WATER CULTURE

EXPLORING THE ROLE OF THE BUILT ENVIRONMENT IN REDEFINING DURBAN'S WATER CULTURE

DHIANTHA ACHARY

Exploring the Role of the Built Environment in Redefining Durban's Water Culture:

A Proposed Recreation Hub and Maritime Museum for Durban Harbour

Dhiantha Achary

211509958

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Supervisor: Magdalene Cloete
Dissertation Document

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I declare that this dissertation is my own unaided work. All citations, references and borrowed ideas have been duly acknowledged. This document is submitted in partial fulfilment of the requirements for the degree of Masters in Architecture at the Faculty of Development Studies and the Built Environment, University of Kwa-Zulu Natal, Durban, South Africa. None of the work has been previously submitted for any degree or examination in any other University.

_____

DHIANTHA ACHARY
211509958
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DEDICATION

This dissertation is dedicated to my parents. Thank you for the endless support throughout this degree.

I am forever indebted to you for your unwavering faith in my abilities and for always pushing me to do my best. Thank you for all your support in helping me realise my passion both in and outside of architecture.

I never would have achieved this goal without your love and support. Thank you.

ABSTRACT

Water controls life on earth as a natural asset. This is just as applicable within the urban setting. An element which is equally enabling as it is incapacitating, water is constantly shaping the way we experience life on earth. The successful operating of the urban environment depends fundamentally on the efficient movement of water into and out of the city. While in urban settings, water is often concealed and controlled to create the illusion of a hydrophobic space, the hidden waterways which run below the surface of cities are proof that water is still a part of our everyday lives.

The relationship between architecture and water is constantly evolving, and the design of modern cities does not always cater to the integrity of water and its natural sources. The dichotomous relationship between architecture and nature further reinforces this disassociation of people water and architecture. This document aims to explore how architecture can adapt and transform to enable a better water culture within cities, so as to protect natural sources and ensure a more resilient city.

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CHAPTER 1

INTRODUCTION TO RESEARCH

FIG 1.0. SMALL CRAFT HARBOUR AT DURBAN , ANDREW HARVARD (https://andrewharvardphotography.com/tag/durban-south-africa/page/14/

1.0. INTRODUCTION

1.1. BACKGROUND

"The common material properties of things, and the shared cognitive and phenomenological processes through which people interact with them, generate recurrent ideas and patterns of engagement in diverse cultural and historical contexts. Despite growing instrumentalism in human 'management' of the material world, and the emergence of new relational forms, these patterns persist." *Veronica Strang,* (2008)

Human beings manage their material world through a series of processes and interactions. These interactions, and the nature of them, are indicative of an underlying culture formed towards that particular material (Ingold, 2000). Culture, in the case of the material world, constitutes a set of beliefs and attitudes toward that material and as Strang (2005,2008,2016) highlights, that set of beliefs persists unless altered by a change in mind-set or a shift in the relationship people have to that thing.

The perception of water by people is often something which is highly dependent on the context. This research investigates the relationship between these interactions with water within specific contexts and the development of a culture toward it. The culture with which water is managed can dictate the positive or negative influence of man over water as a natural asset.

Historically, ancient civilizations had a very different relationship to water than modern civilizations. The cross-cultural sacredness and reverence associated with water has been somewhat lost or diluted over the discourse of time. A large part of this is a result of industrialization. Previously being valued as a "lifeblood', water has lost its perceived value within society. The role of the built environment has played a major part in this modern disassociation of man with water.

The figure **1.5 illustrates the relationship between people and water**, and the integral function it has in defining a culture and community in ancient civilizations. The **figure 1.5 describes the current way in**

which water is interacted with and how instead of forming cultures around water, there is a need to address the culture formed through the attitude and conservation toward water within the built environment.

In his discussion on the rift between architecture and water management, Ashraf (2017) stated that the built environment has redefined the relationship between people and water. This statement is highlighting the commodification of water through urbanisation and the emphasis of reticulation systems within the built environment. From visually concealing water from the design of basic structures to the large-scale canalisation and control of natural water ways, Durban is a prime example of how water has been controlled and managed to the point of exclusion from the everyday life of people.

The investigations into what the culture, in other words the attitude and belief of water conservation, may be within Durban will help to understand the current water crisis from the perspective of its community, as well as the current social value of water within an industrial context.

The primary focused will be at the Durban Harbour and the way in which water is interacted with within the heavily industrialized and pragmatic zone, as well as the possibility of introducing alternatives to how water interacts with architecture.

The holistic ecological context of the Durban Harbour will also be taken into consideration as well as the how this relates back to how water is perceived within the natural environment versus the constructed environment.

This research will serve as an investigation into how the built environment interacts with water, and how this can be altered through architecture's integration into waterscapes, as well as the integration of water into architecture.

Architecture will be investigated as a mediator between people and water and will aim to change the perception of water within the urban context against the backdrop of a highly industrialized and ecologically degraded zone of the Durban Harbour.

1.1.2. STRUCTURE OF DOCUMENT

Chapter One will focus on contextualizing the water crisis within Durban, South Africa, as well as the significance of the harbour in the development of the city. Global water related issues as well as the impact of water issues within different regions will be examined. The problem statement and motivation will aim to discuss the specific issues surrounding South Africa.

Chapter Two will discuss literature which focuses on the relationship between water and the built environment, and how this relationship affects people's attitudes and belief systems to water management. This will be examined in terms of theoretical concepts of place, systems theory and ecological architecture and how they as a system, dictate the manner in which water is interacted with within the urban environment as well as how water culture can be addressed through architecture. Literature around methods of managing water within the built environment will also be discussed.

Chapter Three will look at precedents of architectural scenarios where water is integrated into the built environment. The projects investigated will aim to gain an understanding of how architecture can be used to alter the way in which water is treated in the urban context, as well as to extract principles and practical applications

Chapter Four will look at the specific case study of Durban Harbour and the current modifications which have occurred to the natural environment, the state of the natural environment as well as the industrialization of this area and how it may have affected the way in which water is perceived.

Chapter Five will provide findings from interviews and focus group sessions from people who frequently interact with the harbour. Professionals within the field of harbour systems and imports/exports will also be interviewed to gain a greater understanding of how the harbour functions as a holistic system. This will also include information gathered through observations of the current functioning of the harbour .

Chapter Six will include design proposals at mock jury stage based on the research conducted in previous chapters

1.1.3. MOTIVATION FOR STUDY

"Water is encoded with powerful themes of cross-cultural meaning, as the essence of life; as the source of human and environmental regeneration" (Strang, 2008)

GLOBAL WATER CRISIS

Water related issues affect, or has the potential to affect every country in the world. From rising sea levels and flooding to water scarcity and droughts; water provides a threat in its ability to rapidly shift, leaving countries with either too much or too little to survive. (UNESCO, 2007).

The global water issue is multifaceted in that it is simultaneously dealing with multiple threats of water availability and water control. This is related further to climate change and the intensive industrialisation of water. Climate change affects natural water cycles and movements to provoke sudden and intense instances where water becomes a threat.

The industrialisation of water affects hydrologic and hydrosocial cycles which will be discussed further in Chapter 2. The impact of human influence on water has left cities in a state of vulnerability and lack of resilience where issues of access and control are considered.

FIG. 1.1 Examples of global water issues and their corresponding UNDP 2030 goals to alleviate.

Row 1 (from left to right)

1. Tsunami in Japan, 2011, breaching barriers to control water influx. Available at: http://www.news.com.au/technology/environment/tsunami-warning-issued-for-japan-after-73-earthquake/news-story/d8442c14702a80216af18abe0729c568
2. Flooding in Louisiana, 2016. Available at: https://www.nytimes.com/interactive/2016/08/16/us/louisiana-flooding-pictures-maps.html
3. Typhoon in the Philippines. Available at: https://www.aol.com/article/2014/07/18/typhoon-slams-into-southern-china-one-dead/20933398/

Row 2 (from left to right)

1. Industrial Pollution affecting water sources. Available at: https://helpsavenature.com/industrial-water-pollution
2. Oil pollution in the Delta River, Nigeria. Available at: https://www.theguardian.com/books/2010/aug/29/oil-on-water-helon-habila
3. Gulf of Mexico Oil Spill, 2016. Available at: http://docudharma.com/2010/06/25/page/2

Row 3 (from left to right)

1. Plastic Pollution completely covering River. Availableat: https://secure.avaaz.org/campaign/en/end_plastic_pollution_loc/
2. Submarine plastic Pollution. Available at: https://www.nrdc.org/stories/10-ways-reduce-plastic-pollution
3. Plastic Beer Pack deforming a Turtle. Available at: http://www.ourendangeredworld.com/plastic-pollution/

FIG 1.1.





13
CLIMATE
ACTION




CLEAN WATER
AND SANITATION




14
LIFE
BELOW WATER

1.1.4. DURBAN WATERSCAPE

The separation of Durban from natural water bodies is infrastructural and has been occurring throughout the formation of the urban fabric of Durban . This separation makes access to the water and various waterscapes difficult. Unless it has been long entrenched as a point of entry to the water, e.g. Durban Beach Front. There is little intervention and opportunity for the community of Durban to interact, or foster a healthy relationship with water and water systems within the city.

The poor relationship between the city and the natural water sources, as well as a lack of facilitation between the city/water interface, provides little opportunity for the city to engage with the water. There are few instances where the built environment interacts with the waterscape to provide a platform for an ecologically and socially sustainable relationship to be formed between the community of Durban and the relevant water body, to foster a healthy "water culture".

1.1.5. DURBAN HARBOUR

Durban Harbour is a prime example of the detachment of a natural water body from the built environment. Despite being in such close proximity, neither the city nor the harbour waterscape interact. This point of disjuncture can be attributed to the lack of appropriate architectural intervention and infrastructural barriers in the area.
With the harsh industrialization of the port area, where the functioning of the harbour is valued more than the ecological health of the harbour, the degradation of the ecology within the harbour has resulted in an almost complete loss in biodiversity within the area. Instead water is met with hard surfaces and drains, controlled through canalisation and dredging and very little opportunity for a relationship to be formed between the residents of Durban city and the water's edge is allowed for.

NEXT PAGE

FIG. 1.2 Cranes at the Durban Harbour. (Available at: http://www.panoramio.com/photo/52283975)

FIG.1.3 Gantry Cranes at Sunrise at Durban Harbour. (Available at: http://ports.co.za/shippingworld/article_2006_11_4_1205.html)

1.1.6. REPRESENTATION OF WATER

Architecture has remained traditional in its approach to how water is integrated into the built environment. Water is rarely ever seen within architecture (Moore, 1994) and is often only associated with sanitation and reticulation processes. Water is more often interacted with as a tool or commodity rather than an ecological or experiential opportunity within the built environment (Illich, 1971). This has resulted in the physical and mental separation of people from the ancient reverence of water and has facilitated the formation of an uninformed and dissociative water culture. This has not escaped affecting the community of Durban's relationship to natural water bodies

1.1.7. LOCATION OF STUDY

The location of the study will focus on the Durban Harbour and esplanade area. This will take into consideration the communities and various clubs within the area and how the existing relationship to the water can be enhanced as well as how more interest within the area can be generated. The proposed research will affect the existing Maritime Museum Waterfront area, acknowledging the successes and failures of the Durban Harbour. The established communities which interact with the Durban Harbour will provide a variety of experiences and views with regards to the harbour.

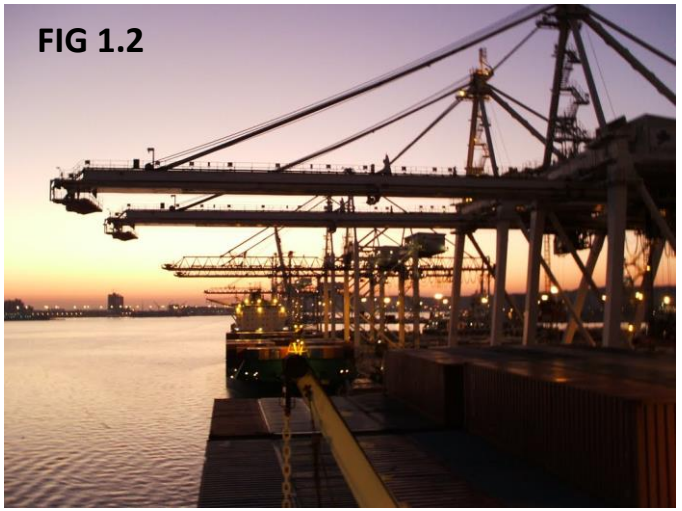


FIG 1.2


FIG 1.3

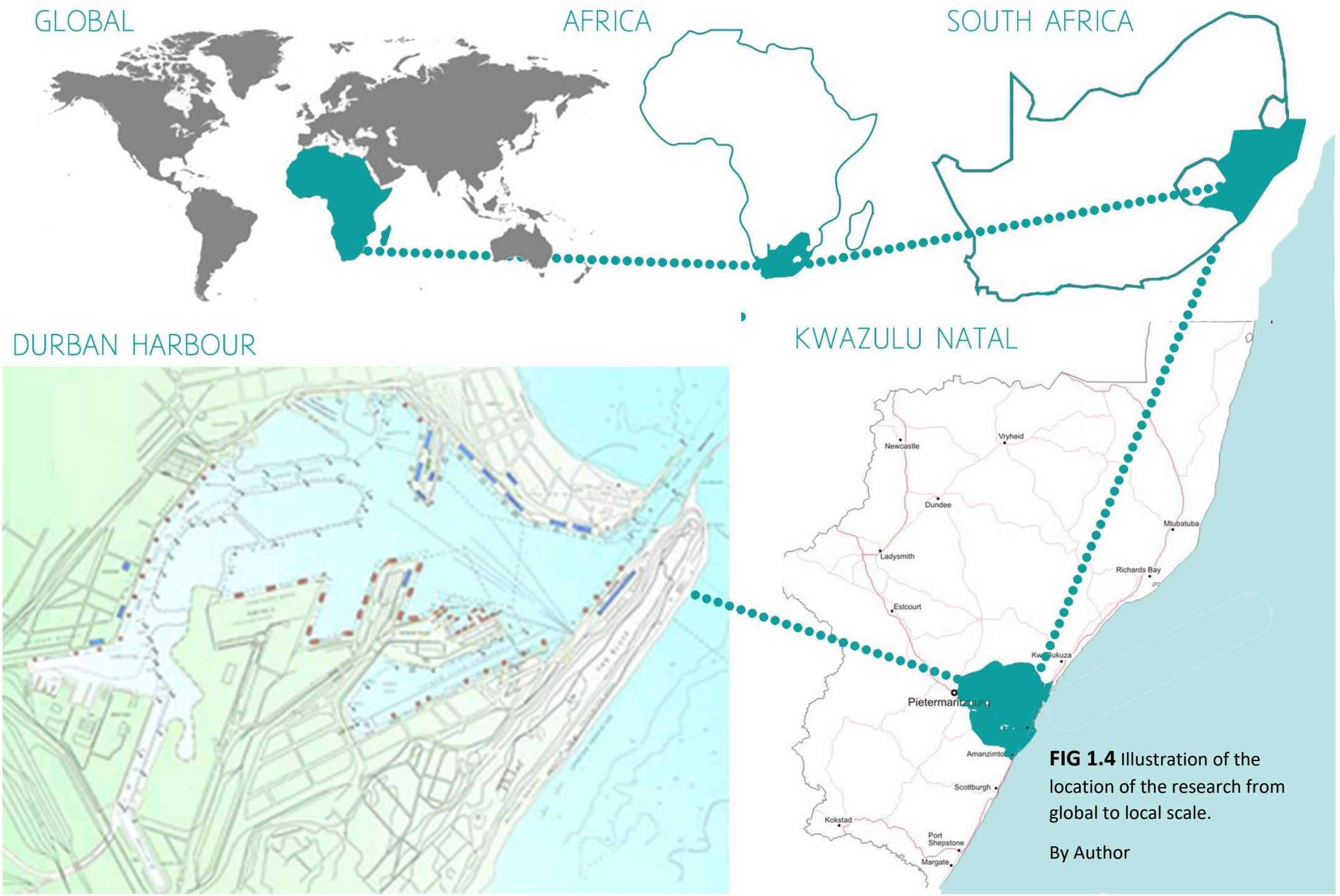


FIG 1.4 Illustration of the location of the research from global to local scale.

By Author

PROBLEM STATEMENT:

Disconnection between the city and the harbour waterscape has resulted in **a loss of resilience,** compromising the water culture of the Durban Harbour

FIG 1.5

problem statement

past ..... present

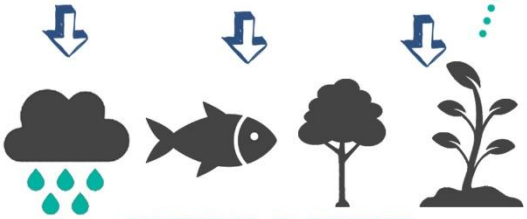
LOW DENSITY VILLAGES

lower density = less demand on water bodies - surface water was adequate

short distances between settlements and water sources = manual transportation at the the source

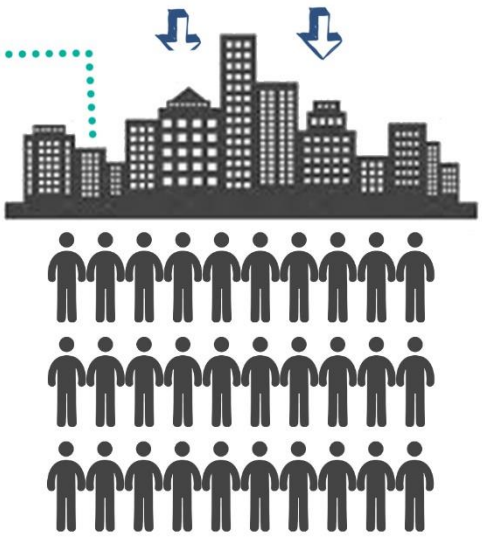
DIRECT CONTACT

water was directly interacted with by people and held value in what it enabled



NATURAL ELEMENT

water was directly associated with and influenced by ecology and natural cycles



HIGH DENSITY CITIES

high density = high demand for water. Surface bodies became insufficent

INDIRECT CONTACT

Transportation of water began.Intrastructure became the point of interaction between peope and water

INDUSTRIAL COMPOUND

water is directly associated with and influenced by infrastructure and human control

HEALTHY ECOLOGIES

DEGRADED ECOLOGIES

1.2. DEFINING THE PROBLEM

The relationship between built and natural environments within urban settings has become threatened due to the dominance of the man-made over the natural. The connection between people and nature has also suffered due to this strained relationship (Orr, 2003). As a result, natural processes and systems, such as those systems involved with water, have been neglected.

The industrial capabilities of nature have been exploited instead, resulting in an imbalanced system. The rebalancing the relationship between water and the urban environment needs to occur in order to create a sustainably resilient water culture.

Durban Harbour is a point where the dichotomy between man-made and natural can be clearly seen. The almost complete dominance of Port functioning industry over natural habitats and environments has resulted in the severe loss of ecology and resulted in a highly vulnerable water system within the harbour and its tributaries.

This lack of Resilience is a result of years of ecological degradation and industrial precedence within the harbour system. There has also been a significant social disconnection with the majority of the waterfront, where a large portion is privatised and inaccessible to interaction with the public. This inaccessibility has resulted in a disconnection between the city and the water's edge.

1.2.1. PROBLEM STATEMENT

The lack of opportunity to access the water's edge at the Durban Harbour has resulted in the disconnection between the city and the harbour and resulting in a loss of its social and ecological value to the city.

This disconnection has resulted in various repercussions, such as the rapid decline in ecological health and the dominance of the Port Operations industry within the area.

PREVIOUS FIG 1.5 Illustration of disconnection between people and water as a result of urbanisation

By Author

1.3. AIMS AND OBJECTIVES

AIM

The aim of this research is to determine how architecture can contribute to reconnecting people and cities to the water's edge. By gaining a deeper understanding of the pressures of urban and industrialised life on water perceived as a commodity, the "water culture", or the way in which water is interacted with can be established.

An architectural response to this water culture will aim to facilitate interaction between people and water, as well as facilitate awareness around the importance of water conservation to attempt to alter the way Durban city interacts with the Harbour waterscape. To investigate how architecture can contribute to a sustainably resilient water culture.

OBJECTIVES

1. To explore the definition of a resilient water culture in the South African context.
2. To investigate the relationship between a resilient water culture and the built environment.
3. To determine the design principles in creating an architecture which promotes a sustainably resilient water culture.
4. To investigate the requirements for the sustainable integration of water into the built environment.

1.4. SCOPE OF WORK

1.4.1. DELIMITATION OF STUDY

Investigating the relationship between Durban and its natural water bodies and its significance to their surrounding communities is a broad a multifaceted task. It is important to choose a key aspect of culture to focus on. The scope of this research does not allow tackling every angle of culture as it is too extensive and complex, especially when factors such as religion and religious/traditional customs are concerned. A specific delineation of culture in terms of sustainability and resilience will be defined through the research in Chapter 2 and 3, and will be used as a lens to study the relationship the city has to the water's edge in chapters 4 and 5.

Since the key location of focus is in close proximity and is, somewhat, a part of the coastal recreation belt for Durban, the lens under which culture is examined will focus on how water is interacted with, the attitude and beliefs to water conservation and awareness of water issues within the community of Durban. Religious and spiritual aspects of water will be considered, but not directly addressed in the research, unless shown to impact recreation.

The communities which interact with the Harbour on a regular basis will be the primary focus.

The architectural proposal will address issues of phenomenology and genius loci as well as an ecologically water resilient architecture. The purpose of the intended building design is to activate the Durban Harbour as a water centric space and provide a platform for interaction and a holistic sensory experience of the water's edge. Bearing in mind the current development strategies and plans of the Durban Harbour and Durban City area, future development proposals will be taken into consideration. A new proposed framework or urban development will not be included in the proposal. Instead, it can be assumed that the proposed intervention will work in conjunction to and tap into the proposed development for the area as per the LAP proposal of 2015.

1.4.2 DEFINITION OF TERMS

Ecosystem

a biological community of interacting organisms and their physical environment.

Seacosystem

A community of organisms, both natural and urban, existing along an ocean (Helmrich, 2011)

Waterscape

Landscape in which water comprises the dominant element or influence.

Hydrologic cycle

The natural, scientific cycle of water through it's various phases on earth

Hydrosocial cycle

The hydrologic cycle with consideration of how social system affect and are affected by the water cycle.

Ecology

The relationship living organisms have with their immediate environment. .

Built Environment

Man-made structures, buildings and infrastructure, constructed with the intention of aiding the human population.

Urban Ecosystem

The synthesising of natural and built environments to form a hybrid environment in which both people and nature adapt to accommodate each other

Socio-Environmental Systems

The interaction between social and ecological systems to acknowledge the effect each has on each other.

Biodiversity

The full extent of plants and animals which exist within a particular ecosystem.

Natural Environment

Naturally occurring environments in which the man-made has not aided it's growth

Resilience

The ability of an object to return back to its original state after stress or shock

Sustainability

The ability to use with the intention of not entirely depleting a source.

STATING THE ASSUMPTIONS

It is assumed that the built environment can play a role in creating a sustainably resilient water culture for Durban. By creating a space where interaction and experiential contact with water is created, it is assumed that this will enhance issues of awareness, conservation and have an impact on the attitude and beliefs of how water is managed within the city.

It is also assumed that the communities surrounding the Durban Harbour will benefit positively from an architectural intervention and opportunity to interact with the water's edge.

1.4. MAIN QUESTION

How can the built environment contribute to a water culture that would enable a sustainably resilient architectural response?

1.5.1. SUB QUESTIONS

2. What is the definition of resilient water culture in a South African context?
3. What is the relationship between resilient water culture and the built environment?
4. What are the design principles which will enable a sustainably resilient water culture?
5. How can architecture integrate natural water bodies to facilitate a sustainable and interactive relationship to water?

1.5. CONCEPTS AND THEORIES

1.6.1. Resilience Theory

Resilience Theory explores with the ability of the urban built environment to adapt with constantly changing circumstances and fluctuations in climatic and natural environments. This can include natural disasters and where Resilience is used to mitigate or prevent damage due to natural disasters. It does also, however, provide principles where cities become more adaptable to long terms stressors, such as fluctuating water supplies and coastline control systems.

Resilience theory makes up the framework and main lens for analysis throughout the document. Three aspects, adaptation, transformation and resilience are used to focus the literature to specific areas of analysis.

1.6.2. Place Theory

Place theory takes into account the experience of a waterscape and the relationship people have and experience within these spaces.

Water has the ability to give certain spaces unique characteristics which as a result, generate site specific experiences. The relationship people have to the waterscape and the experiences within the space, is therefore specific to the context of the space as being part of a waterscape. The relationship formed between people and a water's edge will be examined in an attempt to reconnect people to appreciate natural water bodies and its significance to local context.

Ecological Architecture

Ecological Architecture provides a method addressing both water related issues and the health of environments. By addressing the role of water in repairing the ecological state of natural environments, as well as allowing the built and natural environments to successfully amalgamate, the overall health of the ecosystem as well as the water quality will improve.

1.5.3. Systems Theory

Systems theory addresses the complexity and multifaceted nature of water culture within a community. It acknowledges that there is a sum of parts which work together to create a whole working system. By accommodating one system, often others are compromised. System theory suggests the interconnectedness of these water

systems and allows for a balance to be established between natural, social and

Whole Design Theory

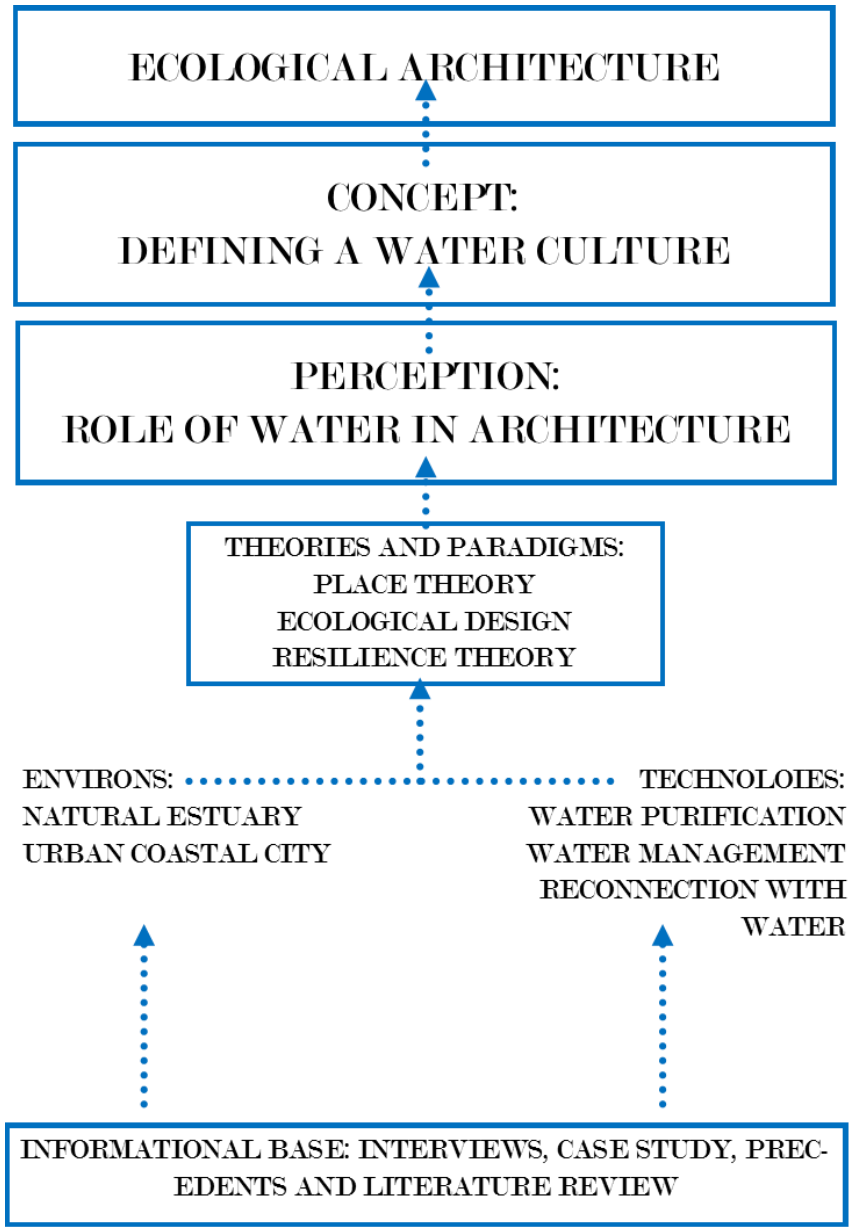
Whole design theory builds from systems theory, where the sum of the parts is greater than the whole. This allows for the understanding of achieving an end goal – being a sustainably resilient water culture – the systems must be addressed across multiple scales and systems to design a working whole.

The document is structured as indicated in figure 1.6

FIG 1.6 Diagram of theoretical structure of document

By Author

FIG 1.6



1.6. METHODOLOGY

The approach to the study is qualitative. The relationship of the urban built environment to the natural environment, as well as the urban community of Durban to the natural water bodies were the targeted areas of focus. The communities which are immediately involved with the Harbour were the communities taken into consideration, as they present the most constant interaction with the water bodies. Although the proposed problem affects the larger area of Durban, the focus area of Durban CBD was examined in depth through a case study in Chapter 4.

1.7.1. Case Study

Mapping of the built environment and its impact on the shape and form of the Durban Harbour will make up the bulk other case study. Through historical maps, a timeline of the Durban Harbour will be developed to fully understand the relationship between the built environment and the development of the current water culture.

These will inform the requirements of an architecture which promotes a relationship to the ecological environment and engages the community in order to build a connection to water bodies which will enable the conservation and protection of water as well as the actual water bodies themselves.

Primary Data Collection: Interviews and Observations

Semi-structured interviews were conducted with role players within the Durban Harbour. These specialists will include role players from institutions such as the city and Transnet as well as community representatives from harbour clubs and associations.

The interviews intended to gain an understanding of the current problems faced by the area in terms of the built environment and water integration. These interviews provided insight into the systems required of an ecologically and socially sustainable architecture. The focus aimed to what missing facilities are were described by interviewees to

determine the requirements of the proposed architecture.

Passive observations were conducted with members of the surrounding community to gauge the current level of awareness and involvement around the Durban Harbour, as well as the relationship the communities have with these water bodies.

Within these communities, emphasis placed on accounting for the established clubs, societies and active participants, to ensure the longevity and relevance of the built environment.

1.7.2. Secondary Data Collection

Literature Review and Precedent Studies

The literature review will include…. As discussed in preceding sections. Precedent studies will include studies which have tackled issues surrounding water culture and the built environment. This will be used to gain a greater understanding of the architectural requirements of an architecture which exemplifies sustainable building techniques and specifically, sustainable water management and one which promotes a water culture. Academic papers, newspaper and historical articles will be used to examine the area, as well as construct a timeline of events which may have affected the socio-ecological situation of the Durban Harbour.

Analysis

The results of the interviews, observations and case studies are all aimed creating a holistic impression of the water conditions situation as well as the level of awareness of the community, and how the two could be attempted to be addressed through architecture in its ability to create awareness and educate the public. This will be analysed through the theoretical concepts discussed in chapter 2 and principles applied in chapter 3.

The aim of the research is to determine how the built environment can be used to create a sustainable water culture. The lens of water culture and how the attitudes of conservation and appreciation for water and the natural environment can be

enhanced through architecture. The responses gained from interviews proved to give great insight into the functioning of the harbour, as well as the current socio-ecological state of the precinct.

This research will show the current state of the relationship between the Durban Point Waterfront and the community of Durban, as well as the types and frequency of interaction. It will also determine the type of architectural technologies which will be most appropriate given the current state of the river and the perception of it from the perspective of the community.

This will also provide information on the focus for the architectural intervention and typology determined by the results of the interviews, based on the needs of the community.

The mapping of the built environment in relation to the Durban Harbour will also give insight to the approach to be taken when considering design aspects of the architecture. Architectural technologies as well as sensitivity to the current state of the harbour will be accommodated and considered through this exercise.

1.7.2. LIMITATIONS OF RESEARCH

The community interviewed within the harbour have been active within the area for a long period of time. Therefore, the information gathered is highly reliable, but views and opinions often dated. This has to be taken into consideration in terms of the LAP and future goals of the city. Limitations in the ethical clearance process delayed interview times a data capture periods to the latter half of the year.

This dissertation will be limited to the Durban Harbour and constraints of community and environmental conditions were be considered when doing both interviews and case studies. Finding precedents which relate the similar socio-economic as well as ecological environments will also be a challenge in the accuracy of information gained from them in terms of contextual and typological relevance.

1.8. Conclusion

The **key questions, aims and objectives** outlined in this chapter will form the basis for the research in this document. Analysed through the theoretical lens of **Resilience Thinking**, these aims and objectives will be used to both define what a sustainable water culture is in Durban, and how this forms an architectural response.

This chapter summarised the need for a new culture around water to be formed, to ensure its preservation as both an ecological and social asset. The interdependencies of water within the social and ecological systems of a community, in this instance Durban, is tightly knit, and careful planning for the future of water within cities is of great value.

Durban Harbour has been victim of the dominance of the man-made over the natural. The industrialization of the harbour has resulted in a social and ecological alienation which needs to be addressed to ensure a healthy socio-ecological system.

Chapter 2 will analyse the relationship between the built environment and natural environments in an attempt to define an urban ecosystem and a water culture which supports the amalgamation of the natural and man-made.

Chapter 3 will compare and analyse the principles of adaptation, transformation and resilience within different contexts across the world to understand how water has been dealt with in different circumstances.

Chapter 4 will look more closely at Durban and Durban Harbour and how the harbour evolved into the waterscape it is today. Based off this case study, an architectural response will be further informed which is contextual to Durban.

Chapter 5 will provide relevant information through interviews of community representatives and professionals in the community

2.0

CHAPTER 2

LITERATURE REVIEW

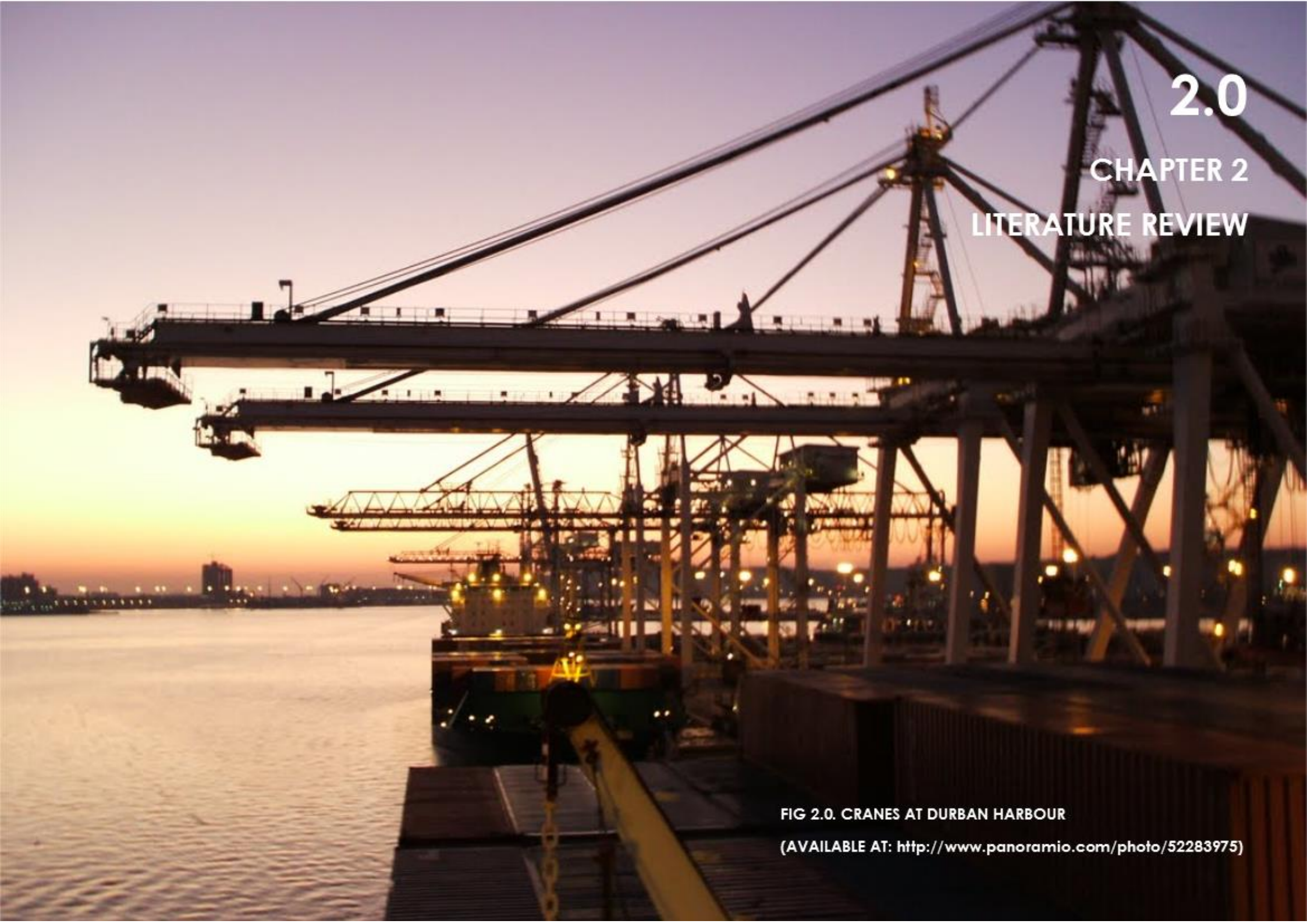


FIG 2.0. CRANES AT DURBAN HARBOUR

(AVAILABLE AT: http://www.panoramio.com/photo/52283975)

2.1. Introduction

Water in its natural form, as the “lifeblood” of human abilities, has enabled life to develop (Strang, 2005). The mere sensory experience of interacting with water, creates an embodied experience with a space, which gives water it’s sense of reverence in almost any culture (Strang, 2016).

Urbanisation has reduced water to little more than an everyday commodity in built environments (Moore, 1994). The interaction between water and the urban environment has been neglected, limiting the opportunity for meaningful interaction and reducing the sensory experience and veneration historically associated with water.

The overriding theory of resilience thinking and its role in defining a water culture will be carried through the discussion, as a linking theme between water and architecture. Both architecture and water are impacted and often dictated by social systems and demands, therefore their relationship is indicative of the social norms practiced in that community. Water provides a point where the intersection between social and ecological systems and the built environment describe a certain attitude or ‘culture’ toward a material like water. By this virtue, the culture associated with urban environments and water can be redefined. To create a sustainable approach - between architectural, ecological and social systems - towards the integration and interaction with water, three concepts within resilience thinking: adaptation, transformation and resilience; will be mirrored with aspects of defining a water culture. This includes place theory, ecological architecture and systems theory. By doing this, an interface between these two topics can be delineated, and principles for architectural design defined.

Adaptation and the architectural response to the place and context of a natural body of water, as well as the sensory experience of water will be examined. This will be used to determine the similarities between the definition of space which both architecture and water create, as well as how the experience of both are enhanced by the

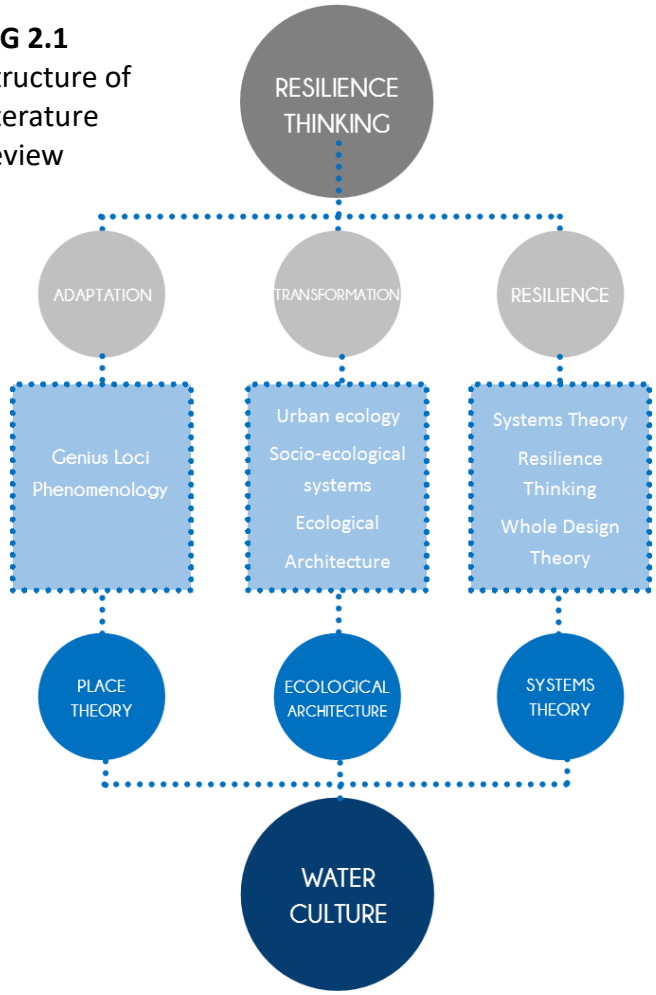
presence of each other. Similarly, the experience of place, namely, **Phenomenology and Genius Loci** created by both water and architecture will be examined as well as what this interaction offers to the formation of culture

Transformation of architectural principles which investigates the introduction of water into the built environment instead of repelling or attempting to control it. In order to change the waterscape environment, as well as the relationship people have to water, architectural systems must transform to accommodate water.

Ecological Architecture and buildings which work with natural systems, as opposed to the detriment of these natural systems, will explore possibilities of architecture as a tool for repairing the disassociation of people and their physical connection to water as the former will enable regenerating a habitat which is conducive to both built and natural environments.

Resilience of the systems which currently dictate the interface of water, people and architecture needs to be taken into consideration. In order to properly link the disparities presented in the current model for waterfront design, **Systems theory and resilience thinking** will be addressed to examine what alienates people and architecture from water in highly industrialized zones, such as Durban harbour. The integration of social, economic and ecological systems is imperative to the redefinition of a sustainable water culture.

FIG 2.1
Structure of literature review



2.2. ADAPTATION

Adaptation of systems, like the complex systems associated with water, determine its ability to modify itself to external and internal changes (Dinur, 2005). These systems are never static, and due to minute internal and external adjustments to its context, are always tending towards an equilibrium. Water systems, where adaptation is often used to describe the materiality and form of water, have a great amount of tenacity and have adapted their environments in order to survive. The increasing pressures of industry and urban systems have pushed the ability of these systems to adapt. As a result, we see the steady decline in the ecological health of natural water systems in urban contexts. Similarly, architecture should not be designed as an imposition into the external system, or environment. Architecture must modify itself to adapt to the environment in which it is situated (Dinur, 2005). Adaptability can be closely related to the theory of place and how architecture integrates to the external systems of the environments (Dinur, 2005). This integration is imperative in understanding the sustainable integration of architecture into a water centred environment.

FIG 2.2.

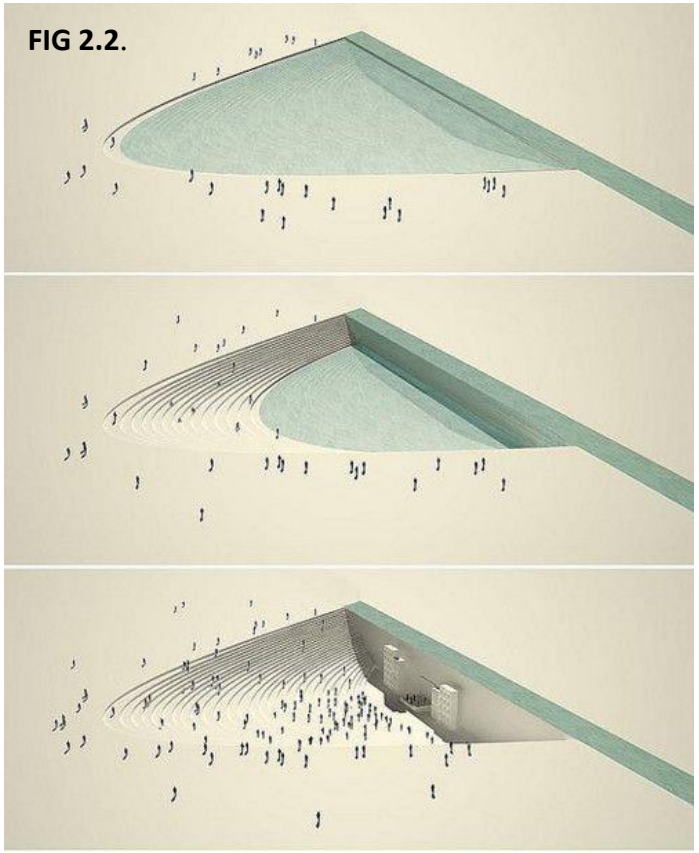


FIG 2.2 An example of urban adaptation: An Amphitheatre allows to be flooded when necessary to absorb the impact of sea-level rise
Available at: https://divisare.com/projects/80216-paisajes-emergentes-luis-callejas-edgar-mazo-sebastian-mejia-3km

2.2.1. Water and Architecture

Water and architecture have a simultaneously intertwined yet contentious relationship. In most Western architecture, water is only introduced into the built environment under utilitarian and controlled methods (Moore, 1994). This is primarily for sanitation purposes, and extends seldom to include the diverse material and sensory qualities of water. Since the built environment houses and transports water in concealed reticulation systems and more often than not, "*the only constant visual of water is in the toilet bowl*" (Moore, 1994).

In the modern context, the presence of water in the built environment has been adapted from a ritualistic relationship with natural water bodies, seen in ancient civilizations, to a manmade mechanization of water through urban reticulation systems. The presence of water is still vital, although it's image altered. The presence of architecture and the built environment is completely reliant on the availability of water and this intertwines the two environments entirely (Ashraf, 2017).

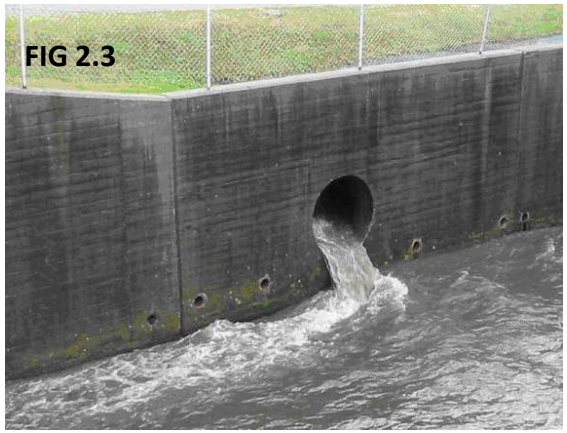


FIG 2.3 The usual water interactions in modern cities
Stormwater Drain
Available at:
http://www.melbourneqa.com/2017/04/17/stormwater-management/

FIG.2.4 Toilet
Available at: https://www.italtile.co.za/laufen-kartell-white-wall-hung-rimless-toilet-excluding-seat-product.html

Architecture has gone to great lengths to exclude natural water from the built environment, with the exception of visual links where desirable and the occasional water feature for aesthetics is included. (Moore, 1994).

Waterproofing is a fundamental aspect of design. Water in the built environment is perceived as a threat to buildings and their integrity. Where some of the measures taken to control water in architecture are valid, the general attitude to water within in the built environment needs to be revisited (Ashraf, 2017). There are increasing pressures on the ecological health of water within the built environment, architecture needs to allow for a progressive relationship with water. In order to alter its perception in the greater social system as something greater than a *"turn of the wrist*" (Moore, 1994), Architecture needs to include water as more than merely a commodity and rather as an essential aspect of experiencing a building.

"Water within the architectural realm is often divided into two denominations. "Water within the architectural realm is often divided into two denominations. Water that contends and water to channel" (Ashraf, 2017).

In his discussion of the changing role of water in architecture, Ashraf (2017) draws on the "types" of water initially described by Illich (1984). Within this definition,

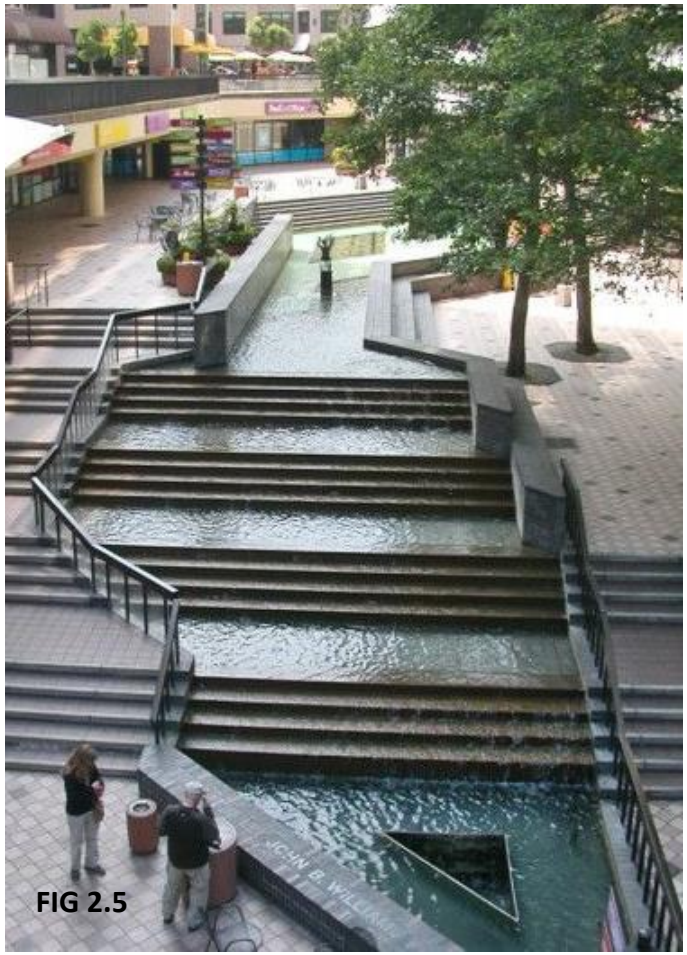


FIG 2.5 Typical public feature with no access or interaction with water.
Unknown, http://www.easywayfinder.com/dothan-al/shopping [accessed 10/05/2017]

water to contend is water from natural origins. It is multiscalar and is omnipresent, ranging from oceans, rivers and lakes to rain puddles and humidity. It is water which is uncontrolled by man (Illich, 1984). In contrast, Illich (1984) speaks of "subservient" or canalised water, which is used purely for the benefit of urban structures through reticulation systems, pipes and pumps.

