreational benefits of the Palmiet River, also acknowledging the sensory benefits of being located next to a river.

> *No. I think it's just there for use just to look at. Basically, people walk by, no one goes in or anything like that. It's just something we look at. It's just a sight of relief for us*

when we get really busy, it's really nice to stand next to it, it's absolutely beautiful. And it's nice to just stand next to it, have you had a look at it, it looks quite nice doesn't it? (Samantha, Secretary, industry, 27 June 16).

Because sometimes when you park your car you can hear the water as it flows through, you know. And sometimes if you have the time, we just take a look and peak. It's a nice sight, if it is not polluted. People go you know the guys, if they are having lunch they go and sit on the river wall there and I am sure they have a look and whatever, maybe it's good scenery (Penny, Administrator, industry, 27 June 2016).

Although respondents didn't recognise the aesthetics of the river as a service provided, according to the Millennium Ecosystem Assessment, aesthetical value and recreational benefits are considered vital ecosystem services. The Millennium Ecosystem Assessment defines ecosystems as "a dynamic complex of plant, animal and microorganisms' communities and the non-living environment interacting as a functional unit" (2005: V), additionally; "Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food, water, timber, and fibre; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling" (Millennium Ecosystems Assessments, 2005: V).

5.4.2. Disadvantages

For other businesses, being near a river is a disadvantage and some even considered it challenging as it directly impacted on their businesses by making them more vulnerable to crime, property damage and discomfort due to the pollution in the river.

5.4.3. Crime

Crime was reported as the main disadvantage of being close to the river. The river provided access to businesses and this led to property loss and damage, such as broken windows. With businesses claiming copper pipes, trimmings and taps as the most stolen items.

"Just the theft and the crime in the area because it is access to our complex, a rear access to our complex. So, prior to us doing a clean-up…it was a hot spot for them to hide, and then they will climb up the wall; steal our piping form the complex, our

electrical cables. So that has had a huge impact on our business; financially draining. (Niel, Business Owner, industry, 27 June 2016).

I think the biggest disadvantage is that it has become an avenue for criminals to use in between businesses because, we have had a case were the drug dealers have been arrested just here 6 months ago. So, criminals do use it as an access point. It's affecting our property in that…because the river, the gabions of the river are not being looked after you can see our walls collapsing outside they have been undermined. (Jack, Regional Manager, 26 May 2016).

Other disadvantages included issues that pertain to the state of the river:

None just creates a lot of mosquitoes. (Tracy, Receptionist, industry, 27 June 17).

I don't think there are many advantages because sometimes that river really stinks. Because I think there is a lot of pollution in that river. So, I don't think there is an advantage for us, no. (Penny, Administrator, industry, 27 June 2016).

Majority of respondents claimed not to have any relationship with the Palmiet River, meaning they didn't interact with it in anyway in their daily activities. However, when they spoke about the river, a unique connection between businesses and the river is unveiled. The connection or most direct experience of the river was through the senses. Respondents often spoke about 'watching', 'seeing', 'hearing or listening' to the river or complained about the 'smell', the stench of the river after pollution accidents. Pollution are a frequent occurrence in the Palmiet River, with 120 pollution events recorded in 2017 (Palmiet Valley.co.za). The frequency of these accidents have become an image of the Palmiet River and shapes the perceptions people might have of the river.

This became the main way in which they related to the river and it also influenced their attitudes and feelings about their location next to the river. Additionally, the 'aesthetics' of the river was the primary reason respondents enjoyed being close to the river. This is a significant finding which illustrates how physiological and cognitive experiences of water influences how it is socially constructed, perceived and regulated (Moose 2003; Gibbs 2010; Linton and Budds 2013). According to Strang (2006), it is through the sensory experiences of water that material realities and cross-cultural meanings of water are created and reproduced.

In the New German Industrial Complex, water is collectively constructed as a means to an end, an external resource enhanced to achieve specific outcomes for the stakeholders. It is a vehicle

to services and income generation for residents of Quarry Road settlement, a production tool for businesses; albeit an external one as suggested "water is the only external control" *(James, Production Manager, industry, 28 February 2016),* and an administrative regulatory tool for landlords and the municipality. This reflects the hierarchical way water is governed, and thus experienced in this complex.