Clarity and control within the built environment is associated with dry land (Ashraf, 2017). The redefinition of how architecture interacts with water will be a redefinition of how people and the mindset of people will change towards it.

Water related issues, such as flooding, droughts and pollution, are rapidly altering the attitude and way water is perceived.

These attitudes and beliefs need to be transformed to create a built environment which is conducive to the ecological environment as well as allowing people who interact with it, to change their relationship to water.

With the rise of urbanisation and the increased interface between people and the city, the relevance of water depends on how it is represented within these environments. Illich (1984) discusses the relationship between cities and water and the evolution of the interface that architecture provides between the two. His arguments consider water as two differently perceived entities, where "the stuff", which he often terms canalised water, indicates the *"stuff which industrial society creates*".

Illich (1984) examines the evolution and presence of water within the built environment, and draws conclusions as to why there is a fundamental difference between, as defined by Ashraf (2017), contended water and canalised water.

Figure 2.6 indicates the timeline of the presence of water within the built environment, and shows how the advent of urbanisation has resulted in the purely utilitarian and subservient transformation water of "H_2O".

"The idea of a material [water] that flows forever back to its own source constitutes a major innovation in the perception of water" (Illich, 1984)

The built and natural environments have been classed as contrary spheres, where one hinders the other and the success of one is to the detriment of the other (Ursprung, 2007). Water is an integral element in both environments which often dictate their functioning, health and holistic success. By using water, in its multitude of functions, cross-cultural reverence, specific experiences and aesthetics, using it as a platform to link the built to the natural environment provides an opportunity to create a renewed attitude towards how water is perceived.

Ashraf (2017) further discusses the ethos surrounding water and urbanism. He calls for a reconsideration of how water is interacted with within cities. The possibility of having cities which are resilient to water in their adaptation to it, provides a platform where water to contend and water to canalise co-exists. The idea of water can be restored to have value in both the urban and natural environments, instead of being only something subservient to the built environment.

By acknowledging the changing role of water in the built environment, the specific qualities of water and how it affects a space must be at the forefront of waterscape design.

Evolution of the Built Environment

The above diagram is based off Vladimir Novotny's (2010) timeline of water in urban environments. He separates the evolution of water into four different paradigms, triggered by shifts in development in urbanisation.

Paradigm I BC – Middle Ages

This paradigm references ancient civilizations and the way they managed water. While traditions and rituals may vary greatly between them, the basic supply and demand of water was common. Water was available through surface water bodies, such as lakes and rivers, and groundwater wells. This water was unfiltered and was transported manually.

As a result, settlements were close to water bodies. Sewerage was not yet waterborne and was not often associated with water yet. Water was used to cook, clean and drink. Due to the unfiltered use of water, these sources were easily contaminated. The shift in paradigm was sparked by outbreaks of disease due to poor sanitation. Below, FIG 2.6 illustrates the basic water supply methods practiced (Novotny, 2010).

Paradigm II Middle Ages - 1850

Settlements and populations began to expand and single water sources could no longer meet demands. As a result, water transportation methods were designed. Aqueducts, canals and storm water drains are evident in civilizations, while rainwater collection and public fountains are seen in others. The housing of water began with the introduction of public baths and sewerage becomes water borne through public flush toilets. Below, FIG 2.7. shows some of the methods used to transport water in the form of (top to bottom) aqueducts, subterranean water storage cisterns, and the oldest sewerage drain, the Cloaca Maxima (Novotny, 2010).

Paradigm III 1850 - 1970

Paradigm III was sparked by industrialisation and the huge migration of the population from rural to urban areas. As a result, the basis for traditional water reticulation systems occurred to meet the high density of people as well as the verticality of buildings. The formalisation and standardisation of underground sewers and storm water drainage changed the way water was moved into and out of the city. In many instances, wastewater was not treated and flowed directly back into natural water sources. Hard surfaces within the city meant the urban run-off volumes were higher and much more contaminated. The contamination and pollution of water sources resulted in compromised water quality, ecology and marine and riparian life (Novotny *et al*, 2010).

It was only around the 1850's and late 1800's that wastewater began to be treated and septic tanks installed in order to prevent contamination of water sources (Novotny *et al*, 2010).

The damage to the environment, however, continued. The combination of industrialisation and urbanisation resulted in the dominance of the man-made over nature and the effects were stating to be seen through global warming to highly fragile ecologies (Novotny *et al*, 2010). Below, FIG 2.7, illustrates (from top to bottom) the canalisation of an entire stream into a concrete pipe for water supply into the city, a contaminated river, fenced off from the city to prevent interaction and a river on fire due to the high level of chemical contamination.

Paradigm IV 1970 – Present

Fast conveyance of water enables cities to grow into larger sprawling metropolises. There is a high pressure on the supply of water into cities, and large amounts of water is wasted due to problems with reticulation systems as well as poor water management by citizen. As a result, natural sources are depleted quickly and ecologies are compromised (Novotny *et al*, 2010).

There is, however, a higher awareness of conservation and the repercussions of industrialisation on the natural environment. Organisations and protocols are implemented in order to curb the previously high-volume use of water. Wastewater treatment is compulsory in almost all urban environments, and the movement toward wastewater recycling is increasing (Novotny *et al*, 2010).

Global warming and climate change result in unpredictable weather patterns. This affects water in the form of sea-level change and unpredictable rains, resulting in flooding or droughts. Water has become a central topic of discussion as its value within urban settings begins to change (Novotny *et al*, 2010).

Paradigm V

The next paradigm in urban water management must take into consideration issues of global warming. Scarcity, flooding and sea-level changes all pose serious threats to highly populated urban environments and only how cities are designed can counteract the effects. A shift in water culture within urban environments to accommodate change in water management and how cities are designed (Novotny *et al*, 2010).

Traditionally hydrophobic cities will have to alter the way water is interacted with. Clarity and control within the built environment is associated with dry land (Ashraf, 2017). The redefinition of how architecture interacts with water will be a redefinition of how people and the mindset of people will change towards it.

Water related issues, such as flooding, droughts and pollution, are rapidly altering the attitude and way water is perceived (Novotny, *et al*, 2010).

These attitudes and beliefs have the opportunity to be transformed to create a built environment which is conducive to the ecological environment as well as allowing people who interact with it, to change their relationship to water (Novotny *et al*, 2010).

FIG 2.6 Paradigms of water management in Architecture. Illustration by Author Based on Novotny,2010

Below, FIG. Illustrates the effects of global warming in cities namely (top to bottom) flooding, tsunamis and unpredictable rains.

FIG.2.7 Paradigms in the Real World

Paradigm I – Top to bottom

1. An ancient well in rural towns was a way of accessing ground water.
2. Canals in town used to fill up with rainwater to supply the community
3. Lake bled – Slovenia: Lakes and rivers were surface sources of water Available at: https://imgur.com/gallery/whuHF

Paradigm II – Top to bottom

1. Aqueducts used to transport water into cities
2. Cistern for underground water storage
3. Cloaca Maxima – the oldest sewerage line

Paradigm III – Top to bottom

1. Lake being canalised for water supply
2. Polluted river in Paris
3. Illinois River on fire due to chemical contamination

Paradigm IV – Top to bottom

1. Flooded Venice due to global warming
2. Tsunami breaching walls in Japan 2011, available at: http://kn1blog.blogspot.co.za/2013/11/blog-post_26.html
3. Typhoon in the Philippines, 2017 Available at: http://www.vladtime.ru/allworld/617004

All images sourced from Novotny, et al, (2010), pp5-25 unless otherwise stated.

FIG 2.6

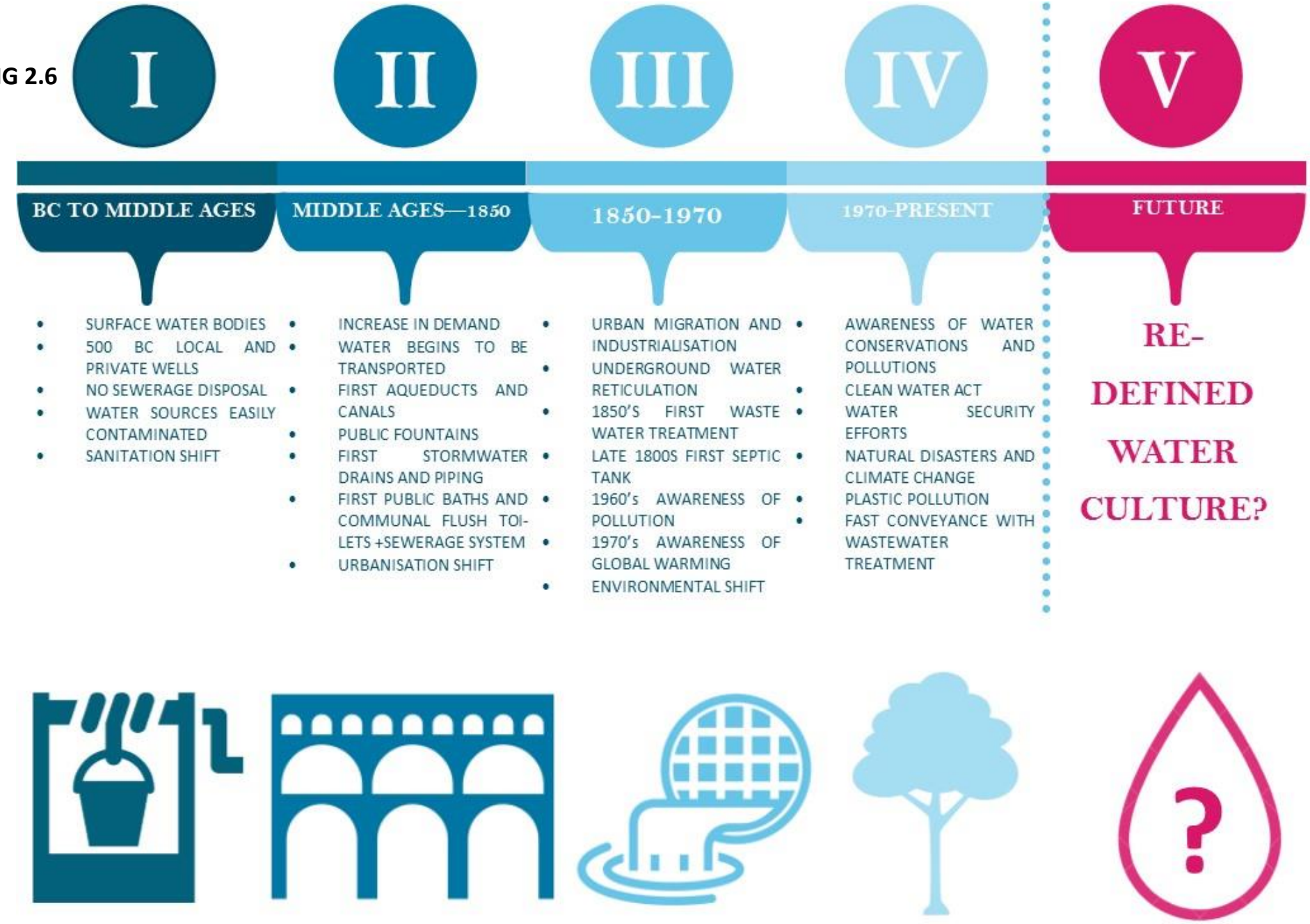
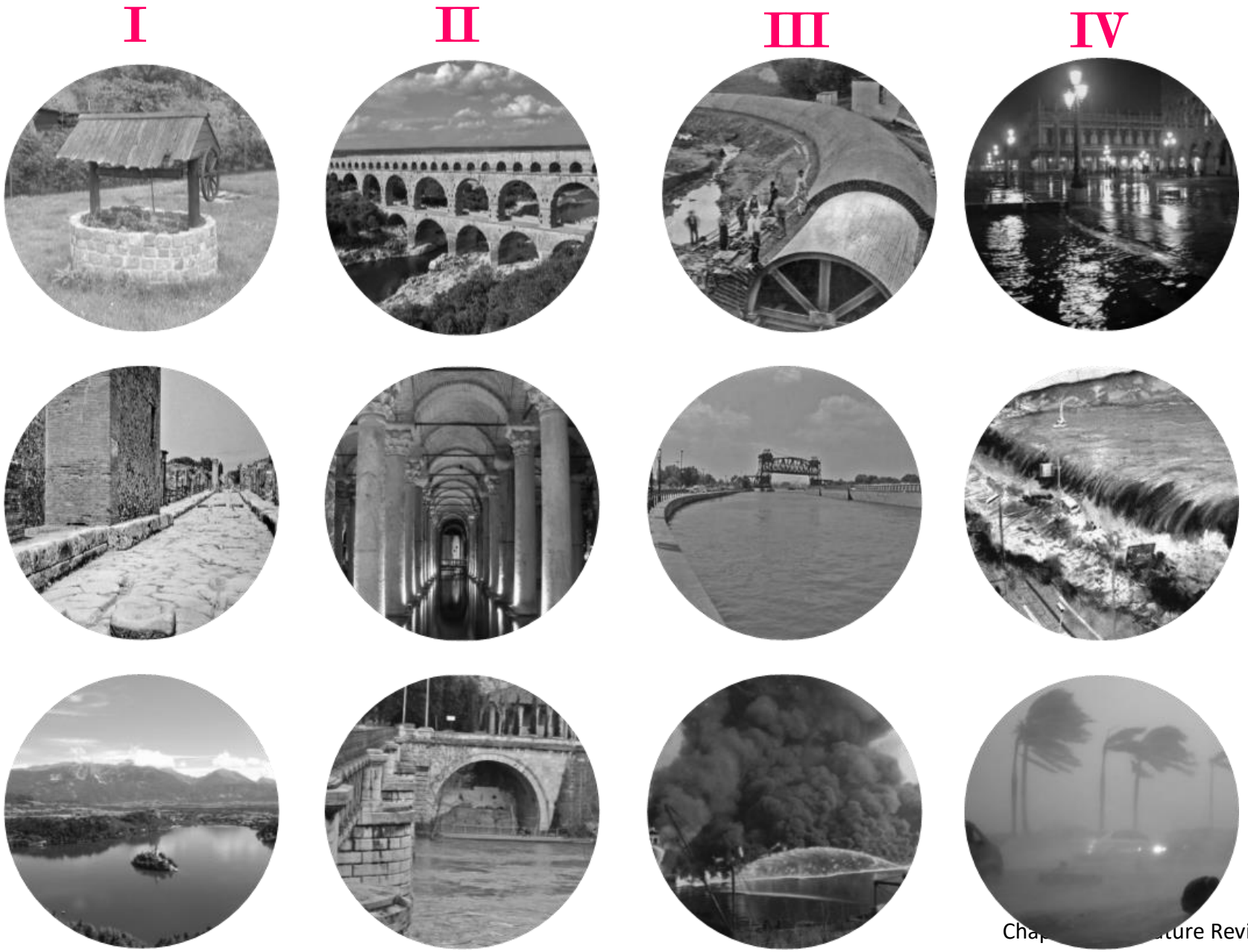

I
II
III
IV
V
BC TO MIDDLE AGES
MIDDLE AGES—1850
1850-1970
1970-PRESENT
FUTURE
SURFACE WATER BODIES
500 BC LOCAL AND PRIVATE WELLS
NO SEWERAGE DISPOSAL
WATER SOURCES EASILY CONTAMINATED
SANITATION SHIFT
INCREASE IN DEMAND
WATER BEGINS TO BE TRANSPORTED
FIRST AQUEDUCTS AND CANALS
PUBLIC FOUNTAINS
FIRST STORMWATER DRAINS AND PIPING
FIRST PUBLIC BATHS AND COMMUNAL FLUSH TOI-LETS +SEWERAGE SYSTEM
URBANISATION SHIFT
URBAN MIGRATION AND INDUSTRIALISATION
UNDERGROUND WATER RETICULATION
1850's FIRST WASTE WATER TREATMENT
LATE 1800S FIRST SEPTIC TANK
1960's AWARENESS OF POLLUTION
1970's AWARENESS OF GLOBAL WARMING
ENVIRONMENTAL SHIFT
AWARENESS OF WATER CONSERVATIONS AND POLLUTIONS
CLEAN WATER ACT
WATER SECURITY EFFORTS
NATURAL DISASTERS AND CLIMATE CHANGE
PLASTIC POLLUTION
FAST CONVEYANCE WITH WASTEWATER TREATMENT
RE-DEFINED WATER CULTURE?
?

FIG 2.7



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Illich (1984) also describes a timeline of water in architecture similar to Novotny (2010) as discussed above. above indicates the timeline of the presence of water within the built environment, and shows how the advent of urbanisation has resulted in the purely utilitarian and subservient transformation water of "H_2O".

FIG.2.8 Hydrophobic Urban Environments in Berlin
Available at:
https://www.greenprophet.com/2011/06/beirut-green-urban-environment/

FIG 2.9 Hydrophobic Urban Environments in Florence
Available at:
https://en.wikipedia.org/wiki/Public_space#/media/File:Piazza_della_Signoria.jpg

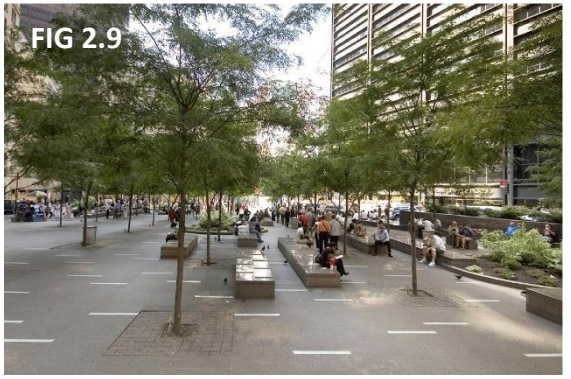

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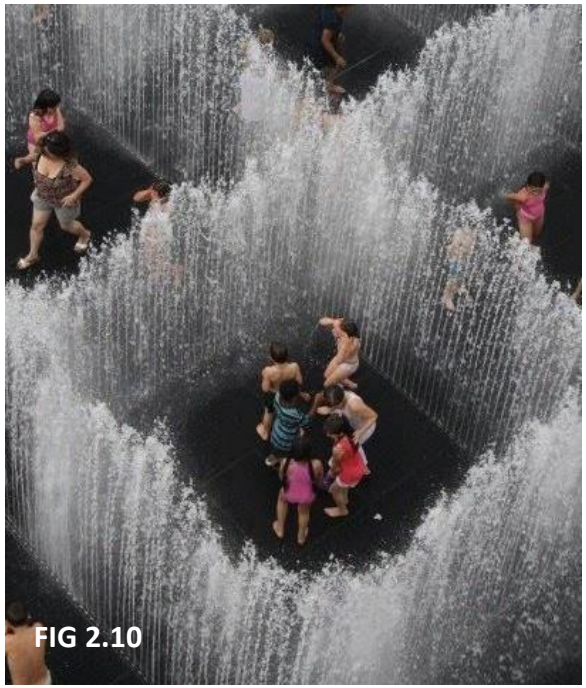
FIG.2.10 Public water feature integrating water and people – a more holistic approach
Available at:
http://conceptlandscape.tumblr.com/post/882013723 77/fountain-appearing-rooms-by-danish-artist

By acknowledging the changing role of water in the built environment, the specific qualities of water and how it affects a space must be at the forefront of waterscape design.



2.2.2. Phenomenology of Water

"Water has the ability to transform the space in which it is situated. The character of this space is dependent on the type of water it houses. Rivers, oceans, lakes, streams, etc. transfer certain characteristics and qualities onto a space"

(Strang, 2016)

Illich (1984) defined two different concepts of water, as water to contend and water to canalise. The perceived material quality of water is vastly different in both these instances. This largely has to do with the interactions and experience of water within the two contexts. Where water may have a constant presence and role in the workings of a typical urban lifestyle, it is rarely considered as something other than utilitarian and a product of complex engineering systems. It is, however, widely appreciated in its restorative ability as a cleaning agent. Occasionally, water is considered therapeutic within urban environments. These instances are often limited to domestic ritual of bathing, or visual stimulation through public spaces and fountains, as well as a retreat or special occasion through public pools and spas (Moore, 1984). Strang (2008) discusses this everyday interaction with water as an interaction at an "immediate sensory level". At this immediate level. Water offers the same properties regardless of canalisation or contending, that is "imbibing it, washing in it, cooking with it" (pp.2). She goes further to describe how this interaction is common to all humans (Strang, 2016) and provides a cross cultural platform for "shared cognitive and sensory engagement with place". This allows for the assumption that the interaction with water is a cross-cultural practice.

"The 20th century transmogrified water into a fluid with which archetypal waters cannot be mixed"

(Illich, 1985)

The difference between water to be canalised and water to contend with, is the role of archetypal, or uncontrolled, waters and their ability to define a space within an urban setting. This is an attribute of canalised water which is very rarely seen. Aside from coastal cities, that have no choice other than to be defined or confined

by this archetypal water, water - as rivers, streams, lakes etc. has been manipulated and reduced into a fluid which loses its ability to define a space and place and is instead subservient to it and the needs of the created space.

The materiality of water as part of the urban scheme is something which is not often considered. Materiality of water and its ability to be defined as something distinct to space without water gives it the adequate foundation for the formation of culture. Strang (2005, 2008, 2016) often refers to water as a “thing”, just as Illich (1984) refers to it as “stuff”. Heidegger (1971) also discusses the concept of a “thing” and its “thingness” or ability to take on and imply characteristics on a space, based on its positioning as well as

FIG 2.11 Water to contend: The Atlantic Ocean
Available at: https://en.wikipedia.org/wiki/Ocean#/media/File:Clouds_over_the_Atlantic_Ocean.jpg

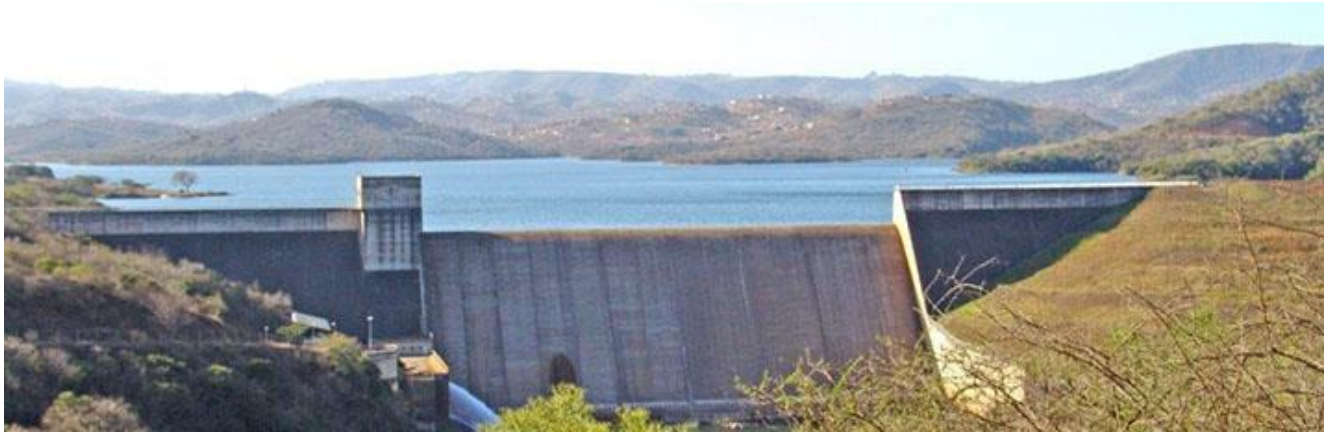


FIG 2.12 Water to canalise: Inanda Dam, Durban, South Africa
Available at: http://msinsi.co.za/inanda/how-to-get-there/

interactions within that space. The significance of water in its ability to connect across a multitude of scales and contexts, establishes the inherent value to humankind and its contribution to the success of our cities.

The multisensory experience of interacting with water allows for people to form a relationship with it and the space it defines.

Since water engages its user on a multisensory and cognitive level (Strang, 2016), the experience of interacting with it does imply meaning, and therefore a significance in its relationship to people. This relationship, between people and water, is what determines how and what meaning is taken from people engaging with water.

FIG 2.13. Water to wash
Available at: https://www.maids.com/blog/pros-and-cons-of-washing-your-clothes-in-hot-water/

FIG. 2.14 Water to drink
Available at:
https://www.quora.com/Why-do-the-water-drinking-taps-in-the-US-give-water-downwards-to-upwards-as-opposed-to-India-where-the-tap-releases-water-simply-with-gravity

FIG. 2.15 Water to cleanse/sanitation
Available at: http://www.waterwomensalliance.org/july-august-ritual-hand-in-hand-by-diann-l-neu/

FIG. 2.16 Water to cook
Available at:
http://www.thealternative.in/lifestyle/conserving-water-in-the-kitchen/

Helmreich (2011), in his discussion on the relationship between seawater and the development of culture, states that "*Water is not one thing"*. He discusses further of the ability of water to shift phases, from solid to liquid to gas, and its ability to engage the human sense at all three phases.

Pallassmaa (2005) argues the emphasis of the visual delight in modernist architecture as being reductive and alienating to the experience of a person within a space. Modernism, which forms the foundation for the design of urban environments, with its machine-like aesthetic tend to conceal and hide natural elements, like water from architecture, needs to be re-evaluated as a basis for urban design.

"This separation and reduction fragments the innate complexity, comprehensiveness and plasticity of the perceptual system, reinforcing a sense of detachment and alienation." (Pallasmaa, 2009)

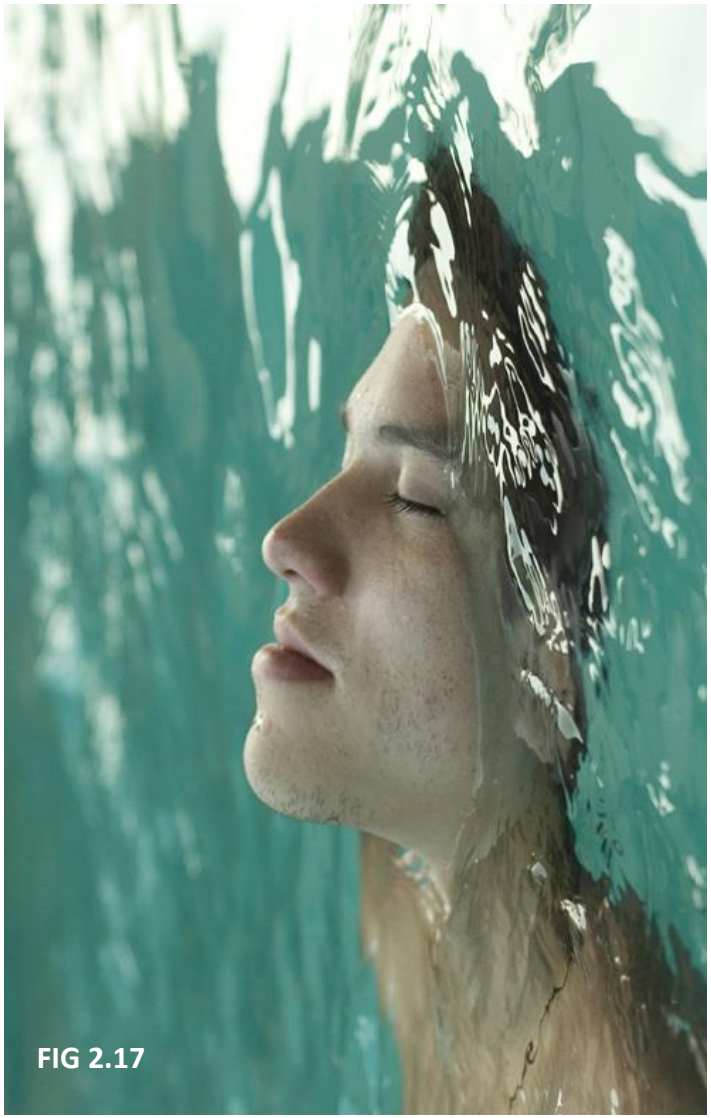


FIG. 2.17 Strang argues that immersion is one of the most powerful sensory experiences associated with water as it occupies all of the senses.
Available at: Dada, R, http://www.strangebeaver.com/2013/05/limbo-caught-between-dreams-and-reality/

Pallasmaa (2009) refers to the reductionist mentality of modern architecture, and its detachment through materiality. Architecture fails to represent its context and identity by not accounting for the holistic experience of a place. Pallasmaa (2009) discusses the materiality of space through a "system of senses" which work in collaboration with each other to give a holistic understanding of space. Water has the ability to affect all the senses as outlined by Strang (2016) and Helmrich (2011).

In this argument, sight and physical connections are important, but senses of taste and smell are equally important in evaluating quality and safety of interacting with water. These senses often determine the health of water, which affects the overall perception of it, and how it interacts with the context and adjacent spaces.

Strang discusses the sense of touch and immersion in water as being something which connects with people cross-culturally, across age and across genders, as it mimics the womb. The physical contact with water also denotes how it is interacted with as a holistic space. It's viscosity, salinity, temperature and speed, all determined by touch, gives each body of water a different type of interaction, and therefore relationship formed with it.

FIG 2.18

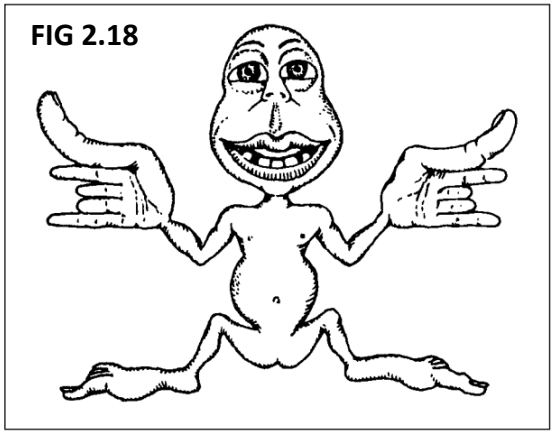


FIG. 2.18. The sensory homunculus, an illustration of how the surface of the body is represented in the somatosensory cortex. Larger areas of the cortex are devoted to the more sensitive parts of the body, such as the fingers and lips. (Ingold, 2000) pg 284

These interactions with water allow for a multisensory experience, which in turn develops a relationship of people to that

environment and the workings of it. The major difference is how waterscapes, be it marine, riparian or man-made, environments allow water to be interacted with, where natural is part of a living, changing and experiential system. Urban canalised water is part of a pragmatic and often detached or alienated experience of space.

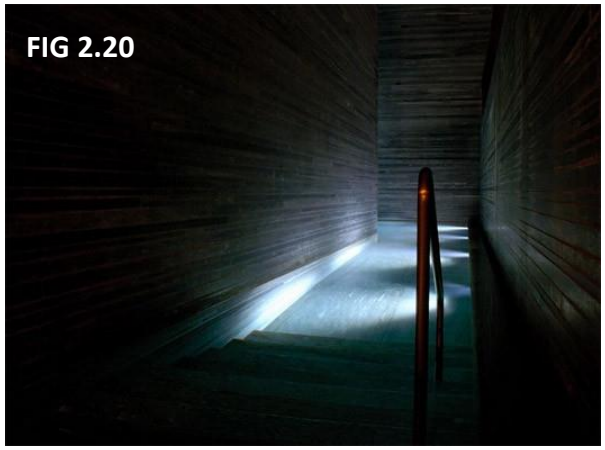
The way a space is experienced also infers a certain identity to that space (Tilley, 1994). This identity is usually described through the naming process and identification of spaces based on their characteristics implied through interactions between humans and the environment. Through this, people interact and experience these spaces differently.

The experience of a space is greatly affected by the presence of water. The quality or safety of that space is further judged by the sensory experience of a person within that waterscape. Architecture within that space must take cognisance of this entirely co-dependant relationship and how it is managed to enhance the relationship between people, space and water.

The phenomenological experience of water within the built environment is often reduced to just a visual experience (Moore, 1994). Bearing in mind the illustration of homunculus as discussed by Ingold (2000), the primary and most impactful integration of water in the built environment is through touch. As explored in Peter Zumthor's Thermal Baths in Switzerland. This illustrates the significance of touch and contact with water in informing the architectural response generated (Ryan, R 2015). Zumthor responds to this experience by dulling the other senses, particularly vision, as light and dark play a huge role of capturing the ethereal spirit of both the location and action of bathing.

FIG. 2.19.

Peter Zumthor's Thermal baths explore the phenomenological experience of physical contact with water within architecture Available at: https://www.architectural-review.com/buildings/thermal-baths-in-vals-



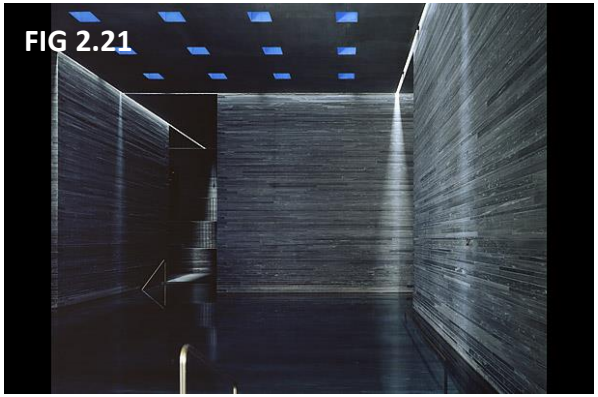


FIG. 2.20. & FIG. 2.21

Peter Zumthor's Thermal eliminate the predominant sense of sight vis the play of light and dark to explore the effect water in architecture has on sound, touch and smell
Available at: https://www.architectural-review.com/buildings/thermal-baths-in-vals-switzerland-by-peter-zumthor/8616979.article

The phenomenology of water in architecture was also explored by designers rAndom International with their "Rain Room" installation at London's Barbican. This installation also used light and dark to help heighten the other senses of touch and sound (Chalcraft, 2012). The installation explored the instinct to touch water, which immediate shifted away vis sensors, even in an enclosed space which is traditionally hydrophobic. This explores the human nature and instinctual responses to the element. Especially the desire to connect physically to the simulated rain (Chalcraft, 2013). The installation also explores the effect of technology on how we interact with nature which will be discussed later on in this chapter.

FIG. 2.22.
rAndom International explored the instinct of people to physically connect to simulated rain, implying an inherent desire to be physically connected to water

FIG. 2.23.
Rain Room also explored the middle man of technology in how we experience something which is usually natural, like rain, in a foreign and controlled environment
Both available at: https://www.dezeen.com/2012/10/04/rain-room-by-random-international-at-the-barbican/

2.2.3. Genius Loci of Waterscapes

"reductive forms of explanation- such as 'scientific' understandings of ecological and hydrological processes – [which] tend to exclude or override alternative and/or more holistic forms of knowledge"

(Strang, 2008)

Strang (2004,2008 and 2016), discusses the presence of water as a necessity for the formation of any human development, therefore giving it a pivotal role in the formation of place, culture and identity of a community. The role of the built environment in creating a sense of place and a sensory engagement in relation to, and integrating water into, its design provides a "centre" (Robinson, 2003), to enable a fuller understanding of the environment. Heidegger (1971) builds on this by stating that the creation of place is inseparable from the creation of architecture.

Where water and its experiential qualities may define a space, and offer specific qualities to it, architecture can transform water based environments into a place of significance to community. Heidegger (1971) describes this idea in his discussion of dwelling and place making, where, "The existential purpose of architecture is therefore to make a site become a place, that is, "*to uncover the meanings potentially present in the given environment."* (pg.112)

Tilley (1994) further discusses this delineation of space from place. He states that *"Places in existential space are foci for the production of meaning, intention and purpose of societal significance."* (pg 89)

Christopher Day (2002) discusses the impact of humans on the natural environment. He argues that if there is harm inflicted on the environment, it is not inherently intended by the mass population, but it is due to a severe disconnection between man and environment. This can be reduced to a misunderstanding of personal action and larger scale implications. He also discusses this disconnection as a result of over simplifications of previously complex

natural systems, as seen with water and the interruption of the natural water cycle through urban reticulation systems, hard surface run-off and untreated sewerage. Through this, the definition of space, and the qualities described by this space, is articulated through architecture. These architecturally defined places reflect the context of its site and the act of place-making is completely and entirely intertwined with the incorporation and consideration of the environment.

Merleau-Ponty (1962) also describes place as human centres of meaning and identity within the vast delineation of space. Robinson (2003) expands on the ideas of centres within the environment, where points of interactions occur through a mediation between body and environment. Places essentially have three aspects which imply a Genius Loci. According to Robinson (2003) the, physical location or the context in which a place is situated, infers symbolism to a space and what it represents to the user. This in turn dictates the function of the space and how it is used. These three aspects combined, transform a space into a place or centre (Robinson, 2003).

FIG 2.24 Christopher Day examines the cyclical and varied nature of the water cycle. Day, 2011, Pp. 40

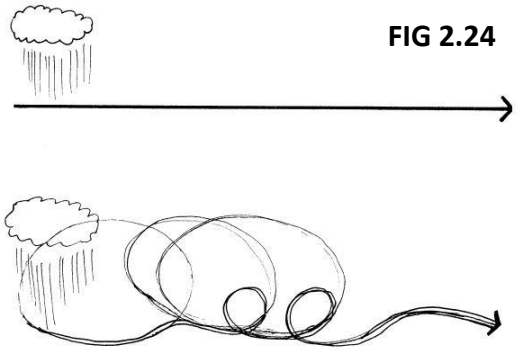


FIG 2.24

FIG 2.25 Diagram of how the physical affects the spirit or genius loci of a space. Day, 2011. Pp. 166

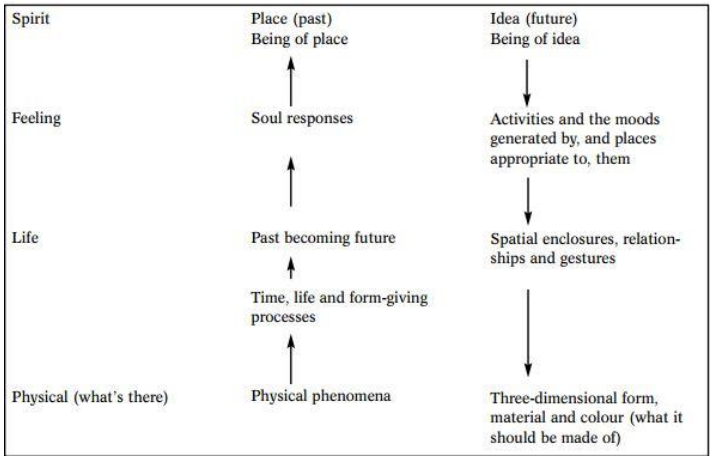


FIG 2.25

Therefore, an architecture which enhances the natural environment and through its impact on place; defines, identifies and functions to the benefit of a water based environment.

Architecture which allows for the building to adapt to the waterscape and waterscape to interact and benefit from the architecture will further enhance the genius loci, and human-environmental connection to place which will infer significance, rather than a lapse in connection between place and architecture.

The role of architecture in enhancing the genius loci provided by the natural environment, allows for the potential reconnection of the people to the space they are occupying, which encompasses both the architectural and natural realms.

This reconnection offers an opportunity to better the current relationship between people and the natural environments and, more specifically, waterscapes. In improving this relationship, a change in cultural connection to nature can occur, allowing for better practices around the attitudes and belief systems to water conservation.

Within the built environment, the genius loci of water is often explored by visual links to the exterior environment. Tadao Ando uses water very often in his architectural place making, as well as to

BELOW: A comparison of different waterscapes and the qualities they infer onto the site

FIG. 2.26 Ocean Edge has a dynamic edge, often turbulent.
Available at:
http://www.boostinspiration.com/photography/beautiful-landscape-photography-by-adam-burton-40-amazing-photos/

FIG 2.27 River Edge has the potential to be either dynamic or quiet depending on the context
Available at:
https://www.flickr.com/photos/pinebird/3584504232/

FIG 2.28 Waterfalls imply a variety of characteristics onto a site most notably, noise.
Available at:
http://hohopics.blogspot.co.za/2015/06/semonthong-waterfall-lesotho-africa.html

FIG 2.29 Lakes are quieter spaces similar to dams. Ideal for activity
Available at:
https://www.lonelyplanet.com/magazine


FIG 2.26

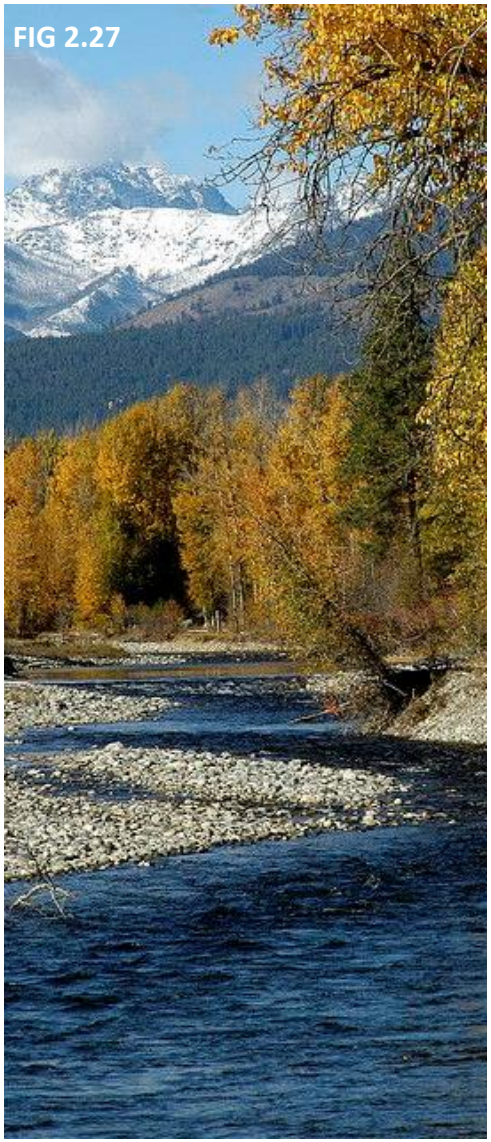


FIG 2.27


FIG 2.28


FIG 2.29

infer specific meanings and experiences into his spaces. Church on the Water and his Water Temple projects explore the genius loci of water by integrating them directly into the architectural experience.

The Church on the water makes use of the reflective quality of water in order to create a plane by which the landscape and architecture can reflect. It was adds light through reflection in order to create a further ephemeral experience within the church.

The Water Temple explores the genus loci of water through the movement through and around it. Placing it on an unfamiliar plane, overhead, as the user has to descend below in order to access the rest of the building

FIG 2.30

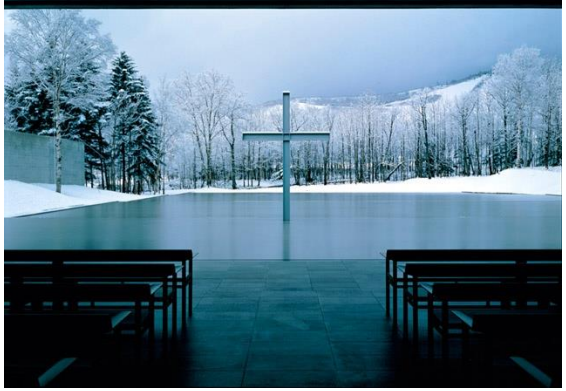


FIG 2.31

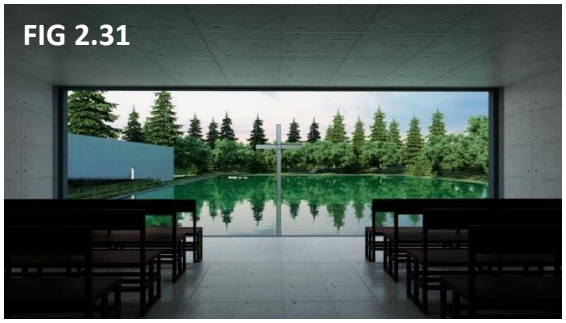


FIG 2.30. Tadao Ando's Church on the Water in Winter
Available at:
http://architectuul.com/architecture/church-on-the-water

FIG 2.31. Tadao Ando's Church on the Water reflecting context
Available at:
http://www.urbansplatter.com/2015/05/church-water-tadao-ando-japanese-architecture/

FIG 2.32

FIG 2.33

FIG 2.32. Tadao Ando's Water Temple Entrance
Available at:
https://weburbanist.com/2016/06/27/reflecting-on-a-master-architect-10-water-centric-works-by-tadao-ando/

FIG 2.33. Tadao Ando's Water Temple
Available at: http://kwc.org/photos/tadao-ando/water-temple-shingonshu-honpukuji/

2.3. TRANSFORMATION

Transformation addresses scales and hierarchy within a larger operating system. It refers directly to the built environment and how it synthesises successfully across different communities and contexts (Dinur, 2015).

Through the transformation of the built environment, interventions at different scales can be simultaneously addressed as well as allow for further transformation to occur. It also takes into consideration the successes and shortcomings of existing systems and attempts to align the design of the built environment to the current context, without being an imposition on the environment (Dinur, 2015).

Transformation of the way water is perceived stems from the way architecture is interacted with, as well as how architecture interacts with water and its natural environment (Strang, 2016). To attempt to understand current systems and their impact on context specific water cultures, as well as attempt to alter it if necessary, transformation of both the built environment and existing systems is required.

To properly understand the concept of transformation, in terms of this research, the following section will firstly investigate a definition for water culture, then examine how both architecture and ecology is affected or can affect the current culture around water in urban environments.

FIG 2.34

FIG. 2.34 Bioswales are an example of how the built environment can be a transformative element in using nature to buffer the effects of urbanisation from the environment
Available at:
http://www.phillywatersheds.org/what_were_doing/gsdm

2.3.1. Defining a Water Culture

"Culture, or civilization, is that complex whole which includes knowledge, belief, art, law, morals, custom, and any other capabilities and habits acquired by man as a member of society." *(Tylor, 1871)*

The definition of culture is a highly discussed topic. While there are many attempts to define the term, there are characteristics and stratifications which organize the multitude of layers associated with the culture of a community.

For the purpose of this research, the community defined and referred to will be under the broad category of the "urban community" and "urban culture". This will be later tailored to address a more succinct, context specific community of Durban and Durban Harbour.

One definition of culture is understood through the human's ability to cope with their environment (Ingold, 2000). Where environment is understood as either man-made or natural, and an urban community is grouped under a community whose day to day lives are rooted in interaction with a highly man-made environment.

The above figure 2.26 illustrates how the interactions between human-environmental relationships are the basis of culture formation. Figure 2.27 further

FIG 2.35

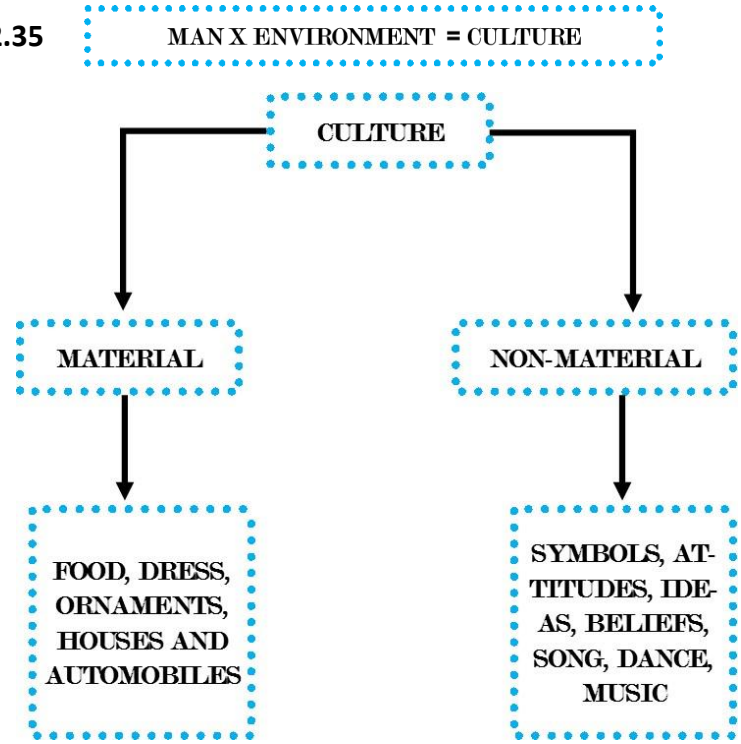


FIG 2.35

FIG. 2.26 Culture can be broken down into how organisms interact with their environments

FIG 2.36 Cultural environments can be broken down into the material environment and non-material interactions and relationships we have to them.
By Author, (Based off Kottak and Genzon 1975)

breaks down this environment into material and non-material entities. The material entities are physical representations of culture, usually constructed (whether tangible or intangible) by humans. This includes the representation of culture through architecture and the built environment.

Non-material aspects of culture describe the set of values, rules, attitudes and beliefs which shape the way people interact with the material world surrounding them.

Characteristics of culture are also ambiguous as they vary according to different contexts and situations. When the stance of describing the relationship between the material and non-material is taken, these relationships can be analysed in a clearer way, namely:

- **Culture is learned** – Society prescribes specific ways of carrying out day to day life. This often dictates how materials things are interacted with, and the significance of those things. (Genzon and Kottak, 1975)

- **Culture is shared** – culture can only be considered where two or more people practice a particular action. It is often a representative of a whole or group of people's attitudes and beliefs. (Kottak, 1975)

- **Culture is symbolic** – it represents the values and importance placed on something. Symbols differ according to the unique qualities and character of a specific culture, and are indicative of hierarchies within that society. (Genzon and Kottak, 1975)

- **Culture is integrated** – it is a system of parts which fit together to create a representational whole. This reflects the practices of a community. (Genzon and Kottak, 1975)

- **Culture is dynamic** – it is constantly changing according to time and space boundaries. They interact

> and exchange with other cultures and are constantly being redefined based on circumstance. (Genzon and Kottak, 1975)

Culture is representative of values which occur between two or more organisms. This makes it reflective of a community (Genzon and Kottak, 1975). This learned, shared, symbolic, integrated and dynamic system of values reflects how a particular community, like an urban community, interacts with a particular aspect of life, like water. While different people are participants to a multitude of different sub-cultures and communities, it is acknowledged their values toward water may vary between those specific communities. A greater urban community will be used to analyse the relationship between people and water.

Learned behaviour, one of the characteristics of culture, has the potential to be redefined by virtue of culture being dynamic and self-regulating according to circumstance. (Genzon and Kottak, 1975).

Learned behaviours are a product of social systems and knowledge, attitudes and habits which is passed down from generation to generation. In order to redefine an aspect of a culture, this knowledge needs to be intercepted and redefined. To do this, a change in process within a community is necessary. The integration of water bodies into the systems of communities depends on the presence of an opportunity, usually in the form of the built environment (Robert Preston-Whyte, 2002). By providing an opportunity for the built environment to interact with water, in a meaningful, sustainable and resilient way, the definition of the way urban communities interacts with water could be altered.

The appreciation and conservation of water will form the basis for the definition of water culture. This ties in closely with the principles around resilient thinking and socio-ecological systems and their integration into communities.

2.3.2. Current Water Culture

At present, the water culture, specifically the attitude to water in terms of appreciation and interaction in urban contexts, is at odds with ecological sustainability (Strang, 2008). The social and economic sustainability of a water source all depends on its ecological health (Helmrich, 2011). Strang (2008) furthers the argument by outlining the holistic success of water bodies where sustainable human interaction is promoted. These interactions, in creating a place of engagement with the environment, are supported through the built environment and offer a point of ecological and social restructuring of how urban waterfronts are being redefined within the city.

The separation of ecological systems, such as the ecology of natural water systems, from urban reticulation systems has resulted in the dilution of the impact, agency and ownership of the community in addressing sustainable problem solving when it comes to water (Strang, 2016). The lack of opportunity for communities to interact with and form a relationship with the natural environments has resulted in the heavy reliance on institutional intervention, where water is controlled by an authority and is not considered the

FIG. 2.37. A WWF Poster highlighting the dangers of plastic pollution on marine life. Awareness towards the failure of current water culture will promote a shift in culture to better the water culture.
Available at:
http://metro.co.uk/2015/09/13/these-images-show-why-littering-is-so-dangerous-for-helpless-animals-5389496/

concern or responsibility of the average citizen.

Redefining a water culture within urban environments will have to address the roots of the issues surrounding the ecological health of water systems. In the case of water bodies within the built environment, the mass industrialization and intensive utilitarian perspective of the water as a tool has resulted in the degradation of many natural habitats as well as a massive decline on the quality of water (Alberti, *et al*, 2013). By addressing issues surrounding the lack of socio-ecological integration in urban contexts, the opportunity for urban communities to take ownership of the interface between the built environment and nature provides way forward in reconnecting people to the value of their local natural water sources.

The major issue tackled by water culture is that of disassociation with man (Alberti, *et al*, 2013) as a something which is to be protected and valued. Instead, water sources are further separated from human life (Strang, 2008) and this disconnection allows for industrial intermediaries to start controlling how and when we interact with a basic and natural element.

2.3.3. Urban Ecology

"The new ecological paradigm recognizes that humans are components of ecosystems (McDonnell and Pickett 1993) Yet ecological scholars often fail to include humans in ecological science" (Hixon *et al.* 2002, Reznick *et al.* 2002, Robles and Desharnais 2002)

Urban ecology examines the city as an ecosystem of human life. As outlined by Ingold (2000) in his study of the perception of the environment, any system where there is an organism and environment can be considered an ecosystem (Hixon *et al*, 2002).

In the case of urban ecosystems, the presence of human constructed spaces dominates over nature (Robles and Desharnais, 2002). The reorganization of natural ecosystems to exist around constructed environments gives way for transformed ecosystems, which result in novel combinations of organisms living in constructed communities (Robles and Desharnais, 2002). While this may benefit some organisms, the diversity, or stability and strength of naturally dictated ecosystems decline as the urban ecosystem grows. Urban ecosystems, characterised by infrastructure: roads railways, hard surfaces and controlled water systems, are so widespread, the monotony and control in cities contend with nature and biodiversity (Hixon *et al.* 2002)

Human activities directly and indirectly affect natural environments. Human urban areas occupy up to 6% of the earth's surface (Alberti *et al,* 2003). This impact is felt directly, through physically altering the topography, vegetation and structure of the site and indirectly through the constant need for resources to sustain such a dwelling (Alberti *et al,* 2003).

FIG 2.38 Typical Ecological Hierarchy

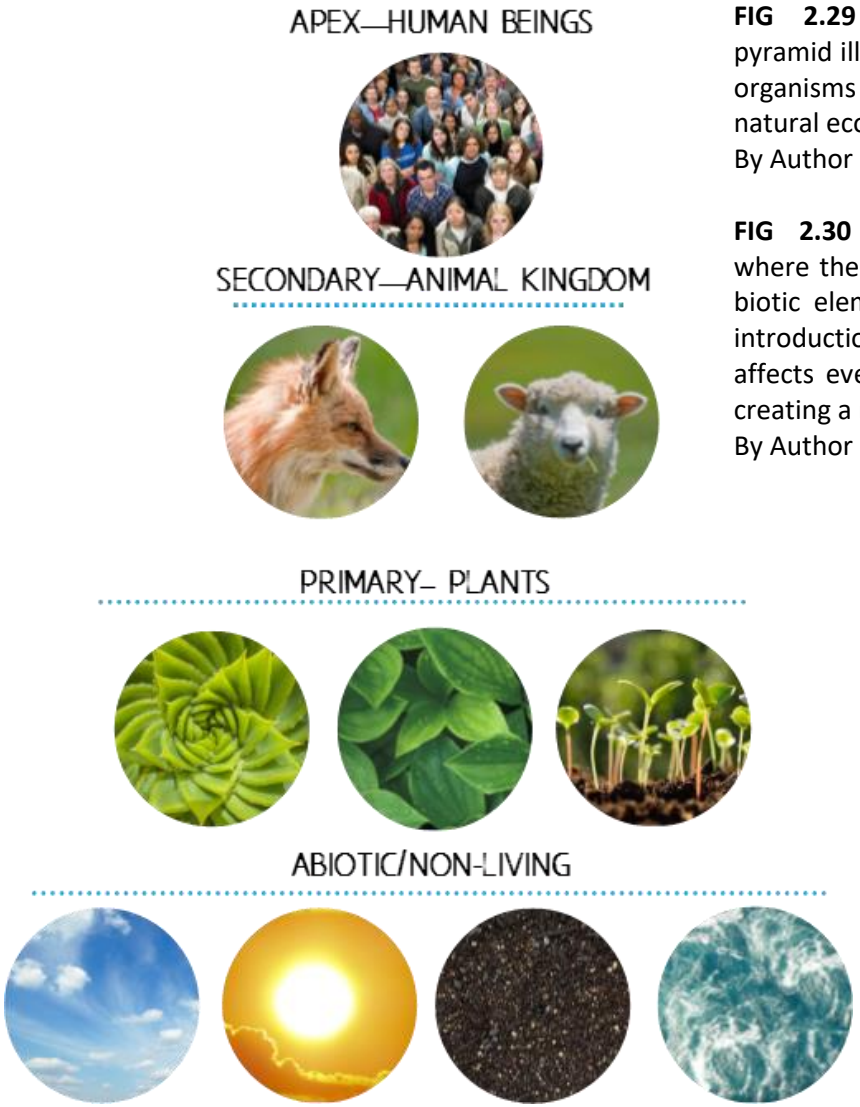
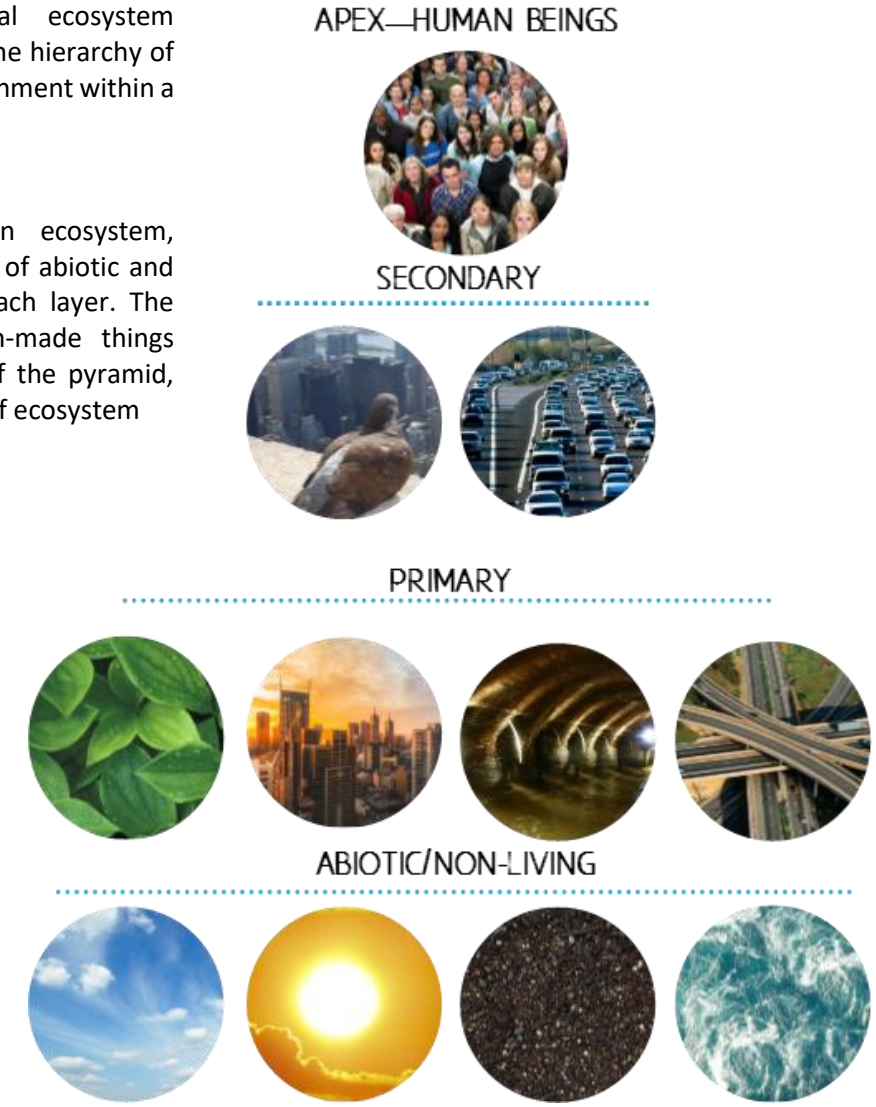


FIG 2.29 A typical ecosystem pyramid illustrating the hierarchy of organisms and environment within a natural ecosystem.
By Author

FIG 2.30 An Urban ecosystem, where there is a mix of abiotic and biotic elements in each layer. The introduction of man-made things affects every layer of the pyramid, creating a new type of ecosystem
By Author

FIG 2.39 Urban Ecology- mix of living and non-living



Natural resources required to support an urban square meter can be 100 to 300 times its size. Therefore, urban ecologies have the capacity to not only affect their local ecosystems, but have national and even global repercussions (Moffat*, et al,* 2017). Cities are therefore spaces of consumption and in most cases, spaces of waste and pollution of natural resources.
Cities have often been defined by their ability to produce and are economic drivers, however their capacity to be drivers of natural ecology has remained unexplored (Alberti *et al,* 2002),

Cities vary in their demands according to the demands of its inhabitants. Due to this, different cities have different ecological repercussions. These repercussions need to be analysed and addressed at a local and community level, before the global repercussions can be considered. Through the study of individual urban ecologies, the relationship between humans and their biophysical habitats can be strengthened. Patterns which emerge from these interactions can be addressed to instil a sense of ecological resilience and diversity.

2.3.4. Defining the Urban Environment

". . .a process between man and nature, a process by which man, through his own actions, mediates, regulates, and controls the metabolism between himself and nature. [.. .] He sets in motion the natural forces which belong to his own body, his arms, legs, head, and hands, in order to appropriate the materials of nature in a form adapted to his own needs. Through this movement he acts upon external nature and changes it, and in this way he simultaneously changes his own nature. . . (Marx, 1971),

Humans and their social behaviour is often separated from ecological systems and is treated as an outsider to the successful operation of an eco-system (Hynek, 1985).

There is a "stale dichotomy" of nature versus man-made (Ingold, 2000). A more "dynamic" approach of organism and environment, and how these two interact to form an ecology of life needs to be established.

An ecosystem is broken up into substance and form, where substance is the energy which drives the system and from is the pattern and information resultant from the system. Through this, he reduces ecosystems into a mathematical equation, where:

Ecosystem = Organism + Environment

In this equation, the combination of environment and organism can either be seen as two independent entities being juxtaposed against each other, or as a compound whole: the ecosystem. Humans are not exempt from the category of "organisms" outlined in the previous equation (Ingold, 2000). Our interactions as organisms feed into and are governed by our interactions with the environment, whether that environment is natural or built.

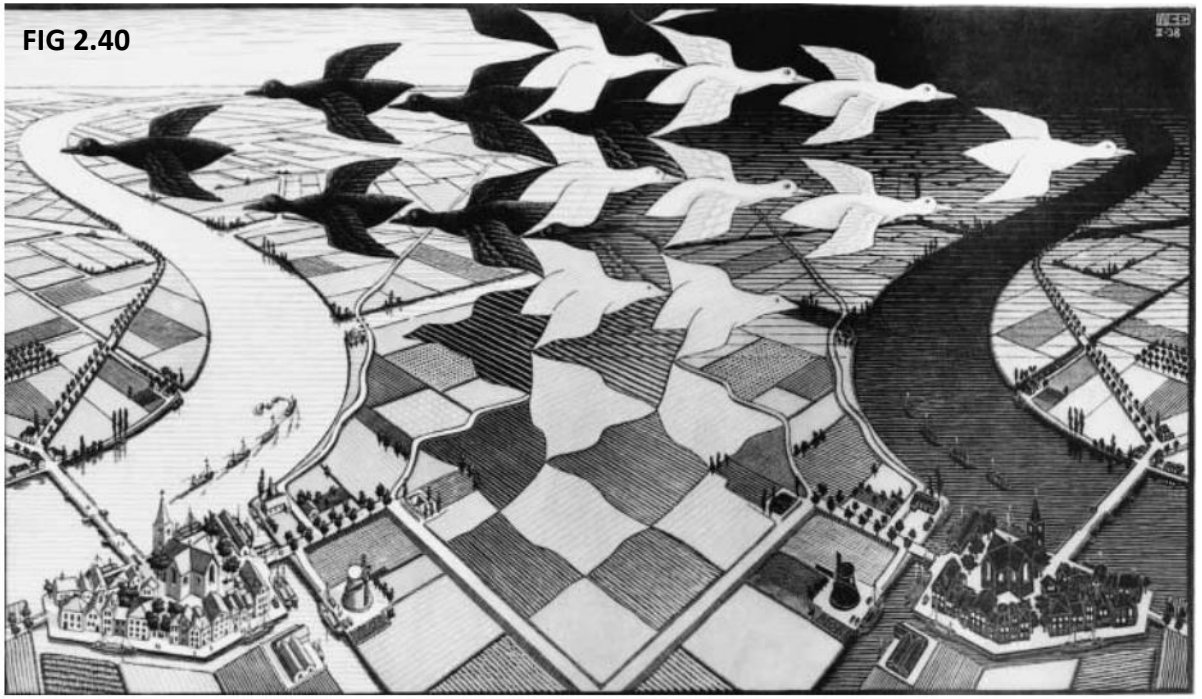


FIG 2.40 Illustrating how the same landscape can be perceived differently depending on how one moves through a space. (Ingold, 2000, page 17)

Through this, the distinction between man-made and natural environment is blurred. Humans cannot be perceived as something external to an environment, and inflict

their presence onto it. Instead humans are developed in, and develop their environments and should be seen as a holistic entity (Ingold, 2000).

Ingold (2000) further discusses the environment as three criteria for interaction. By using these criteria, we can examine how humans shape their relationship to the environment. These points allow for a range of contexts, which fully encompasses natural to urban contexts.

1. **Environment is a relative term** and defines a space where organisms interacts differently and specifically based on their relationship to it (Ingold, 2000). This allows for both the natural and the man-made to be considered environments with an ecosystem.
2. **The environment is never complete** and is constantly changing, fluctuating around an equilibrium to maintain its processes. Due to the variety of relationships, there is a constant balancing of systems to maintain an environment (Ingold, 2000). This point is particularly important when the hybridity of urban and natural environments needs to be considered. The balancing between the two systems is entirely necessary for a successful ecosystem.
3. **Environment should not be confused with nature**, if nature does not make up the environment (Ingold, 2000). Both urban and natural contexts are environments, with specific organisms which have transformed and adapted according to their environmental pressures. In recent studies, nature and environment are often used interchangeably. Urban environments can interact with nature, but are not necessarily natural environments.

The environment becomes something which is more complex that the juxtaposing ideas of built and natural environments. The urban context becomes a hybrid of

these two extremes, built and natural, allowing for a redefinition of how it is interacted with.

The relationship an organism or person has with an environment depends heavily on how that environment is experienced and perceived (Ingold, 2000). The perception of a space creates a roadmap for how an organism navigates and interacts with a specific environment. By allowing for the hybridity of an urban environment which encompasses both the man-made and the natural, this movement through city spaces becomes a multi-layered experience.

Bateson (1972) and Levi-Strauss (1974) further discuss this relationship of humans to the environment in terms of how the environment is perceived according to humans. Their approaches are different in terms of whether environment is experienced as an external influence on internal processing, requiring movement and experience (Levi-Strauss, 1974) or is a much more blurred experience, where environment is relative to the perceiver regardless of experience (Bateson, 1972).

Heidegger (1971) tends to lean more towards the argument of Levi-Strauss in the perception of the environment and the influence of phenomenology in the experience of space in order to understand it. Along with Levi-Strauss (1974), Heidegger (1971) examines the environment in terms of phenomenology, where perception is fostered by movement and experience of space.

FIG 2.41

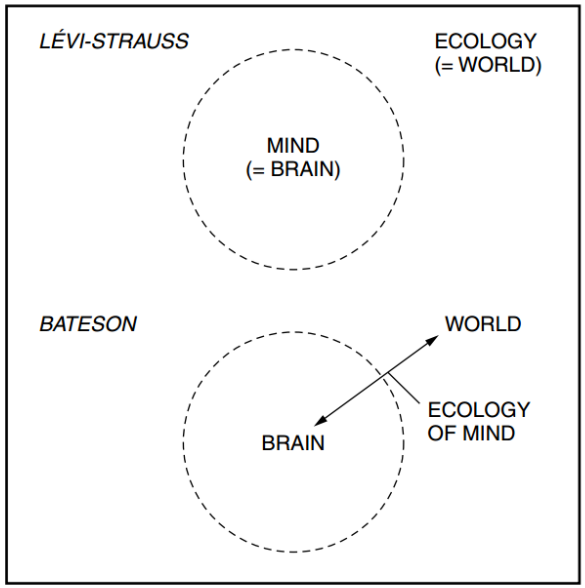


FIG 2.41 Diagram of Bateson's idea of perception of the environment as an external process which is unaffected by the experiences of the perceiver versus Levi Stauss' ideas of internal processing of the environment as something which affects and is affected by the individual (Ingold, 2000, pg 33)

Due to the combination of natural and built environments to create a hybrid urban environment, an urban ecology is resultant.

Water culture within the urban environment is dictated by how connections are made between places and spaces (Ingold, 2000). These connections inform the perception of the environment by the community which inhabits it (Ingold, 2000). Therefore, the urban environment, and more importantly, the urban ecology, is affected by water culture through accessibility, and how water is connected to the urban environment (Strang, 2016).

This research is focussing specifically on the ecology of water and waterscapes within the urban environment. The relationship between people, the urban environment and water is constantly evolving. Further discussion on how the natural systems involved with water have transformed to accommodate the influence of the urban environment will better inform the architectural and urban design process. Through this, an analysis of the shortcomings of the urban ecology in terms of water management can be addressed. The influence of urbanization on the hydrological cycle must be taken into consideration, and an understanding of how water moved through cities, in terms of nature and architecture is required in order to create a meaningful shift in water culture.

2.3.5. Hydrosocial cycle

"Water is not a singular object. . . Rather, water reveals its complex, multi-layered biophysical identities for particular enactments, depending on assemblages that are in place or still in the making. As a result of the assemblages in which it finds itself, water can be and become a border, a resource for regeneration" (Barnes and Alatout, 2012, pp. 484–485).

The hydrosocial cycle is defined as a process by which society and water make and remake each other over space and time (Linton and Budds, 2014). It acknowledges the hybridity of urban environments and ecologies and the inevitable affect one has on the other.

While, in some cases, nature can be separated from the urban environment, the natural force of water cycles is omnipresent, forcing a relationship between the natural cycles, the hydrological cycle, of water and the man-made, social cycle, of water processes. As a result, the hydrological cycle is representative of an urban ecology system and process, where the two environments and organisms are completely dependent on and affect the cycle.

FIG 2.42 how the hydrosocial cycle reduces water down to an element of H2O

FIG 2.43 The hydrologic cycle and the various layers and stages water goes through
(Both: Linton, 2014, pg. 172)

FIG 2.42

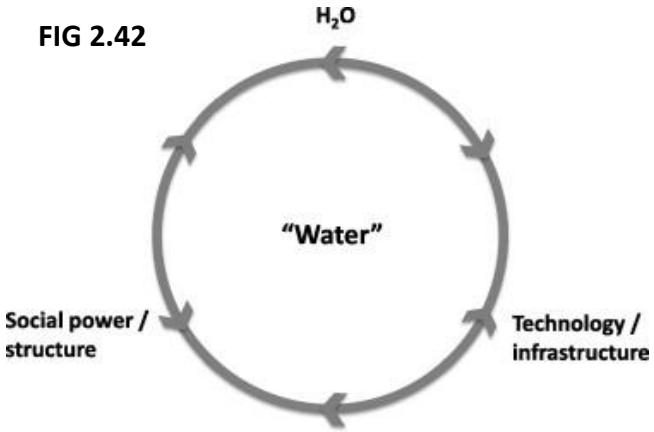


FIG 2.43

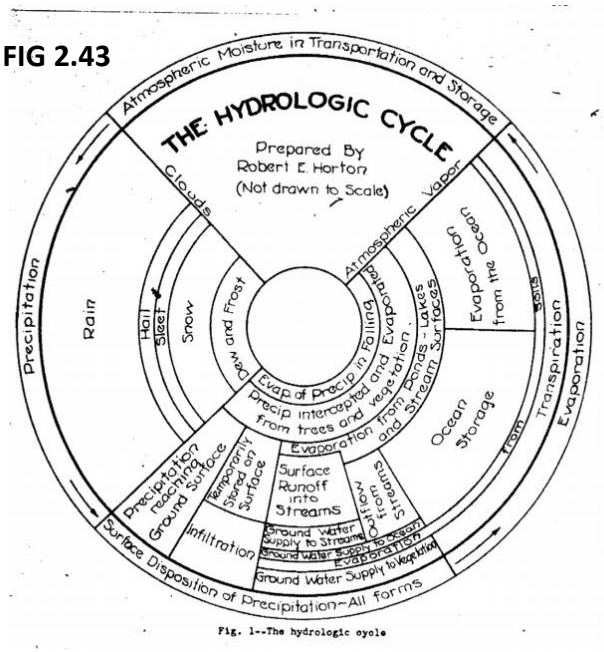


FIG 2.44

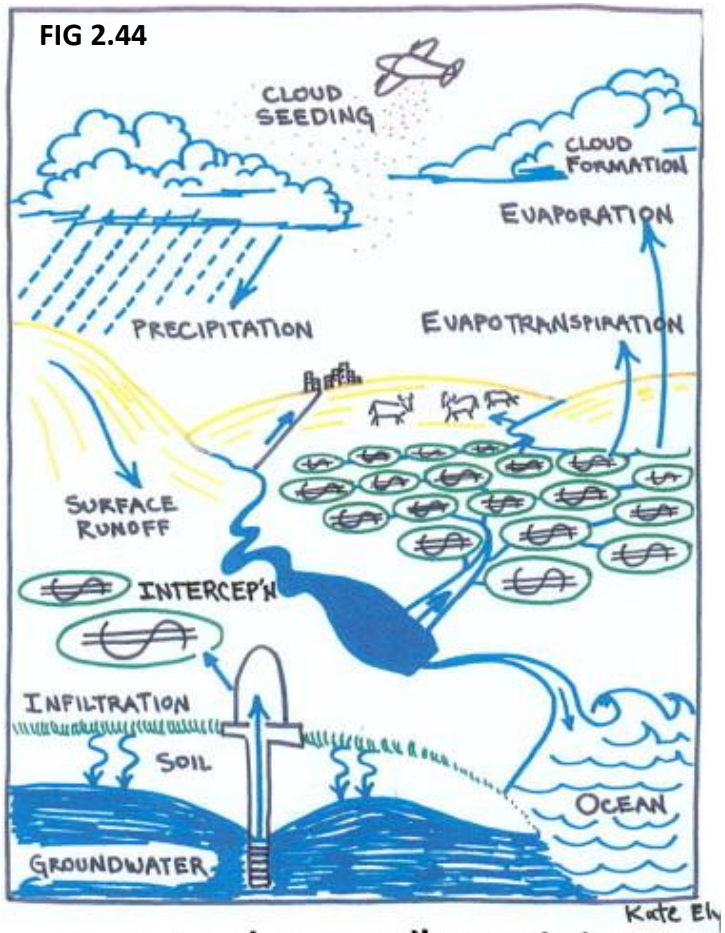


FIG 2.45

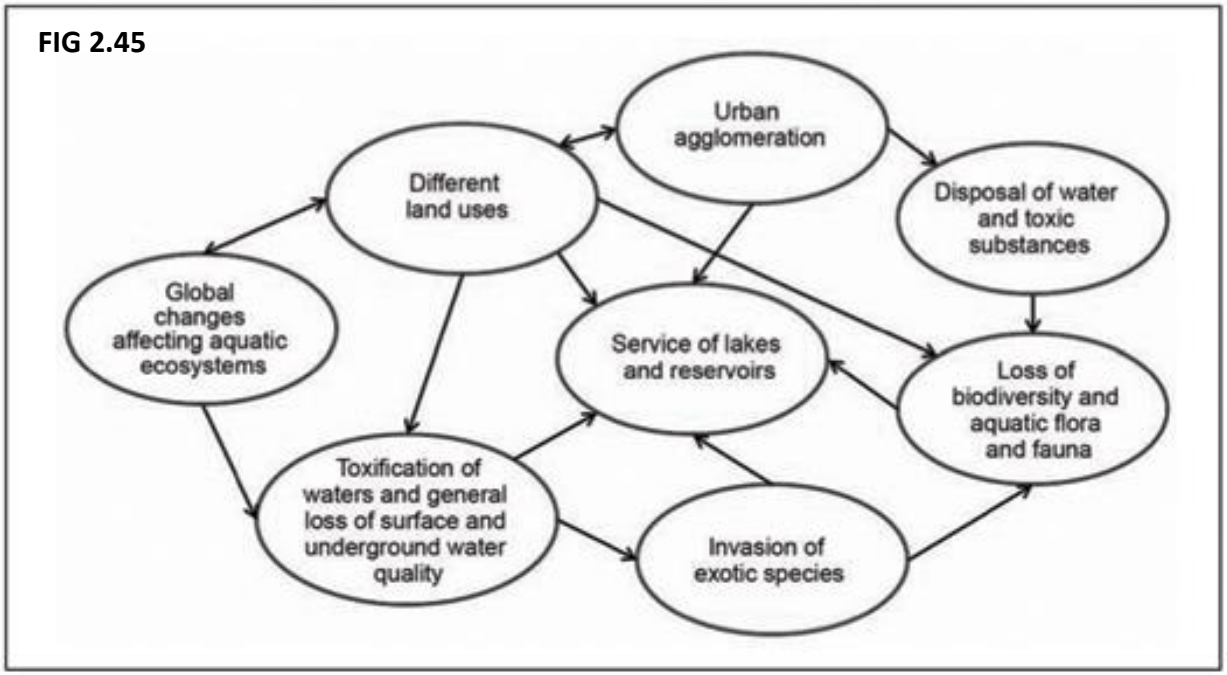


FIG 2.44 The hydrologic cycle as it is today, where money influences water flows significantly (Linton and Budds, 2014, pg. 173)

FIG 2.45 The effects of the hydrosocial cycle and linear off-shoots from the cycle which result in waste and/or pollution (Tundisi, 2008, pg. 2)

The hydrosocial cycle is outlined by Linton and Budds (2014) in three key ideas:

Water management the interlinked nature of water and society is examined in its cyclical effects on each other. Changes to the natural cycle of water affects humanity which in turn affects the water cycle, which effects humanity and so it repeats itself. This gives rise to water being understood as an urban ecology, where man-made water management systems begin to impact natural system.

Water and society are related internally: different relationships with water gives rise to different reactions from water or different types of water. This aspect refers back to Illich (1985) and Ashraf (2017)'s delineation of water to contend and water to canalise. The hydrosocial cycle acknowledges that society interacts with canalised water differently to contended water.

Types of water produced, however, do not affect the material properties of water, merely the repercussions of their production. These repercussions can either be beneficial or detrimental to society.

Based on the hydrologic cycle, the hydrosocial cycle takes into account human influence on how water is shaped and affected, and vice versa, how water shapes and affects human life. The hydrologic cycle is a social construct to help humans better understand the natural processes water undergoes in order for us to access it, and is completely independent of human impact. The hydrosocial cycle, however, considers how humans impact the functioning of the hydrologic cycle as well as any kind of water processes on earth. It also takes into account how water reacts as a result of human impact, such as global warming causing rising sea level, flooding, droughts, abnormal rainfall etc. (Linton and Budds, 2014)

The hydrosocial cycle is used to examine how water is produced. With reference to a discussion earlier made by Ashraf (2016), water has two forms: water to contend and water to canalise. The hydrologic cycle looks at both aspects and how human activity affect water to canalise, where

humans exert their force for their advantage, and how water to contend, the repercussions of such actions, then reacts. Linton and Budds (2014) further this discussion by stating that water internalizes social relations. This ties into discussions by Strang (2004, 2008 and 2016) about the agency of water, and how it is able to, as an inanimate object, affect and shape the lives of humans. The hydrosocial cycle can also be used as a vessel to understand not only society's relationship to water, but the social nature of water and how it is used as a mirror for the effects of human activity on natural systems.

Water is a point of intersection between ecological and social processes. Water management within the urban environment may only address one of these processes at a time. Ecological impacts are usually dealt with independently from social impacts, resulting in a one-sided attempt at solving a greater cyclical problem. The hydrosocial cycle allows for the simultaneous "relational-dialectical" examining of water within the man-made realm.

The hybridity of water is also examined in terms of how it links ecology to society through production and through natural process. This hybridity shows how water and power are linked in both societal and natural instances (Linton and Budds, 2014). This calls for a rethinking of the relationship between things as well as the relations constituting things. Hybridity allows for what was previously considered inherently different, like the hydrologic cycle, to be amalgamated as a larger system and issues addressed as a whole. Any change to the production of water, whether it is physical, institutional or discursive will change the hydrologic cycle to become something more complex and its repercussions affected more widely.

Every instance of water production is the product of a social structure. These structures can be readdressed and re-examined to allow for water to be properly integrated within the built environment,

and provide a platform to this societal-ecological relationship to be redefined.

By addressing the specific environments where there is an intersection between the man-made and nature, the built environment and architecture, the negative effects of urbanization on the hydrosocial cycle can be minimised.

Ecological design and sustainability methods provide an alternate approach to traditional urban development which can reduce the negative impact of cities on water systems.

2.3.6. Sustainability

The role of sustainability in the development of ecological design gives rise to the principles established for a successful ecological design (Van der Ryn, 1996). As a reaction to the modernist era of the man-made dominating over the natural, sustainability began to critically question the balance and performance of architecture within its environmental context (Tzonis, 2003).

Sustainability is defined as the "*holistic response to the environmental crisis that makes much needed connections between nature, culture values power relations and technology"* (Van De Ryn, 1996).

David Orr (2003) examines the principles associated with sustainability. He outlines the basis for a transition to sustainability, from a current state of wasteful and unjustifiable design to a state where design allows for a "balance and performance" which is both socially and environmentally stable.

Humans are finite and fallible. Orr (2003) highlights the limits to the foresight of humans and the multiscalar consequences of their actions. Acknowledging a flawed system will enable the development of a new paradigm. Aligned with the human-environmental relationships, a redefinition of what makes up an urban environment is required in order for people to recognise

their impact on the holistic issue of sustainability.

Sustainability is a bottom up change. Local, self-reliant and self-organised communities are the building blocks for change. The ripple effect of cities and their global impact on natural resources was discussed by Alberti, et al (2003) in their analysis of what makes up an urban ecology.

While these ripple effects can be felt globally, there is a bottom-up change needed in order to tackle larger issues. Small, community based and contextualised changes need to be made before tackling larger scale systems and operations. In terms of water and water culture, sustainability of water needs to be addressed at community levels within specific contexts before major reticulation systems can be changed.

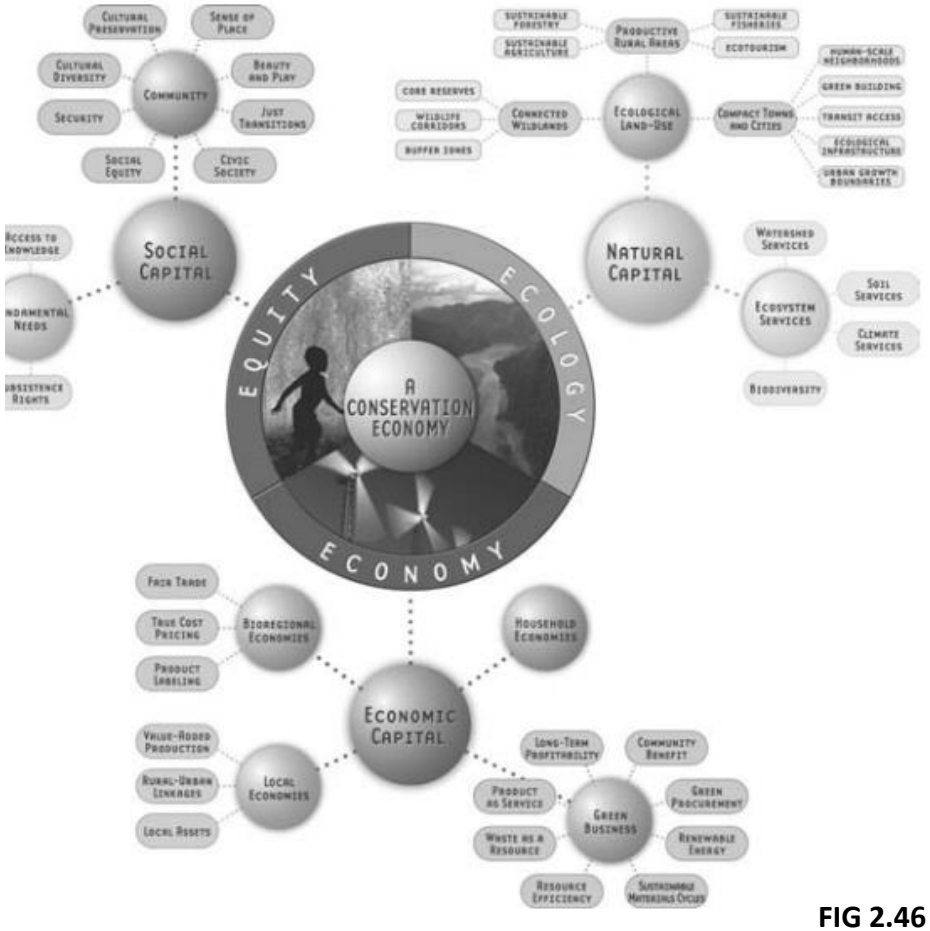


FIG. 2.46 Diagram illustrating the influences of an urban ecology. Certain drivers affect certain outcomes. (Van der Ryn, 1996, pg. 17)

FIG 2.46

Traditional knowledge is critical. It can be evolved and modified to suit current contexts and tackle relevant problems in place responsive ways. Through this, adaptations to specific contexts, as discussed in chapter one, can be made. Traditional knowledge of an environment and the ecology within in can inform what ecological goods and services can be enhanced by sustainable design principles.

FIG. 2.47
Traditional Japanese Rain Chain. Available at: https://www.japanvisitor.com/japan-house-home/rain-chains

FIG. 2.48
Modern Application of traditional rain chains. Available at: http://www.fubiz.net/en/2015/08/11/vegetal-rain-chains-facade-building-in-japan/

Nature is Design. Nature possesses a multitude of metaphors and processes to draw on for a successful system which is sustainable. Van der Ryn (1996) describes design as the "hinge" that inevitable connects culture and nature. In order to redefine the relationship between water and the built environment. These principles of sustainability need to be applied to architecture when examining the role of water in the built environment.

FIG. 2.49
Inspiration from nature exhibited in the Eastgate Shopping Centre in Harare which uses a passive cooling system inspired by termite mounds. Available at: https://inhabitat.com/building-modelled-on-termites-eastgate-centre-in-zimbabwe/

Technological Vs Ecological Sustainability

Sim van de Ryn (1996) separates sustainability into technological sustainability and ecological sustainability. Technological sustainability allows for the image of the machine to be continued, where advances in technology are used as solutions to environmental problems. While technological advances, like solar power, wind turbines etc, allow for some solutions to ecological crises, ecological solutions provide the "bottom up", traditionally rooted and driven by nature solutions Orr (2003) offers in his transition to sustainability.

The concept of ecological design stems from the acknowledgement of ecological goods and services. The focus on ecological systems as well as ecological goods and services allows for a design mentality which is informed and driven by ecological processes, values and metaphors.

2.3.6. Ecological design

Ecological Design is defined as *" any form of design that minimizes environmentally destructive impacts by integrating itself in living processes"* (Sim van de Ryn *et al*, 1996)

Ecological design attempts to understand the design of the built environment as being something which is learned from and is inclusive of nature and natural processes (Sim Van der Ryn, *et al*, 1996). Ecological design seeks to both enhance the ecological health of a specific context, as well as provide a point of departure for the design process of man-made inventions.

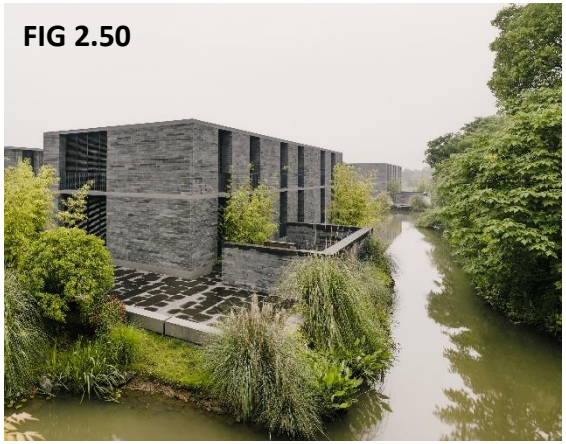
Adopting processes already present in the urban ecology is also an approach to ecological design which allows for architecture to directly relate to the natural environment.

In his discussion of ecological design, Sim van der Ryn (1996) outlines five principles of ecological design. These principles are multi-scalar and are not specific to any particular type of design or designer.
These principles provide a method to execute ecological design, as well as forms a basis of core questions to tackle when

designing an ecologically responsive design.

Solutions grow from place. Similar to David Orr's third principle of sustainability, Van der Ryn (1996) suggests that each ecological habitat required a site and context specific ecological response. This can draw from traditional knowledge of local ecosystems, as well as the in depth understanding of complex systems which may already exist. Adaptations to site specifics also encourages the use of ecological goods and services to negate the any man-made impacts on the ecology.

FIG. 2.50
XiXi Wetland Park Estate directly intergrates the built environment into its planning. Available at: http://www.worldarchitecturenews.com/project-images/2015/26037/david-chipperfield-architects/xixi-wetland-estate-in-hangzhou.html?img=5



Ecological accounting informs design. Van der Ryn (1996) uses the metaphor of economic accounting to highlight the lack of consideration for ecological health during design. Just as the economics of a building is calculated, so should the ecological costs and profits of designing a space. The effects of the built environment must always aim for an "ecological profit" where the impact of the manmade is symbiotic with nature instead of incurring ecological costs.

Design with Nature. Nature offers a variety of inspirations for the design process. Design must also always take into consideration how a space can be design *with* nature and not around it. Just as nature makes full use of all waste is a closed loop, design should aim to do the same, eliminating harmful waste.

FIG. 2.51
Column structure exhibiting biomimicry of tree trunk structure Available at: https://www.designboom.com/architecture/john-mcaslan-partners-kings-cross-station/

Everyone is a designer. This emphasis the role of stewardship in the ecological design process. If designs are tailored to suit the needs of specific communities, it will be a continuing point of the community's evolution. The participatory design process is important to understand the place and the demands of the site. The input of those most familiar with the site is invaluable.

Make nature visible. In the modernist era architecture mimicking the machine, nature was often ignored and pushed to the side as a backdrop to highly manufactured buildings. Buildings tend to be "sealed envelopes" with very little being exposed to the elements. This forms one of the most fundamental points of disconnection between people and nature.

These ecological design principles allow for specific approaches to be taken when designing for and with water and waterscapes. For the purpose of this document, where the focus is specifically on water and water systems within the built environment, the applications of ecologic design will be examined with the possibilities of water in mind.

FIG. 2.52
Rahul Mehrotra's Garden Building directly involves all income levels of the community.
Available at:
http://rmaarchitects.com/architecture/kmc-corporate-office/
http://rmaarchitects.com/architecture/kmc-corporate-office/

FIG. 2.53
Making Nature visible, Geofferey Bawa directly includes nature in his designs.
Available at: http://travelblog.pledgeholidays.com/legacy-sri-lanka-architectural-genius-geoffrey-bawa-revealed-new-book/

2.3.7. Applications to water systems

Mador (2008) discusses the role of water in architectural design, in his analysis of alternate methods and systems of incorporating water into the built environment. Within this discussion, he lists 29 possible ways water could be integrated into the design of the built form which allows people to interact with and reconnect with water as something more than a utilitarian tool. For the purposes of this research, a few of these suggestions will be extracted. It should also be noted that although this article is viewed from the perspective of biophilia, several of Mador's (2008) suggestions overlap with Orr and Van der Ryn's (1996) principles for sustainability and ecological design.

The applications discussed by Mador (2008) will be extracted and summarised based on the five principles of ecological design discussed by Sim van der Ryn (1996).

Water culture, within sustainability ecological design, can be expressed through how water is managed (Mador, 2008) to ensure sustainable access to drinking and potable water, as well as how it is accessed, to ensure the health of water sources and ecologically (Sim van der Ryn, 1996). These management and accessibility requirements begin to inform the architectural design process as outlined by Mardor (2008) in the following discussion on water within the built environment.

a. Adaptation: Place based applications

Extended Waterscapes: a water oriented connective space. This can also include using a natural water body to interact directly with the built structure. Traversing a watercourse to offer the maximum potential experience of the user to the adjacent natural waterscape Mador (2008).

Interior vs Exterior: Blurring the distinction between inside and outside by incorporating water from the exterior space into the interior space through features or interior pools and basins Mador (2008).

Water Gardens and Ecosystems can also be incorporated as something which weaves into and out of the built form, intimately

relating the interior to the exterior context and supporting systems for the waterscape to exist Mador (2008).

Aquariums offer a unique experience of being within a built space, but connected to a living ecosystem Mador (2008).

b. Transformation: Ecological Applications

Water management: Interior water handling to emphasise the movement of water through the building instead of being concealed. **Stormwater** management across a multitude of scales to address urban run-off and prevent pollution of natural water systems Mador (2008).

Water Purification: Engineered natural purification systems to purify rain and storm water. Biological wastewater treatment to allow the recycling of grey water Mador (2008).

c. Resilience: Systems based applications

Hydromimicry and processes and systems used to treat water which mimic natural processes Mador (2008).

Roof gardens to decrease hard surfaces and increase rainwater harvesting Mador (2008).

To include as previously mentioned: biological purification systems and extended waterscapes Mador (2008).

Ecological design provides one aspect of a complex system in which waterscapes, especially operation ones, exist in. The success of the ecological design depends on the success of its integration within the greater system, as well as the strength of the links between the various role players associated with the context of a waterscape.

The + Pool by BIG and Dominic Leong in New York's Hudson River actively cleans and purifies water as it floats in the river, creating a safe swimming environment. It simultaneously allows for the interaction of the community as well as the restoration of the ecological environment, resulting in a sustainable system which benefits man and nature

FIG 2.54

2.4. RESILIENCE

The Oxford Dictionary defines resilience as “The capacity to recover quickly from difficulties; toughness” (Oxford Dictionary Online, Anon, 2017). More specifically to socio-environmental systems, it refers to the ability of a system to absorb disturbance without flipping into another state (Cote and Nightingale, 2012)

The resilience of a system refers to the specific connections between the parts of the system that make up an environment (Cote and Nightingale, 2012). It is concerned with the flows which make up the system and the relationship between the multitude of factors which make up the context of a space.

These relationships are either promoted or hindered through how the built environment is connected to both the social and ecological systems of an environment. By providing an architecture which facilitates the relationships between people, ecology and the built environment can be strengthened, promoting a different culture of sustainability, and water culture. The connection of the waterscape to architecture can be examined in terms of the strength of the smaller social and ecological relationships of the environment. A renewed system of relationships can be formed to establish a change in culture. Systems theory provides a frame of reference in which to examine these smaller relationships and how the contribute to resilience as a whole.

FIG 2.55 UNDP sustainable goals for 2030 for a resilient city. Various factors play into developing resilience. A system of elements work together.

Available at: http://www.undp.org/content/undp/en/home/presscenter/articles/2016/01/15/undp-welcomes-the-launch-of-the-asian-infrastructure-investment-bank.html

2.4.1. General Systems Theory

General systems theory allows for a multitude of theories to be simultaneously investigated. Initiated by Bertalanffy (1968), systems thinking provided a method of examining phenomena in a more holistic manner. As a reaction to the reductionist mentality of the scientific fields, Bertalanffy (1968) suggested a method of analysis which took into account the greater system into which smaller more specific systems contributed to. These systems occurred at a variety of different scales and spheres, and aimed to incorporate as many facets of life as possible.

System theory bridges otherwise autonomous fields and examines the interrelated and interdependence of their parts. In architecture, it allows for the investigation of the relationships between things which may not directly impact on the built environment, but contribute to and depend on it.

Figure 2.39 illustrates the participants required to examine a system. Inputs are various factors which may be contributing to the system in the form of services or labour, and indicates energy spent. Output indicates the products of the entire system and the resultant energy product. The process, which the inputs undergo to become outputs, are the general workings and manners in which energy is spent achieving the end goal. Much like an ecological system, an ecology consists of a series of interrelated parts and inputs which contribute to a whole, or output.