Furthermore, it is partly through these specific experiences that River Watch is able to be effective in its communication and reporting of pollution incidents and spillages. The mundane task of looking at a river, be it for leisure, workers sitting at the river edge eating their lunch, or just parking their cars in the morning has been transformed into an act of activism against pollution. Equally, it is through the senses that the river connects all the stakeholder in the catchment. For example, in case of a pollution accident, the smell forces everyone to take note of the state of the river. It can be likened to a distress signal from the river, in a way this is the rivers way of making the community aware of its presence. Even businesses who are not part of River Watch, the river involves them, and they indirectly become a part of watching the river. Through the senses, people interact with the river either way, they cannot opt out, acknowledging the river becomes intrinsic to the everyday functions of businesses. By the very nature of its existence the river has intercepted businesses and reconfigures the idea of "business as usual".

5.5. Industry's understanding of climate change

5.5.1. Knowledge about Climate Change

Businesses demonstrated varying degrees of knowledge about climate change and its impacts. Water scarcity and increasing temperatures were mentioned as the main consequences of climate change.

> *"I know very little, not too much… That it affects water, I mean the amount of water that we have, and all of that. (Samantha, Secretary, industry, 27 June 2017).*

> *Look I got a fair understanding of it can't really go into detail, but I understand the principle of how it is working and that we are getting hotter and hotter each year and that its affecting the Ozone layer and that it is affecting a whole lot of stuff. (Niel, Business Owner, industry, 27 June 2016).*

Whilst others were in the middle, acknowledging the changes in the climate, but also questioning the 'science' of climate change and how it was being articulated.

> *It's clearly changing, I don't think anyone really knows why. The fact that it is changing is a given. There are a lot of theories, but I don't think anyone knows why. People think the CFCs cause the weakness of the ozone layer, but when one volcano erupts then why aren't the other volcanoes erupting because of the people? People are not causing volcanic eruptions; people are not causing earthquakes.* (Jack, Regional Manager, industry, 26 May 2016).

A large portion of industry respondents expressed concern about the 'climate change discourse', these ideological beliefs about climate change influenced adaptation strategies. Some respondents from business cohort expressed lack of trust in the discourse of climate change, lamenting that the concept has been made more visible in order to distract from other real issues such as pollution and the role of big businesses in environmental destruction.

> *"Well I do know about climate change and I think personally, I think it is the corporation's jumping on the bandwagon. I don't think it's as serious as they are making it out to be. I think the environment is important to see what is going on and to stop emissions, but to me it's very strange that you get companies like Shell and British Petroleum now suddenly being big environmentalist when they have been the ones destroying the environment for the last 50 years.* (Andrew, Director, industry, 27 June 2016).

> *I think the whole climate thing has been hijacked, so I think they are making a lot of noise, we should be concentrating on other things like general pollution and how we are treating the environment as individuals you know* (*Valerie, Business Owner, industry, 27 June 2016).*

The data illustrates a linear progression with regards to knowledge and beliefs about climate changes, with responses ranging from limited knowledge, ambivalence and finally scepticism. However, within these varying ideas of climate change, there is also some awareness of the changes in climate and weather and how these might impact on business. This creates a challenge with regards to developing and implementing adaptation strategies.

For the municipality, the issue of climate change was more a technical or strategic matter, one which is future plans and strategies are discussed by top management.