FIG 2.56

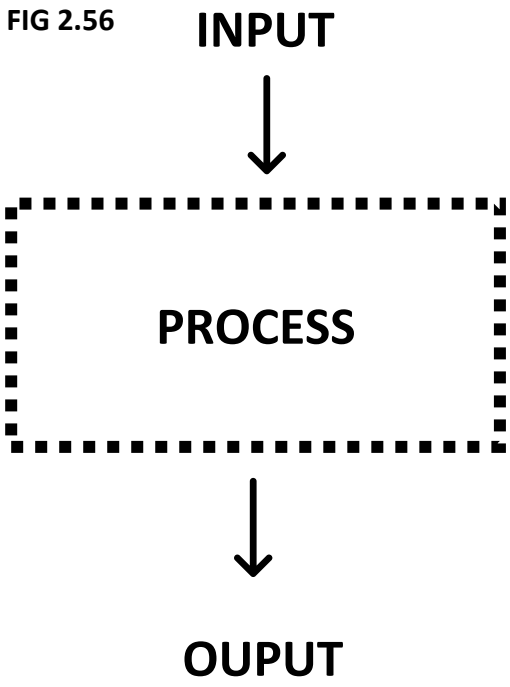


FIG 2.56 Typical system set up of inputs and outputs.
By Author,2017

As Bertalanffy (1986) observed, systems are open to interact with their environments and are constantly evolving and adapting to suit their circumstances. Any change to an actor of the system, input, process or output, will result in an alteration of the overall system, and eventually, a new output of the system.

Systems are usually seen as linear processes where there is a definite input and definite output. By acknowledging that microsystems interact with other microsystems to form a macrosystem, the possibility of cyclical systems are also possible (Arnold and Wade, 2015). Cyclical systems are indicative of natural systems, where closed loop systems occur. Within these systems, there is always a reason for and input and a use for an output, reflecting a zero-waste scenario, as man-made systems often cannot do due to their linear flow. This is similar to the fundamental operational difference between the hydrological cycle being entirely cyclical and hydrosocial cycle, having linear offshoots, resulting in outputs which end up being wasted.

Systems theory explains how minor changes and alterations in the system, even at micro-scales, result in changes in the final output, as seen in the major differences in outputs for the hydrologic and hydrosocial systems. Relating back to Orr (2003) and Van de Ryn (1996) in the criteria for sustainability and ecological design, acknowledging the role of small scales provides a platform for architecture to incur positive shifts in greater systems. The above scenario can also apply to built environments and the resilience of urban ecologies to adapt and transform according

FIG 2.57

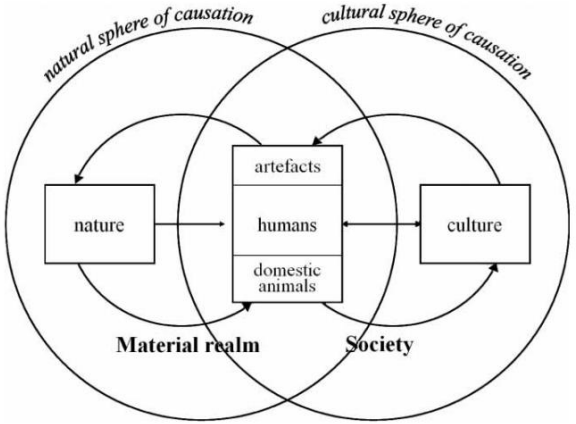


FIG 2.57 The built environment falls into the intersecting section of nature and culture, along with humans and domestic animals. This illustrates the effect it has on either sphere
(Source: Fischer-Kowalski and Weisz 1999, p. 242, in Moffat and Kohler, 2008.)

to possible changes, as a result of infrastructure and a man-made environment, to the overall system. The overall systems strength is indicative of how well the system functions as well as how well the system can resolve issues, like recovering from shocks. This is reflective of how resilient a system, or city, is.

2.4.2 Resilience Thinking in Design

According to Berkes (2005) Resilience refers to the ability of a system to recover from destabilization and retains its identity, feedbacks, structures and processes, without flipping to a new threshold or phase.

FIG 2.58

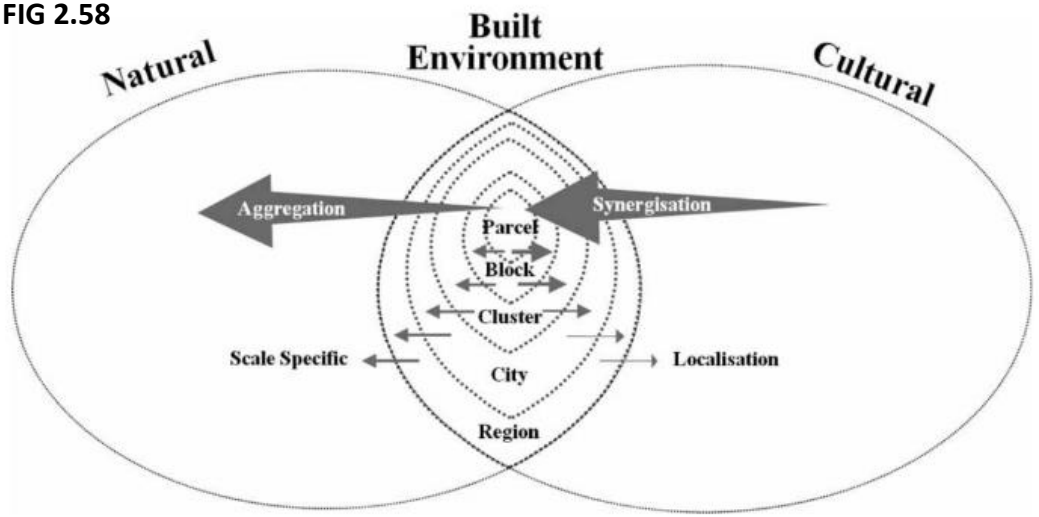


FIG 2.59

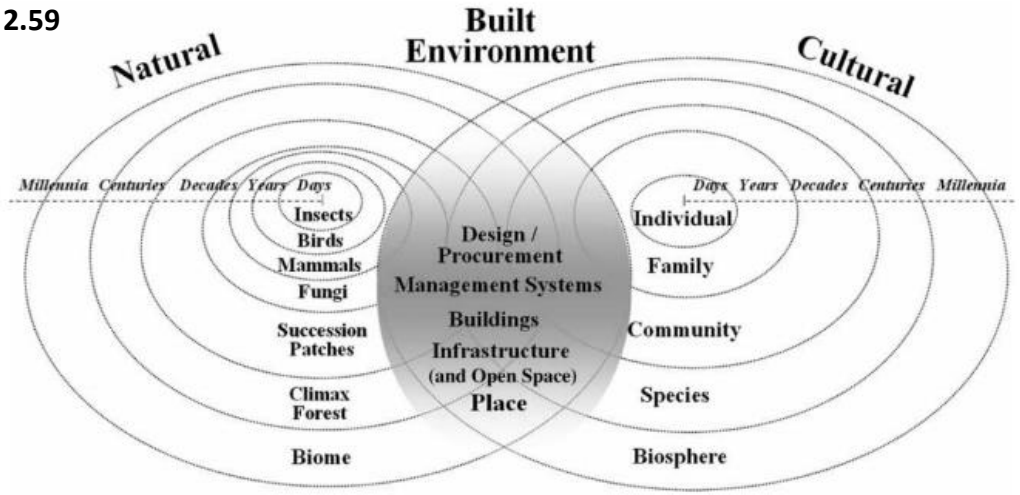


FIG 2.58 Diagram of the overlapping spheres of nature and culture. The scales at the overlap indicate the levels at this socio-ecological change can be made as well as the effects range it will have.

FIG 2.59 Diagram of the aforementioned spheres where the possible effectors of change have been highlighted. These effectors ae specific to be built environment and have the potential to affect both nature and culture.

Both Images (Moffat and Kohler, 2008, pg. 261 and 263)

Similarly, Nightingale and Cote (2012) defines resilience thinking as the systems oriented approach to human environmental relations to model social-environmental change.

Ecological and social processes are traditionally considered independent of each other, where the influence of one is inflicted on the other instead of being inherently interrelated. This dichotomous view of nature and society is problematic (Moffat and Kohler, 2008). As outlined by Van der Ryn (1996) and Orr (2003) the dissociation of people from their natural environments results in the dominance of man-made over the natural, and ultimately, an unsustainable system (Moffat and Kohler, 2008).

Resilience deals fundamentally with the possibilities of variability, disturbance and unpredictability within socio-environmental systems. The interrelatedness of social and ecological systems is an important stepping stone for the development of resilience thinking. By acknowledging the relationship between human and ecological environments, socio-environmental systems (SES) becomes a relevant tool in assessing the ability of these systems to adapt under stress (Moffat and Kohler, 2008). Key ideas of resilience and resilience thinking, which have been carried throughout this chapter, are adaptation and transformation.

Folke, et al (2003) argues that adaptation refers to the relationship between external drivers and internal processes which facilitate how people interact with their environments, and how these interactions can adapt to changes and fluctuations of the system. Berkes (2005) builds on this notion by stating that adaptability is not mechanistic, but instead stems from human agency and the role of institutions and structures. Architecture forms part of this agency and providing its users with agency to control and understand their environments.

Transformations addresses the stability of structures and institutions of systems and their tendency to create new systems under pressures of change.

FIG 2.60

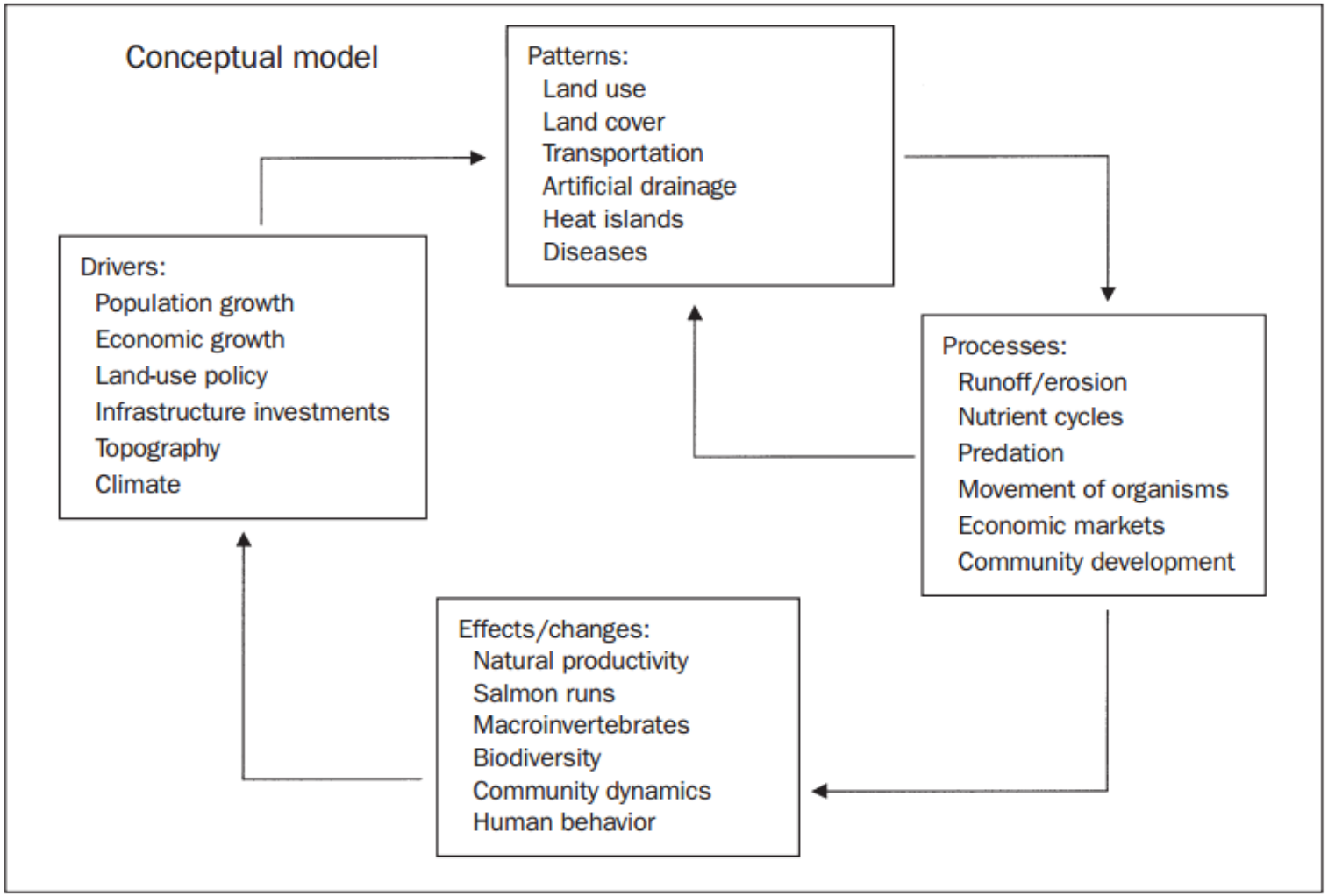


FIG 2.40 a diagram of the patterns, processes, effects and drivers of a socio-ecological system. Nature integrates with social systems and is recognized as a contributor as well as acknowledged in the effects social systems might have on ecology.

(Alberti, *et al*, 2003, pg. 1173)

Transformation is a result of two different forces (Folke, et al, 2003), which can be deliberate transformation or forced transformation. Deliberate transformation is intentionally initiated on multiple scales and points of engagement. It is a proactive form of resilience, which is usually pre-emptive of a major shift. An example of a deliberate transformation is the attempt of the Japanese in 2015 to protect themselves against Tsunamis by constructing a man-made forest as a shock absorbing barrier. The transformation of the system and space was pre-emptive of a disaster. This also displays a transformation in approach to the problem, where natural systems and methods are used to accommodate possible shocks to the system. Forced transformation falls on the opposite end of the scale, where an uncontrolled, un predicted event causes a shift, which affects all scales and calls for large scale transformation. (Folke*, et al,* 2003). This can be seen through the ongoing battle of the Netherlands to rising sea levels. The threat of unpredictable sea levels and flooding has changed the approach to how water is integrated within the build environment. The city has adapted and transformed across a multitude of scales and systems in order to accommodate the influx of water into the city.

The built environment, as a socio-ecological system, should aim for deliberate transformation in order to mitigate forced transformation. The management of these adaptive and transformative abilities of systems will either allows for the creation of barriers or bridges in dynamic land and seascapes.

Often, social norms are seen as secondary elements in society (Nightingale and Cote, 2012), but instead, normative factors, such as power relations and cultural values form an integral basis for how ecological systems are approached from a social standpoint (Nightingale and Cote, 2012). Therefore, the resilience of a social environmental system depends on how the system functions as a whole, and how strong the interconnections between society and ecology are. This depends highly on awareness of the social system and the opportunity for contact and interaction between the two.

Water culture describes a social power relation between the man-made and the ecological. It is a normative relationship between the inhabitants, biotic factors, of an environment or ecology and the abiotic, or environmental factors of an ecology society (Nightingale and Cote, 2012).

The manner in which waterscapes and water based environments is approached by a society dictates how that waterscape is viewed, and therefore interacted with (Ingold, 2000). As discussed in the phenomenology of water as well as in the human perception of the environment earlier in the chapter (Strang, 2008,2016), these factors play a huge role in determining how a water body is approached.

The system of dependencies, where social norms dictate actions and inherently affect ecologies, indicates the need to a reformation of water culture in order to address the way water is interacted with within the urban environment. This overall relationship describes the resiliency of the water culture within a particular urban environment, ecology and society.

2.4.3 Whole Design Theory

Whole design theory provides methods by which a resilient system can be achieved. Whole design theory favoured social and technical processes that evolved by continual reconfiguration (Sadler, 2008)

Systems, whether they are urban, natural, political or social, are complex and are often studied in a vacuum (Bertalanffy, 1986). Along with systems theory, whole design theory allows for the systems which make up a socio-ecological structure to be examined in relation to each other.

Outlined in the Whole Earth Catalogue of 1968, written by Steward Brand and Buckminster Fuller, the Whole Earth Catalogue aimed to bridge the discrepancies of the modernist movement and mass industrializations in architecture. Within the catalogue, of methods and technologies of achieving a sustainable design, the Whole Earth Catalogue defined a theory which encompassed "systems within systems"

Whole systems ideas were also used as a base to attempt to tackle social and environmental dichotomies and imbalances within the modernist movement (Fuller, 1975). Whole design theory acknowledged the detriment of the environment as a result of the mass production and globalization of modernist architecture. Focusing on the relationship between ecology and society, Whole

FIG 2.61

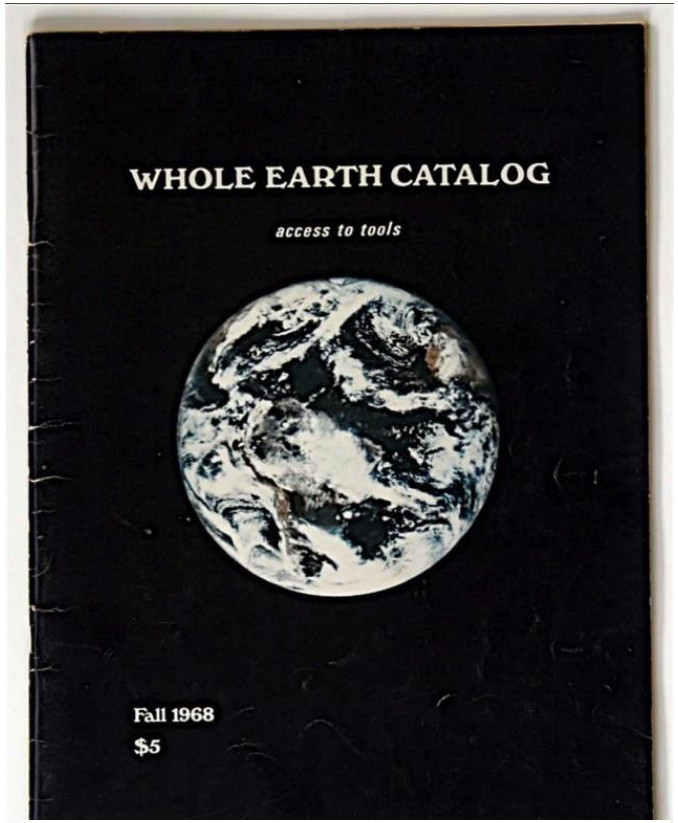


FIG 2.6 The Whole Earth Catalogue provided sustainable solutions for a more responsible design process. It was one of the first instances of social awareness of the effects of the built environments on nature. Available at: http://www.spatialagency.net/database/whole.earth.catalog

design theory attempted to bridge the gap in systems between human and non-human (Sadler, 2008).

In terms of architecture, the built environment is made of primarily two systems, being social and ecological. Bateson (1972) touched on this relationship in his "ecology of the mind" where the mind is a natural system which perceived a natural system.

Whole design theory aims to address the link between these many systems which exist in the built environment, that architecture needs to acknowledge. More specifically, architecture needs to acknowledge its global impact and local context, which modernism often did not.

2.4.4. The Harbour as a Sum of Parts

Human and natural environments are defined by a series of interrelated systems. Within the human inhabited environments, social systems often dominate over ecological systems (Purkyne, 1984).

Of these ecological systems, water plays a huge role in the structure of an ecological system, where for any ecological system to survive, there must be the presence of some water. Edgeworth (2014) further discusses human interactions with water as the counterbalance which exists between man's social systems, and nature's ecological systems, and its importance in closing the gap in creating a sustainable approach to the environment, and more specifically, water.

In their seminal work, *Cradle to Cradle*, on effective environmental approaches, McDonough and Braungart, (2002) tackles the dangers of separating the ecological environmental systems from the societal, interactive and constructed systems, where "Human beings are seen inevitably destructive toward nature" and must be "curbed and contained".

Resilience thinking theory tackles this issue head on in the approach of integrating social and ecological systems in order to create a bottom up initiative. The conservation of natural assets, as opposed to institutionally imposed regulations to

govern them, and integrating them into social spaces where they form a part of an ecosystem, will enhance their resilience as a whole. This change in mindset, ownership and agency discussed in resilience thinking will form the basis for a change in water culture.

To reignite a water culture the design of the built environment needs to be integrated and synthesized with the natural environment (McDonough and Braungart, 2002). This will challenge the assumptions of how water is interacted with as a purely economic commodity (Edgeworth, 2014).

Durban harbour is particularly affected by the dominance of man-made over natural systems. The industrialization of certain zones, especially in terms of the harbour and the intensity of operations which occurs at this point has resulted in the disassociation between the public realm and the waters' edge. The urban water front is made up of a myriad of social, economic and ecological systems. These systems range across different facets of day today activities and communities. With particular focus on the dynamics of ports and trade active harbours, economic systems take priority, often at the expense of other systems. This imbalance of importance in systems can, and has on many occasions, resulted in detrimental conditions for the ecology and sustainability of harbours and their operations. Social successes on the harbour have also been compromised due to the dominance of the trade and economic functions of the area. Overall, the complete ascendancy of the port operations has created an extremely unbalanced and poorly integrated system, leaving it vulnerable to external pressures like climate change and ecological strength as well as social investment.

In order to stabilise the harbour as a system, the importance of various role players need to be addressed. The current emphasis of port functions is necessary, but have resulted in the alienation of the harbour from the city as a social space, and has seriously compromised the ecological health of the harbour. By reducing the harbour as a predominantly utilitarian waterscape, its strength as a system is thus diminished.

FIG 2.62

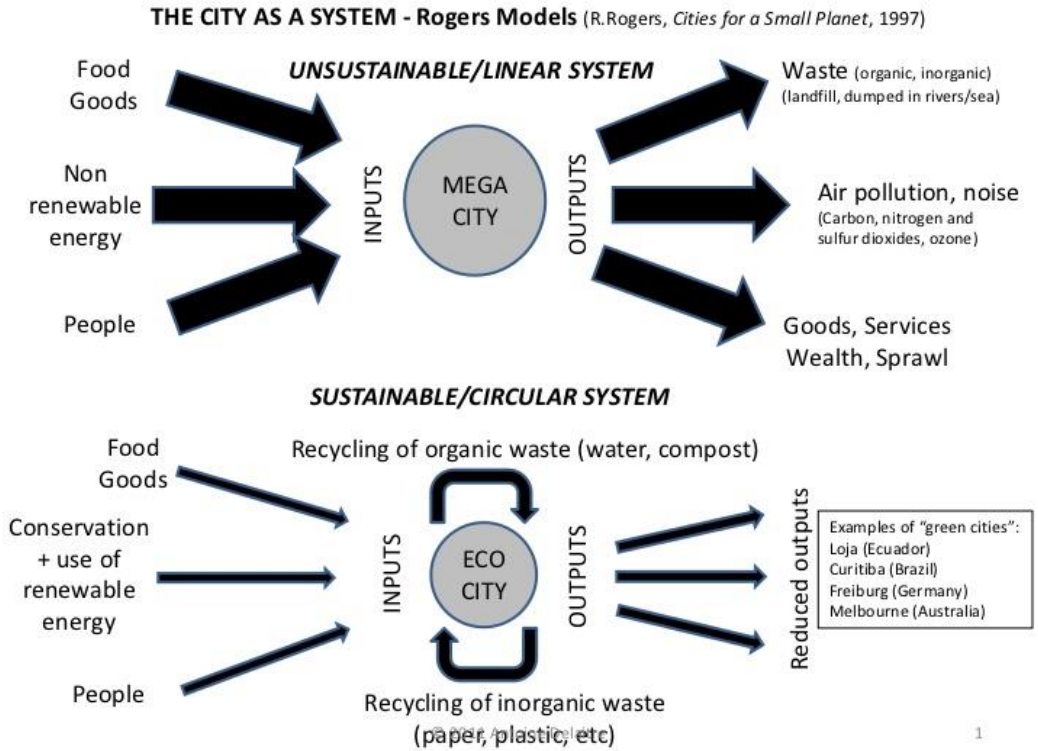


FIG 2.63

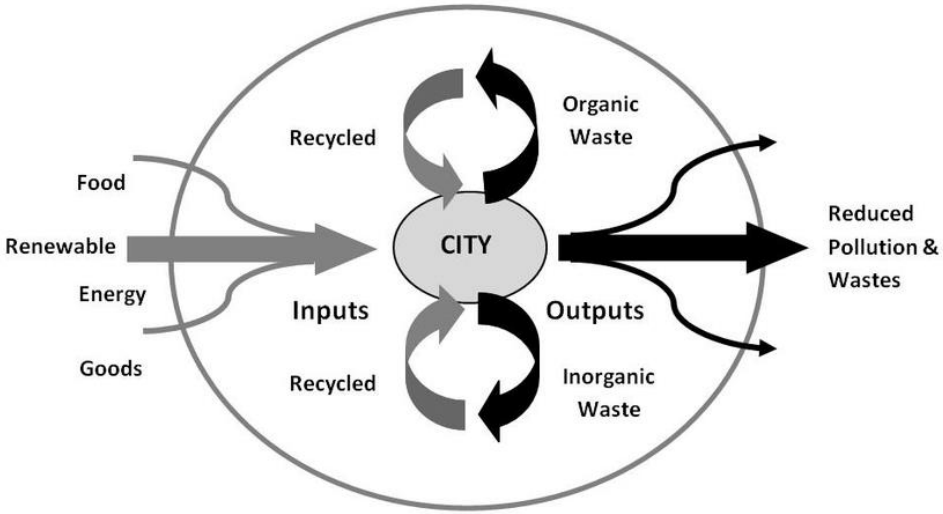


FIG 2.62 Illustrates a linear system in which inputs into a megacity results in goods and services which are beneficial to the city, as well as waste and pollution, which is usually renegaded to the natural environment, compromising the health of ecosystems. An eco-city, alternatively, offers a reduction in that waste produced to reduce the effects on the environment.

Available at: http://geographylaunchpad.weebly.com/the-city-as-a-system.html

Sourced from Waugh, D. (2002) Geography: An Integrated Approach 3rd ed., Nelson Thornes & Oxford Course Companion by Nagle and Cooke.

FIG 2.63 Diagram zooming in on the cyclical eco-city, where organic and inorganic wastes are recycled within the process to reduce waste and pollution.

Korpilo, Silviya. (2014). Integrating the concept of urban metabolism into planning of sustainable cities: Analysis of the Eco Cities,

2.5. Conclusion

Culture and the environment are strongly focused around sense of place as well as the experience of it. This extends to natural and built environments, as the experience and perception of both environments allows people to form a relationship with the space they interact with. Within both the natural and built environments water plays a pivotal role to the success of both the structure and the inhabitants.

Since qualities of phenomenology, sense of place and integrations of ecological and social systems, are present in both the built environment as well as water contexts, the amalgamation between built environment and natural water environment is fundamental to the redefinition of the culture surrounding water in Durban.

The relationship between man and environment is well established, but the connection between built and natural environments needs to be reviewed, especially where water and water management is concerned. The consumption and disposal of water through instant and often hidden system has resulted in the disconnection between people and the natural essence of water.

In order to address this, there must be a shift in architectural design, in order to incorporate water in a manner which is meaningful and facilitates a connection between man and his environment.

The hydrosocial cycle gives some insight to this intricate relationship between man and his environment, and more specifically his impact on water and the generation of "types of water".

Resilience of cities to water is also as important as the representation of water in architecture. The ability of cities to adapt, transform and be resilient to sudden changes in water, whether it is too much or too little, is fundamental to how water in interacted with from the perspective of the built environment as well as from the perspective of human beings.

3.0

CHAPTER 3

PRECEDENT STUDIES

FIG 3.0. DURBAN HARBOUR GANTRY CRANES AT TWILIGHT

(AVAILABLE AT: https://www.5stardurban.co.za/city-forges-partnership-with-transnet-to-grow-the-economy/)

3.1. INTRODUCTION

In order to properly understand the requirements of an architecture which responds to the waterscape and settles successful into its context and habitat, practical applications of the principles discussed in Chapter 2 must be analysed.

Chapter 2 identified Adaptation, Transformation and Resilience as key concepts through which architecture is responsive to water within an urban environment.

The following precedents were selected based on their **responsiveness to water as an informant** of phenomenology and the experience of place, their ecological and contextual appropriateness as well as their function in reconnecting people to the water and strengthening the systems of a community. They were also selected based on the proximity of a water body to an urban development, as well as a disconnection between the public and the relevant waterscape.

The precedents will be analysed according to the three concepts carried throughout this document, namely: **Adaptation, Transformation and Resilience.**

The purpose of this analysis is to examine the practical applications of how water can be integrated into the built environment, as well as how this integration benefits surrounding communities and the ecological health of the water systems.

Building technologies examined here will be applied in Chapter 6 as these precedents form the design precedents.

Precedent Study Location:

Copenhagen, Denmark

Due to its low-lying land and extensive coastline, Denmark has always employed water management strategies. As a result, their technologies and methods of coping with water influx has put them at the forefront of urban water management systems (Kristiansen, 2012).

The many canals, coastlines, harbours and rivers which course through the country, Denmark is inherently intertwined with water in a very physical way. This intimate relationship has also resulted in water being a threat to urban and densely populated areas, with flooding and sea level rise posing many threats to the functioning of the country (Kristiansen, 2012). Urban wastewater has been of focus for Denmark. With high pollution instances during the 1970's and 1980's, Denmark turned its focus to address the quality of water entering the ocean from the city (Larsen, 2016). With huge environmental health stakes, Denmark now treats all urban run-off and wastewater before it reaches the bay. By doing this, a massive transformation in the health of the water occurred. This was also achieved by shifting focus to the ecology of the urban environment, and how nature can be used in conjunction with the man-made to solves issues around water management. As a result, a shift in water management and planning resulted in a transformation of both the urban and natural realms within cities (Kristiansen, 2012).

> "Denmark can now be considered as a European water-hub: a centre for knowledge technology services and solutions in the field of water" **(Kristiansen, 2012)**

WATER USAGE

POPULATION : 5.371 MILLION

WATER USAGE : 114 LITERS PER CAPITA PER DAY (L/C/D)

COASTAL KILOMETRES : 7314 KM

PERCENTAGE WATER : 2%

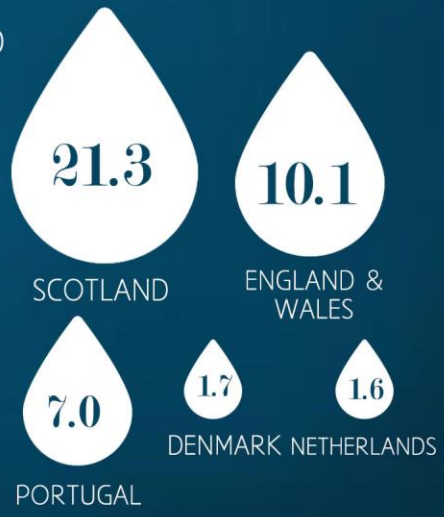
WATER IN DENMARK

ADAPTATIONS

100%
WASTEWATER IS RECYCLED

DECENTRALIZED WATER

WATER LOSS (PIPE M3/KM/DAY)



TIMELINE OF EVENTS

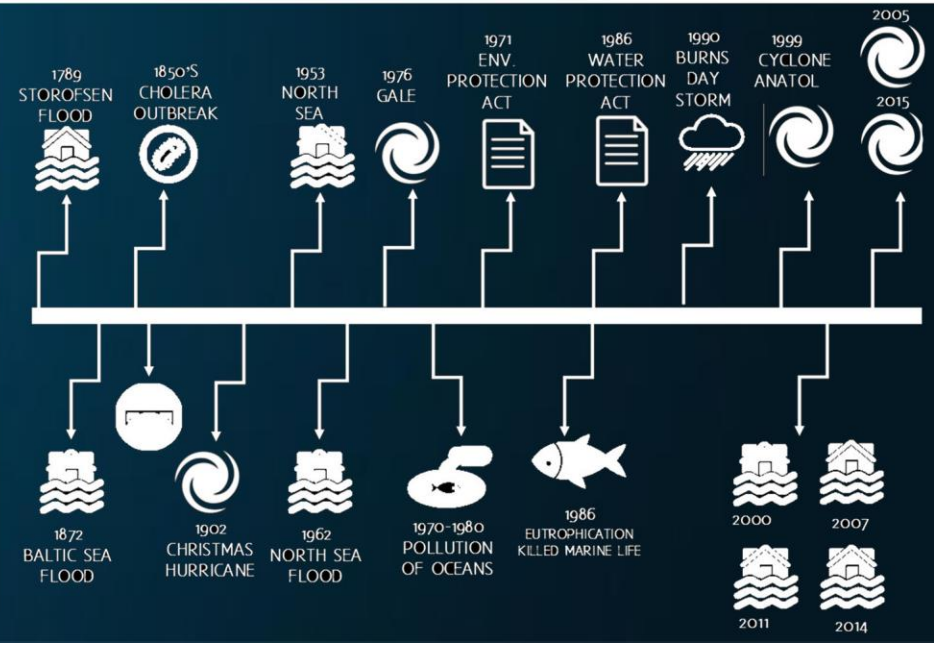


FIG 3.2

Water source flows into the harbour from the ocean

Canals feed off from this source and integrate directly with the urban fabric

The urban grain is fairly large, with midrise mixed-use buildings flanking the water's edge

Road network stops a before the water's edge, allowing pedestrians to take precedence over cars. This promotes access and a social emphasis on the interaction between city and water. Pedestrian and cycle lanes are provided.

Green space in and around the harbour allows for absorption of urban runoff as well as reducing the amount of contaminations. Green spaces also promote waterscape ecologies

Copenhagen Harbour Baths

CHALLENGES:

URBAN FLOODING

Low lying areas a susceptible to flooding from the ocean. Cities have transformed to accommodate for this.

SEA-LEVEL RISE

Climate change poses a huge risk to the urban environments. Allowing for areas of drainage within the urban fabric absorbs impact

WASTE-WATER MANAGEMENT

Water quality tackled by addressing urban run-off and waste water treatment before reaching natural water bodies

INTERVENTIONS:

ADAPTATION

Integration of water into the urban fabric and landscape. Defining the city as a waterscape

TRANSFORMATION

Techniques for water control which directly impacts and involves natural ecosystems.

RESILIENCE

Allowing water to be integral to everyday life as something other than sanitary

3.2. CITY SCALE: COPENHAGEN

Project Name: Copenhagen Harbour Baths

Architects: JDS + BIG

Location: Copenhagen, Denmark

Typology: Recreation/Aquatic

Copenhagen as a city, is much like the rest of Denmark, is in constant contention with water issues within the built environment. Much of this flooding is due to the low-lying land which makes up the bulk of Denmark and its vulnerability to rising sea levels. This constantly put the city at odds with water within the built environment.

While there are many instances of flood control methods, Denmark is changing how water is perceived with innovative water management methods. Their built environment speaks of a futuristic relationship between the built environment and water, where water is welcomed into the built environment instead of pumped out or attempted to be controlled.

Adaptation-People and the Environment

The Copenhagen Harbour Baths is a design intervention in Denmark which encourages the interaction between people and their environment. Since water is omnipresent in many Danish cities, the interaction with it needs to be encouraged in order to build resilient communities and practices toward a “water culture”.

The harbour area is in a state of transformation, much like Durban Harbour,

FIG.3.3 Copenhagen Harbour Bath aerial view.

FIG 3.4 Swimming Area at Baths

(Both available at http://www.archdaily.com/11216/copenhagen-harbour-bath-plot)

FIG 3.3

FIG 3.4

where industrialized port functions, cultural and social functions are all beginning to interact to create an experience which is unique to Copenhagen. The primary issues identified relate to ecological health of water, the pollution from harbour operations and the industrialization of the harbour area. here is a huge effort to

FIG 3.5

FIG 3.8

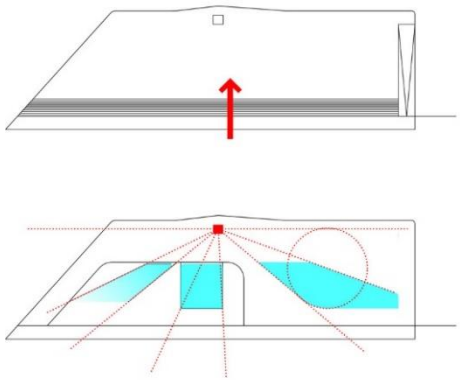


FIG 3.6

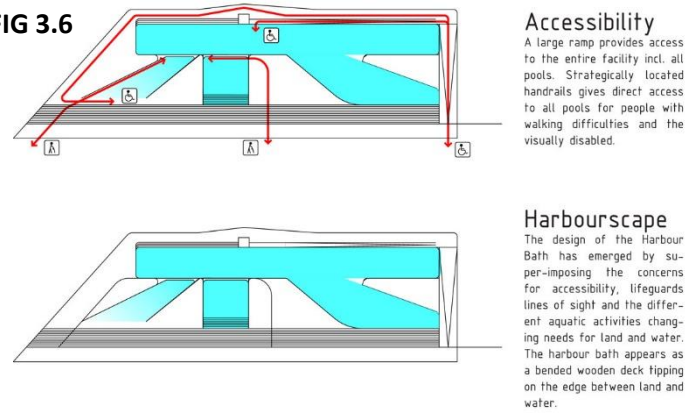


FIG 3.7

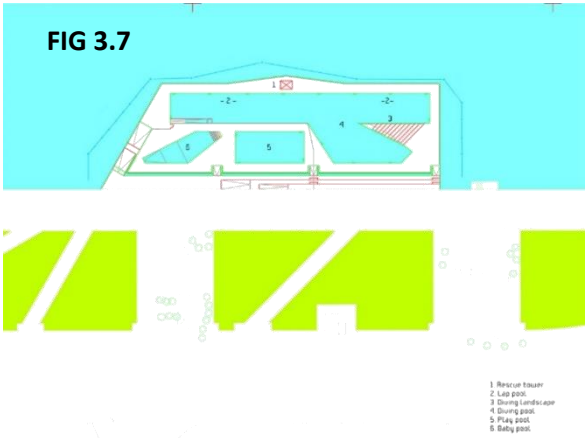


FIG.3.5 Baths being used by community. (Available at http://www.archdaily.com/11216/copenhagen-harbour-bath-plot)

FIG 3.6 Principles of accessibility and harbourscape used to integrate people and create and identity for the baths

FIG 3.7 Illustration the layout of the baths

FIG 3.8 Principles of Continuity and Safety to properly integrate and protect the public

reconnect people to the water as a social aid once again as it would have been prior to industrialisation.

The harbour is also in a state of architectural transition, where waterfront buildings are redefining a dialogue of water works with the built environments. The result is an embrace between water and the built environments.

Transition – Natural and the Man made

The Copenhagen Baths provide a transition between land and water which is traditionally enclosed and concealed in the city.

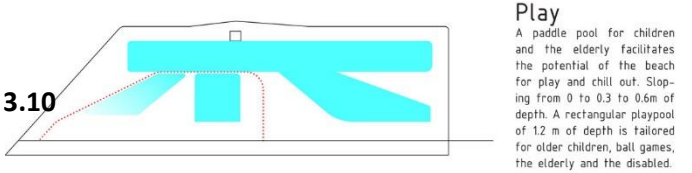
The baths also provide a unique experience in its positioning, being in the middle of the city, and providing a unique experience otherwise not associated with the space.

The juxtaposition of urban and natural interfaces provides a method for people to reconnect to both environments and create an equal and balanced relationship with both realms of nature and the man-made.

In this instance, architecture, land and water are all designed with equal consideration for their experience, materiality and interaction. The baths are also an attempt to improve water quality within the harbour. The water being

FIG 3.9

FIG 3.10



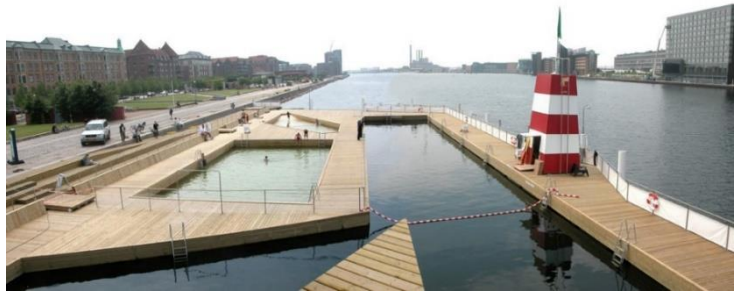


FIG.3.9 Principles of Swim and Play used to reconnect people to the water through recreation and encourage a change in perception of the space (Available at: http://jdsa.eu/bad/)

FIG 3.10. View of the baths and city (Available at http://www.archdaily.com/11216/copenhagen-harbour-bath-plot)

interacted with is filtered and cleaned to ensure the safe bathing of the public. As a result, the surrounding area of water has dramatically improved due to the new a healthy relationship between people and this particular stretch of the harbour edge.

Resilience – Linking Systems

The Harbour Baths also provides a unique experience in that it is still related to the context of the harbour mechanics. There is no shielding or screening of the practical and *nitty-gritty* aspect of harbour workings, ensuring an experience which is entirely focused around place and the experience associated with changing the perception of an environment. Harbours, which are otherwise associated with large scale, highly pragmatic, industrialized functions, are now providing social spaces and a chance for the city to reclaim the "harbourscape".

Water quality is highly monitored and improved by the functioning of the baths, as water awareness and consciousness is promoted through the physical and social relationship to the water.

The entire system of social-ecological and practicality is strengthened through the assimilation of the various systems, as opposed to being completely shielded and treated as separate systems.

FIG 3.11

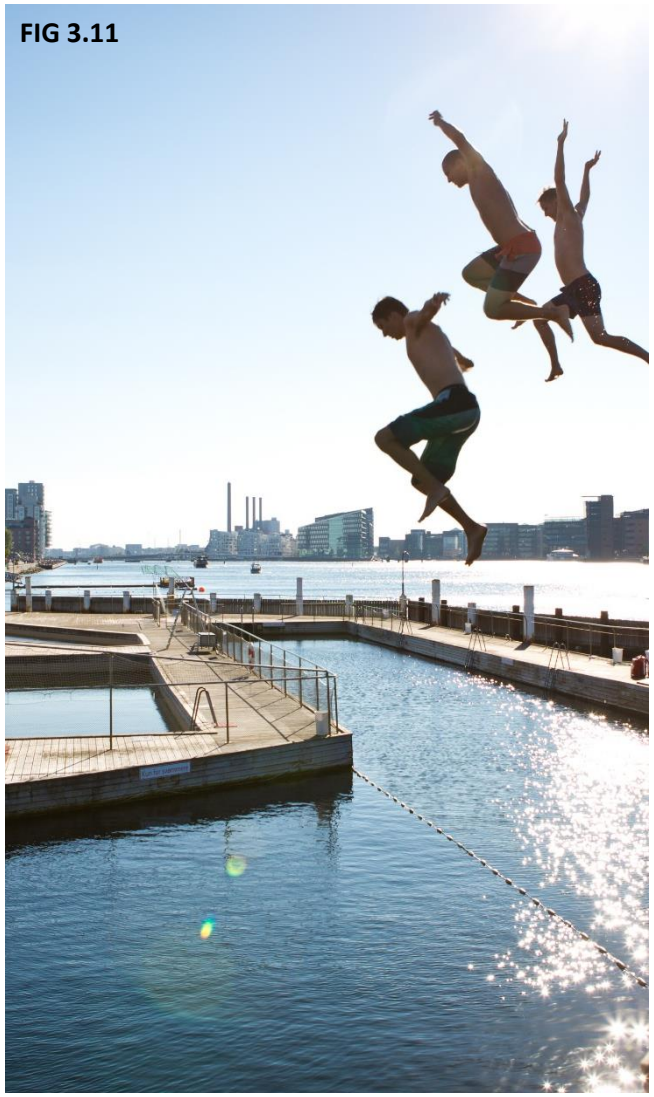


FIG.3.11 Copenhagen citizens using the Harbour Baths

Available at: http://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2014/01/22.01.13-Copenhagen-360x240.jpg

Precedent Study

Location: Osaka, Japan

Japan has historically had an intimate relationship between people, water and architecture. Basic principles of Daoism and Confucianism revolve around how movement through space is dictated by water (Graham, 2014). Making full use of the phenomenological qualities of water, Japanese design is rooted in celebrating its integration with the built environment (Graham, 2014). Japan also has a tumultuous relationship with water. This arises from water engineering and management. While water engineering practices date back thousands of years, the effects of climate change pose a new threat on Japanese cities (Takahasi, 2009). With extreme flooding, heavy rains and tsunamis, Japan has been forced to adapt and transform its cities to become more resilient to the stressors of the modern environment. Water culture, an idea which hasn't yet been explored by many other nations, is something which has been tackled by the Japanese. Consciousness around the significance of water is implemented in Japan. In order to foster a better relationship with water, Japan has dedicated specific days in the calendar to its awareness and appreciation. It has also identified 100 areas which attribute unique waterscape characteristics and made them landmarks, to encourage local tradition and pride in the local people (Revival and Fostering of Water-Related Culture, 2008).

> "Life in these cities is intensively interrelated with this water, as it was in the past"
>
> **(De Graaf and Hooimejer, 2008)**

WATER USAGE

POPULATION : 127 MILLION

WATER USAGE : 314 LITERS PER CAPITA PER DAY (L/C/D)

COASTAL KILOMETRES : 29 751 KM

PERCENTAGE WATER : 12.07%

WATER IN JAPAN

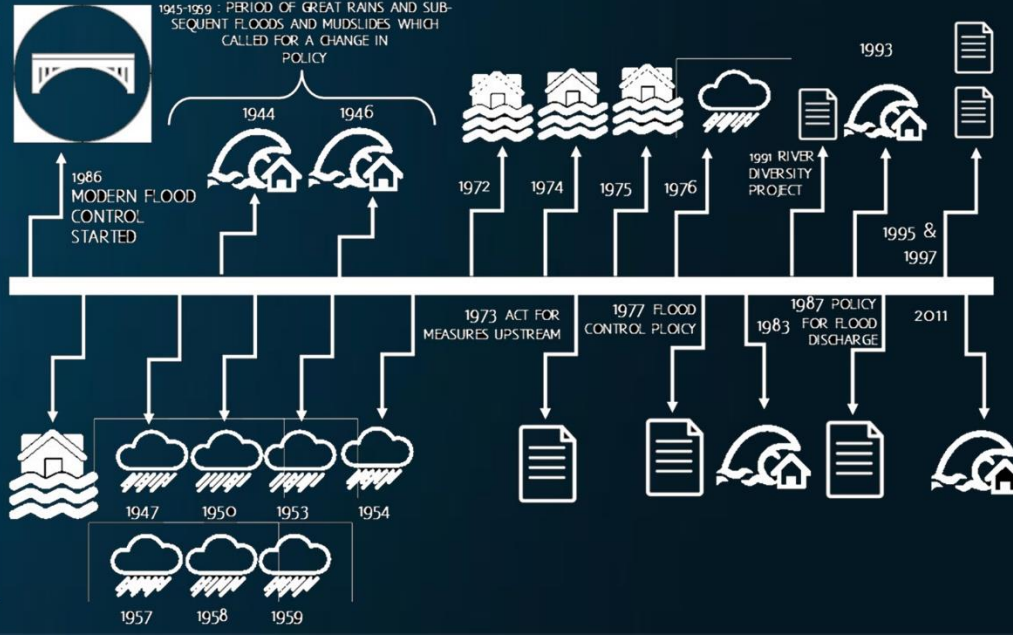
NATURAL DISASTERS

FLOOD

TSUNAMIS

TYPHOONS

TIMELINE OF EVENTS



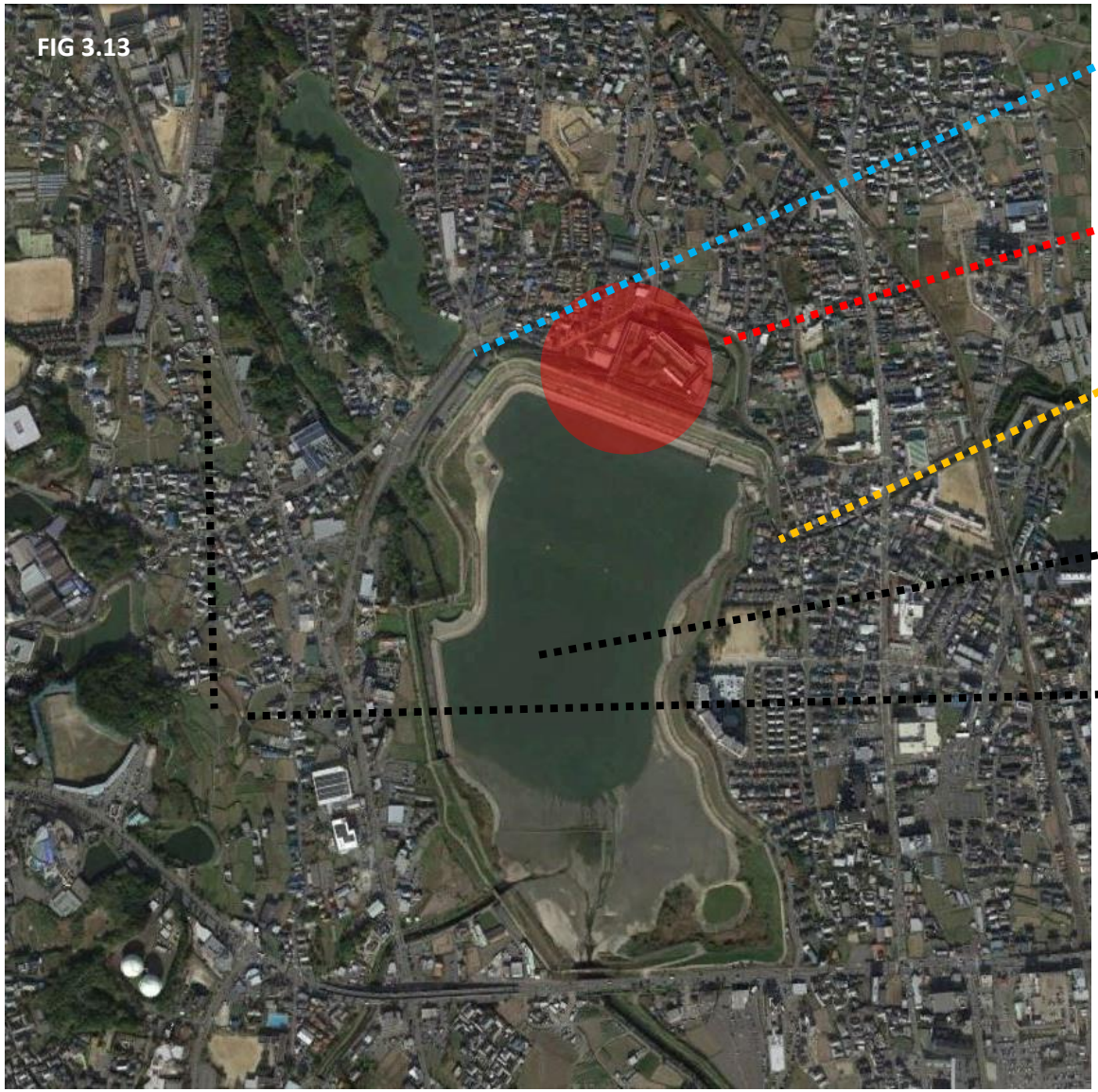


FIG 3.13

Water source is entirely landlocked by the urban environment. The low banks results in frequent flooding

Sayamaike Historical Museum

The urban fabric is fairly low density, with low and mid-rise buildings with large roadways

The building site is close to the water body, making use of the waterscape within the design

The area has a fair amount of vegetation indicating ecologies within the area which can be promoted within the building site

3.3. CITY SCALE: OSAKA

Project Name: Sayamaike Historical Museum

Architects: Tadao Ando

Location: Osaka, Japan

Typology: Educational/Cultural Centre

Japan has had a turbulent relationship with water control. Constant flooding and coastal sea level rises are constant threats to the Japanese population. Various measures of control are implemented to curb the effects of natural disasters in Japan. As a result, the positive and progressive aspect of the relationship the Japanese have with water and water engineering is overlooked.

The Sayamaike Historical museum aims to celebrate the relationship the Japanese have with water. This project is located in Osaka, Japan, one of the coastal cities in Japan. The museum curates the various water engineering technologies implemented by the Japanese throughout history. With immediate context of the Sayamaike Pond, where the museum is located, is a huge generator for how the architectural experience is dictated through the space.

Adaptation – Recognizing the essence of place

Sayamaike Pond was a man-made agricultural reservoir and flood control mechanism which dates back as early as the 7th Century, making it one of the oldest

FIG 3.14

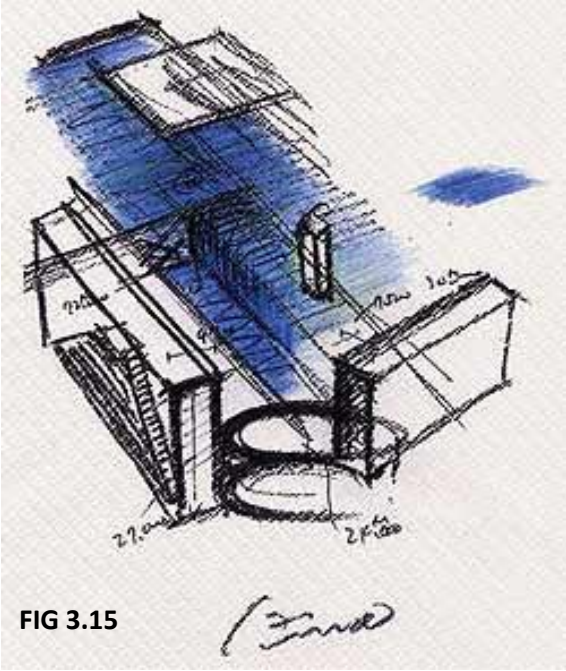
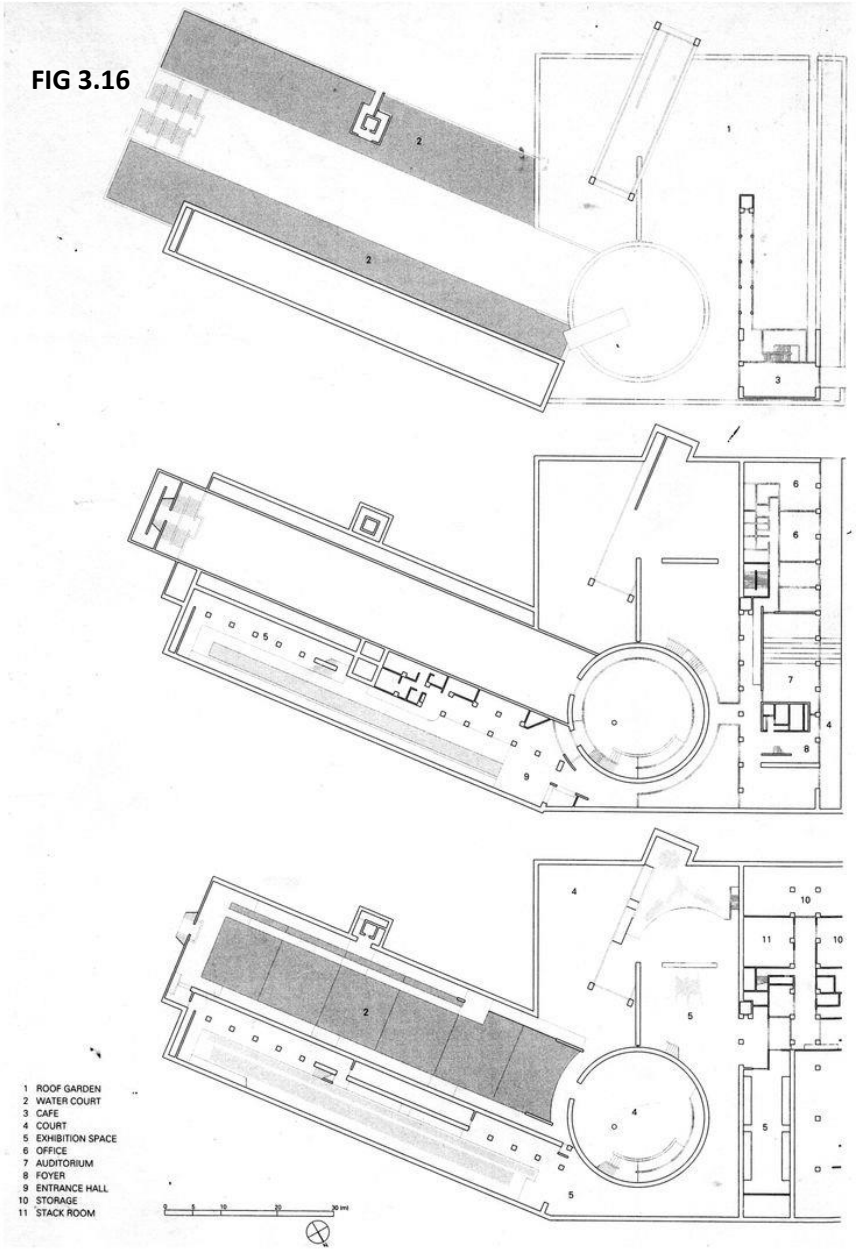


FIG 3.15

FIG 3.16



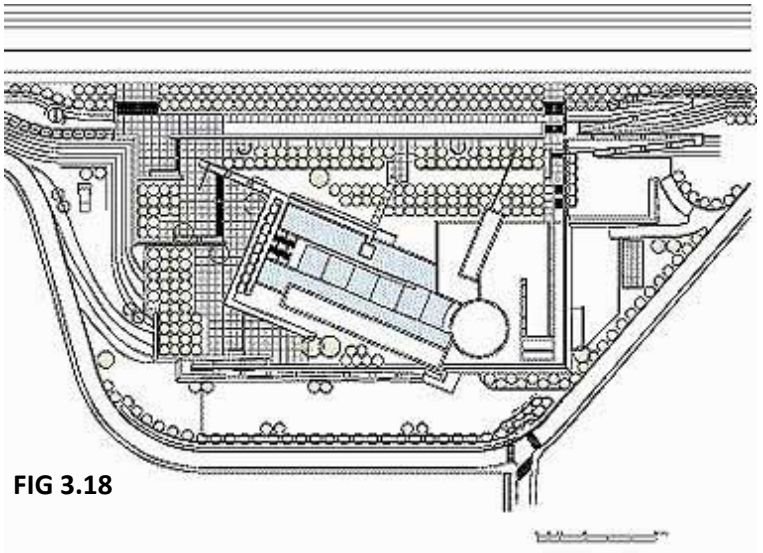
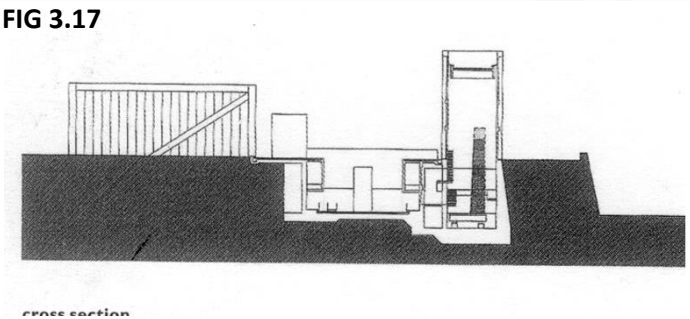
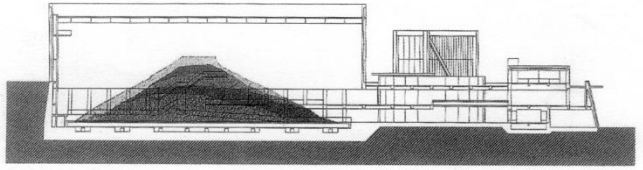


FIG 3.18

FIG 3.17





(Above)

FIG.3.14 External View of the Museum

FIG.3.15 Sketch by Tadao Ando illustrating the intimate relationship between the building and water.

Both available at: https://arcspace.com/feature/sayamaike-historical-museum/

(Left)

FIG. 3.16 Plans and section of the Sayamaike historical museum.

The maze-like entrance of the building leading out into the museum space emphasises the journey, exploring the relationship people and architecture have with water. The central large space s made up of water and is “discovered” at the end.

FIG. 3.17 Sections show the human scale and volumetric rations employed to emphasis the journey through the building

FIG. 3.18 Site plan illustrates how the building sits in the river bank edge and becomes a civic space

All Available at: https://za.pinterest.com/pin/323555554457974846/

examples of water control in Japan. Now, a flood control dam, the site holds many relics and artefacts of Japanese water engineering. Evidence of the ingenuity and engineering of the Japanese, as well as a historical site of great value for its immediate community, the pond is of great historical and cultural heritage.

The sense of place and genius loci is carefully considered by Ando. His direct integration of the site in the construction of the museum pays homage to the land, where water, land and architecture become aspects which build off each other. The environment itself becomes the museum and creates a seamless journey throughout the building.

The intimate relationship between the environment and place grounds the architecture in the history of Sayamaike. Through the building, there are constant references to the height of the water level in the pond, scaling of volumes according to exhibitions and the sensory experience of water. This includes integrating water into the experience of the building. Water patios, stairs and indoor waterfalls all attempt to encompass the experiential

quality and phenomenology of water within the design.

FIG.3.19 and FIG 3.20

Water curtain as the large water area is approached

Available at: https://arcspace.com/feature/sayamaike-historical-museum/

Transformation – Technologies and interconnections

The building technologies facilitate the relationship between water and architecture. Feeding into adaptation, the transformations within the architectural space aim to include water within its experience. The sequencing of spaces and architectural "maze" is guided by the presence of water within the structure of the building. The design aims to highlight the role of water in the Sayamaike community and the journey experienced through moving through the spaces. Scale and volume contextualises the journey while water is used to guide from one space to another, fundamentally integrating it into the experience of the environment and architecture.

FIG 3.21

Entrance into the water patio

Available at: https://arcspace.com/feature/sayamaike-historical-museum/

FIG 3.22

Circulation textures

Available at: https://arcspace.com/feature/sayamaike-historical-museum/

Precedent Study Location:

Vancouver, Canada

Developing as a modern city, Vancouver, British Columbia, Canada, has made concerted efforts to ensure their built environments and architecture is sustainably sound. This includes the proper integration of water sustainable technologies into their current architecture.

Waterscapes which were previously victim to the downsides of traditional urbanisation have been readdressed, and slowly regenerated in order to rebalance the nature-man-made systems which was previously disrupted (Koop, 2008). Core issues with urbanisation have been identified and tackled. The decentralization of water management in Vancouver has resulted in a small scale, high impact solution for managing urban run-off, waste water management and controlling water pollution (Koop, 2008).

While this may not have been implemented across the entire city, development schemes allow for the direct involvement of the community in managing water, instilling an urban water culture (Koop, 2008).

> “How the city is designed and operated has a direct effect on rainwater and runoff quality and quantity. Cumulatively, management of the city urban design determines the health of Vancouver’s watersheds” **(Koop, 2008)**

FIG 3.23

Infographic Illustrating Canada's relationship to water

By Author

WATER USAGE

POPULATION : 36.29 MILLION

WATER USAGE : 343 LITERS PER CAPITA PER DAY (L/C/D)

COASTAL KILOMETRES : 202 080 (world longest)

PERCENTAGE WATER : 8,92%

WATER IN CANADA

EFFORTS

97% (in 1999)
WASTEWATER IS TREATED

DECENTRALIZED WATER

TIMELINE OF EVENTS

RESILIENCE

1970
CANADIAN ENVIRONMENTAL LAW ASSOCIATION IS FOUNDED (CELA AND CERLF)

1980
"HOW TO FIGHT FOR WHAT'S RIGHT' BY JOHN SWAIGEN IS PUBLISHED FOR PUBLIC USE

1990
MAJOR RESEARCH PROGRAMS INTO SUSTAINABILITY. INTERNATIONAL RECOGNITION

2000-2010
SUSTAINABILITY AT THE FOREFRONT OF CANADA'S DESIGN PRINCIPLES. PUBLIC GUIDES PUBLISHED

CHALLENGES:

POLLUTED WATER

Poorly managed industries pumped untreated water directly into natural water bodies resulting in polluted water bodies

DEGRADED ECOSYSTEMS

Rapid urbanisation and pressures of growing populations resulted in the dominance of the man-made over the natural

WASTE-WATER MANAGEMENT

Decentralised water management systems implemented to combat the effects of urbanisation.

INTERVENTIONS:

ADAPTATION

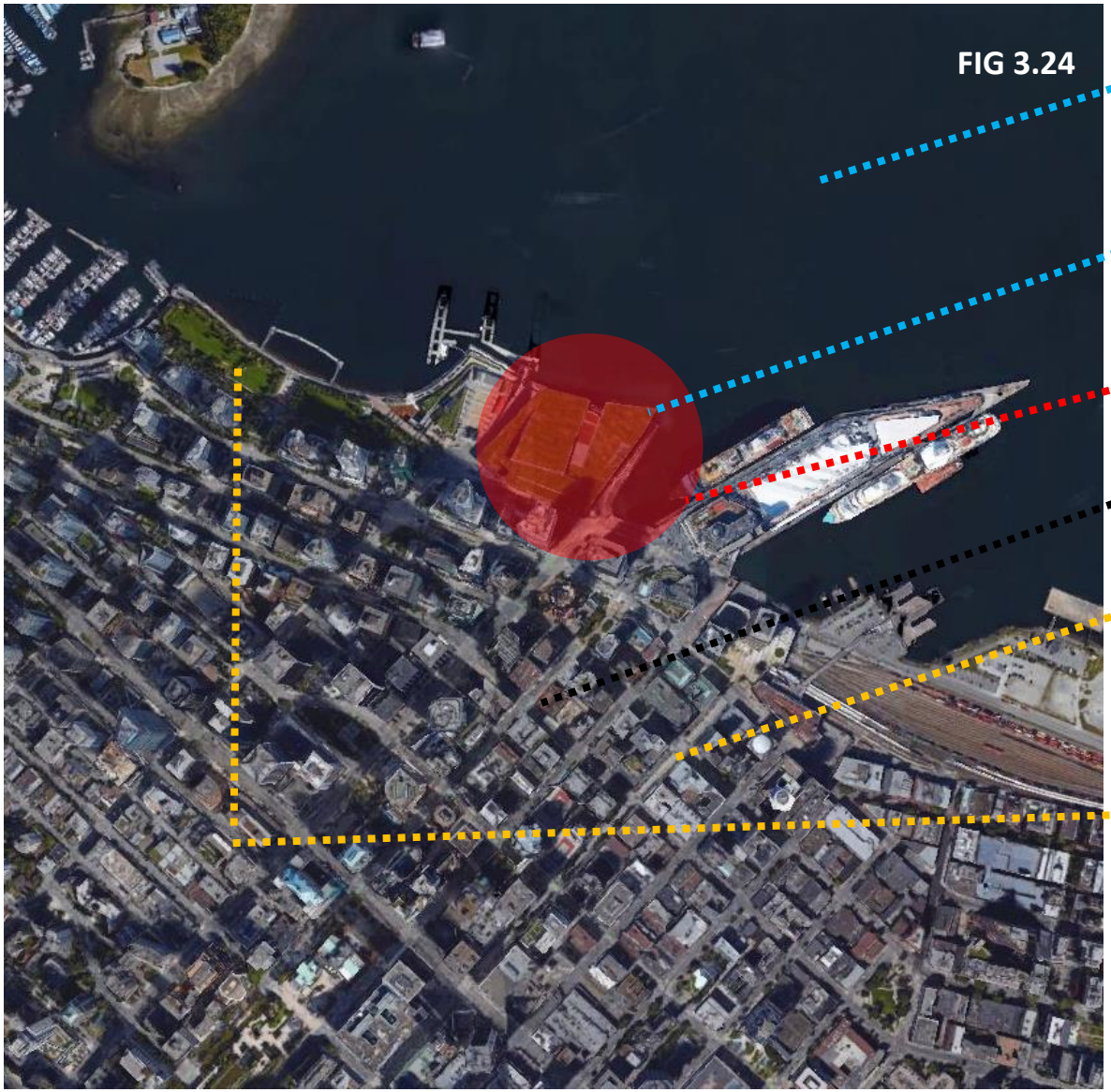
Integration of water into the urban fabric and landscape. Defining the city as a waterscape

TRANSFORMATION

Techniques for water control which directly impacts and involves natural ecosystems.

RESILIENCE

Allowing water to be integral to everyday life as something other than sanitary



Water source comes in from the ocean into an active port. There has been loss of marine life and ecological health within the area

Building sits on a platform which protrudes into the water, forcing it to interact with the water on three edges

Vancouver Convention Centre West

The urban grain is dense and fine, as the edge sits along a dense urban area

Road network channels pedestrian and vehicular traffic to the water's edge. A standard grid is following in order to achieve this

Green space is limited, but the green roofs and attempts to promote ecologies within the area can be seen

3.4. CITY SCALE: VANCOUVER

Project Name: Vancouver Convention Centre West Building

Architects: LMN Architects

Location: Vancouver, Canada

Typology: Convention Centre/Public

The Vancouver Convention centre simultaneously addresses the interface between the city and the waters' edge, as well as the people and the water. Aiming to be the first platinum LEED (Leader in Energy and Environmental Design) convention centre in the world, the building takes into careful consideration its impact on the environment as well as the surrounding community.

3.4.1. Adaptation – People + Environment

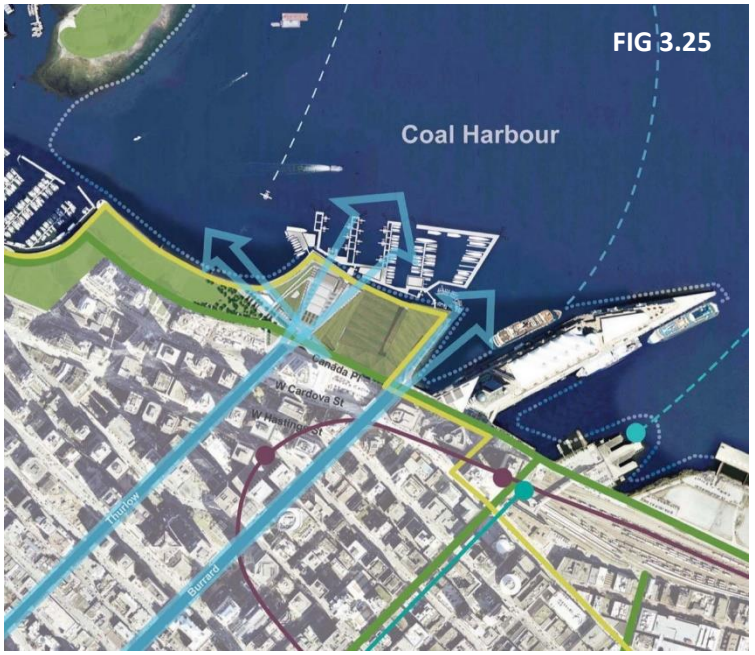
The Convention centre allows for the natural ecology and social spheres to interact with each other. By providing access directly to the water's edge and transforming the use of the site which is usable by the public as well as intertwined with ecology, the building showcases the interdependence of social and ecological spheres.

"The design approach creates a community experience that is simultaneously a building, an urban place, and an ecosystem" (LMN Architects, 2011)

Being situated on the old site of a coal harbour, the ecological health of the site had been seriously compromised in the interests of harbour activities.

The project aimed to reintroduce the public into the space as well as maintain a

FIG.3.25 Plan of how the scheme reconnects to the axes of the city fabric. (Available at: http://www.archdaily.com/130373/vancouver-convention-centre-west-lmn-da-with-mcm)



functioning convention centre. This was achieved by channelling people to the site from the city, as well as making the building transparent and accessible, always allowing for a visual connection to the water.

The above urban strategy in Figure 3.21 illustrates how the building uses important axial links to promote the flow of people to the site, making it completely accessible and takes advantage of pre-exiting flows and links to the water.

FIG.3.26 View of the Green roofs used to collect rain water and provide roosting areas for marine birdlife

FIG. 3.27 View of centre from pedestrian promenade as a destination point in the waterscape

(Available at: http://www.archdaily.com/130373/vancouver-convention-centre-west-lmn-da-with-mcm)

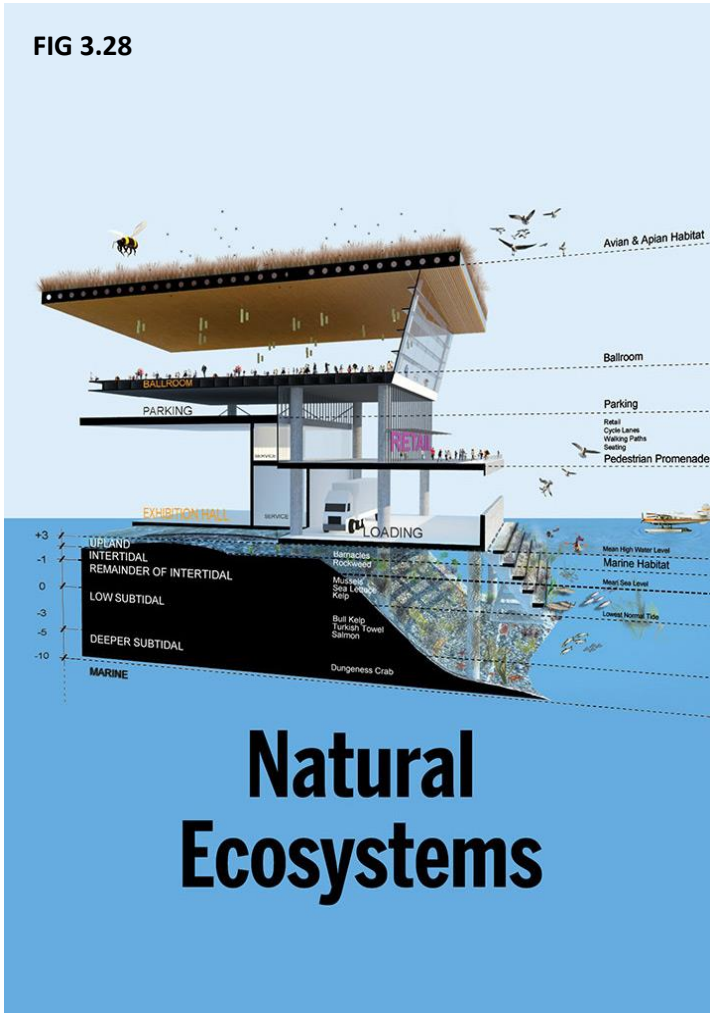


FIG.3.28 Section of building illustrating the integration between architecture and the natural environment. The building aims to regenerate the degraded ecology through architectural intervention

(Available at: https://lmnarchitects.com/project/vancouver-convention-centre-west)

3.4.2. Transformation – Architecture + Ecology

The primary aim of the building was to incorporate sustainable and ecologically regenerative principles. This took form through the introduction of a marine skirt. The artificial reef has allowed for the return of marine habitat to the site. The industrialization of the area, infilling and hardened surfaces had negated the possibility of a marine habitat forming around the harbour. The marine skirt is constructed of porous concrete beams which sit in submerged tiers. These porous beams mimic rock surfaces, which allow for the growth and healthy algae, coral and return of marine life, like fish and sand dwelling creatures. The below illustration

FIG 3.29 Water System

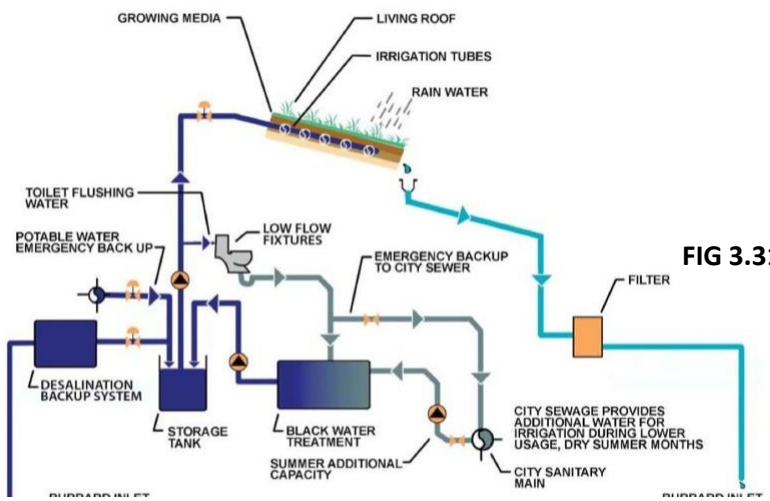
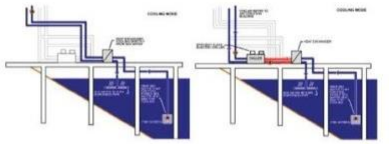
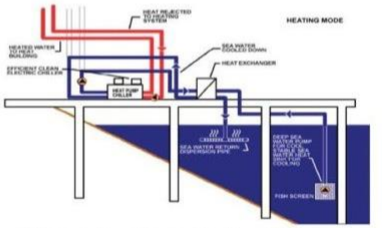


FIG 3.30 Cooling



- "Free Cooling" in the Spring and the Fall
- System produces 2,100 tons of Chilling
- System rejects heat to the Sea Water

FIG 3.31 Heating



- Extracts heat from the Sea Water
- Chillers also prodcue 50% of heating requirements
- System Produces 1,300 tons of heat = 21 mil BTU/Hr

FIG.3.29. Illustration of the building's water system and the integration of natural systems versus traditional sanitation practices

FIG.3.30. Illustration of cooling system using natural movements of water

FIG.3.31 Illustration of heating system using natural ocean movements

(All available at: https://lmnarchitects.com/project/vancouver-convention-centre-west)

describes how this is integrated seamlessly into the building. In keeping

with its goal for addressing total marine ecology, the building has also taken into consideration the marine birdlife of the habitat. The green roofs, which among other uses, have allowed for roosting places to establish, resulting in a renewed bird and bird-watching community within the harbour.

Water systems management within the building has also been a primary concern for how the building functions, as an architecture which is responsive to a body of water.

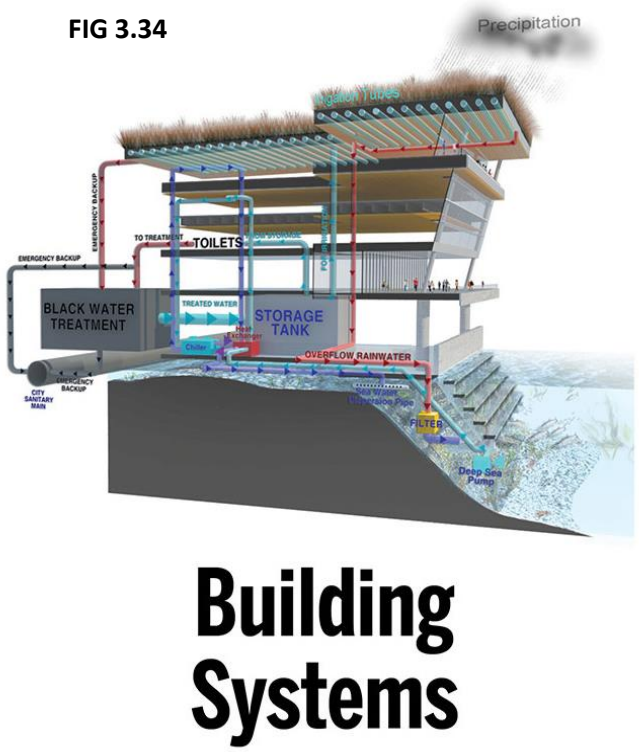
The systems implemented within the building have accommodated natural water harvesting, from rain water, as well as desalination of harbour water to be used within the building. This is used in the form of grey water, and takes into consideration

FIG.3.32 Structure framing of views to integrate to context

FIG.3.33 Aerial view of scheme relating to the harbour and to the city

(Available at: http://www.archdaily.com/130373/vancouver-convention-centre-west-lmn-da-with-mcm)

FIG 3.34



Building Systems

FIG.3.34 Section illustrating the building services and water management systems to decrease dependency on grid water systems

(Available at: https://lmnarchitects.com/project/vancouver-convention-centre-west)

the treatment of the water before it reaches the harbour again.

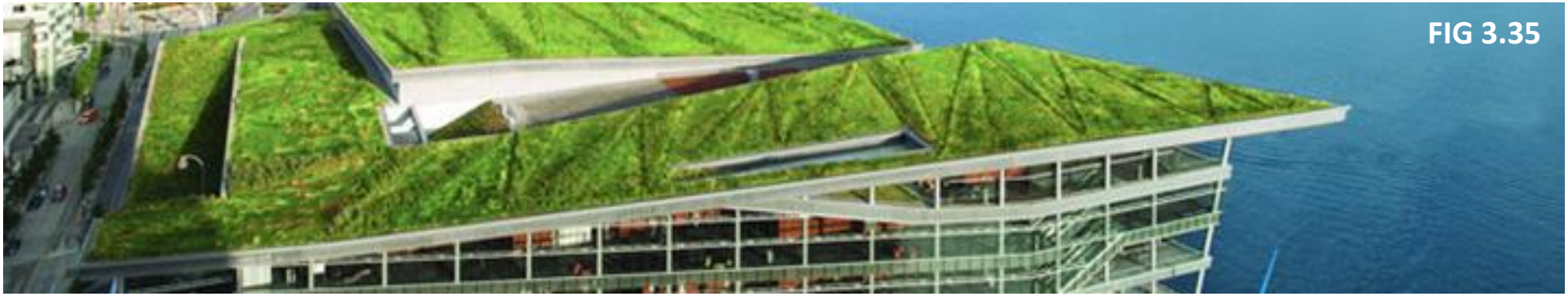
Harbour water also makes up part of the heating and cooling systems used in the building. Being situated in Canada, the building has to deal with extreme temperature variations between summer and winter. The building makes use of the harbour water in its temperature control methods to cope with its environments and simultaneously purify the water.

The convention centre does not operate as a typical convention centre. The public is completely integrated with the architecture, having toured the building and being aware of all the ecological issues it is trying to tackle. The surrounding spaces as well as green roofs are completely accessible, making the building part of the urban fabric, and not a standalone structure used temporally.

FIG 3.35

Aerial view of the roof gardens and nesting areas on the Vancouver convention centre

Available at: https://www.vancouverconventioncentre.com/facilitv



3.5. CONCLUSION

Chapter 1 established research questions and objectives to outline the principles required to implement a sustainable water culture.

The above precedents attempt to analyse the architectural responses in terms of Adaptation to place, Transformation to suit ecological design and the Resilience of the contribution of the architecture to strengthening an existing socio-ecological system.

Water culture is also examined in the capacity of the projects to regenerate a space which was previously dominated by manmade, and through architectural intervention, has adapted and transformed the relationship between people and water.

The Copenhagen Harbour Baths by BIG and JDS architects illustrated a harbourscape which has over time become disassociated with the community of Copenhagen. Similar to Durban Harbour, this project tackles reconnecting people to water through a physical and phenomenological level.

The floating islands of Seoul provide an example of how water, previously perceived as a barrier, is now properly integrated with and forms an extension of the city. The symbiosis of architecture and nature is furthered through the islands' ability to move with the tides and ebbing of the water.

The Vancouver Convention centre exemplifies how architecture can be used to regenerate a previously highly industrial space, into a social space. The building also tackles ecological principles and sustainable water culture, in order to improve the existing marine ecosystem.

The practical applications examined in these precedents will begin to inform the architectural response explored in Chapter 6. These precedents are tightly related to their respective contexts, taking into consideration economic, ecological and social systems. The contextualising of Durban is required in order to formulate an architectural response which responds to the needs of Durban community and the context of Durban Waterscape.

4.0

CHAPTER 4

CASE STUDY: DURBAN HARBOUR

FIG 4.0. SMALL CRAFT HARBOUR AT DURBAN , ANDREW HARVARD (https://andrewharvardphotography.com/tag/durban-south-africa/page/14/

4.1. Introduction

The aim of this research is to investigate how architecture can contribute to a sustainable and resilient water culture. This was investigated through the lens of developing a sustainable and resilient relationship between people, the built and natural environments and water.

The research further explore how architecture, when confronted with water based environments or “waterscapes”, reacts to and accommodates water in its design, beyond the basic services associated with building design. The investigation considers the qualities which water impart onto a site, specifically the phenomenological aspects and genius loci, as well as the impact these have on the human perception of water and its environment.

The relationship between man and the environment, whether it is natural or urban, is investigated in terms of how architecture can be used to change the perception of water and allow for redefined relationships to be formed between the naturally occurring realm and the evolving urban environment.

The pervious chapter explored how the theoretical concepts established in chapter 2 are applied in architecture. These aspects of design are all linked together to form a system for an environment, where one factor of the system is ultimately linked to the others. The precedents were examined under the lens of resiliency and resilience thinking, in order to foster a sustainable relationship between people and water within an urban environment and ensure a sustainable future for water consumption within the city.

Since the requirements for the contextual investigation must include an interface between water and the urban environment, Durban as a city offers a multitude of opportunities to analyse how the city interacts with the water. For this research, the Durban Harbour were selected as it presents an instance where a highly dense, urban environment interfaces a previously completely natural environment of the bay.

This chapter will firstly investigate the facilities around the water's edge in Durban Harbour. The city's influence on the development of the harbour will follow and thirdly how the harbour's development has impacted the city. The architectural attitude toward water as well as how the city currently interacts with the harbour and the relationship between people and the waterscape will be analysed in terms of adaptation, transformation and resilience.

The discussion will conclude with the significance of the harbour and what it represents for different communities.

Due to the scattered nature of the harbour recreational facilities , an overview of a collection of smaller buildings will be done, where architectural principles outlined in chapter 2 can be interrogated per structure and as a whole for the precinct, where applicable.

FIG 4.1.

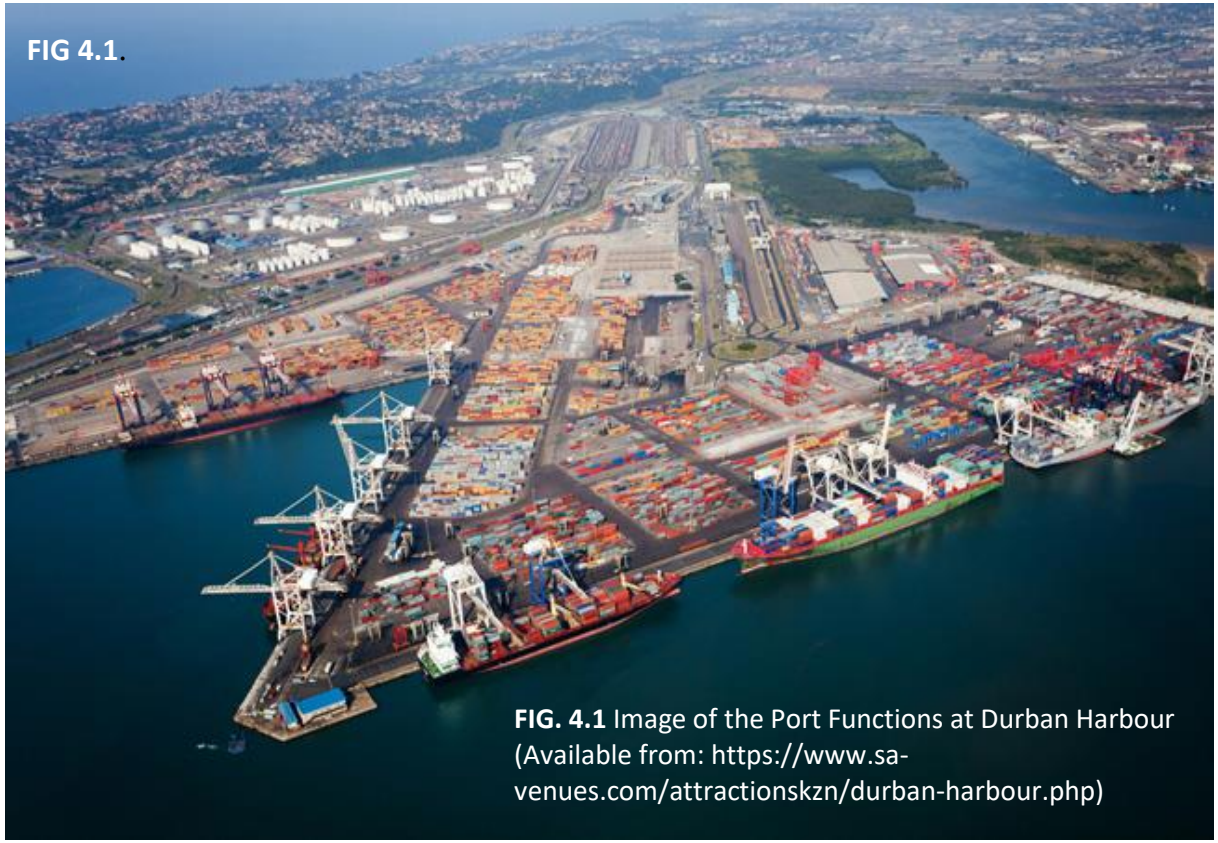


FIG. 4.1 Image of the Port Functions at Durban Harbour (Available from: https://www.sa-venues.com/attractionskzn/durban-harbour.php)

4.2. Justification of Study

"And after all, Durban is an African waterfront city" (Monaco, 2014)

Durban harbour is an important landmark of the city. As a gateway point to Durban, it is often the first interface encountered with Durban. It provides a point where there is an interface of edges between people, the city, nature as well as high economic activity (Monaco,2014).

Dubbed as Africa's busiest port, Durban Harbour is an example of an environment where the man-made environment and needs have dominated over the ecological environment. Being one of the only instances in the world where the central business district is only a block away from the harbour, Durban offers a unique scenario where natural, urban and industrial zones transition over a very small physical space. The connections between these various aspects are condensed and intensified into a highly charge but underutilized space, which is always at the forefront of Durban.

Economically, Durban Harbour and the port offers (see FIG. 4.1) great significance in its contribution to the functioning of the city (Port Summary, Unknown). This emphasis on the industrial functioning of the harbour has, however, resulted in the decline of natural resources, resulting in a highly vulnerable ecological system and a dominant industrial system (Estuaries of Durban, Department of Environment).

The harbour also provides a variety of other functions, such as residential, recreational facilities and commercial zones, as well as protected ecological sites. These zones will be discussed in depth throughout this chapter, with particular focus on recreational facilities which promote water based activities.

Fig. 4.2 Image of breakwaters at Durban Harbour (Available from: https://blog.l2b.co.za/tag/ngqura/)

4.3. Location

Located on the east coast of South Africa, Durban, Durban Harbour offers an important stop in terms of imports and exports nationally and internationally.

Handling 31,4 million tons of cargo per year, the Port is a highly functional zone. Due to this, it is also a blend of industrial, commercial and social zones. With strict and limited public access, the harbour has become largely detached from the city of Durban. (Port of Durban, 2008).

Bound by the city on the northern and western edge, the ocean on the eastern edge and the Bluff on the south, the Durban Port is juxtaposed between very different environments and pressures.

Figure 4.3 on the next page outlines the harbour within the greater Durban Metro area. Surrounding neighbourhoods and areas are also highlighted to show the mix of urban grains which surroundings the harbour and the various potential communities which could be affected by reconnecting the harbour to surrounding communities.

FIG.4.3

FIG. 4.3 Durban Metro indicating the harbour and surrounding areas.
By Author

Main Features

The Harbour was originally a shallow lagoon with a mix of salt water from the Indian Ocean and fresh water from river mouths. The area is therefore classified as an estuary, with one of the rarest instances of an estuarine bay and bio-diversities in the country.

The total area is 1854 hectares, including water area, and is protected by breakwaters on the north and south sides of the harbour entrance.

The harbour is significantly deeper than it is naturally supposed to be. Dredging has consistently taken place over the past 60 years to ensure adequate depth and is maintained for the movement and docking of ships (McDonald, *et al,* 2008).

Functions of the Port

The harbour was initially intended for imports from the British colony, but over the years has adapted to accommodate largely exports out of South Africa.

It is surrounded by 302km of railway line which link it to various points of the country, allowing for the transportation

FIG. 4.4 Image of Durban Harbour in the 1940's. Edges were still sandy and depths were not dredged yet. Shallowness of the lagoon can be seen. Available at: https://mpoverello.com/category/durban-harbour/

FIG. 4.5 Image of the railway plan extending from the harbour and later expansions of the line. Available at: http://steam-locomotives-south-africa.blogspot.co.za/2009/04/durban-railway-station.html

FIG. 4.6. Durban harbour and surrounding areas.
By Author

The harbour is flanked by a variety of different neighbourhoods and areas, all possessing different characteristics and urban grains.

As seen in figure 4.6, the harbour sits at the edge of the city, despite this, it is central to Durban as a whole, as it borders many different areas, ranging from recreation, to residential and industrial and commercial. With the strongest points of connection to land at points where ships berth as well as where cargo is handled, the harbour edges are either largely industrialised or are difficult to access. This is due to high security control measures around imports/exports and to guard the public from the heavy machinery operating on site.

The Northern edges have the most potential and most to gain from being reconnected to the harbour edge. Fringed by the Durban CBD and the Point Waterfront area, the harbour offers significant value in terms of retail value, if the edge is reassessed.

Southern edges are much more dedicated to the Transnet operations, and surrounding communities are often pushes away from the edge. The only source of interaction is part of the Bayhead Natural Heritage Site, which is well established within the Durban South communities as well conservationists, but fairly unknown to the greater Durban population.

FIG.4.7.

FIG. 4.7. Historical Painting of Durban Harbour, 1900.
Available at: http://www.cumberlandscarrow.com/portnatal.htm

4.4. Historical Context

Located on the edge of the city, and being one of the major points of entry to Durban, the Durban Harbour has a rich historical heritage in the development and growth of the City of Durban.

As the first points of contact for European settlers, Durban's urban environment grew from the bay, with surrounding villages settling around the harbour area (Pearson, 1995).

The following maps (figure 4.12-figure 4.14) illustrate the growth of Durban as a city, starting from the harbour and expanding north and eventually west and south of the original Congella settlement.

FIG. 4.8. and 4.9 Image of Windjammers in the Harbour in 1890's and Salisbury Island in 1963 (Available from: https://www.fad.co.za/Resources/industrial/durban.htm)

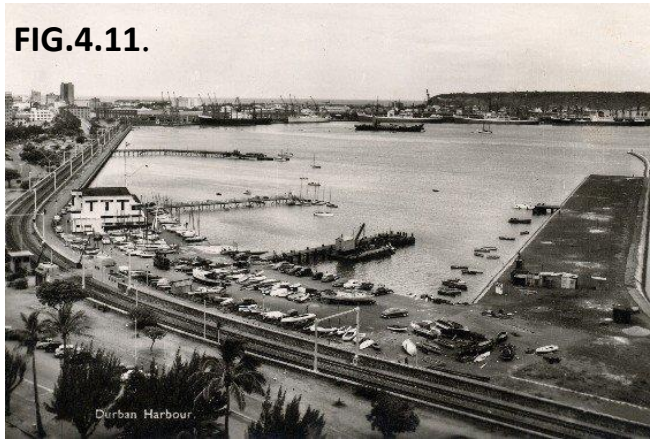


FIG 4.10 and 4.11 Image of Durban Ocean Terminal 1963 and Durban Harbour 1963 (Available from: https://mpoverello.com/category/durban-harbour/)

The first settlers, who arrived via the Durban Bay, landed at the port in 1849. The first instance of a cargo ship being docked in Durban is in 1852, carrying 15 000 sugar cane tops from Mauritius (Pearson, 1995).

The relationship between the beginnings of the urban environment and the water's edge can be seen in how the harbour serves as a limb from the edge, connecting the development of the town of Natal, to various other parts of the city, as seen in figure 4.12, like the Umgeni area, outer west suburbs like Pinetown, as well as south towards Maydon Wharf (Pearson, 1995).

Map of Durban dated 1823 (Illustrated from LAP, 2015)

Illustrating the natural habitat in Durban before settlements had started to form.

The most noticeable characteristics which have been altered include the canalisation of the Eastern and Western Vlei'e, as well as the length of the eastern vlei, connecting the city to the uMgeni River.

The dense mangrove forests throughout the bay should also be noted as being drastically altered over time. This is due to the development of Port functions for Durban Harbour.