> *I think we are governed by our standard operations, so we are quite operational (Respondent 3, municipality, 10 December 2015, interview 1).*

With Civil Society showing optimism that talks about climate change will lead to more discussions about water:

> as current topics, climate change, global warming, the drought and possible water restrictions are proving useful in getting individuals attention on water pollution issues *(Lee, Civil Society, via email, 26 January 2016).*

5.5.2. Climate Change Adaptation Strategies

Despite some awareness of climate change, some businesses did not have adaptation strategies; listing barriers such as cost, denialism and lack of institutional strategic plans

> *We don't direct process changes to counter that, however we are improving our chemicals and our processes… again it boils down to cost, if it's beneficial to us immediately then you would do it. Long term you have to think about whether you can afford to make those changes now, or revisit them later (James, Production Manager, industry, 28 February 2016).*
>
> *Jah, I think I will be pushing daisies by then, I will be gone by that time. Jah no, not really. There are enough other things to worry about like trying to stay afloat in these economic times… to just try and keep your business profitable and afloat without worrying about other stuff* (*Valerie, Business Owner, industry, 27 June 2016).*
>
> *I haven't gotten that far yet (Niel, Owner, industry, 27 June 2016).*

Climate change refers to the "threat and unfolding environmental impacts of current climate change... Climate change constitutes a complex risk domain, an attitudinal object, and a social representation of a phenomenon that is as much a social phenomenon as it is a physical phenomenon" (Reser and Swim, 2011: 277). Responses to Climate Change varied, majority of the business stakeholders felt climate change was not a big concern for the business and as a result, they did not have mitigation or adaptation strategies in place to combat the change in climate and its impacts. Whereas civil society believed discussions about climate change propel water issues. Furthermore, respondents from industry perceived the risk of climate change as concerns for the future and not as something of immediate attention. This was due to climate change denialism, and financial constraints. Thus climate change adaptation was viewed as a luxury or a secondary priority.

Climate change adaptation research acknowledges that adaptation might be a challenge due to a number of resource constraints (Grothmanna and Patt, 2005; Broad et al, 2002; Wilbank, 2003; O'Brien et al, 2004), and suggest more context specific adaptations, which will help people identify more immediate risks and vulnerability and therefore move towards more realistic, localized adaptation strategies.

5.6. Summary

This chapter presented the data and findings of the study. The data shows that relationships between stakeholders are complex. For industry, there are internal (landlords) and external stakeholders (CSO, municipality, communities) which dictate and regulate their relationship with the Palmiet River. These relationships also influence their perceptions of the river. Through its involvement with CSO and active participation in the river clean up, industry challenged some of the dominant narrative and discourse about the one directional and exploitative relationship between industry and rivers. Furthermore, the data shows that there is still a high lack of trust in climate change, this has direct implication on climate change adaptation strategies.

CHAPTER SIX

DISCUSSION AND CONCLUSION

6.1. Introduction

The study sought to explore hydrosocial relationships in the Palmiet Catchment, more specifically between industry in New Germany and the Palmiet River. Following researchers working on the PRP (Sutherland et al 2017), the hydrosocial cycle was employed as a theoretical framework to understand how collaboration between various stakeholder's help inform water governance approaches in the catchment (Williams et al 2018). This was done to emphasize the relations between the social and the hydrological in the catchment. Whilst this thesis seeks investigate similar phenomenon, it supports the work of the PRP by looking at hydrosocial relationships primarily through the perspective of industry, and addresses the missing gap, left by limited engagement with industry. According to Williams et al (2018) "researchers struggled to engage in with business organizations in the catchment, although interviews were undertaken with the Pinetown Industrial Conservancy and with an industrial property owner. This lack of engagement by the private sector remains an ongoing challenge" (2016: 08). This thesis therefore works towards closing that gap by bringing in insight from industry and showcasing the complex relationships between industry and the Palmiet River, and other stakeholders in the Palmiet Catchment.

The following chapter will discuss in greater detail the themes and finding which emerged from the data and is structured as follows; firstly, discussing the role of ecological infrastructure in influencing the sensory experiences of the Palmiet River and the resulting shared social construction of water. Secondly expanding on industry's understanding of climate change as well as the challenges facing industry with regards to climate change adaptation strategies. Thirdly; exploring the relationship between industry and ecological infrastructure. Lastly, the conclusion and suggestions for further research.

6.2. Ecological Infrastructure and Sensory experiences of the Palmiet River

Whilst majority of the respondents claimed they did not have a direct relationship with the Palmiet River, a subtle and intricate relationship emerged when respondents praised the river for it aesthetical and recreational values. The sensory experience signals an important aspect

of the connection between the Palmiet River and industry and is a significant facet of relationship, and one that is often ignored. Mainly, it reveals the interconnected nature of this relationship by breaking the binary of water and society (Budds, 2009; Linton and Budds, 2013), showing that these two entities are connected beyond the boundaries of biophysical environment. These findings are in line with Strang (2006, 2014) and Gibbs (2010) who argue that water plays a pivotal role in helping us think more in-depth about the interaction of humans and other material worlds. Essentially illustrating that at different points of connection people and things (in this case the river) recreate and reproduce each other, forming new meanings and experiences of each other.

Pollution, more so the 'sight' and 'smell' influences the negative experiences and perceptions towards the Palmiet River. Industrial effluent accidents in the Palmiet Catchment have been documented in a number of studies (du Preez and de Villiers, 1987; Naidoo, 2005; Moodley et al, 2014). The graph below presents resent data (2015-2017) collected and captured by River Watch.

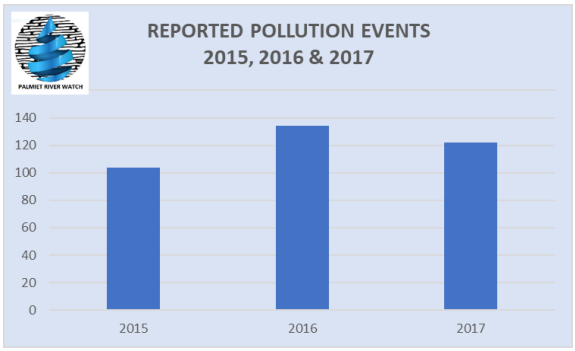

Figure 5: graph depicting pollution events in the Palmiet River (2012-2017).

Source: PalmietValley.co.za.

According to (Joubert and Maze, 2014), eThekwini Municipality spends R135 Million on chemical to clean water for the city monthly, this amount is more then what is spent on maintaining wetlands across the country. This money goes to cleaning pollution accidents, caused by industry and poor infrastructure.

These findings can be extrapolated to demonstrate the agential nature of the river and water in this catchment, "this suggests that the perceived qualities of things are actively promoted by their particular properties. In the constantly negotiated and transforming relational materiality of things and persons, agency may therefore be said to be distributed between human actors and non-human 'actants' that 'variously enable and support, or resist and disrupt, human

intention'" (Strang, 2014, p 139). The data shows that the river supported, resisted and disrupted human intentions throughout the catchment. We also see the element of disruption from the river, when there are floods, pollution accidents and when the river bank has not been maintained. The 'sight' and the 'smell' and experiences of crime and vandalism also influenced industry's experiences of the river, thus creating a communal disconnect and rejection of the river.

6.3. Climate Change attitudes: Ambivalence to Skepticism, barriers to adaptation strategies

In the context of this study, climate change plays a particular role because It has been identified as a threat to on water security in the city of Durban (Roberts 2008). As the city is working towards building resilience against climate change, politics of climate change adaptation have been brought to the forefront, as developing cities like Durban are vulnerable to its impacts. Climate change adaptation is thus an important issue for both industry and water bodies, like rivers.

As the results have shown, climate change adaptation strategies remained a big challenge of industry, noting a few barriers such as financial restrictions, limited organizational support, and claims that climate change will not have any direct or immediate impacts on their businesses. This finding confirms previous research (Broad et al, 2002; O'Brien et al, 2004; Wilbank, 2003; Grothmanna and Patt, 2005), which show that despite concrete evidence, adaptation and mitigation strategies are not an organic progression for communities and organizations that are vulnerable to climate change, rather there are greater obstacles which make these strategies difficult to design and implement.