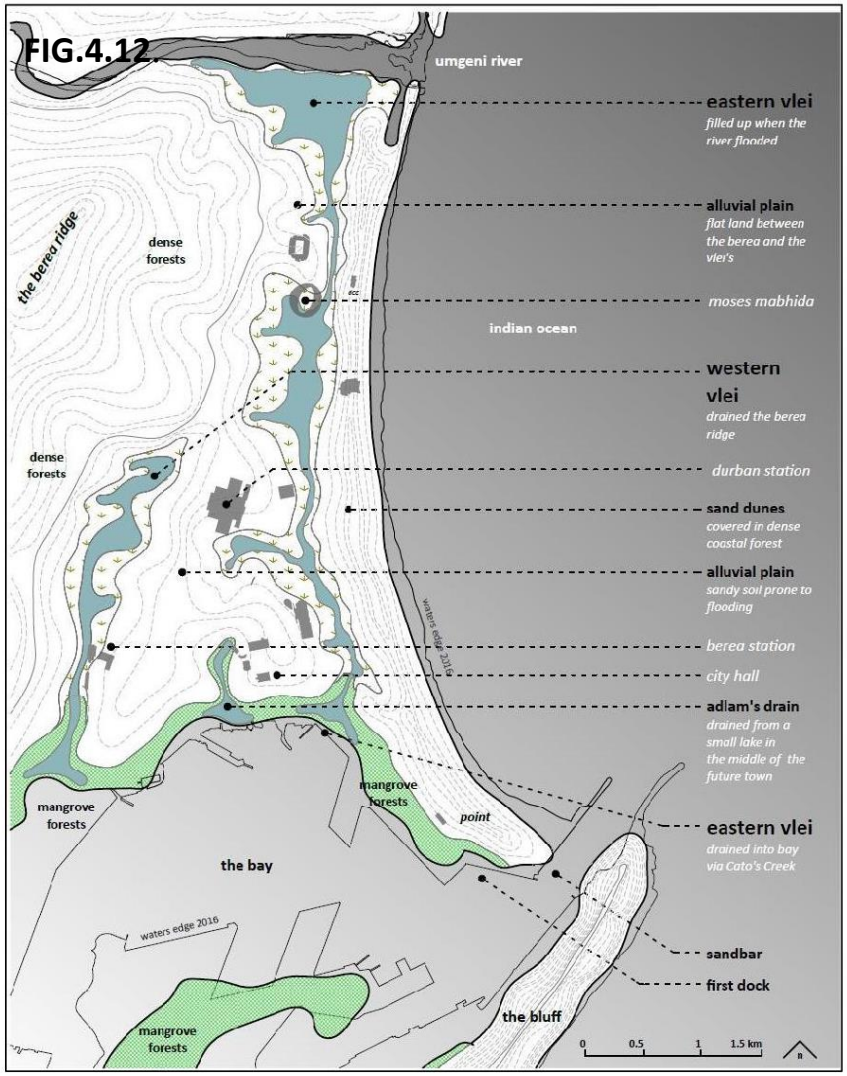


FIG 4.12. LAP Local Area Plan map of Durban in 1823 (LAP,2015)

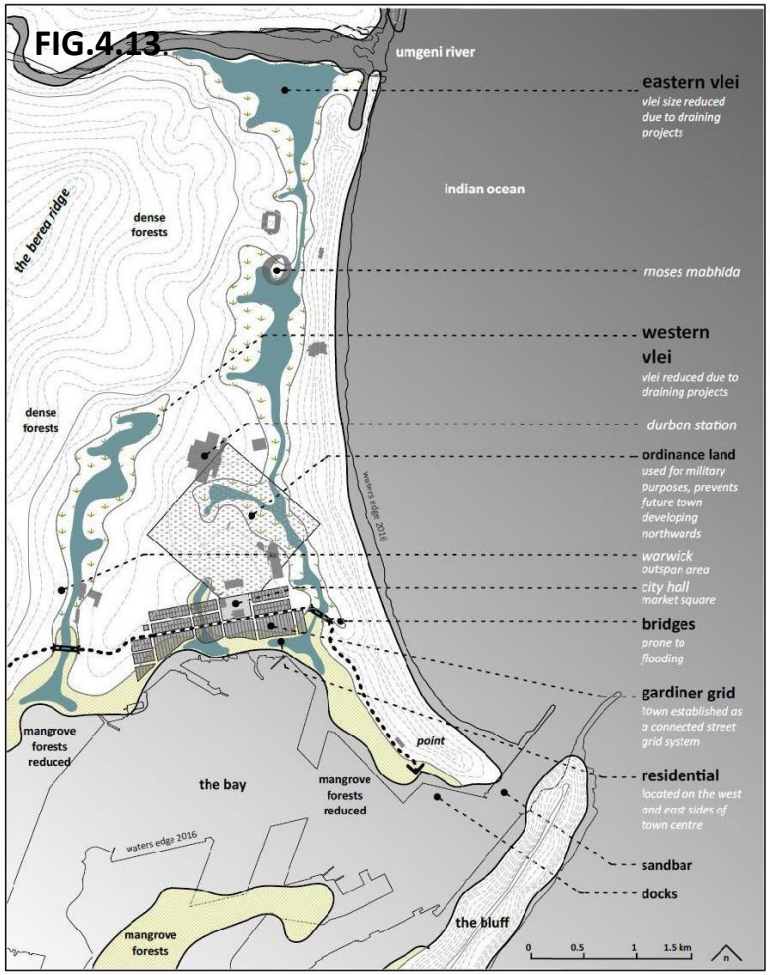


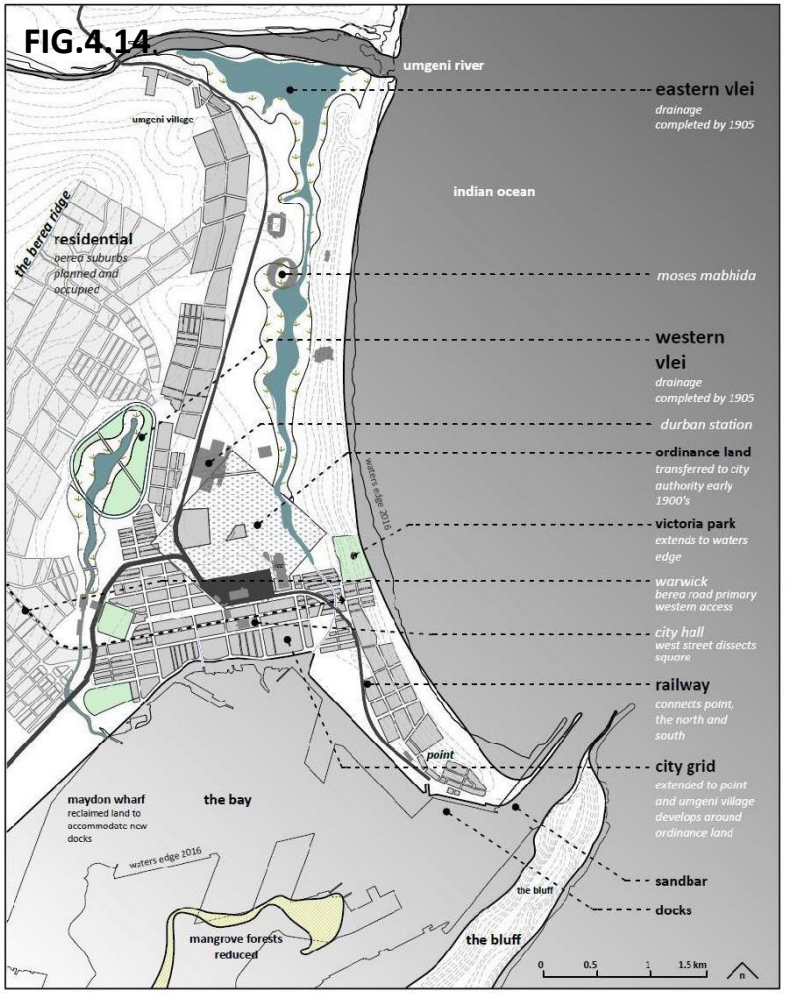
FIG. 4.13 Map of Durban dated 1845
(Illustrated from LAP, 2015)

The development of a city structure can be seen starting from the harbour as a point of growth. The initial city grid can be seen in this layout.

The reduction in size of the mangrove forests must be noted as one of the first instances of ecological control in Durban.

FIG. 4.14 Map of Durban dated 1898
(Illustrated from LAP, 2015)

The development of the city has resulted in the further canalisation of the eastern and western Vlei's. These would start to drain into the harbour, altering the salinity levels of the ecosystem. The size of Salisbury island and the mangroves have also been drastically altered.



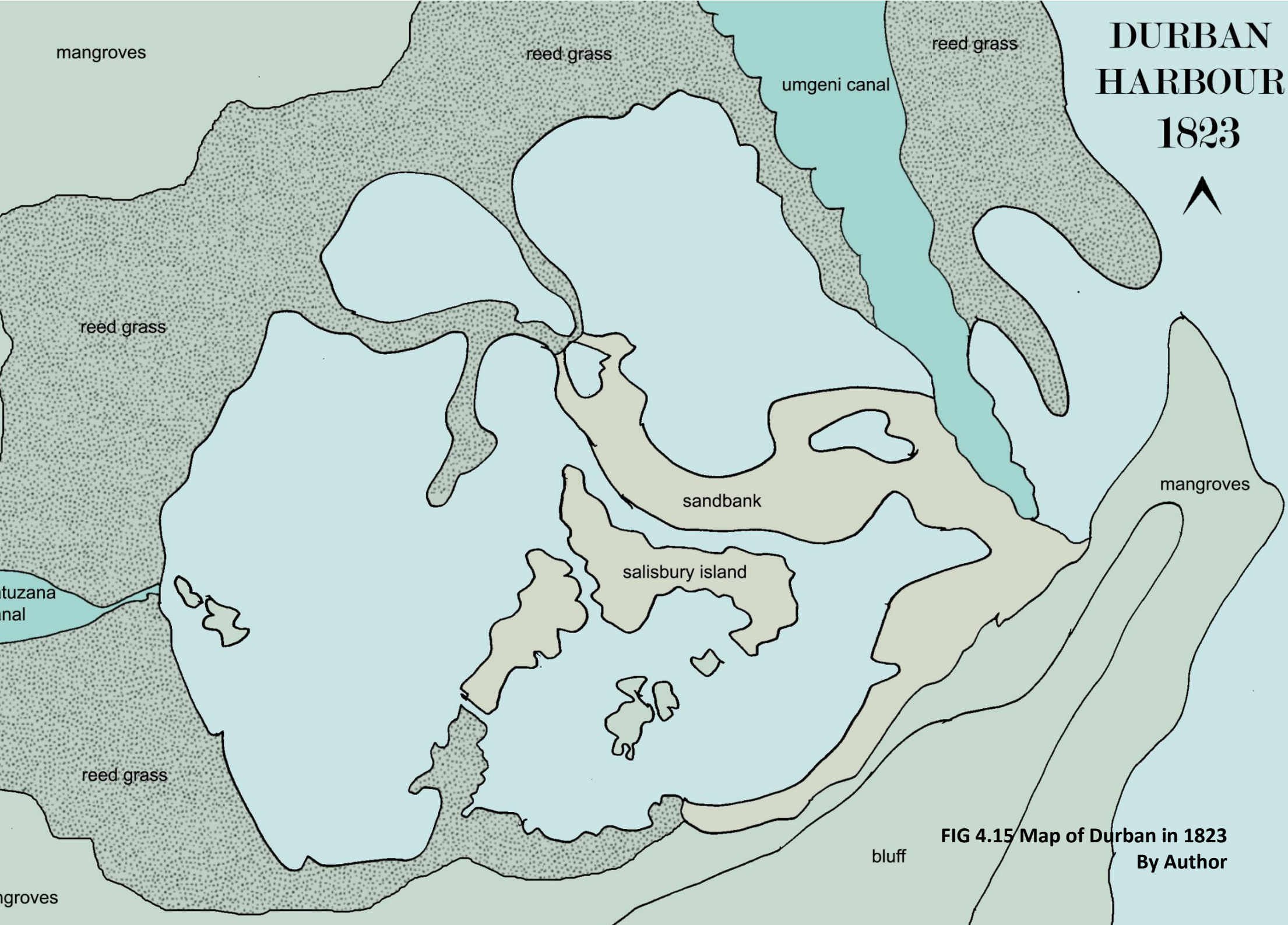


FIG 4.15 Map of Durban in 1823
By Author

Effects of Urbanisation

The following figures, 4.15 -4.18 Graphically illustrates the transformation of Durban Harbour from 1823-2017.

The maps illustrate the size of the water body within the harbour, as well as the progressive addition of hard surfaces and industrial areas to the harbour.

The leaps of development made by the pressure of accommodating the port functions as well as catering to the growing city is reflected in the maps. The growth of the city into what it currently is can be easily tracked. This study provides evidence of how the harbour has become detached from the water's edge as a result of industrialisation.

The largest impact is through areas which have been added to the harbour edge, not spaces which have transformed over time. With the exception of the northern edges, the shape of the harbour has been radically altered through the addition of artificial edges growing predominantly from the south and west of the water's edge. These additions were always industrial and in effect have transformed the entire edge, including the edge along Durban CBD. Due to these additional area being constructed purely or port functions, the aspect of social and ecological integration was not at the forefront or focus of the design.

1823 (Fig. 4.15)

1823 reflects Durban Bay before there were any formal settlements along its edges. It is the most accurate depiction of what the bay was before the influence of urbanisation and man-made elements.

The bay was a shallow estuarine lagoon, with freshwater flowing from the, uMgeni and uMhlatuzana rivers and salt water from the Indian Ocean. The lagoon was large and loosely defined by mangroves along the edge and dense reed beds along the inner edge. High sandbanks with mangrove growth filled most of the interior of the bay, with little space to navigate ships. In 1889, a small settlement began to form along the Northern edge of the bay

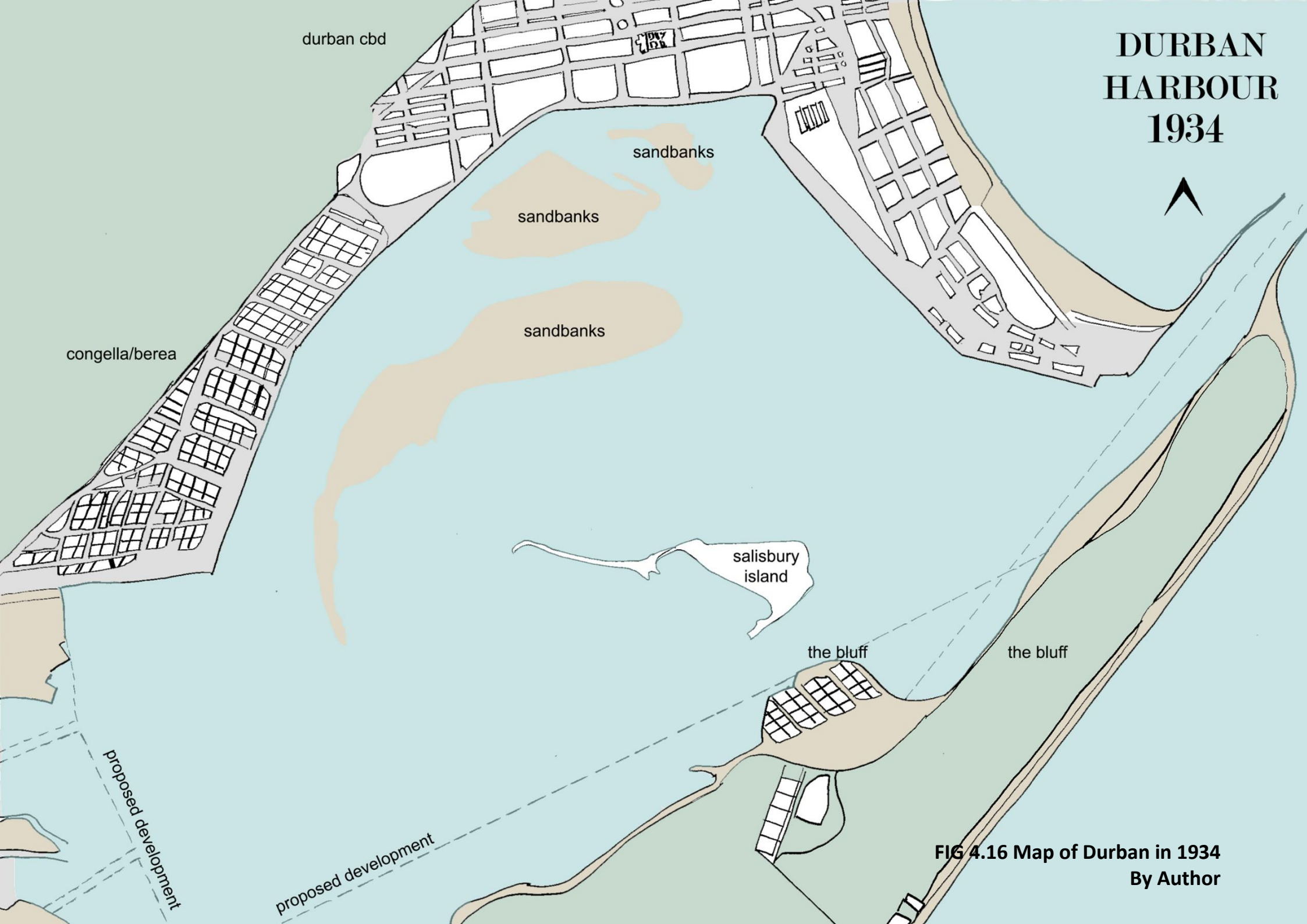


FIG 4.16 Map of Durban in 1934
By Author

1934 (Fig. 4.16)

1934 shows a drastic change in the structure of the bay. Most reed beds have been cleared and mangroves cut back to reveal a formal edge to the bay. Internal sand banks have been sunk due to the beginnings of dredging to accommodate more saltwater into the bay, allowing ships to enter easily. The uMgeni River is canalised and redirected to flow into the northern edge of the bay and the Western Vlei drained (as seen in figure 4.16 above). Settlements have taken root to the north and around to the west of the bay, slowly becoming more formal and structured. The need to accommodate cars will lead to the hardening of surfaces and the beginnings of urban run-off.

During this time, Tram lines would run through Durban CBD in a North-South and East-West direction. This would provide transport to the water's edge, at both the harbour at beachfront, and provided a much more public and meaningful link from the harbour to the city. Trams also allowed quick transport around the city, and postponed the need to hardened surfaces until they were discontinued in 1949, where cars began to dominate the structure of the CBD.

The railway lines, which have now become a barrier to the water since it is used only for the transport of cargo, were used by the public as well to travel to southern parts of Durban, as well as inland, later on.

The industrialisation of Durban was heavily marketed around this time. With the booklet "Industrial Durban: Oppourtunities for Port Natal" released in the early 1930's to attract

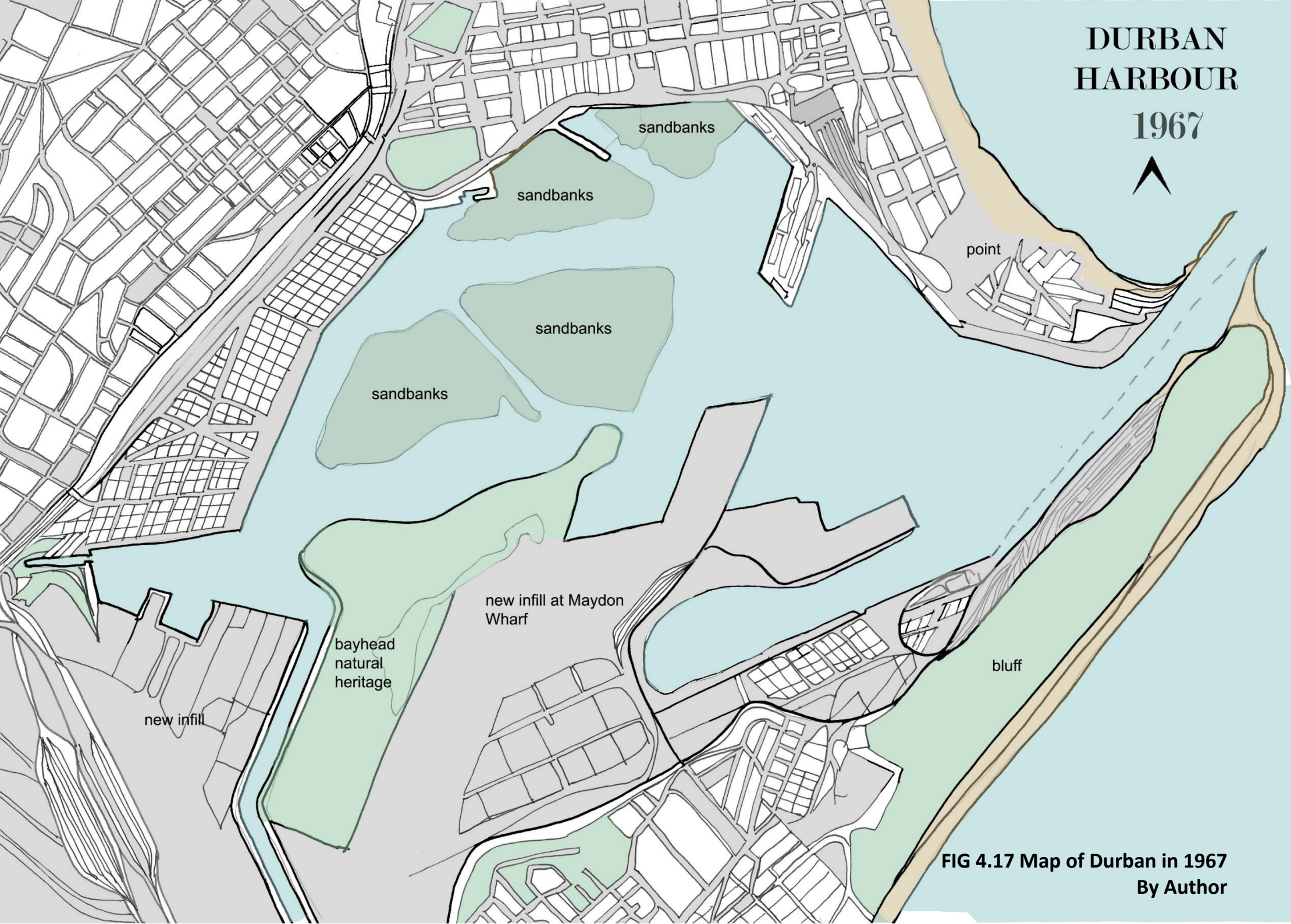


FIG 4.17 Map of Durban in 1967
By Author

1967 (Fig. 4.17)

Urban growth in the city has expanded rapidly to the north, northwest and western areas of the bay. The expansion of Congella/Lower Berea to meet the Durban CBD has entirely enclosed the bay. The introduction of buses and cars has resulted in hard surfaces and increased urban runoff. The majority of vegetation has been removed from the harbour and replaced with industrial areas. The last of the Mangroves, aside from the Bayhead Heritage site, are cleared out around this time and the formalisation of the bay edges occur through concrete platforms to aid shipments in and out of the city.

Dredging has been improved and the bay is much deeper than it originally was, leaving only a few sandbanks visible at low tide.

While the northern edge of the bay shape is similar to 1939, the southern edge has changed to accommodate more ships docking at Maydon wharf.

It is also important to note that during this time period, Durban harbour also had a significant impact on the deep-sea marine life surrounding Natal. Whaling in Durban was a huge industry, started in 1902. Record numbers of whales were brought in via the well populated Indian Ocean. As many as 2200 whales per year were caught by unprecedented whaling efforts (Jackson, 2005). The ecological impact of whaling was felt tremendously as over the 76 year period that whaling was active. Whaling was banned in 1979 due to the almost complete depletion of sperm, fin and sei whales.

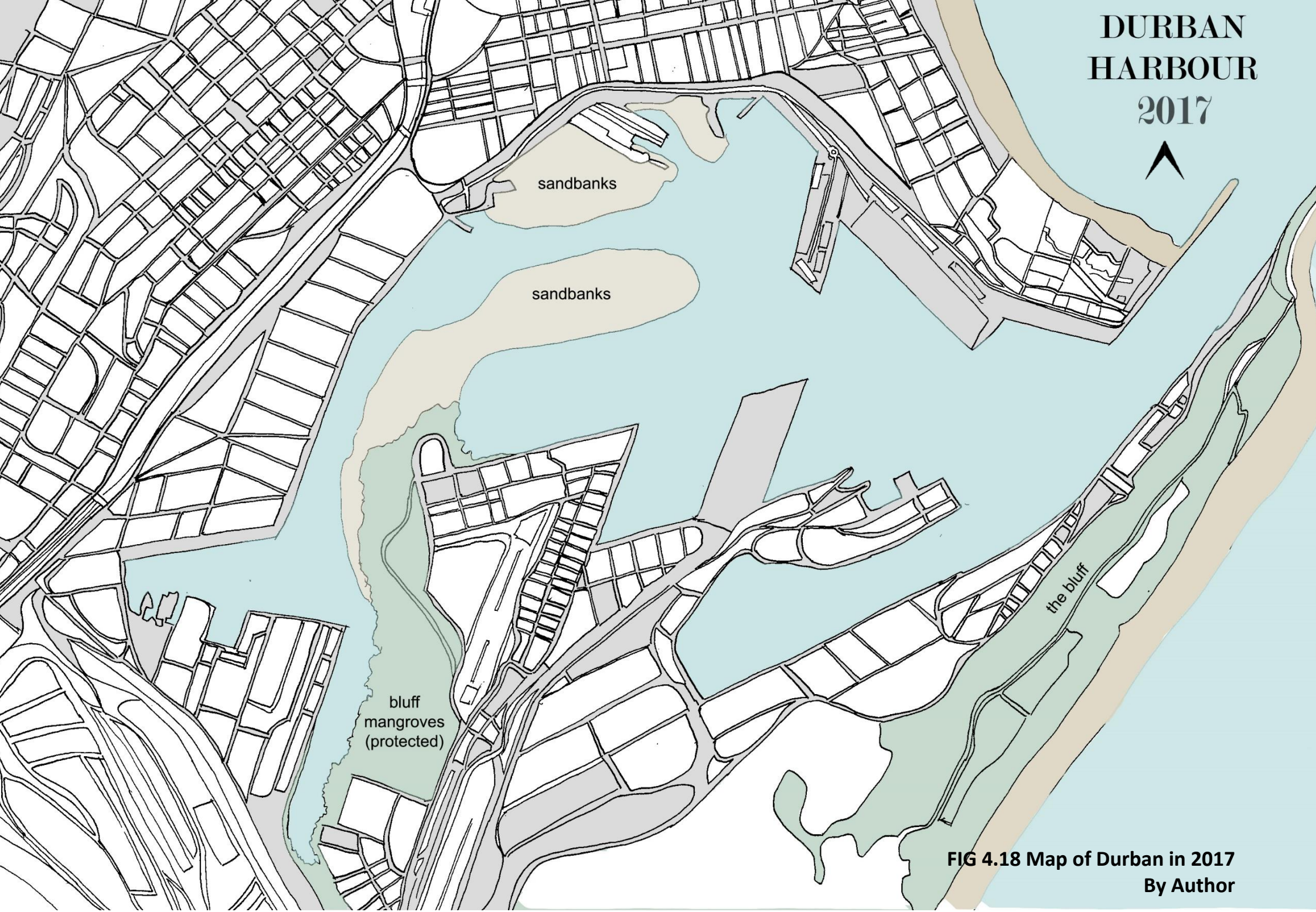


FIG 4.18 Map of Durban in 2017
By Author

2017 (Fig 4.18)

The shape of the bay has transformed even further than what it was in 1967. Now a fully-fledged operating port, the Durban Harbour has little to no evidence of natural ecologies. Highly polluted water from unfiltered urban run-off results in water which is unsafe to interact with. The final stages of expansion from the previous century can be seen in the modification of Maydon Wharf and the Southern edge of the Harbour.

The remaining evidence of nature can be seen at the Bayhead Natural Heritage Site. This is a protected mangrove estuarine area which received freshwater from the uMhlatuzana canal. The highly contaminated silt canal is a part of, but not protected by this heritage site.

The city has fully developed, with expansion of the north, west and south sides occurring around the harbour. The significant development of industrial handling space along the south side has resulted in a completely new edge which has no natural or social opportunities for interaction. The dominance of ownership by Transnet and Port functions within the harbour and especially along the southern edge means there is almost no interaction of the public with the area. This results in the harbour becoming a forgotten space, pushed to the edge of the city.

The city has simultaneously grown from and apart from the harbour by allowing the dominant function of the area to service industrial uses.

FIG 4.19 Map of focus areas for analysis
By Author

4.5. Adaptation

4.5.1. Place on the water

The historical significance of the Durban harbour allows it to inherit a rich cultural heritage and place of importance in Durban City. Bearing architectural evidence of the British settlers, points of heritage, some of which are highlighted on figure 4.19., throughout the precinct are maintained and protected as being some of the oldest instances of western architecture in Durban.

The economic activity, by modern standards, also implies importance of the area within the city as an economic hub. This interaction rarely involves the public as it is dominated and privatised by Transnet/Portnet functions.

While there may be provisions for a few points of interaction with the harbour and water along the edge of the harbour, these points are fairly disjointed, being sprawled out along the edges and independent of each other. While some of the areas examined were designed as recreational space, they often fall short due to their location, context and access. This prevents the harbour from functioning as a space which exemplifies the cultural heritage of the harbour as a public space.

There are few instances where water is integrated into the built environment. The current architecture are mainly facilities which work in conjunction with the water, by accommodating various water sports, providing views and vistas out toward the ocean, but rarely engage with water on a sensory and experiential level.

The following section will address adaptability, more specifically, the question of “how does architecture facilitate a relationship between people and water as a place?” will be addressed.

Key buildings, highlighted on figure 4.19., which are accessible and allow interaction with either public or private entities will be analysed. The opportunity for interaction between people and water as a point of phenomenological experience and genius loci will be examined.

4.5.2. Wilson's Wharf

Situated on the Victoria Embankment, Wilson's Wharf is an established recreation and leisure precinct on the Durban Harbour.

Falling within a larger area of various activities, Wilson's Wharf offers one of the few recreational stops along the water's edge which is consistently engaged with by the public. Figure 4.20 highlights the small craft harbour.

Dotted with restaurants and semiformal traders, the hub is geared mostly towards restaurants and commercial entertainment. The marina offers a chance for visitors to views private boats and yachts docked near the hub and there are also opportunities to hire boat cruises. These do does provide a platform for the people to interact with water. However, these facilities are expensive and are only used by a few. The provided activities do not directly engage the built environment with the water. While there is in an attempt to connect to the harbour on a visual level, there is very little opportunity for the appreciation of water as a social asset.

FIG 4.20 Image of Wilson's wharf and small craft harbour (https://plak.co.za/moreinfo/65550/zacks-wilsons-wharf)

FIG. 4.21 Image of Wilson's wharf restaurants (https://www.sa-venues.com/things-to-do/kwazulunatal/wilsons-wharf/)

4.5.3. Port Natal Maritime Museum

The Port Natal Maritime museum was established to commemorate the influence of maritime culture on the development and success of Durban. Celebrating the busiest port, the museum offers an experience of three exhibits and an exhibition hall. Docked at the harbour edge is the JR Moore tug and minesweeper SAS Durban and suspended on land is the Ulundi tug, as in figure 4.22. All the exhibits are open to the public.

The museum is outdated and handles high volumes, with a limited amount of interaction between architecture and the water. The exhibition hall is totally detached from the exhibits and resembles a temporary prefabricated structure figure 4.23. While there are elements of significance and history within the structure, particularly the stained clerestory windows, which were salvaged from a pub on the point, it contributes very little to the site other than housin tightly organised exhibits. There is a huge need to expand this area in order to accommodate more artefacts which the museum has already acquired. There is little architecture at this point, where the built environment is almost non-existent and falls short of conveying the grandeur and importance of maritime culture within the harbour. Adequate parking space is available, but very little interest, where the museum is quiet, only reaching 20-30 visitors on busy weekends. The museum is not recognised as a destination in its own right, but rather seen as a stop in junction with the Wilson's Wharf area.

FIG. 4.22 Ulundi Tug Boat Image by Author

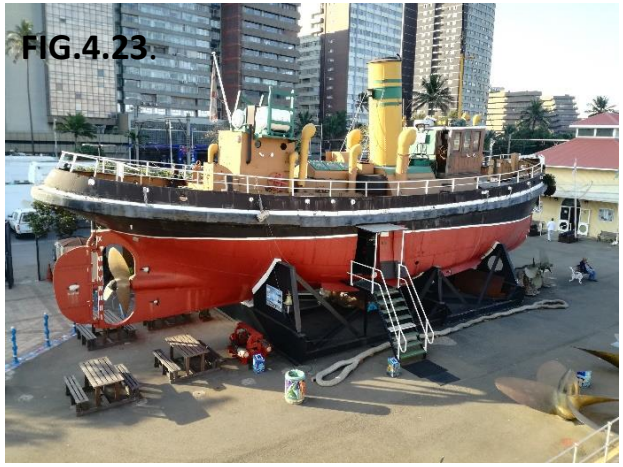


FIG.4.23 Interior Port Natal Maritime Museum (Available at https://www.sa-venues.com/things-to-do/kwazulunatal/natal-maritime-museum/)

4.5.4. BAT Centre

The Bartel Arts Trust Centre is a non-profit organization aiming to provide young artists with a platform to practice their skills and develop their entrepreneurial skills. With particular focus on youth within the area with no access to formal training or education, the centre provides a space where small businesses can be developed and launched. Designed by Paul Mikula in 1995, the centre offers a wide variety of services for everything ranging from visual arts, music to performance and dance. Indicative of the new south Africa, the centre aimed to provide a point of inclusivity in a previously white dominated area, (KZNIA (4), 1996).

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The structure was constructed in 1995, making it one of the newer buildings on the harbour's edge. With a curved metal sheeting roof , as in figure 4.25 and brick and plaster structure, the building relates to the water and harbour architecture in terms of form and materiality. By referencing the fluidity of water, the curved roof provides some point of reference or inspiration from the water. Despite this, the building does retract from the water's edge by putting a vehicular access route, as in figure 4.26, between itself and the water's edge. This disassociation from the water is much like many of the other structures along the harbour.

FIG.4.25 Image of BAT Centre Exterioir
(Available at http://www.durbanet.co.za/bat/batinfo.htm)

FIG4.26 Image of BAT Centre Exterior
By Author

FIG.4.25

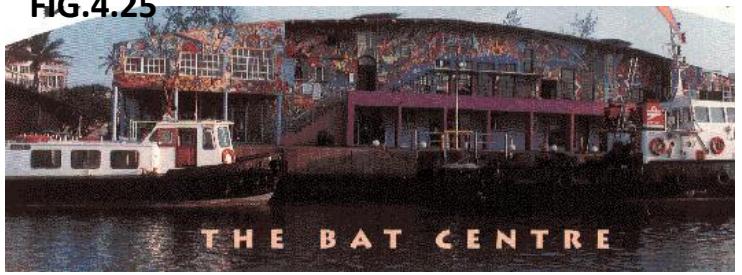


FIG.4.26.

4.5.5. Royal Natal Yacht Club

Built in 1858, the Royal Natal Yacht club is one of the oldest clubs to be formed in the Southern Hemisphere by European Settlers. During the time of early settlers, the yacht club formed part of the few leisure activities available. Since then, it has remained as a point of recreation and leisure for yacht owners.

While the club is fairly accessible, it is not open to the general public, unless by previous arrangement. The building is well established and maintained. Constructed from brick and mortar in a traditional pitched roof structure (figure 4.27), the yacht club is symbolic of the era it was constructed in, where it was made initially of wood and iron. Renovations and additions, namely the curved roof space which attempts to relate the waterscape (figure 4.28), have resulted in the present day building which relates more to its historic origins than the harbour and the water's edge.

FIG. 27 Image of Royal Natal Yacht Club
(Available at: http://rnyc.org.za/venue-hire/)

FIG. 28 Image of Royal Natal Yacht Club from Quay
(Available at: http://www.icoyc.org/images/dynamic/getImage.gif?ID=2345592)

4.5.6. Durban Rowing Club

Soon after the establishment of the Royal Natal Yacht Club, the rowing club was established pre-1911.

Providing both competitive and leisure facilities, the yacht club contributes significantly to the development of the water sport.

The building is however, run down. Constructed from traditional brick and mortar and sheet metal roofing, illustrated in figure 4.29, this small building is used more as a storage facility for boats instead of a gathering place for people at the water's edge. Rowing is a sport which is inherently connected to the water and the current facility does not represent the significance it holds for Durban and the culture of rowing in this city. There is an oppourtunity to provide a building which fully encompasses the sport of rowing, which includes the athletes as well as spectators, and the needs which surround an international sport.

FIG. 4.29Image of Durban Rowing Club
(Available at: https://kznpr.co.za/durban-cbd/nggallery/durban-cbd/durban-harbour/page/2)

4.5.7. T Jetty

T-Jetty forms an integral part of the harbour functioning. The jetty was constructed in 1939, figure 4.32 shows the jetty in 1964, to increase the berthing area of the north-eastern end of the bay. It added a huge 71% more berthing space to the Point Docks (Pearson, 1995).

It would later become the focal point for harbour functions. This is because it provided an extremely important link back into the city, making it the ideal location for the Ocean Terminal building and N-shed Passenger Terminal (Pearson, 1995).

Ocean Terminal Building

The ocean Terminal building is a prime example of modernist architecture within Durban. Designed in 1961 by Janusz Warunkiewicz of MS Zakrzewski and Partners, the building is indicative of its modernist era (Allan, 2015). Constructed from off shutter concrete, figure 4.29, with a sustainably designed punctuated façade of brise-soleil, the building ventilates and cools itself using cross breezes coming off the ocean (KZNIA, 2014). The building is iconic in its simplistic yet responsive design, figure 4.30. While the scheme may not interact directly with the water, it was intended as an office space, with twelve storeys of usable space, the building was originally intended to house Port Captain and Controls offices, the building is now occupied by Transnet/Portnet offices.

Intentionally designed to encompass the public function of the site, the terminal building was designed in layers, where lower levels were dedicated to cargo handling and storage, and the third level, accessible via an elevated roadway, was intended to be accessible to the public. The dominance of vehicular movement through the site due to an increase in cargo handling meant that the elevated road, used as a pedestrian access path, was no longer safe to use and slowly, the space became less public, to be point of it being dominated by purely harbour functions (Richards, 1963: 196).

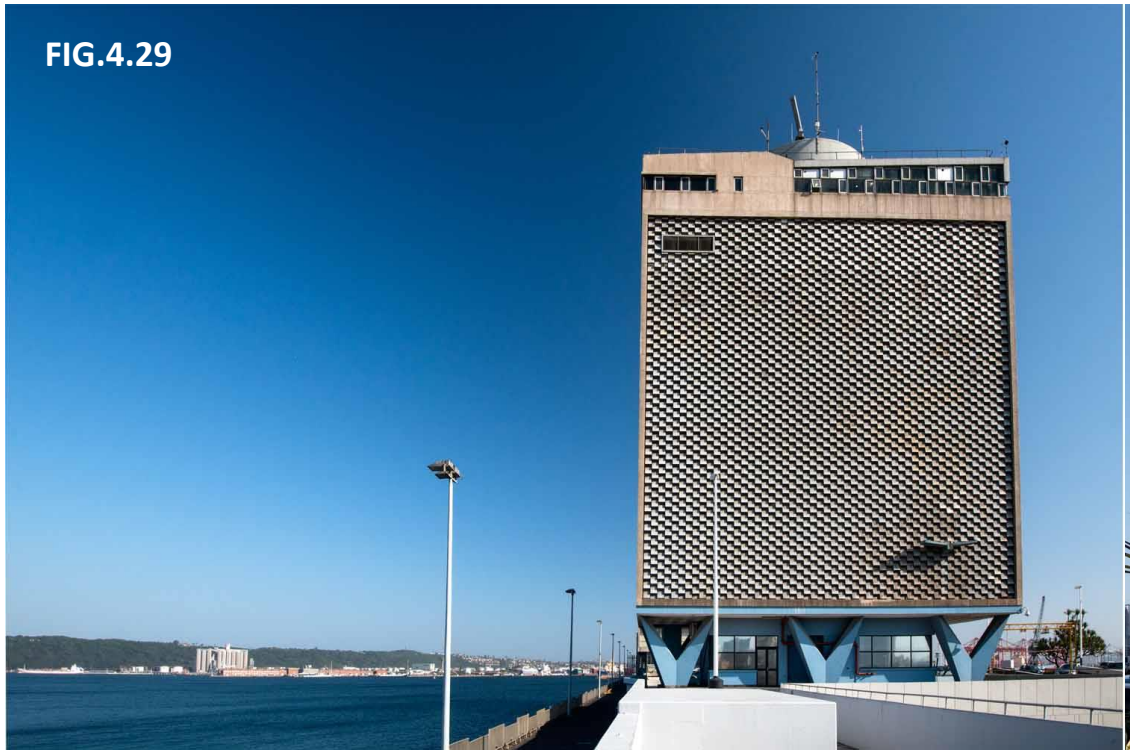


FIG.4.29 Original Ocean Terminal Building designed in 1961 North Elevation with punctured brise-soleil
Available at: http://www.kznia.org.za/durban-city-guide/modernism/ocean-terminal-t-jetty

FIG. 4.30 Ocean Terminal Building North Elevation of newer addition with punctured brise-soleil referencing the older building
Available at: http://www.kznia.org.za/durban-city-guide/modernism/ocean-terminal-t-jetty

N-Shed

The most public aspect of T-Jetty was the passenger terminal building. Having a strong link into the city via Stalwart Simelane Street (then Stanger Street), the terminal had a strong connection back into the city.

With the dominance of vehicular movement, this area was also cut off from the city, as the whole of T-Jetty was. N-Shed, originally intended as a make-shift structure, as seen in 4.31, still exists as a passenger terminal. Struggling to accommodate its functions in the 21st Century, the building is in great need to refurbishment. It was announced in May 2017, that a redesign of the passenger terminal has been put into motion (Cole, 2017).

N-Shed also responds poorly to the water's edge. Surrounded by hard surfaces, the building does not acknowledge the surrounding waterscape architecturally, with limited ventilation and views from the building. It is a highly utilitarian space and provides great opportunity to have a meaningful connection to the water via an architectural response.

FIG. 4.32 Durban's T-Jetty from Above. Available at: http://ports.co.za/news/article_2009_01_21_1034.html

FIG. 4.31 N-Shed at T-Jetty Available at: http://www.panoramio.com/photo/64658990

4.5.8. Architectural Adaptation to Water

The majority of the buildings in and around the harbour precinct are heritage buildings. Since the harbour was the first point of contact for settlers, a large portion of buildings constructed in the area hold a great historical significance. These buildings are also contextual to a different era of Durban, where they were constructed for robustness and dictated by colonial and modernist influences rather than to relate to their context.

The available technologies of the era they were constructed of, as well as architectural references, lends itself to use more traditional colonial architecture as a reference.

As a result, the materiality of the yacht club and the rowing club refer to these techniques and materials more strongly than the BAT Centre and Wilson's wharf, which are relatively recent constructions. The use of metal roof sheeting is a common element through all the buildings, and is suggesting of the maritime and industrial influence of ships on the general aesthetic of the harbour during the mid-1900's.

As mentioned, the BAT Centre and Wilson's Wharf are comparatively much more recently constructed buildings, and therefore pays more attention to the materiality of the harbour, as well as allowing more visual interaction and connection to the water. These are achieved through proper framing of views and strategically placed windows and vistas. Although they are more recent structures, none of the buildings take into consideration the presence of water further than a visual connection.

The historical reference of the yacht and rowing club influence them to resemble traditional western architecture of the late 1800's when they were constructed.

The buildings are rectilinear, formal and are not oriented toward the water, let alone adapt its form to interact with it.

Despite this, the buildings are heritage buildings and hold historical value within the harbour precinct and should not be modified to look different, but perhaps respond better to future climatic threats.

The BAT Centre is the only building which responds in terms of form the harbour. Its curved roof relates back to the water somewhat, and although the building is still traditional, the outdoor deck provides an external link to the water's edge.

None of the current buildings along the esplanade are adapted to respond to being in a waterscape. There are no measures for sea level rise, flooding or direct point of interaction between the architecture and the water or natural environments.

4.5.9. Response to Genius Loci

Due to the scattered nature of the buildings, recreation within the harbour is disjointed and segmented according to function. With the exception of the BAT Centre and Maritime Museum, the functions are spread out and unrelated to each other architecturally or functionally, and operate as independent entities rather than a functioning whole.

While this may work in terms of an economic strategy, the distance between the structures and inaccessible land between them makes it difficult to form a holistic sense of place for the esplanade which the public can access. The strongest sense of place and community centres around Wilson's Wharf, which is mostly due to the various restaurants and semiformal traders in the area.

4.6. Transformation

Bridging the ecological and urban environments

4.6.1. Social and ecological systems in the harbour

The information in the following sections were obtained via interviews with people involved with both the ecological conservation of the harbour, at eThekwini Department of Biodiversity Planning, as well as with the functioning and success of the Port at Transnet. It also includes information obtained from reports drafted by the city as well as by Transnet which reflect both the ecological and industrial needs of the harbour.

The ecological condition of the harbour is severely neglected. The importance of port operations takes precedent over the conservation and protection of both marine and land ecology, the deterioration of the natural habitat in and around the harbour has taken a severe knock over time.

The urban development around the harbour and buildings sited within the precinct also do not respond to the original ecology in any way, with no sustainable technologies implemented in the infrastructure. The majority of the buildings in the precinct were constructed between the 1900's and 1980's, where the main objective was creating infrastructure and utilitarian buildings. As a result, the architectural language around the harbour does not respond to context, nor the climatic and ecological health of the area.

The built environment is intimately involved with the natural environment and even more so within the harbour precinct, as discussed in chapter 2. The impact of the man-made has a direct effect on the natural and affects the entire system if not treated sensitively.

The socio-economic benefits of the ecological health of the harbour is outlined in the Durban Bay Estuarine Management Plan (Allen, *et al,* 2013). In this document, the commodification of Durban Bay is examined. The document examines the interdependence of ecological and pot functions. The emphasis is on ecological

goods and services, or what nature has to offer and take away from the successful functioning of the port and the health of the surrounding water.

These ecological goods are defined as being vital to the economic and social success of the harbour, but are subject to deterioration through the mismanagement and abuse of natural assets and habitats.

A “Social Contract” needs to acknowledge, where the interdependencies of the social, ecological and economic environments are all acknowledged and addressed for the long-term benefit of the city.

4.6.2. Ecological Health

The earliest record of an ecological study on the harbour was conducted in 1950, where the ecological state of the harbour was reported to be intact and resilient (Allen, *et al*, 2012).

The harbour used to be a much larger area, where the water occupied 35km2 of the harbour. Now it has been reduced down to 13,5km2 due to land infill and hardening of the edges to form and artificial boundary shape conducive to port functions. The harbour was also an extremely shallow estuarine bay, and only reached a maximum depth of 3m. With the advance of technology and ships becoming bigger and requiring more depth, the harbour has been dredged, since 1960, to a maximum depth of 20m and average depth of 12.5m. This increase in depth has seriously affected the salinity and balance of the estuarine environment (Allen, *et al*, 2012).

Figures 4.33 – 3.35 illustrate the ecosystem of a mangrove forest and the various biodiversity which has been lost.

Where the current harbour offers very little evidence of any biotic or abiotic life, the original harbour was home to vast salt marsh vegetation and seagrass, which have all, except for a protected 5%, completely disappeared. Juvenile fish, prawns and molluscs, which traditionally mature in estuarine conditions have reduced dramatically in terms of fish and been eliminated completely for prawns and

FIG.4.33

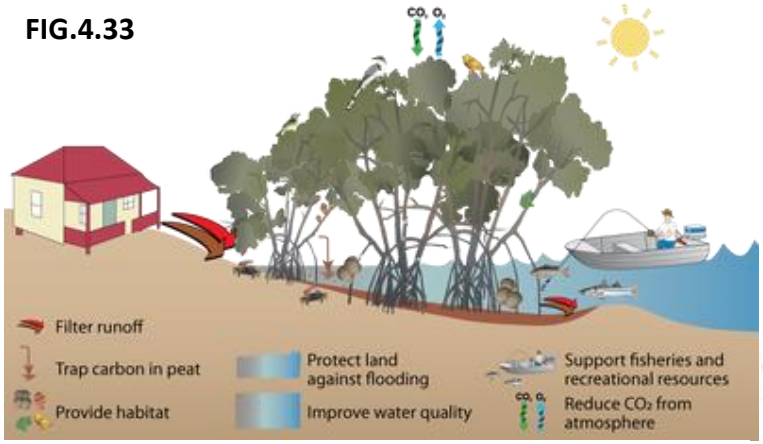


FIG. 4.34 Illustration of Mangrove Ecological Services
(https://www.wetlands.org/Portals/0/Final%20Mangrove%20Capital%20TR1%20management%20regimes%20and%20mangrove%20ES.pdf)

FIG.4.34

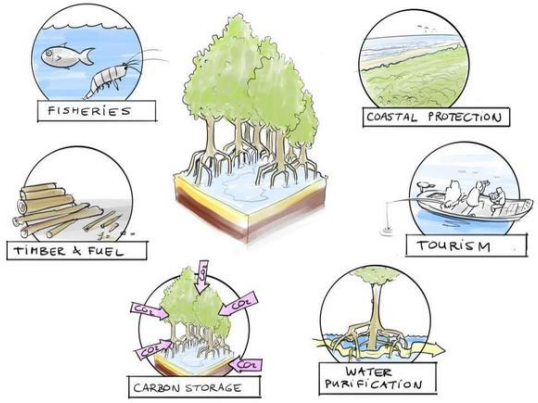


FIG. 4.33 Image of Conceptual Diagram of Mangrove Ecological Services
(Available at: http://ian.umces.edu/imagelibrary/displayimage-search-0-7612.html)

FIG.4.35

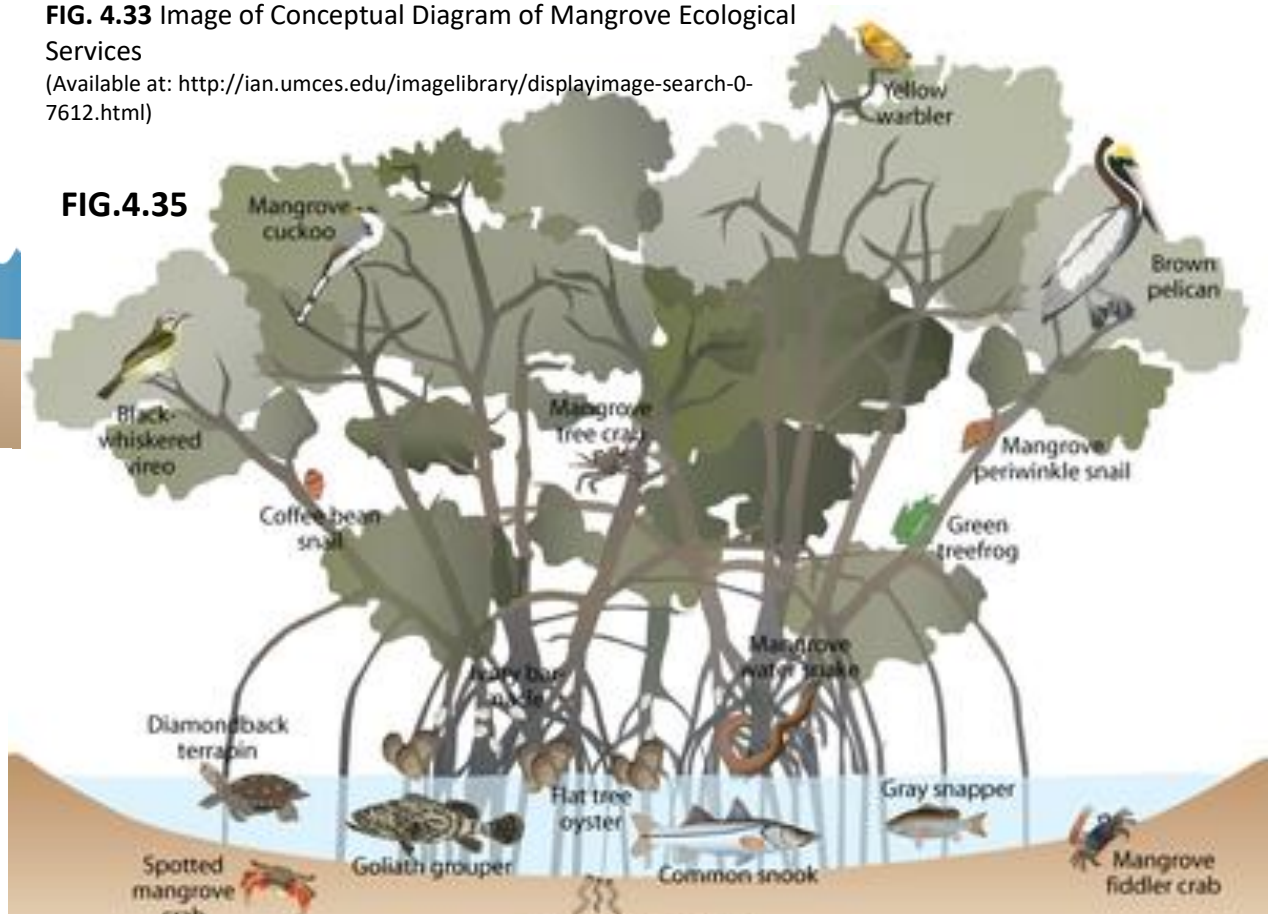


FIG 4.35 Image of Conceptual Diagram of Mangrove Ecological Systems
(Available at: http://ian.umces.edu/imagelibrary/displayimage-search-0-7609.html)

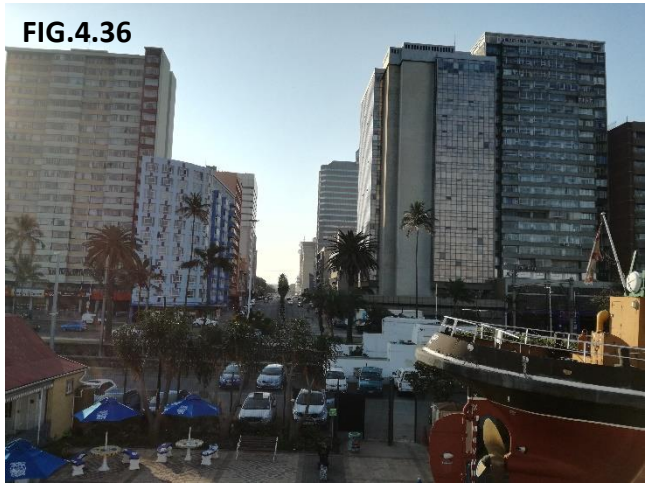
molluscs, due to overfishing and bait harvesting (Allen, *et al*, 2012).

As a result, the current ecological state of Durban Bay is highly vulnerable and has lost all resilience to human impact.

4.6.3. Impact of Urbanisation

The developments and success of Durban city can be attributed to the harbour and exemplifies the interdependent growth of the port and the city. Virtually the entire bay has been urbanised into a highly modified environment which is not conducive to the survival of natural ecosystems.

The presence of hard surfaces, figure 4.36 and 4.37 has also contributed to an increased amount of urban run-off. This run-off is unfiltered and flows directly into the bay, and more specifically, this site. As a result, the bay is highly contaminated with leeched chemicals and oils from the city. This is the primary cause of pollution in the harbour.(refer) Urban environments are traditionally hydrophobic as discussed by Ashraf (2017) in chapter 2. Much of Durban is historically a wetland. The draining of the eastern and western vleis illustrated in Figure 4.36 and 4.37 is also indicative of the canalisation of water and destruction of habitat.



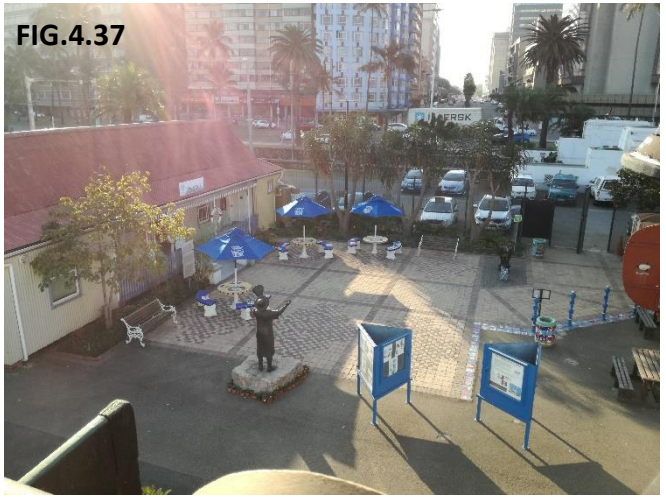


FIG 4.36 Image of the city adjacent to the harbour
Image by Author

FIG 4.37 Image of the hard surfaces which interact with the water and pollute run-off

The Estuarine Management Plan (Allen *et al,* 2012) outlines the influences of urbanisation in the following ways:

1. Infrastructure

Infrastructure which enables urban run-off to be drained into the bay is necessary for the functioning of the city. However, the ecological repercussions of excessive, contaminated freshwater entering the bay has resulted in the imbalance of nutrients results in low oxygen levels in the water, affecting biotic systems in the bay.

This can be counteracted by the introduction of estuarine vegetation, which acts as a filter for contamination, reducing the amount of nitrates and overloading of nutrients in the bay.

The hardened surfaces and roads which surround the bay cannot be altered and are considered an irreversible impact. The further creation of hardened surfaces and reduction of the water area can benefit the ecological recovery of the harbour.

The reintroduction of this vegetation will also provide buffers from storms and rising sea levels.

2. Irresponsible Land Use

The irresponsible land use in and around the harbour has resulted in the badly managed vegetation and abuse of natural resources. Rezoning and closer examination of the various land uses will address this issue.

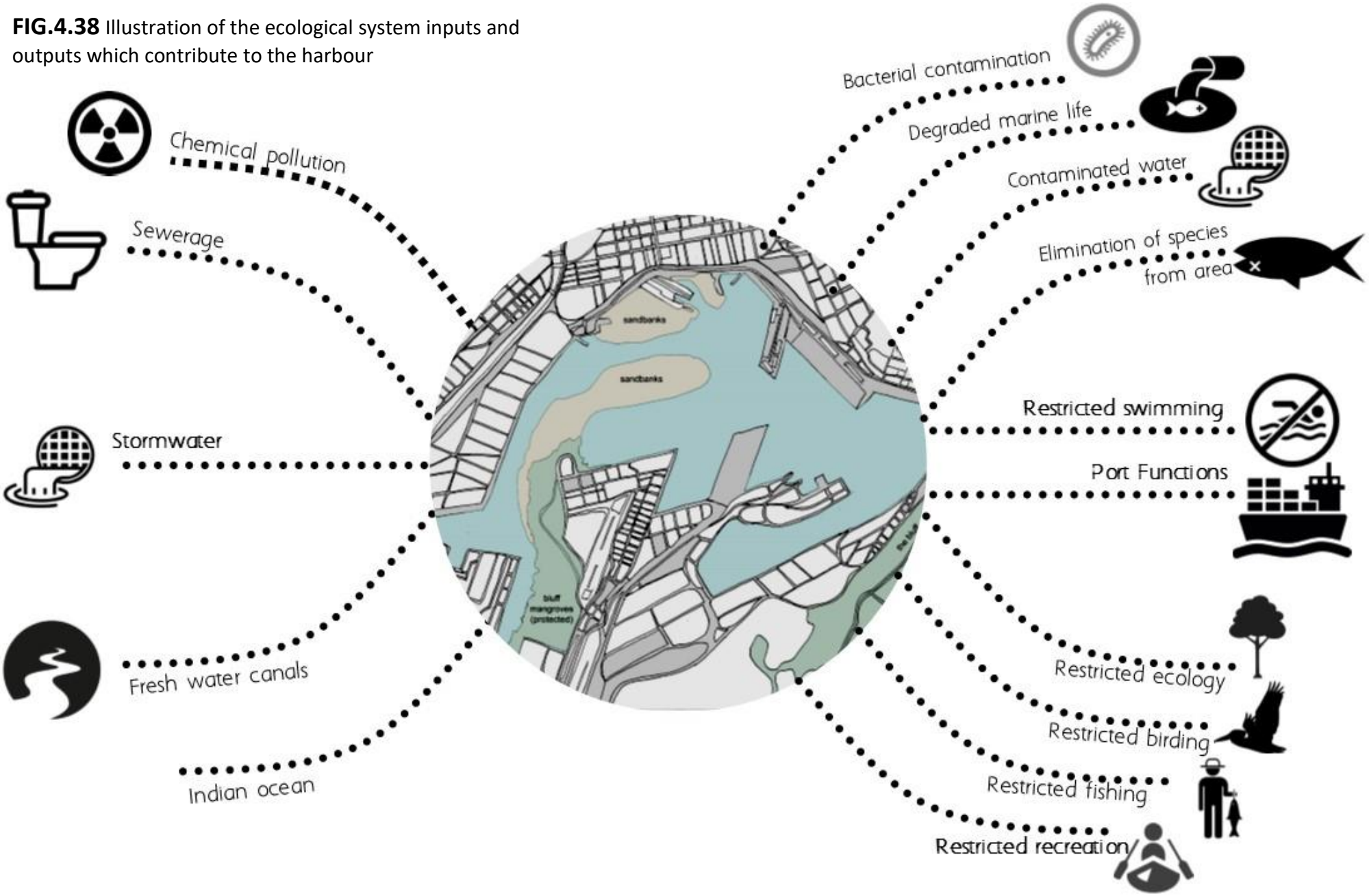
3. Water Quantity

The amount of urban runoff and increase in water in the harbour due to dredging has affected the natural habitats of the harbour. Where urban runoff encourages the growth of alien vegetation along the feeder canals, increased depths reduce the area of shallow water where indigenous vegetation can be grown.

4. Water Quality

Considered unfit for human contact, the water quality of the harbour is constantly altered due to the large number of ships which pass through the bay daily, spilling oil and carbonising the water.

FIG.4.38 Illustration of the ecological system inputs and outputs which contribute to the harbour



Reed beds and natural estuarine vegetation is no longer resilient enough to filter the contaminant, resulting in low levels of water quality. While efforts are made by Transnet to control any chemical contamination from the ship and port functions via surface skimming of oil and contaminated wastewater treatment, there is inevitably some chemical contamination coming from the highly industrial zone.

There are regular clean ups of plastic waste by the eThekwini municipality in an effort to create employment within the area. The main contributor to the contaminated water at the harbour and especially along the edge, is due to polluted urban run-off which is untreated and flows directly into water sources surrounding, via canals, or the harbour itself. The constant flushing out of the city into the bay needs to be addressed in order to properly solve the issue of contaminated water.

4.6.4. Opportunities for Ecological Infrastructure.

There are currently no examples of ecologically responsive architecture within the harbour precinct. While there are mitigations for oil spills through surface filtering tug boats, Plastic pollution clean-ups and water quality monitoring, the effort to conserve natural ecology within the harbour is deficient.

The role of architecture in addressing the ecological needs within the urban-

FIG.4.39

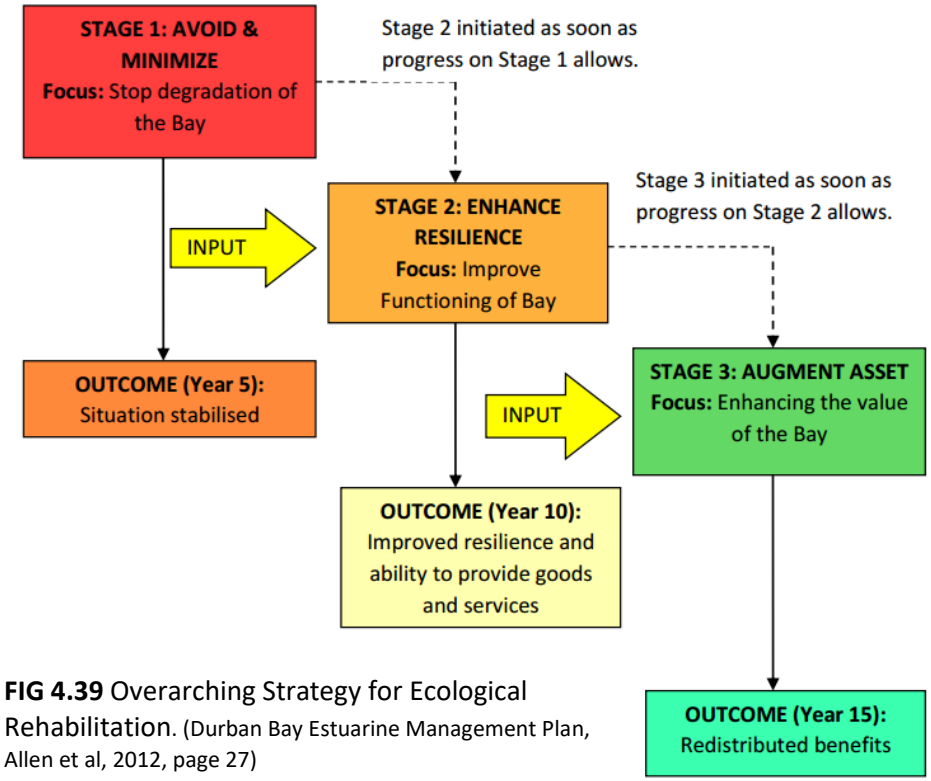


FIG 4.39 Overarching Strategy for Ecological Rehabilitation. (Durban Bay Estuarine Management Plan, Allen et al, 2012, page 27)

ecological environment needs to be examined in terms of how nature and manmade structures can work together to tackle issues which have degraded the harbour thus far. The EMP offers a systems based approach of inputs and outputs (Figure 4.39) to tackle the ecological degradation of the bay. This system shows a 15-year plan to tackle both the ecological and social integration of the harbour. Figure 4.40 displays the key problem areas and threats of the harbour, describing which aspects needs to be tackled first.

Stemming from this, the disassociation of people from the harbour also extends from this lack of consideration for natural habitat. The lack of agency and ownership within the space, as previously stated in chapter 2 as being vital for ecological design, has resulted in the harbour becoming the "backwaters" of Durban.

As mentioned in chapter 2, the health of a waterscape is often determined by smell/taste (Helmrich, 2012). If the harbour resembles water in the context of

FIG 4.40 Major Threats to Durban Bay Ecology. (Estuaries of Durban, Forbes and Demetriades, et al, 2008, page 86)

Anthropogenic threats (ranked in order of importance for SA estuaries)	**Threats**	**Notes** **FIG.4.40**
1. Habitat loss	High	Extensive infilling and canalisation along with water quality issues.
2. Eutrophication	High	
3. Freshwater diversions	Low	Canalised rivers do influence the distribution of flows
4. Sewage	High	Sewage spills, leaks and WWTW inefficiencies have occurred
5. Chemical contamination	High	Industrial basin immediately adjacent to the upper estuary
6. Litter/debris	High	
7. Introduced species	Medium	Alien species have been recorded in the Bay but there is no evidence as yet of impact
8. Sea-level rise	Medium	This could easily escalate to a high risk as retreat or habitat shifts are impossible due to the physical constraints which have been placed on this system and there is therefore no resilience in the system to buffer this threat
9. Overexploitation	Medium	Possibility that this threat is higher than anticipated as there is substantial fishing activity and bait collection in this system

FIG.4.41

Legend

- Public Access Point
- Industrial Use
- Recreational Area
- Conservation Area
- City Interface Zone
- Priority Area for Water Quality Monitoring
- Transnet Jurisdiction

CLIENT	EM, TNPA & DEA
DRAWING TITLE	Estuarine Zonation Plan
DATE	2015-06-19
SCALE	1:25000
DESIGNED BY	NZ
CHECKED BY	SN
DRAWN BY	NZ
CHECKED BY	SN
PAPER SIZE	A3
CONSULTANT / CONTRACTOR DRW. NO.	0115402 Estuarine Zonation Plan

industrialization, the perception of water within the community of Durban is one of exclusion and lack of ownership. While some people depend on the harbour in terms of commercial and retail purposes, and subsistence fishing, very few people are actually willing to interact with the water itself as it is deemed unhealthy. The reintroduction of nature, as a mitigation for the damage of urbanisation offers a point of re-creation for both the social and ecological systems present in the harbour.

Figure 4.41 below displays the Estuarine Management Plan for Durban. This plan illustrates portions of the harbour zoned for specific uses. The implementation of this plan will allow for the impact of urbanisation to be minimised and the ecological health of the river to increase. The proposed site for this research falls within the recreational area zone in the EMP and is a major point for the interface between the city and the harbour.

Along with the EMP for the ecological health of the harbour, the social integration of the city needs to be considered. The social investment as outline in chapter 2 is important for the success of a resilient overall harbour system.

The connection of the harbour to the city as well as between the harbour and the ecological context will allow for the formation of a water culture which is based in sustainability. These connections will help strengthen the system which already exists within the harbour area. By emphasising the right aspects of the harbour, a more balanced system can be accomplished.

ABOVE FIG 4.41 Estuarine Management Plan for Durban Bay. (Durban Bay Estuarine Management Plan, Allen et al, 2012, page 45)

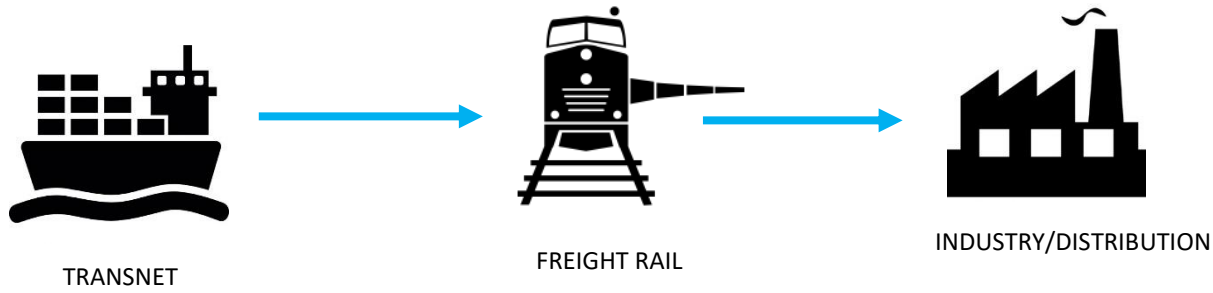
4.7. Resilience

The resilience of the harbour is dependent on the number of linkages and connections it has to its surrounding environments, as discussed in chapter 2 (Folkes et al, 2010). By examining how the harbour links to the greater part of the city, as well as the water's edge, we can determine how resilient the precinct is as a system.

To do this, the various role players, as in involved must be identified and how they link to the workings of the city will give rise to physical and intangible connections that link the harbour to the city.

FIG 4.42 Illustration of current role players at the harbour
By Author

FIG 4.42 ECONOMIC/PORT FUNCTIONS



RECERATIONAL (SOCIAL) FUNCTIONS

TOURISM (SOCIO-ECONOMIC) FUNCTIONS

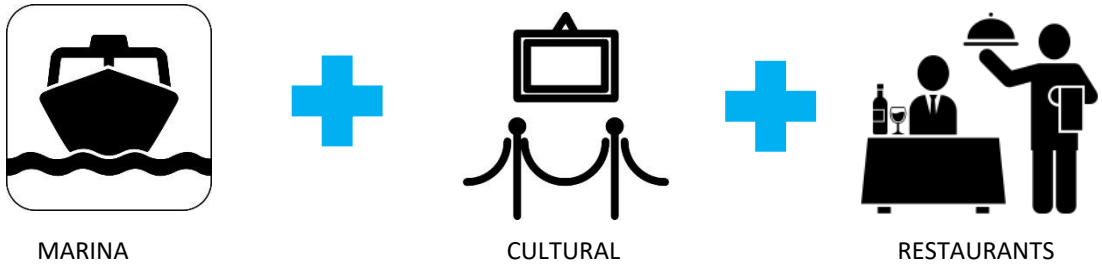
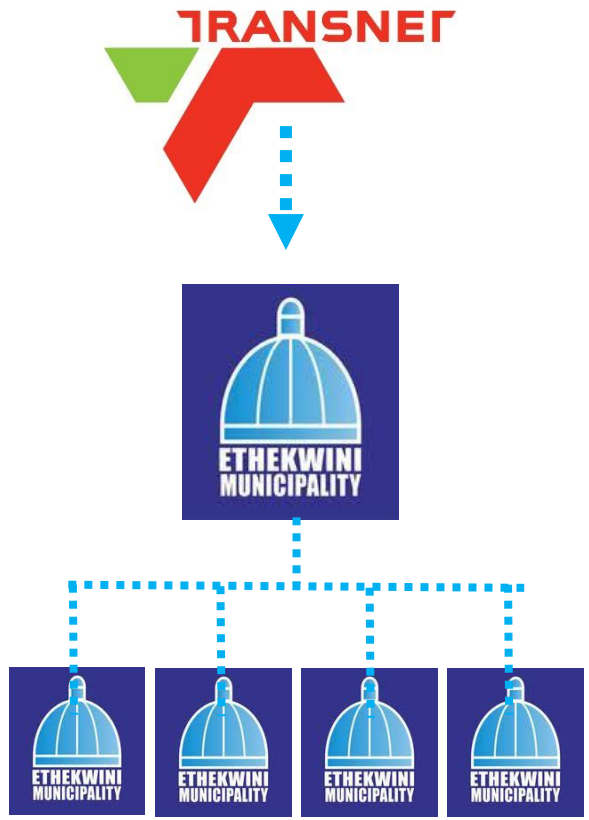


FIG 4.43 Illustration of current hierarchy of control over the harbour
Bv Author

FIG.4.43



4.7.1. Economic

Currently, the most prominent economic role player in the Durban Harbour is the Transnet/Portnet import and export industry. Hauling in over 31.4 million tons of cargo, the Portnet division of Transnet manages the workings of the harbour and owns and controls a large portion of the land usage and leasing. This industry has radically transformed the connection of the esplanade and the interaction with the city and the water's edge. The highly functional zone is largely inaccessible to the public. With only certain points of access open to the public, the harbour becomes a largely privatised space of urban space and natural resources.

While the control and security of ports is important, the systematic closing and barricading of the harbour has resulted in minimising interest and disassociation of the harbour from the population of the city, as well as the urban fabric of Durban. This is largely due to the need to secure the area, both to guard the import and export goods as well as to protect the public from heavy machinery. Significant closures of the north breakwater and T-Jetty, which were integral to the involvement of the public in the harbour, resulted in an extremely closed off edge. With one entrance point, off Margret Mncandi Road, the access to the water's edge is highly controlled and often unaccommodating to visitors. Access is dominated by vehicles,

with little instances of design for pedestrian movement.

The import/export industry also links into the city and inland through the railway line used to distribute goods from the port to other parts of the country. These lines also that act as a barrier to the edge and are highly controlled spaces.

Tourism through cruise ships contribute a large amount economically, but architecturally, the service is not accommodated well, where the temporarily revamped N-Shed has outlasted its makeshift design. As of May 2017, a new proposed passenger terminal has been initiated for Durban to remedy this.

There are smaller supporting economic endeavours also associated with the harbour, namely the recreational activities discussed earlier in this chapter at Wilson's Wharf and the smaller clubs and associations along the esplanade. They are the only points of contact which interact with the city and allow access to the water's edge. However, within themselves, these spaces are largely privatised and are exclusive to members only.

4.7.2. Social

Social role players within the community include the various clubs and associations along the esplanade, educational groups who visit as well as environmental conservationists. The most frequent visitors are people who live and work around the area. The harbour is treated more as a destination stop in the city rather than a functioning part of it, which is regularly visited by people.

Social groups also include fisherman, who do not necessarily belong to any clubs or associations, but have formed social groups situated at different points along the waterfront. Fisherman are either recreational or subsistence fishers.

While there are occasional groups who gather around the harbour area as a meeting point, it is not a public space where the public can gather often.

There is a significant disconnection caused by the lack of development of the Harbour Area. This can be attributed to the lack of

pedestrian and vehicular access, the emphasis of infrastructure through roads and railways and segregation of spaces through the privatisation of land via clubs and Transnet.

4.7.3. Ecological

Ecological systems were discussed in depth earlier in the chapter. Serious disruptions of biotic and abiotic factors have led to the almost complete urbanisation of the waterscape. This mass loss in habitat has resulted in an ecologically vulnerable system which will not be able to absorb future shocks.

4.7.4. Linking the harbour to the city

The harbour is currently a hinge between linking the beach front to the "backwater" of the city (Monaco,2014). The lack of development at the Point waterfront has become a point of discontinuity from the beaches along the east coast to the Durban Harbour. There is a problematic linkage between the primary recreational coastal front of Durban and the highly functional harbour (Monaco, 2014).

Due to this lack of development around the point, which is slowly starting to progress, the harbour has become detached from the promenade, an extremely public space which has become integral to Durban as a city.

The Local Area Plan or LAP (2015) addresses issues of connectivity and access through a series of road networks and development leading up to the water's edge. Since existing infrastructure is considered one of the major barriers in the development of the port, future development needs to respond to allowing access and connectivity from the city to the water's edge (eThekwini Inner city LAP, 2015).

The linking of water is also essential between the beach and the harbour. While water doesn't necessarily need to be connected physically, the continuation of a water culture should be strengthened and carried to the harbour.

This link will provide a closed loop which encloses the city (Monaco: 2014). The continuation of the promenade will provide a constant access to which the water's edge will always be accessible to the public. The LAP (2015) also proposes the removal of the railway line and the redevelopment of the point area through to the sugar mills as a non-industrial zone. The transition of the industrial area to a more human-based space will improve the interconnectedness of the city with the water. The promoting of people movement along the esplanade as opposed to the many barriers of vehicular movement currently present will also aid in reconnecting the city as being intimately connected to the water's edge. The following Figures 4.44 and 4.45 indicate current set up of infrastructural barriers and the proposed LAP plans which promote accessibility and ecology.

FIG 4.44 Plan of the proposed Point
FIG 4.45 Waterfront Development 2016
Both available at:
https://businesstech.co.za/news/business/118933/a-look-at-the-r6-billion-waterfront-project-for-durban/

FIG.4.45

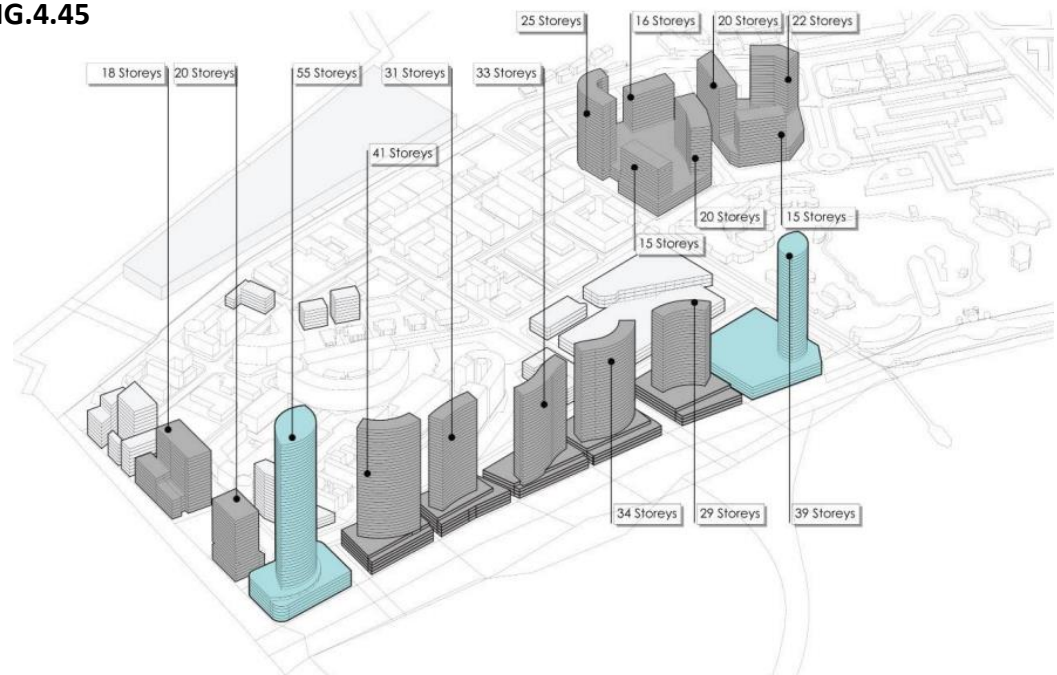


FIG.4.46

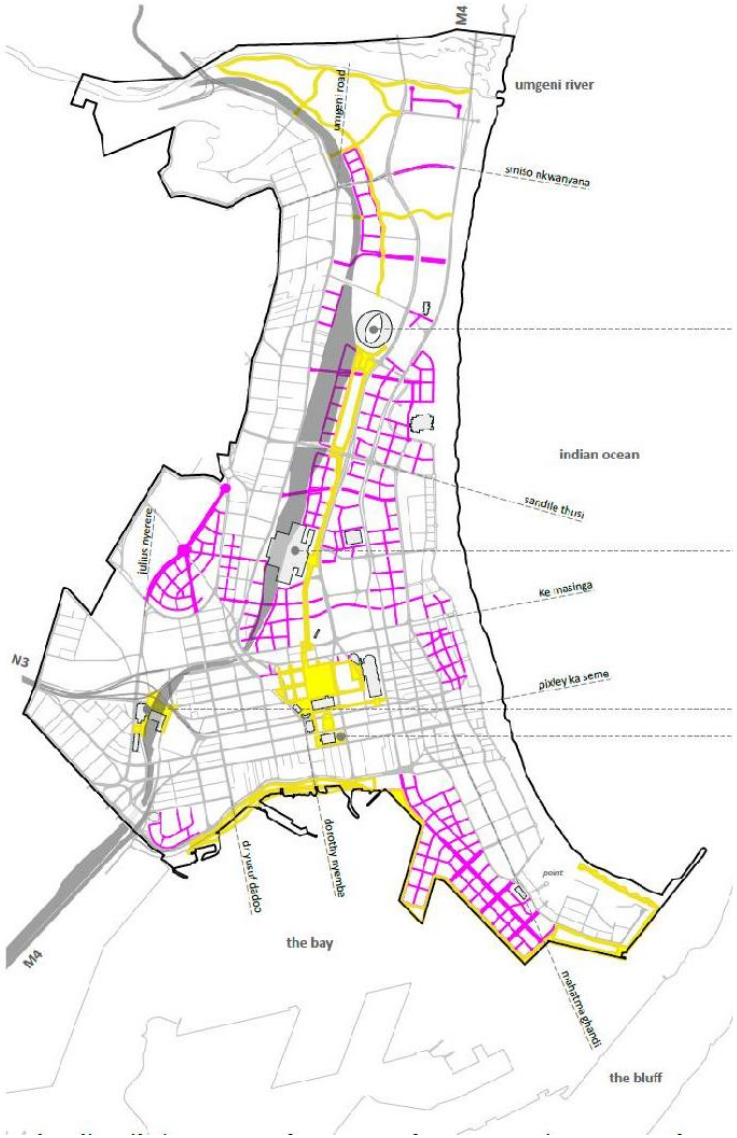


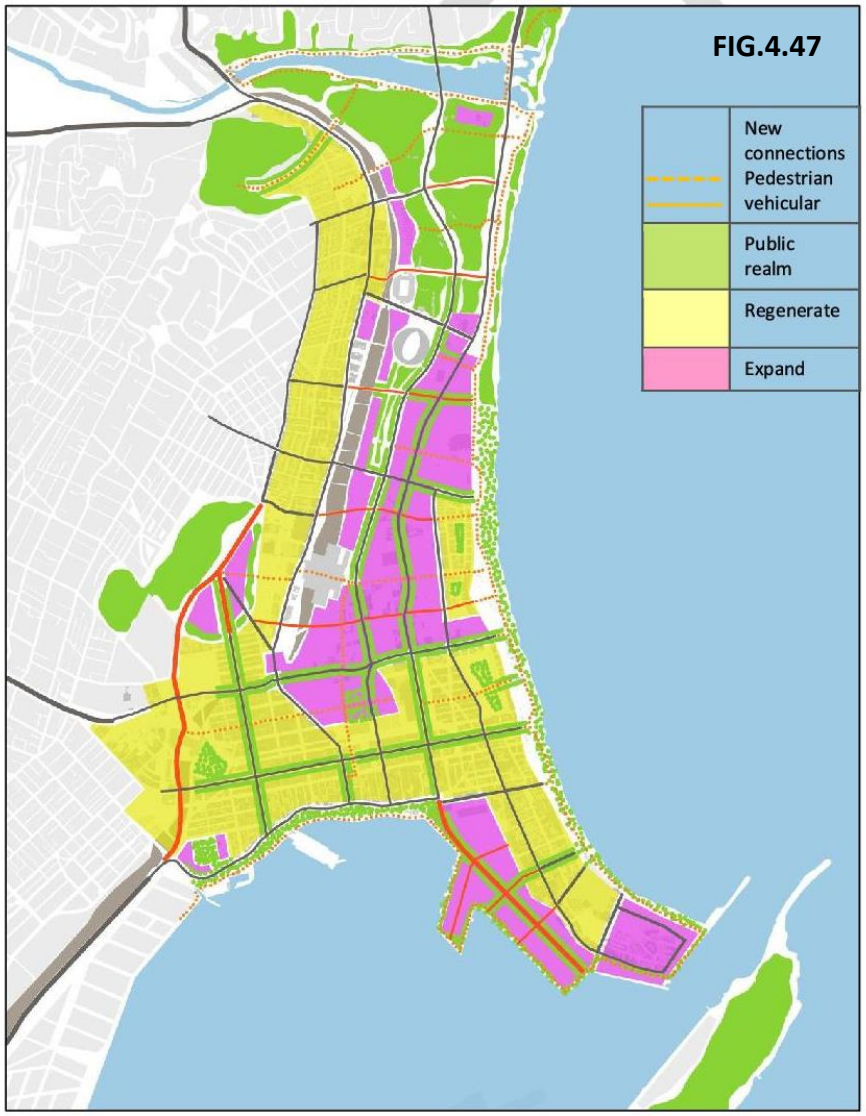
FIG 4.46 and FIG 4.47

LAP Proposed Inner City Zoning Diagram

The proposed new pedestrian development plan indicates which part of the city needs to be regenerated and expanded to allow for better circulation and access to pedestrians. This works in conjunction with the restructuring of roads and designation of pedestrian only spaces as seen in figure xxx

(eThekwini Inner city LAP, 2015, page 81)

FIG.4.47



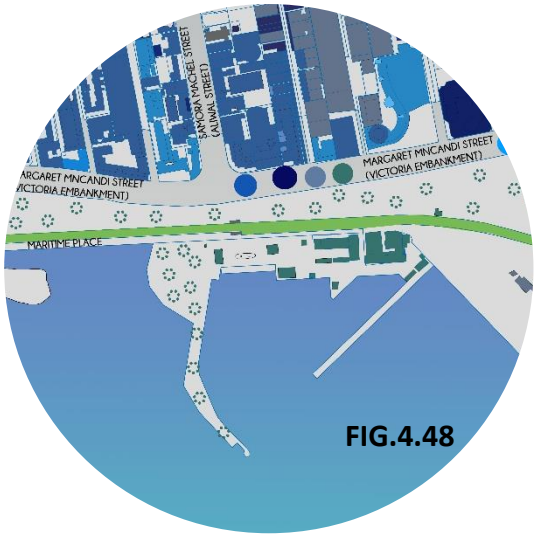


FIG 4.48 Plan of current interface between city and harbour
(By Author)

FIG.4.50

FIG 4.50 Plan and section of current interface between city and harbour indicating a series of barriers and infrastructure (red) separating the harbour from the city
(Illustrations by Author)

FIG 4.49 Plan of LAP proposed interface between city and harbour
(eThekwini Innercity LAP, 2015, page 81)

FIG.4.51

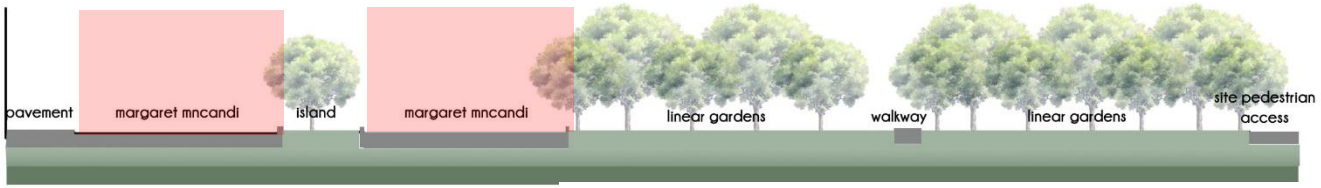


FIG 4.51 Section of current interface between city and harbour where the size and frequency if barriers has been reduced

4.7.5. Gateway to the City/Water

The current infrastructure of the Durban harbour is not conducive to the encouragement of a water culture. There are very few instances of architecture which responds to the waterscape and defines the harbour as having something to offer the city, aside from privatized land dedicated to industrial functions.

The harbour is the first point of contact for a large number of people, arriving on cargo ships and cruise liners, as well as the last point of exit for people. The harbour no longer defines Durban in a way other than providing the economic function of the port and heritage buildings scattered around the area. There is no architectural response which is indicative of an arrival to

FIG.4.52

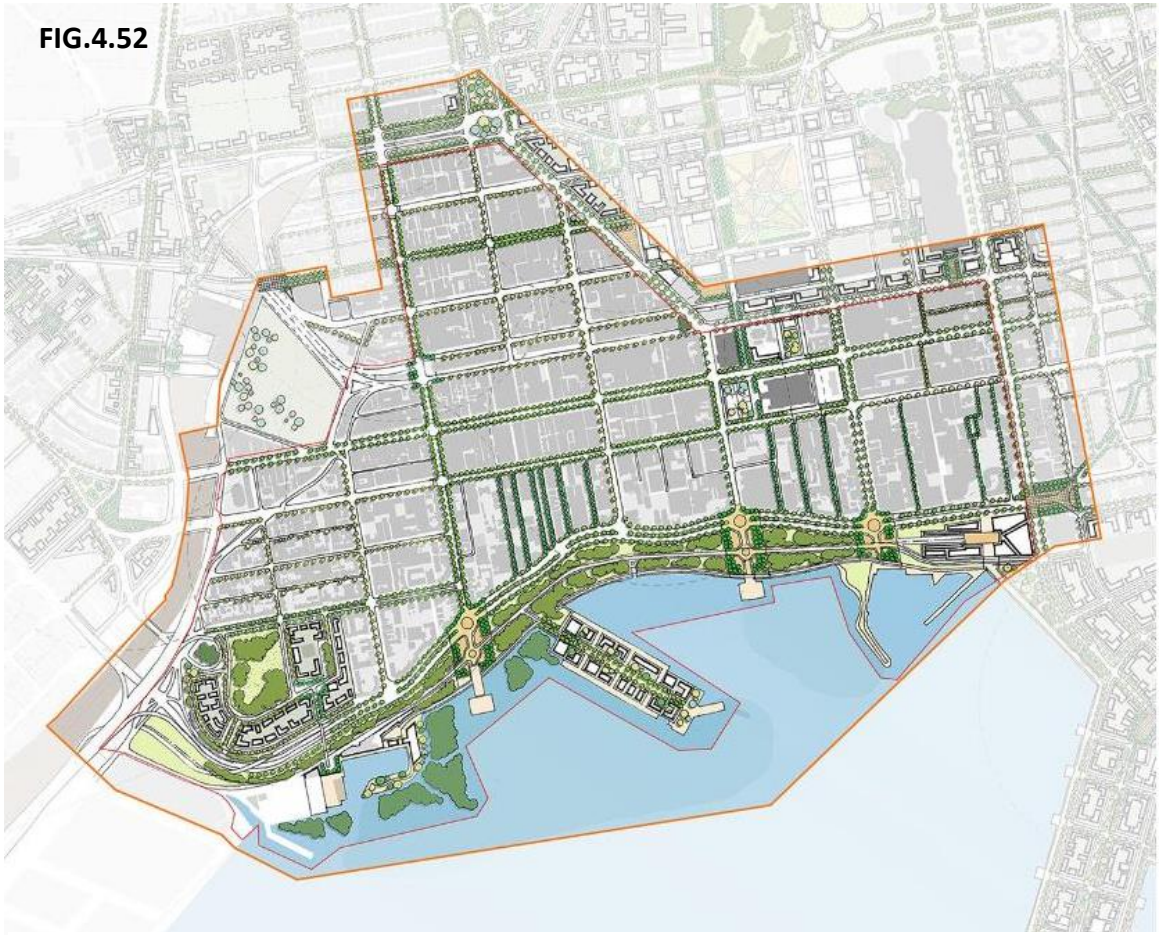


FIG 4.52 LAP Proposed Inner City Precinct Vision illustrating the setup of linear parks, extension of the promenade and regeneration of ecological services to the harbour edge. (eThekwini Inner city LAP, 2015, page 81)

a city which is so intimately entwined with water.

On the opposite end of the spectrum, there is at no point in the harbour area, an instance where architecture introduces people to water. The harsh hardened surfaces and steep concrete barrier walls all suggest something to be guarded against rather than embraced within the built environment and general living space of people.

The Local Area Plan (LAP (2015), figure 4.52, plan shows the breaking down of harsh infrastructural barriers to the water and the introduction of a linear park along the city edge. This plan allows for a softer interface between the city and the harbour, as well as promoting pedestrian access to the waterfront.

The above figures 4.48-4.51 illustrated how the city interfaces with the water's edge. Currently a system of barriers of roads and railways lines from a difficult interface to interact with.

The LAP offers a solution to this by removing the railway lines, reducing the road widths and providing softer green surfaces to appeal to pedestrian movement

This returns ownership and agency back to the community of Durban. By implementing these changes, the waterfront has the potential to set up stronger connections and build up a stronger, more resilient system which properly integrates the city as a role player within the harbour.

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4.8. Conclusion

The Durban harbour illustrates the dichotomy between ecological health and urbanisation. The dominance of the industrial manmade environment over the ecological and social functions of the Port present a problem where water cannot be properly integrated with the city.

As a result of this, the ownership and agency within the harbour is compromised, further deteriorating the space and allowing for the dominance of the manmade within the waterscape.

The relationship between water culture and the built environment, as outlined in Chapter 1 as a research question, has been analysed in the case of the Durban harbour, South Africa.

Adaptation and response to water within this case study has seen to be dictated by industrial operations. The architectural response is often purely functional, offering very little experiential and sensory experience with the water.

Transformations of the harbour over the last 20 years has shown the further industrialisation of the harbour, and segregation of the harbour from ecology as well as from the city. The EMP (2012) sets up a series of systems phases and key issues to tackle when addressing the ecological health of the harbour.

Resilience of the harbour system in terms of social-ecological services is severely compromised due to the disassociation of the city and the harbour. This is addressed through the proposed LAP (2015) and rezoning the eastern harbour into a less industrial and more community oriented zone, allowing the community of Durban to reclaim the space as being part of the city.

The overall system of the harbour is disconnected from the city. By integrating the social system of the city with the ecological system of the harbour, as outlined in the LAP and EMP, the resilience and water culture established in the precinct can be redefined.

5.0

CHAPTER 5

FINDINGS AND RECOMMENDATIONS

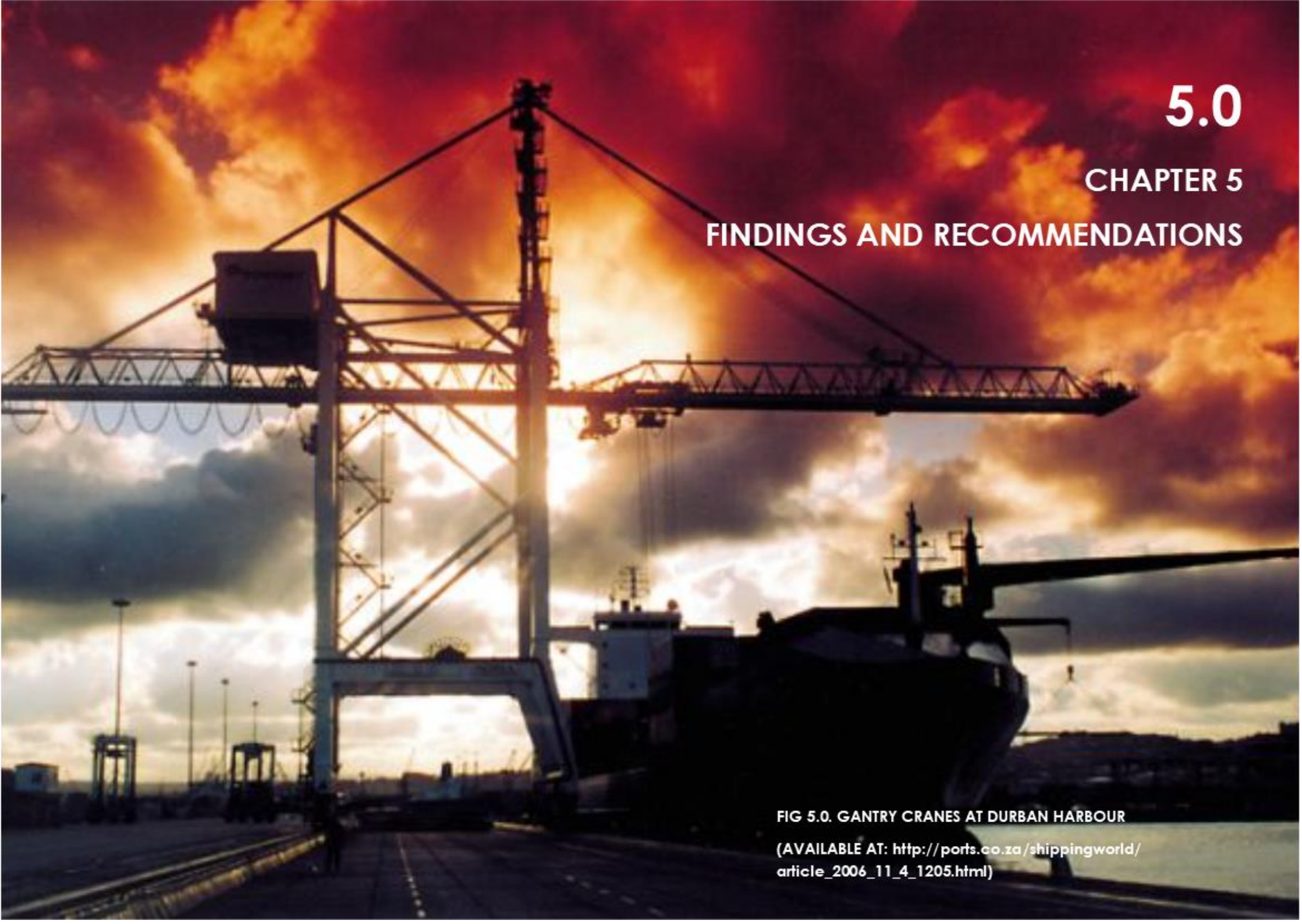


FIG 5.0. GANTRY CRANES AT DURBAN HARBOUR

(AVAILABLE AT: http://ports.co.za/shippingworld/article_2006_11_4_1205.html)

5.0. Introduction

The research conducted and reported in this document has aimed to determine what the relationship between the city and water is and how it can change to encourage a more water conscious urban environment.

The problem statement was outlined in chapter 1 as:

Disconnection between the city and the harbour has resulted in a loss of resilience of ecological and social success of the harbour.

The lack of opportunity to access the water's edge at Durban Harbour has resulted in the disconnection between the city and the harbour and has lost its value to the city.

This disconnection has resulted in various repercussions, such as the rapid decline in ecological health and the dominance of the port industry within the area.

Chapters 2, 3 and 4 have attempted to further understand the disconnection between people and natural water bodies. The aim of the research is to

Determine how architecture can contribute to reconnecting people and cities to the water's edge*. By gaining a fuller understanding of the pressures of urban life on water as a commodity*

This research has been conducted from the standpoint of resiliency and resilient cities and their ability to cope with environmental and social pressures by operating as a diverse and holistic system.

These findings have been constructed to answer the main research questions set out in chapter 1, namely:

How can the built environment contribute to a sustainable water culture so as to form a resilient architectural response?

The findings which are outlined in this chapter will begin to understand how the built environment, people and harbour can operate as a successful urban ecology, what barriers there currently are and what the possible solutions can be informed from this.

5.1. Findings

As stated in Chapter 1, there were several methodologies used to examine the relationship of water to the city as well as Durban to the Harbour.

The literature review in chapter 2 examined the relationship of water to the city and the evolution of how the city interacts with water as a natural, economic and social asset. From chapter 2, it can be concluded that the definition of water within the city has changed over the course of time, from something intimately tied with social and ecological processes, to something which is relegated as being a purely utilitarian and economic tool and asset. This disconnection from the city, as a social and natural asset, has resulted in mass ecological degradation, as seen in Durban Harbour. Through reconnecting people to the waterscape in the city, a renewed redefinition of the waterscape in relation to the city can be approached.