However, for industry in this study, climate change was not considered an immediate threat, and many felt that these threats were speculative and therefore could not justify allocating resources to adaptation. This reveals a unique predicament for industry, were issues of profit, cost and negative perceptions of climate change; mainly skepticism intersect in ways that create barriers to developing and implementing adaptation strategies. Industry perceptions about climate change ranged from ambivalence to skepticism and these views appear to also be a contributing factor to the lack of climate change adaptation strategies; in addition to finance, and organizational support. This is an important finding given the already antagonistic relationship between industry and climate change. These tensions often stem from

disagreements about the extent of anthropogenic causes in exacerbating global warming and triggering climate change (Gallup et al 1999, Hobson and Niemeyer, 2012; Dunlap 2013).

The data findings from this study suggests that there are two distinct factors that shaped industry perceptions about climate change, namely; Knowledge and trust. These two factors align with Marquart- Pyatt et al., (2011) who study public opinions of climate change, and the impacts of these views on policy and legislation. In this study, these two variables also seem to influence the slow and relaxed attitudes about climate change adaptation strategies.

According to (Marquart- Pyatt et al, 2001, Poortinga et al 2011), knowledge about climate change is vital in shaping attitudes and response strategies. However, seeing as climate change is hotly contested, people hold on to tangible evidence to better understand climate change. Similarly, findings from this study show that respondents who acknowledged climate change, noted dramatic changes in weather patterns and the extreme weather conditions such as; drought, flash floods, heat waves and the ongoing water shortages in the City of Durban as primary knowledge and evidence of climate change. Whilst this is a positive place to start, in the context of adaptation strategies, heavy reliance on weather patterns is not efficient method to understanding climate change as it means inadequate planning for distant events, making industry more vulnerable.

The lack of 'trust' in climate change 'discourse', as well as the institutions leading this 'agenda' was an issue for industry. Industry representatives who lean towards 'skeptical' in the "skepticism- denialism continuum" (Dunlap, 2013, p 693), questioned the over emphasis on human caused effects of climate change. They also questioned the over investment of big businesses in funding global climate change initiatives. According to Marquart-Pyatt et al (2011), lack of trust in climate change discourse is common, "climate change is very complex, and most members of the public lack the background and time to carefully consider the scientific literature. Instead, they are likely to accept the views of trusted information sources and endorse policies promoted by organizations they trust" (2011: 40). Industry's mixed views and reactions to climate change present a challenge for developing climate change adaptation strategies. However as demonstrated by the PRP, ongoing collaboration and collective governance between stakeholders in the catchment such as the different municipal departments, CSO, conservancies has the potential to positively influence industry with regards to protecting the ecological infrastructure as well as developing and implementing climate change adaptation strategies.

However, given the contentious relationship between industry and climate change, (Eriksen et al., 2015) posit that adaptation and vulnerability- in the context of climate change is highly political (see also Corry and Jørgensen, 2015), yet also under theorized, therefore making it a corruptible concept. One which fails to identify and address the different ways power is reproduced or contested in adaptation. According to the authors, "we assert that climate change adaptation processes have the potential to constitute as well as contest authority, subjectivity and knowledge, thereby opening up or closing down space for transformational adaptation" (Eriksen et al., 2015: 523). This argument suggests questioning these responses by industry. As they enable industry to opt out from discussions about climate change- which is a position of power they are using to protect themselves from their contribution in exacerbating the anthropogenic causes of climate change.

6.4. Hybrids: The relationship between Industry and Ecological infrastructure

The Palmiet Catchment accommodates various stakeholders and is often a site of competing and contrasting interests. The data suggests that the presence of the Palmiet River influences the dynamics between the stakeholders and acts as a connector of the different stakeholders. This is demonstrated in a number of ways throughout the data. Firstly, the role of the river as a connector and equalizer is demonstrated through coordinated efforts by CS to mobilize around matters of the Palmiet River. Although the contentious history of investigating the positioning of CS has been discussed in the previous chapter. In the context of this case study, it is positioned in the center, playing an influential role mobilizing different stakeholders such as the municipality, industry and domestic sphere to advocate for the wellness of the Palmiet River.

This is demonstrated by the river's ability to connect and make mainstream issues of the informal or less privileged by; connecting residents of the informal settlement and businesses as well as the middle-class residents together. This is done by utilization of the river as a means to access water, sanitation or water for wetting cardboard boxes or leisure and aesthetics. The river can bring together various stakeholders and gather the evidence of the socio-economic conditions surrounding communities along the catchment and disrupt the 'formal' versus 'informal' binary, by revealing the internal connection between the spheres. Within this context of exclusion and invisibility of informal settlements, the river can therefore be understood as an integrator; it blurs the line between the formal and informal. Enabling communities to access basic services such as water, accommodation and avenues to income generation. The recycling

of materials for income generation enmeshes the formal public spaces with the informal invisible spaces. The use of river water by *'the cardboard ladies'* or *'scrap metal collectors'* much further down the cycle has direct impacts on more formalized infrastructures, such as storm water drains. True to the cyclical nature of water it connects issues of homelessness, unemployment back to the municipality and the state.

These findings affirm Linton and Budds (2013) who argue that water carry the physical properties of it surrounding society. Naidoo (2005) and Moodley at el (2014) analyzed the chemical properties of the Palmiet River, and they find that the river is heavily polluted mainly by industrial waste, domestic pollution from private residents along the river. Highlighting the relational –dialectical relationship of water and society, demonstrating that "water and society make and remake each other over space and time" (Linton and Budds, 2013: 04). Although the Palmiet River is a prominent feature of the catchment, industry often related to it in a didactic, one dimensional way. Often seeing it as a feature of their environment which required more investments from their side, such as labour, security, compliance with municipal rules and legislation; yet not yielding any direct rewards for them. These responses from industry presented a paradox, where in one hand they expressed no relationship with the River, and on the other hand later praised its aesthetic values.

This paradox illuminates the misunderstanding and undervaluing of the ecological infrastructure and the services provided by the river. According to Millennium Ecosystem Assessment (2005), ecological services are often undervalued and overexploited because people are still not clear about what they are and how they work. This is further exacerbated by rapid urbanization and the much slower roll out of municipal services to accommodate the growing demands of city and urban dwellers (Seto et al. 2013; Vollmer and Grêt- Regamey 2013).

Ecosystems provide a number of services which are hugely beneficial to society. River ecosystems provide services, such as raw materials, waste disposal, recreation, shape and design landscapes, their floodplains provide fertile land for agricultural purposes (Pagiola, 2007; Vollmer and Grêt-Regamey 2013). These ecosystem services, depending on the context and level of development of that area or country, work as primary service providers or play a supporting role to already existing infrastructure. In less developed countries, ecosystems often function to meet the basic needs of the population such as basic water and sanitation. In context similar to Palmiet Catchment, were humans settle within close proximity to rivers, rivers

provide a number of services that compensate for the lack of formal municipal infrastructure. Namely;

> *direct sanitary use: bathing, washing goods, and other sanitary purposes excluding toilet use, recreation: passive (sitting or walking along river) and/or active (fishing or swimming), harvesting plants: collecting materials (fruits, fiber, medicinal herbs) from plants growing directly in the soil along the river banks, i.e., not from potted plants or private gardens* (Grêt- Regamey 2013: 1545-1546).

With regards to industry, business and economic development, ecological infrastructure provides a number of benefits to industries located next to a river; access to fresh water, flat topography, fertile alluvial soils and plethora of environmental services (Gallup et al 1999; Portnov and Schwartz 2008; Vollmer and Grêt-Regamey 2013), these and other socio-economic factors can also be attributed to the development of industries in KwaZulu-Natal, more especially in the Durban area. According to Valodia (1999) Durban's position as a port city was one of the reasons for the rapid industrialization of the city post 1960. Similarly, Lumby (n.d), in his documentation of the history of industrialization in South Africa, acknowledges how water was one of the main reason's industrialists targeted the Durban-Pinetown area in addition to land and cheap labour.

The brief synopsis of the growth of industry in Durban serves to highlight the importance of rivers and water in fostering and sustaining industrial development in Durban. As aforementioned, the hydrosocial model theory emphasizes the hybridity of water and society, they are internally connected, and through their interaction they continuously make and remake each other. The point most relevant however, is the reference to the extra benefits of being located to water or rivers, such as topography, land, climate, raw materials. This point highlights the often-unrecognized role of ecological services and infrastructure provided by rivers and how these contribute to industrial and economic development.