Chapter 3 examined precedents of how the built environment has simultaneously addressed issues of ecology, place making and resiliency. This provided strategies and principles which can be utilised in order to address a healthy water culture within Durban Harbour.

Chapter 4 examined the harbour as a case study. This took into consideration the current architectural language and responsiveness to the water as well as the ecological impact of the harbour and how these issues can be addressed through various urban and area plans.

The following findings have been based on interviews with role players in Durban harbor. This is to properly understand the challenges facing the harbor as well as the views of the community who actively interacts with it. Representatives from facilities that promote water culture in Durban were also interviewed to

determine what are the popular water based activities and possible strategies to encourage a healthy and sustainable water culture. These facilities include representatives from:

1. The Port Natal Maritime Museum
2. The Royal Natal Yacht Club
3. Durban Undersea Club
4. Durban Rowing Club

Interviews were also carried out with the larger institutions of

5. Transnet/Portnet as well as the eThekwini Department of
6. Environmental Affairs to gauge an understanding of the roles these institutions play within the harbor as well as how their influence is either positive or negative to the health of the harbor.

Observations were carried out in order to determine the frequency of use, the volume of traffic (pedestrian and vehicular), as well as the nature of interactions between the public and the waters' edge. These observations were carried out at different times of the day as well as at different point of the week and over holiday periods in order to understand when the peak visiting time to the Harbour were.

The questions in the interviews were slightly tailored to each facility and the role they played within the greater Harbour scheme, but were broken down into social and ecological perceptions of the harbour to both frequent and infrequent visitors. The representatives of the institutions represented their greater community and the concerns and suggestions of their respective institutions/facilities.

The literature review conducted in chapter 2 aimed to answer questions 1 and 2 from a theoretical perspective and generate informed questions to incorporate into the interviews to answer questions 3 and 4.

1. ***What is the definition of resilient water culture in a South African context?***

a. In chapter 2 it was determined that water culture can be defined as the attitude and belief systems a community has toward a natural body of water. This was examined through the relationship people have to the waterscape and how this defines a place as well as the ecological impact of a properly integrated urban ecosystem. The interdependencies of these systems were further examined to determine that in order to promote a healthy urban ecology, access to natural spaces by the public within the city is imperative to the success of an ecological system within an urban area.

b. The primary research revealed that most of the interviewees, approaching the questions from different standpoints of social, ecological and commercial perspectives, stated that the harbour was in a negative place in terms of both ecological and social success, but was important as a Port, being an economic function. Here, the utilitarian perspective of the harbour is highlighted, as discussed in chapter 4, where the dominant aspect of the harbour is perceived as being for the harbour functions and not as a place for nature or people. This is representative of the current water culture which surrounds the harbour. Despite this perception, the majority of interviewees expressed a keen interest in interacting more with the harbour on a social and recreational level, and expressed the need for it to be reconnected with the city as an asset to the public as much as an economic asset.

2. ***What is the relationship between resilient water culture and the built environment?***

c. In Chapter 2 the relationship between the built environment and water was discussed. It was determined that the current urban environment is constructed in a way which detached people from water at the source. This encourages a minimal interface between people and water beyond a utilitarian purpose, further fostering the perception of water as a commodity within the city. A resilient water culture would provide various points of contact with water throughout the urban environment, especially where this environment related directly to a natural body of water. These contact point were to encourage the holistic experience of water, which included a variety of sensory experience to highlight the relevance and importance of water within the urban environment.

This disconnection was also acknowledged by the interviewees where the access to the harbour, due to it being largely privatized as well as an unfriendly industrial environment, was highlighted as a major problem. The environmental health has suffered at the hands of the built environment and the unresponsiveness of the buildings and edge treatment to the water. The hard-concrete vertical edges have interfered with natural habitat patterns as well as urban run-off, dispensing harsh chemicals and plastic pollution into the water.

The storm water reticulation system for a large portion of the city also drains into the harbour, leaving it vulnerable to contamination. There are no systems in place to filter and purify the water to get it to a safe quality before it enters the harbour. This has resulted in a harbour space where it is dangerous to come into contact with the water, resulting in illnesses for humans and a threatened habitat. Despite this, the harbour remains resilient, still maintaining marine life and is capable of a habitat recovery.

3. What are the design principles which will enable a sustainably resilient water culture?

The design principles to encourage a sustainable water culture are determined by the theories examined as well as the five characteristics of culture outlined earlier in the document. These are rooted in resiliency theory. Adaptation of the building to acknowledge and embrace water as a central aspect to the proposal, to encourage the sense of place to be tied to the water and be a part of the water scape. Transformation highlights the ecological impact of the design and the ability of the building to both use ecological services offered by the natural habitat, as well as provide a protective environment to ensure the health of the natural ecosystem. The sustainability of the building will also be taken into consideration in how it utilizes water and the processes within the building to minimize the impact of the city on the surrounding ecosystem.

Resiliency informs the accommodation schedule for the building, where representative from the community, cultural activities, institutions and city can work in collaboration to address issues seen within the area. The proposal should be a point of crossing between the different spheres within the harbour, where issues surrounding water use and management within the harbour can be addressed and resolved effectively.

Resiliency will also address the climatic resilience of the building and its ability to withstand the pressures of climate change. Accommodations for flooding and tidal movements have been examined through various technologies as well as strengthening the ecological and social activities within the building and building area.

The lack of impact which the community has in the way the harbour is managed has been expressed through the interviews. There are limited or poorly advertised channels to use to comment on and monitor the health of the harbour by the public. There is the notion that the community has very little say in how the

harbour is managed and even if authorities can be contacted, these concerns are addressed only in some instances. The dominance of control over the port from Transnet as an economic asset has resulted in a lack of interest by the public to invest in the harbour as a social place.

1. ***How can architecture integrate natural water bodies to facilitate a sustainable and interactive relationship to water?***

d. Chapter 3 investigated the idea of ecological goods and services and how the harbour can benefit from the rehabilitation of the mangroves as a filter for the contaminated storm water run-off. Through methods of integrating systems and creating a resilient environment, the interaction between architecture and the environment, as well as social interaction can be increased.

e. Through interviews, it was identified that there are limited facilities in the harbour area which allow the public to interact with the water. Instead, facilities open to the public only provide commercial activities and do not provide opportunities to interact with the water. Facilities in the area which do provide interaction are often closed clubs which require membership to participate in designated activities. While these activities provide great social benefits, the public are either unaware and have the perception of being excluded from these activities

FIG. 5.1 Sayamaike Historical Museum, Osaka, integrating architecture and water.
Available at:
https://arcspace.com/feature/sayamaike-historical-museum/

FIG 5.2. Architecture Promoting interacting with water in Copenhagen.
Available at:
http://www.archdaily.com/11216/copenhagen-harbour-bath-plot

FIG 5.3. Immersion as an experiential aspect of architecture.
Available at:
http://www.strangebeaver.com/2013/05/limbo-caught-between-dreams-and-reality/

5.2. Recommendations

The data collected through primary and secondary research methods have informed architectural design principles and accommodations which the building needs to allow for in order to properly integrate the community of Durban City.

The overarching principle of **Architecture as an interface** to allow for a variety of interactions to occur, between people and architecture, people and the environment and the environment and architecture.

FIG 5.4. Water sports in Durban Harbour
Available at:
https://twitter.com/DurbanRowClub/status/671613452746670080

FIG 5.5. Bayhead Natural Heritage Site
Available at:
http://wessadurban.blogspot.co.za/2012/03/bayhead-mangroves-in-celebration-of.html

Adaptation

Architecture + Environment

Adaptation has been focussed to the responsiveness of architecture to its context as being part of the waterscape.

1. The proposed architecture should celebrate its context as being something connected to a body of water as well as being a part of the greater harbour scheme. This could be done through the architectural language of form and materiality which reflects the hybridity of industrial and natural environments encountered at the Durban Harbour.
2. The building should encourage interaction with the water and allow for water to be part of the architectural experience. This is to encourage interactions with the water and alter the perception of the harbour as a purely industrial space.
3. Water must be considered in the total sensory experience of the space in order to foster a sense of place as well as identity within the urban context.
4. The space should encourage water activities in order to develop the skills of the community as well as provide a positive recreational association with the harbour.

5. The promotion of natural habitats within the harbour will allow for it to become an identifiable space within the city. The rehabilitation of the natural environment will provide a renewed sense of place which will redefine the space within the harbour.


FIG 5.1.

FIG 5.2


FIG 5.3


FIG 5.4


FIG 5.5

Transformation

Architecture + Ecology

Transformation has been identified as the relationship between the built environment and the natural environment, and how the two systems can work together to form a renewed urban ecology.

The following principles describe potential principles and solutions to minimise the impact of the architecture on the existing ecological systems as well as enhance and rehabilitate any other systems which may have been compromised through industrialization of the space.

1. The water management systems within the architecture must take into consideration the impact of the built environment on the harbour.
2. Urban run-off – a major contributor to the decline in water quality – must be treated and purified before it reaches the harbour.
3. Rainwater harvesting and grey water recycling and purification must be incorporated.
4. Ecological services such as mangroves, reed beds, bioswales and sand filters are options to be incorporated within the building's purification systems.
5. The building must limit the series of hard surfaces surrounding the harbour.
6. Restoration of the bay ecological habitat – namely the mangroves and marine life – must take priority when addressing ecological issues within the space.

Resiliency

People + Architecture

Resilience has been defined as the interdependency of systems which occur within a single context. This takes into consideration the connections between the community, institutions and city, in the instance of Durban Harbour.

1. The building needs to allow for total public access as well as public access to the water.
2. The building needs to act as a mediator between people and the environment as well as between people and the built environment.
3. The community being accommodated must be able to create connections with each other and the architecture must foster a shared experience.
4. The building must accommodate representatives from the authorities, the city and from the community to allow for the crossing of ideas as well as intersection within the community. Issues and awareness must be raised through these platforms and the architecture should encourage an open discourse.

5.3. Conclusion

The principles outlined in the above chapter will form part of the design process which informs the execution of the proposed building scheme.

These will be tightly related to the theories of place making, ecological architecture and resiliency of cities.

The main principles will be as follows:

1. To create a sense of place at the Durban waterscape, acknowledging its context as being both urban, industrial and natural.
2. To incorporate the sensory experience of water within the architectural experience of the structure.
3. To employ sustainable methods of water management within the building and address urban impact on water.
4. To rehabilitate the ecological habitat within the design of the architecture and address ecological goods and services.
5. To provide a platform which voices the various role players within the Harbour context.

Further Research

There are many opportunities for further research with the Durban Harbour. It is a multidimensional space and has a host of role players.

The level of homelessness within the area needs to be considered. At night, there is a large homeless community which occupy various points of the esplanade. There is a need to develop a strategy to reduce and rehabilitate the indigent.

The arts scene within the area has great potential to form a cultural hub along the esplanade. With the closing of the Catalina theatre and the need for more space at the BATS Centre, the esplanade could offer a vibrant setting for a renewed cultural hub for the city. The potential to link the cultural hubs present further into the city, such as the City Hall, Playhouse, Old Post Office, Old Court House and Kwa-Muhle Museums as a cultural "circuit" through the city to the harbour edge provides a framework for future development

Plastic pollution and the filtering of urban runoff also needs to be addressed. Possible plastic processing and recycling facilities are required.

6.0
CHAPTER 6
DESIGN REPORT

FIG. 6.0 Render of Proposed Building from promenade extension.
By Author

6.1. Introduction

The drawings included in this chapter were presented as part of the Mock Jury Presentation.

These drawings are a representation of the development of this document. Stemming from a literature review, to precedent and case studies and based off the insight gained from the primary research explored in chapter 5. The proposed architecture is a Maritime Museum and Recreation Hub for Durban Harbour which aims to encompass the various experiences associated with water within an urban environment. The environmental health of the harbour, as explored in chapter 4, is severely degraded, and this proposed architecture aims to facilitate a water culture within the social community, that allows for the ecological health of the harbour to regenerate.

6.2. Adaptation

The proposed building intended to physically link the city to the water's edge via a ramp which made up the second floor of the structure. The building became an active space, where there was no definite inside or outside, but rather, a flowing of space from which water was experienced at different levels and in different ways.

The structure adapted to the environment of the harbour by accommodating various water related activities unique to the harbourscape, as well as acknowledging the shortcomings and disconnection between the harbour and the city.

By Incorporating the waterscape directly in the architecture, and providing points of contact and phenomenological exploration of water, the building became a series of different water based environments, allowing for a varied and water centric experience.

6.3. Transformation

Tackling issues of water management and ecological sensitivity, the proposed building was intimately connected to the site and context. Ecological restoration through marine steps, and the mangrove restoration allowed for the re-introduction of natural elements as well as natural water filtration methods. Bioswales and a water purification system for urban run-off ensured a minimised impact of the city on the ecosystem.

The Building itself uses alternative ways to manage water, through exposed drainage and hydroponic and aquaponic filtration systems.

6.3. Resilience

Resilience was explored through how the various systems of the building worked together as well as connected back to the city, primarily explored in the urban plan.

FIG. 6.1. Site Analysis Diagrams
By Author

problem statement

past ..... present

LOW DENSITY VILLAGES
lower density = less demand on water bodies - surface water was adequate

short distances between settlements and water sources = manual transportation or use the the source

DIRECT CONTACT
water was directly interacted with by people and held value in what it enabled

NATURAL ELEMENT
water was directly associated with and influenced by ecology and natural cycles

HIGH DENSITY CITIES
high density = high demand for water. Surface bodies became insufficient

INDIRECT CONTACT
The insertion of water began infrastructure became the point of interaction between people and water

INDUSTRIAL COMPOUND
water is directly associated with and influenced by infrastructure and human control

HEALTHY ECOLOGIES

DEGRADED ECOLOGIES

AIM

ARCHITECTURE AS A RESTORATIVE RECONNECTING AND RE-CREATIONAL LINKING BETWEEN THE MARINE ENVIRONMENT AND THE COMMUNITY OF DURBAN

OBJECTIVES

-WATER TO BE INVESTIGATED ACROSS A SERIES OF INTERFACES
-TO CREATE AN EXPERIENCE WITH WATER WHICH IS INTERDEPENDENT WITH ARCHITECTURE
-ENSURING THE BUILDING TO PROMOTE ECOLOGY AND FOR NATURAL SYSTEMS TO -ENHANCE ARCHITECTURAL EXPERIENCE

CONCEPTUAL FRAMEWORK

1. CULTURE IS LEARNED

2.3. CULTURE IS DYNAMIC AND INTEGRATED

3&6. CULTURE IS SHARED AND SYMBOLIC

PRECEDENTS:

SENSORY EXPERIENCE OF WATER INTEGRATION, LEARNED

SAYAMAIKE HISTORICAL MUSEUM- TADAO ANDO, OSAKA, JAPAN

TYPOLOGY CENTRES AROUND WATER CULTURE AND COMMUNITY CONNECTION TO WATER.

ENGAGES A SENSORY EXPERIENCE WITH WATER AND IT'S MATERIALITY

TIGHTLY CONNECTED TO THE SITE AND GENIUS LOCI

ECOLOGICAL DESIGN AND SENSITIVITY LEARNED, SHARED

VANCOUVER CONVENTION CENTRE WEST - LMN ARCHITECTS

FIRST LEED CONVENTION CENTRE

REHABILITATES ECOLOGY
MAKES USE OF ECOLOGICAL GOOD AND SERVICES
RECONNECTS THE CITY TO THE WATER'S EDGE

COPENHAGEN HARBOUR BATHS - BIG+JDS ARCHITECTS

RECONNECTS PEOPLE AND THE CITY TO WATER
ACTIVATES EDGE
REHABILITATES ECOLOGY
PROMOTES WATER CONSCIOUSNESS

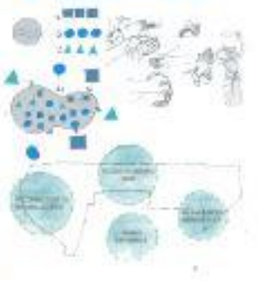
JOURNEY THROUGH LEARNED SHARED, DYNAMISM

YOKOHAMA PORT TERMINAL - FOREIGN STUDIO

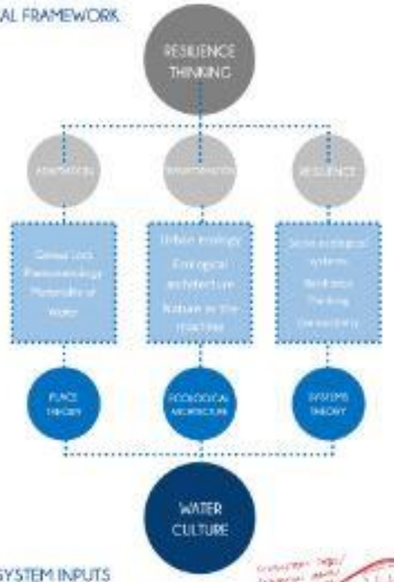
INTEGRATED INTO SITE

STRUCTURE MINIMISES IMPACT ON ECOLOGY DURING CONSTRUCTION

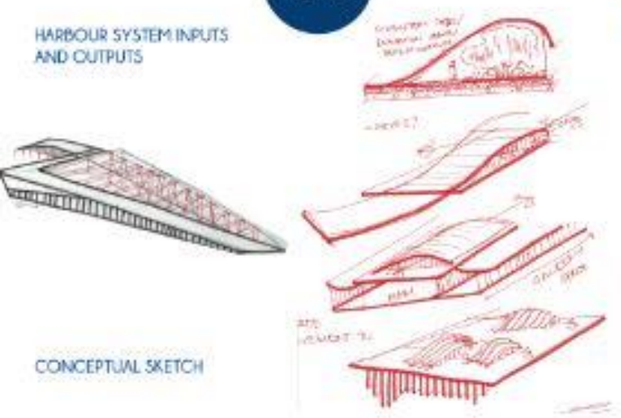
MAKES USE OF ROOF AS AN ACTIVE SPACE TO VIEW THE WATER



THEORETICAL FRAMEWORK

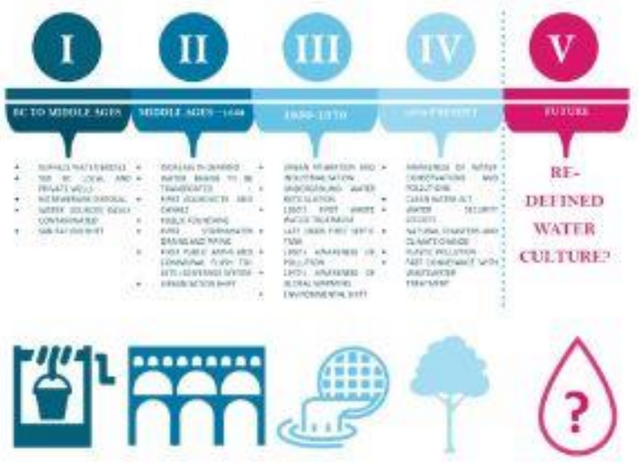


HARBOUR SYSTEM INPUTS AND OUTPUTS



CONCEPTUAL SKETCH

TIMELINE OF THE EVOLUTION OF WATER IN CITIES



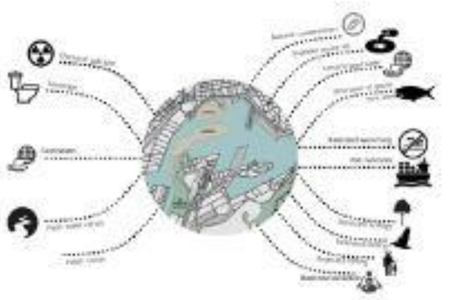
BRIEF DEVELOPMENT:

ETHEKWINI MUNICIPALITY

DURBAN LOCAL HISTORY MUSEUMS

CLIENT:

LOCAL HISTORY MUSEUMS GROUP CURRENTLY OPERATES THE MARITIME MUSEUM. THE PROPOSAL WILL BE AN EXENTION OF THIS OPERATION WHICH MORE DIRECTLY INVOLVES THE GREATER DEPARTMENT OF PARKS AND RECREATION



TYPOLOGY
MARITIME MUSEUM AND RECREATION HUB -

THE focus on physical connection to water
Water culture is being explored, therefore the transition between land and water becomes imperative. A maritime museum offers that platform of exploring the transition between water and land through various stages of architecture, being built environment, to maritime vessels to water directly.

FIG. 6.2. Design Primer
By Author

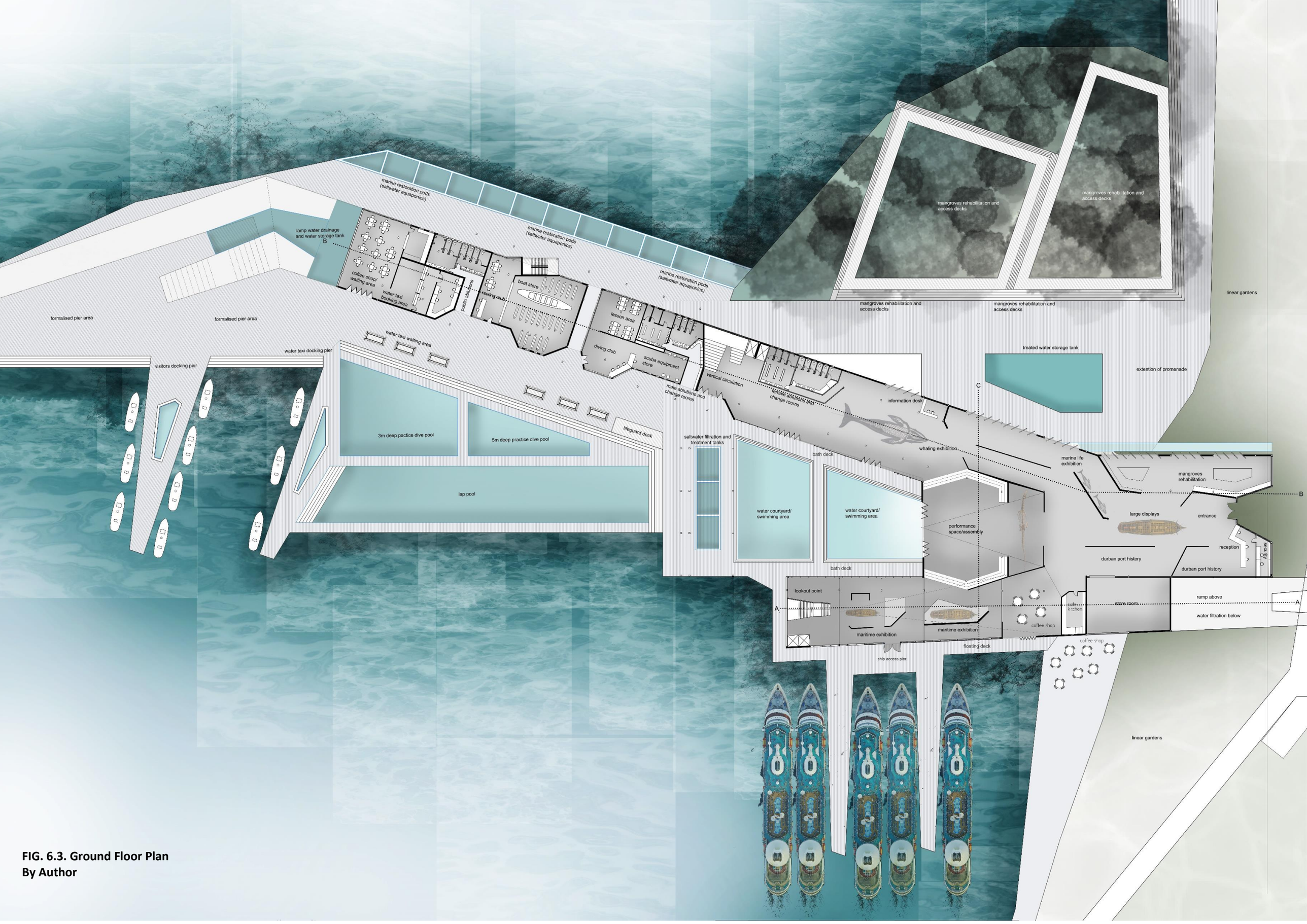


FIG. 6.3. Ground Floor Plan
By Author

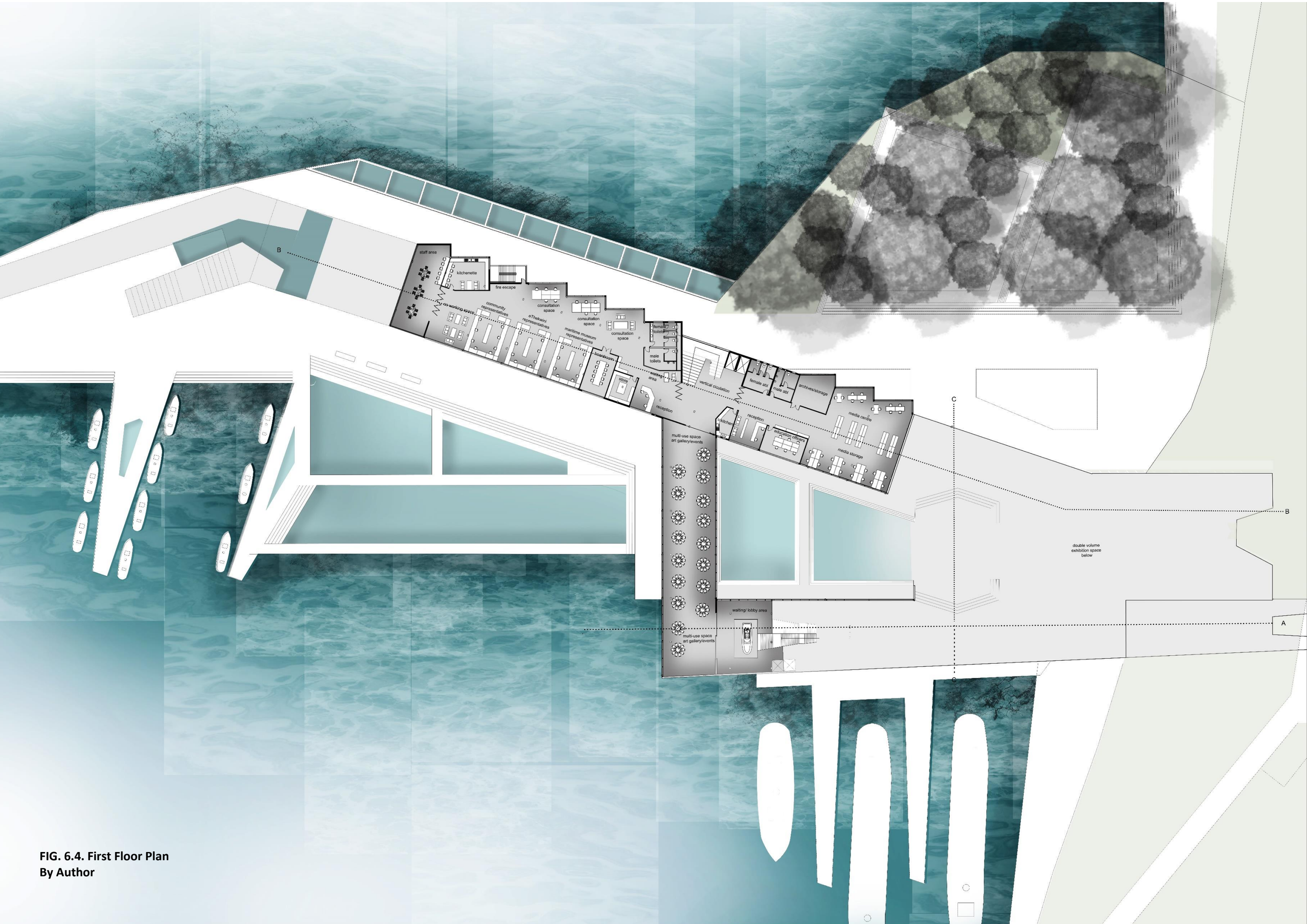


FIG. 6.4. First Floor Plan
By Author

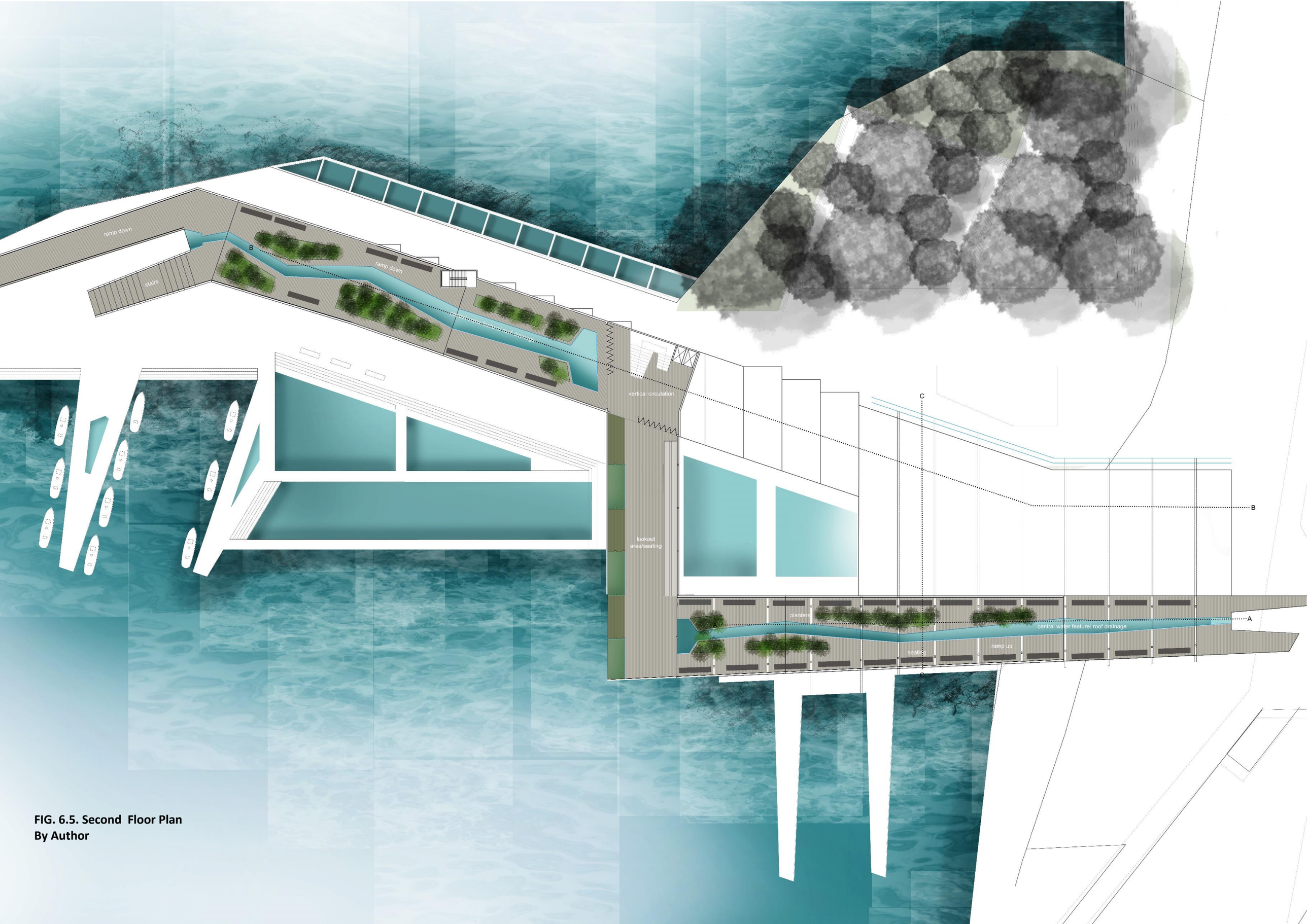


FIG. 6.5. Second Floor Plan
By Author

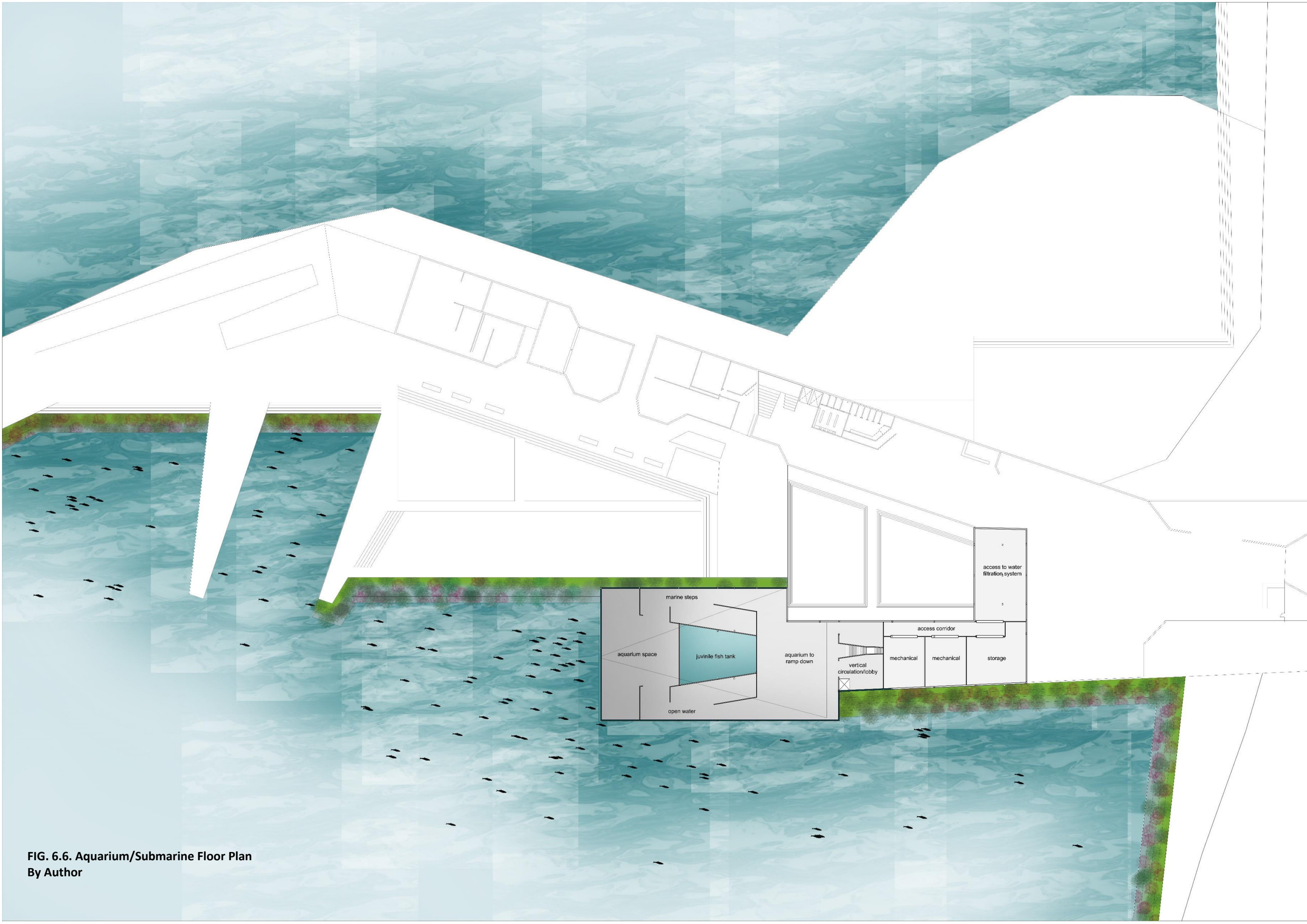


FIG. 6.6. Aquarium/Submarine Floor Plan
By Author

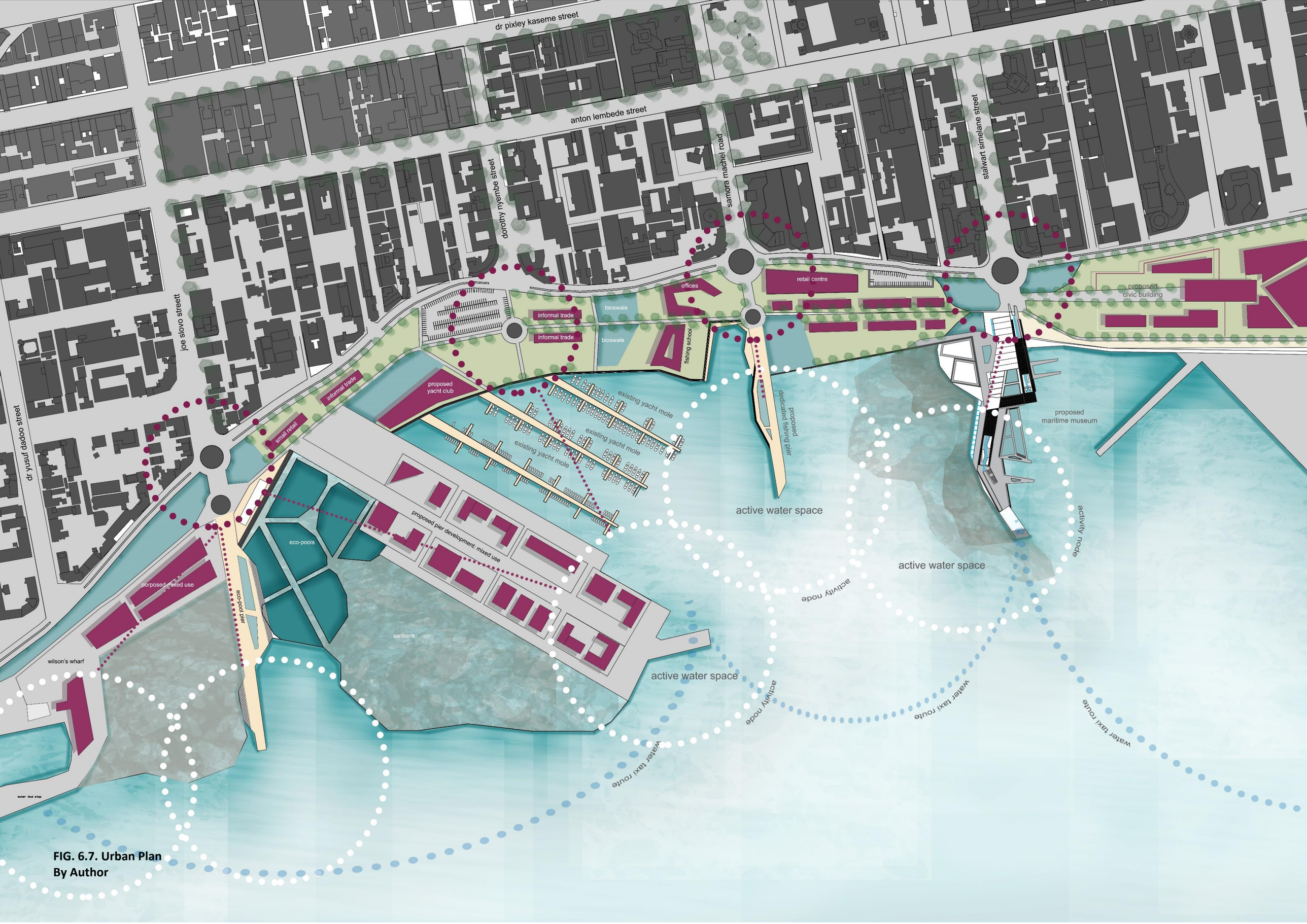


FIG. 6.7. Urban Plan
By Author

FIG. 6.8. Section B-B (Not to Scale)
By Author

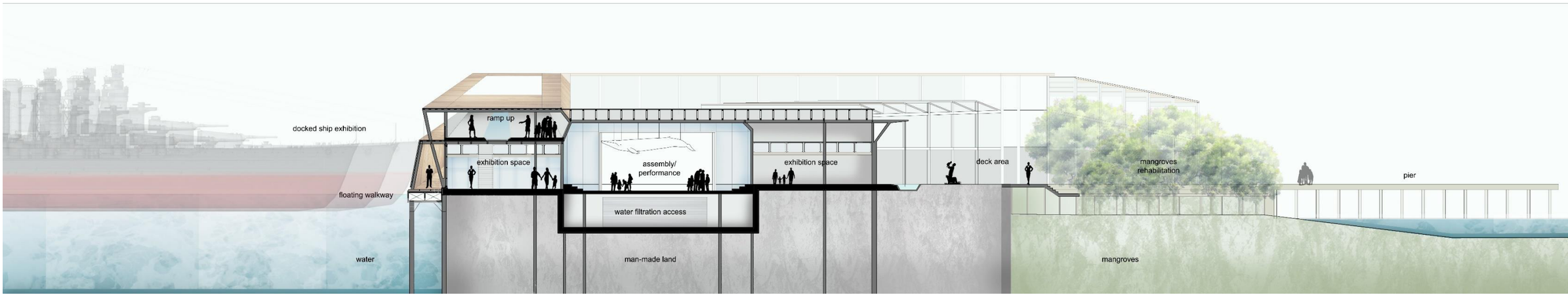


FIG. 6.9. Section C-C (Not to Scale)
By Author

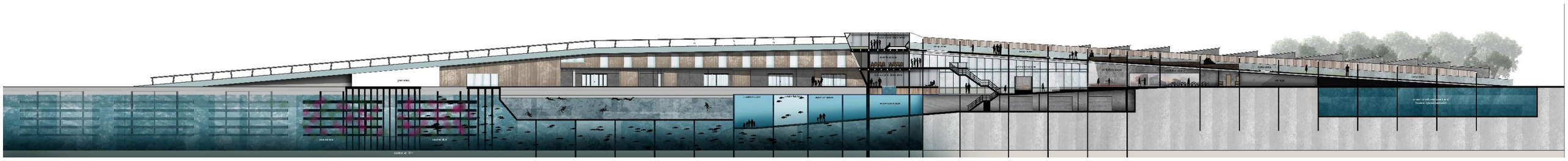


FIG. 6.10. Section A-A (Not to Scale)
By Author

FIG. 6.11. East Elevation (Not to Scale)
By Author

FIG. 6.12. West Elevation (Not to Scale)
By Author

FIG. 6.13. South Elevation (Not to Scale)
By Author

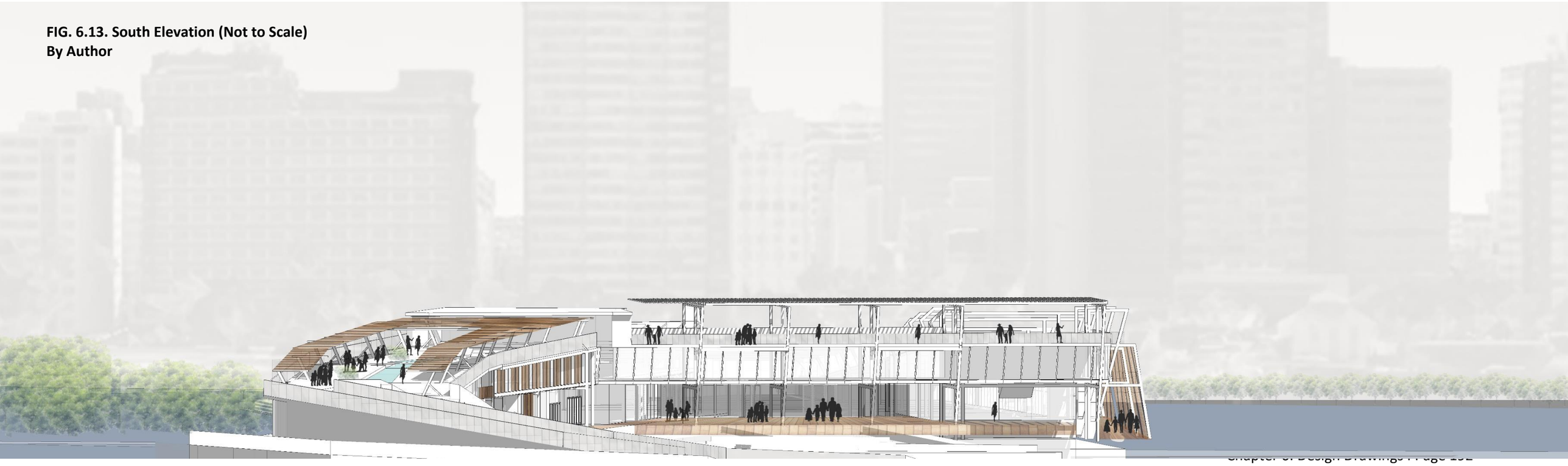
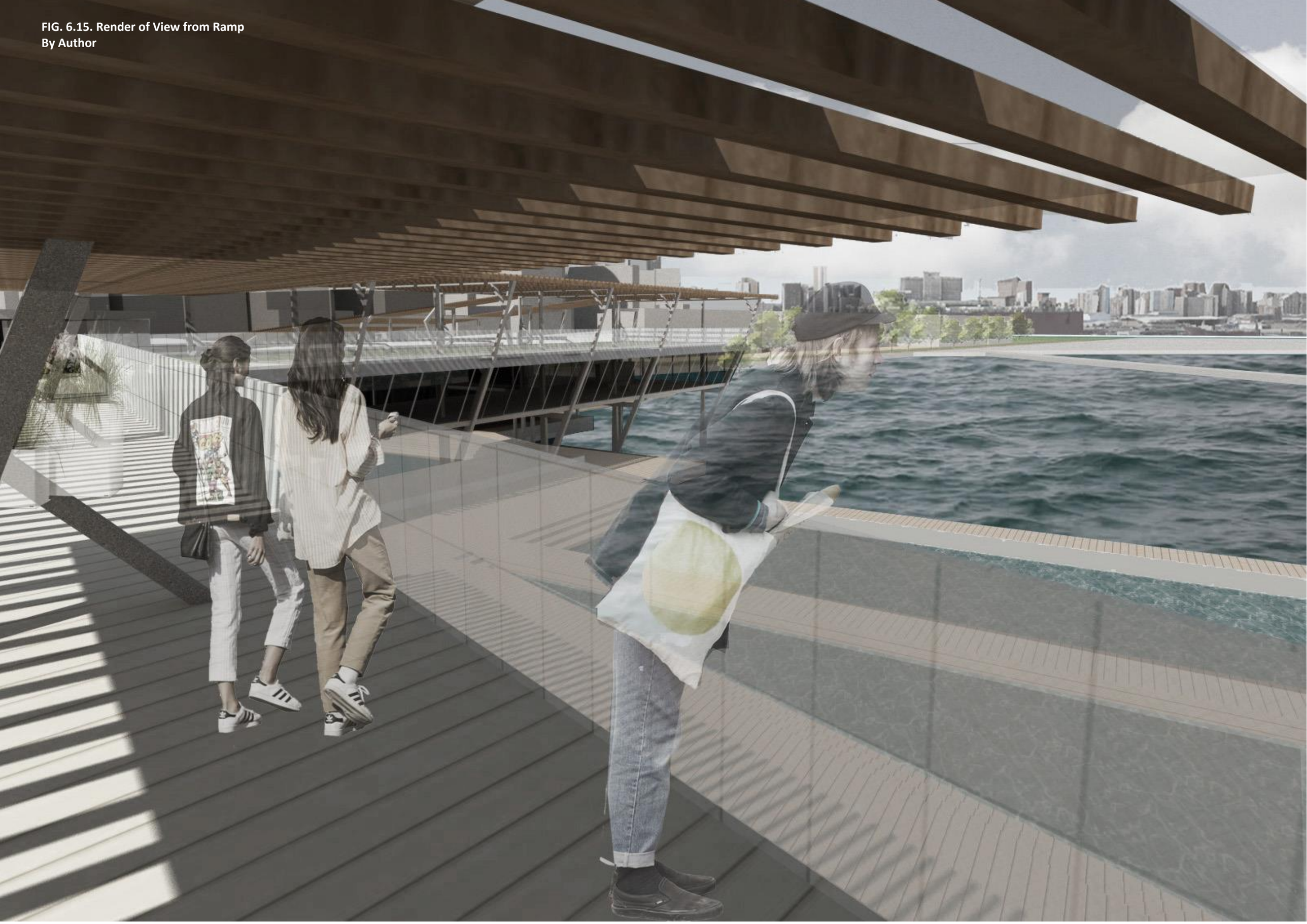


FIG. 6.14. Render of North Entrance (Not to Scale)
By Author

FIG. 6.15. Render of West Promenade
By Author

FIG. 6.15. Render of View from Ramp
By Author



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LIST OF FIGURES

CHAPTER 1

[online] Available at:
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Row 1 (from left to right)

1. Tsunami in Japan, 2011, breaching barriers to control water influx. [online] Available at: http://www.news.com.au/technology/environment/tsunami-warning-issued-for-japan-after-73-earthquake/news-story/d8442c14702a80216af18abe0729c568 Accessed:28/10/2017
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Row 2 (from left to right)

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1. An ancient well in rural towns was a way of accessing ground water. (pp.4)
2. Canals in town used to fill up with rainwater to supply the community (pp.12)
3. Lake bled – Slovenia: Lakes and rivers were surface sources of water [online] Available at: https://imgur.com/gallery/whuHF

Paradigm II – Top to bottom

1. Aqueducts used to transport water into cities (pp.20)
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3. Cloaca Maxima – the oldest sewerage line (pp.23)

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1. Lake being canalised for water supply (pp. 14)
2. Polluted river in Paris (pp.3)
3. Illinois River on fire due to chemical contamination (pp.7)

Paradigm IV – Top to bottom

1. Flooded Venice due to global warming (pp.19)
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