Moreover, ecological infrastructure supports economic development, by providing "essential services and reducing risk" (SANBI 2014: ii). And more specifically in the South African context, ecological infrastructure supplements the development objectives of the country which are to reduce poverty, reduce unemployment and develop rural areas. Stronger collaboration between government and private sector and civil society is required to make these objectives a reality, and a conscious effort in investing in ecological infrastructure; integrating into

governments and making it a central component of national planning is a practical step towards meeting those goals.

Whilst the benefits of ecological infrastructure are greatly noted and supported by the findings, it is important to think creatively how to operationalize research and knowledge of ecological Infrastructure. Daily et al (2009), lament the lack of meaningful inclusion of ecological infrastructure in social and economic decision making, and therefore call for strategic planning and research which focuses on operationalizing this knowledge. Fischer et al (2015) recommend mainstreaming cultural ecological infrastructure and services, by linking them to national development agendas and policies such as Sustainable Development Goals (SDGs). Similar to (Daily et al, 2009) they argue that simply noting these services is not enough, and thus advocate for weaving matters of ecological infrastructure into national policies.

6.5. Conclusion

This chapter discussed the finding of the study in detail. firstly, outlining the sensory experiences of the Palmiet River as reported by industry. These experiences shaped their attitudes which influenced their perceptions of the Palmiet River. Attitudes towards Palmiet River were mixed; somewhere positives and others negative. Some appreciate the aesthetic value of the river. Whilst others cited crime and pollution as their main issue with the river.

Secondly, interrogating industry attitudes towards climate change. This was a complex finding in the sense that industry was not homogenous in their levels of knowledge and their beliefs about climate change. Industry attitudes towards climate change had a direct impact on whether or not they found value in investing in climate change adaptation strategies.

The last section of this chapter discussed the connection of industry and ecological infrastructure, expanding on the unique ways in which industry relied on the ecological infrastructure provided by the Palmiet River.

Overall, the findings of the study support the main proposition of the hydrosocial cycle which is “water internalizes social relations and politics, as opposed to being merely objects of politics” (Linton and Budds, 2013, p 02). As well as the hybrid element of the cycle which purports that “water and society make and remake each other over space and time” (Linton and Buudds, 2013, p 01). The Palmiet River embodies and represents the social and economic dimensions of the greater Palmiet Catchment. In its location at an industrial complex, the

Palmiet River has enhanced, altered and fostered new relationships amongst and between stakeholders, with ecological infrastructure and climate change playing a significant role in connecting and facilitating relationships between stakeholders. This demonstrates the 'agential' nature of the river (Wittfogel 1957; Bakker 2013) in that it enabled industry, CSO, private residents and the municipality to consolidate efforts to address issues affecting the river.

Further Research

The main avenue for further research identified in this study, is a more in-depth exploration into understanding industry views and attitudes towards climate change. Firstly, to understand how these further complicate contemporary articulations of hydrosocial cycles and stakeholder relationships. Secondly, how these are barriers to climate change adaptation strategies for industry in developing countries. Challenges with regards to the limited knowledge and lack of trust in the climate change discourse means that industry are underprepared for current and future changes in climate. This has bigger implications for the socio-economic development efforts of the city of Durban.

Although there is an upsurge in research and literature looking at the role of ecological infrastructure in the context of climate change and water scarcity. There is a need to investigate the different ways to mainstream these findings and frameworks in order to influence policies and different social and economic programs.

As aforementioned (page 58) the notion of 'homeless' people in the context of the Palmiet Catchment is complex and requires further interrogation, as the catchment comprises of private households of various socio-economic status along, with the Quarry Road informal settlement located at the bottom of the catchment, as well as a number of other informal settlements in the catchment. A study looking into the informal uses of the river would be vital and would provide a more in-depth understanding into this subset of stakeholders in the catchment.

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Appendix A- Questionnaire: Industry/ Civil Society

New Germany Businesses.

**Prior to the beginning of the interview respondents will be made aware that their identities and details will be kept confidential*

Date and Time:

Name of Respondent:

Business/ Organization:

Job Position:

Contact Details:

Background Questions

1. How long has this business been operating in New Germany?
2. What attracted you to this specific area of New Germany?
3. Was it a deliberate decision to have your business located near a river?

Stakeholder Relationship

4. How would you describe your relationship with eThekwini Municipality Water and Sanitation Department?
5. Have you interacted with the municipality regarding your relationship with water?
6. Have you had any interactions with the eThekwini Municipality Catchment Management?
7. Are you aware of any environmental groups operating in the Palmiet Catchment?

River Relations:

8. What are the advantages of having a river near your business or establishment?
9. What are the disadvantages of having a river near your business?
10. What do you think about the current state of the river?
11. How do you interact with the river in your daily activities?
12. Do you think it is important that the river be kept clean? (why)
13. Who do you think is responsible for keeping the river clean?
14. How would you describe your relationship with the river?

15. How can you improve your relationship with the river?
16. What services (if any) does the river provide for your business?

Climate Change:

17. Do you know about climate change? If yes what do you know?
18. How do you think climate change will affect the river and water in general?
19. How do you think climate change will affect and impact on your business?
20. How do you plan on mitigating threats of climate change?

Appendix B- Questionnaire: Municipality

**Prior to the beginning of the interview respondents will be made aware that their identities and details will be kept confidential*

Date and Time:

Name of Respondent:

Business/ Organization:

Job Position:

Contact Details:

Background

1. Please tell me briefly about your organization/departments/branch.
2. What is your role in the organization /departments/branch?
3. Which area of the Palmiet catchment do you predominantly work in?
4. What activities/ type of work do you do in the river?

Challenges

5. What are some of the challenges you face in the work you do in the Palmiet catchment?
6. How have to you managed or dealt with some of the challenges in the past?
7. What are the critical issues 'facing' the river?

Stakeholder Relationship

8. Which other organizations, if any, are you in partnership with, with regards to the work you do in the Palmiet Catchment?
9. How would you describe your relationship with the industries located in the upper catchment?
10. How would you describe your relationship with the municipality?
11. What are some of the strategies (if any) have you used to engage with the industries? b) Can you say these efforts have yielded positive results in increasing communication and engagement with the industries?
12. Which municipal department do you interact with/ communicate the most with?

Relationship with the River

13. At an (a) organizational and on a (b) personal level what are your goals for the river?
14. What are some of the obstacles that are hindering the achievement of those goals?
15. What do you think are some of the important services rivers provide for society?

16. From your experience and perspective how can industries improve their relationship with the river?

Climate Change

17. Do you consider the impact of Climate Change in your work?
18. What are some changes (if any) have noticed in working/ managing the catchment that you may attribute to climate change?
19. Any concluding remarks/ comments

Appendix C: Letter of Informed Consent

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

Informed Consent Letter

Researchers Name: Nolwazi Ntini

Cell phone Number:

Supervisor: Dr Catherine Sutherland

Office Telephone Number: 031-260-3274

My name is Nolwazi Ntini (Student number: 208523299), I am a student at the University of KwaZulu-Natal currently studying towards a Masters Degree in Development Studies. I am doing research on *"Community Attitudes towards Water in Palmiet Catchment".* The project will be supervised by Mrs. Catherine Sutherland from the School of Built Environments and Development Studies from the University of KwaZulu-Natal, Howard College.

Your participation in this project is entirely voluntary; you may refuse to answer questions and you can pull out of the interview at any time.

The interview will be confidential and your identity will be protected, all the information revealing your identity and personal information will be kept between myself and the supervisor.

The interview will be audio-recorded and transcribed; excerpts from the interview will be used on the final research project. Once the research has been completed, the information will be disposed of in an appropriate manner.

Do you consent to the following?

Audio-recording the interview:

Yes	No

Having extracts of the interview used on the research projects

Yes	No

By signing this form you are agreeing to the above mentioned conditions.

.....

Participant's signature: Date:

.....

Researcher's signature: Date: