PROGENITOR: AN EXPLORATION OF INDIGENOUS VALUES AND WATERWAY MANAGEMENT THROUGH IMMERSIVE DIGITAL LANDSCAPES

BY

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A thesis

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P R O G E N I T O R

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PROGENITOR

1. a person or thing that first indicates a direction, originates something or serves as a model; predecessor; precursor:

2. a biologically related ancestor

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I would like to thank the following for supporting me throughout my years of university; also the memories formed would not have made me who I am today be good or bad. Cheers!

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Lonestar 2014
Derek Kawiti – Supervisor
Lemeon (my cat)
Nature Itself
The Ol' Man
Court
All whanau and friends!

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And most importantly for teaching me respect and giving me a willing mind to always help others, this thesis would not have been possible if it weren't for Mum.

Thank you
Dyl

Pepeha

Ko Taupiri te maunga
Ko Waikato te awa
Ko Tainui te iwi
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Ko Te Awamarahi toku marae
Nō Waitakere ahau
Enoho ana ahau ki Wellington
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A B S T R A C T

Over the last One hundred years water quality of New Zealand harbours and waterways have diminished due to the unconcern of infrastructural development and poor public waterway and harbour awareness. By exploring the conventional methods traditionally involved with kaitiakitanga and how to digitally map and represent these values through virtual representation, simulation and management, the ultimate aim of this thesis is to establish a kaitiaki approach to restoring a maori holistic world view perspective and the mana tupuna of the indigenous peoples of Porirua.

During the past decade, the Maori indigenous peoples of New Zealand have had land returned from the crown in light of the post treaty settlement. Due to the deforestation and ecocide of many Tribal lands across New Zealand, Tangata Whenua and Ahi Kaa have culturally detached with their lands, and the need to re-establish the Kaitiaki and mana within those areas is highly prioritized. The argument that unfolds now is *'How to restore and revitalize sacred landscapes that have been exposed to the demise of natural resources and have lost significance value resulting in the disappearance of mana and whakapapa of many tribal lands?'*

Through both a landscape architectural lens and an Indigenous lens the aim of this thesis is to research and employ new and alternative methods of resource management by incorporating new and upcoming design software in correlation to Maori Land holdings and collaboration with iwi.

The collateral damage caused by commercial and industrial development has over the past decade has also sabotaged values of Kaitiaki due to the increase of hard surface infrastructure and polluted waterways. Current methods of mapping traditional landscapes are limited when it comes to the ability to encapsulate an environment with cultural values. This research investigates the potential of digital tools and iwi collaboration to enhance the experiential aspect of an environment through an immersive, interactive and open collaborative 3D environment.

By leveraging the potential of photogrammetry to represent a 3D scene of certain areas, the potential to test and simulate current land management will be tested through a 3D model. Equipped with live feeds of data such as climate, tree species, this model's purpose will be to emulate a cultural landscape and reconnect the loss of kaitiaki between Iwi and their Rohe.

This tool will be designed to enable user interaction and commentary to simulate realistic scenes of their day to day scenery in order to become more aware of the impacts of kaitiaki and whakapapa.

Both Iwi and council have a long-term interest in the design of good landscapes that reflect culturally while enabling methods of traditional kaupapa and kaitiakitanga. My goal is to aid this design process through landscape architecture.

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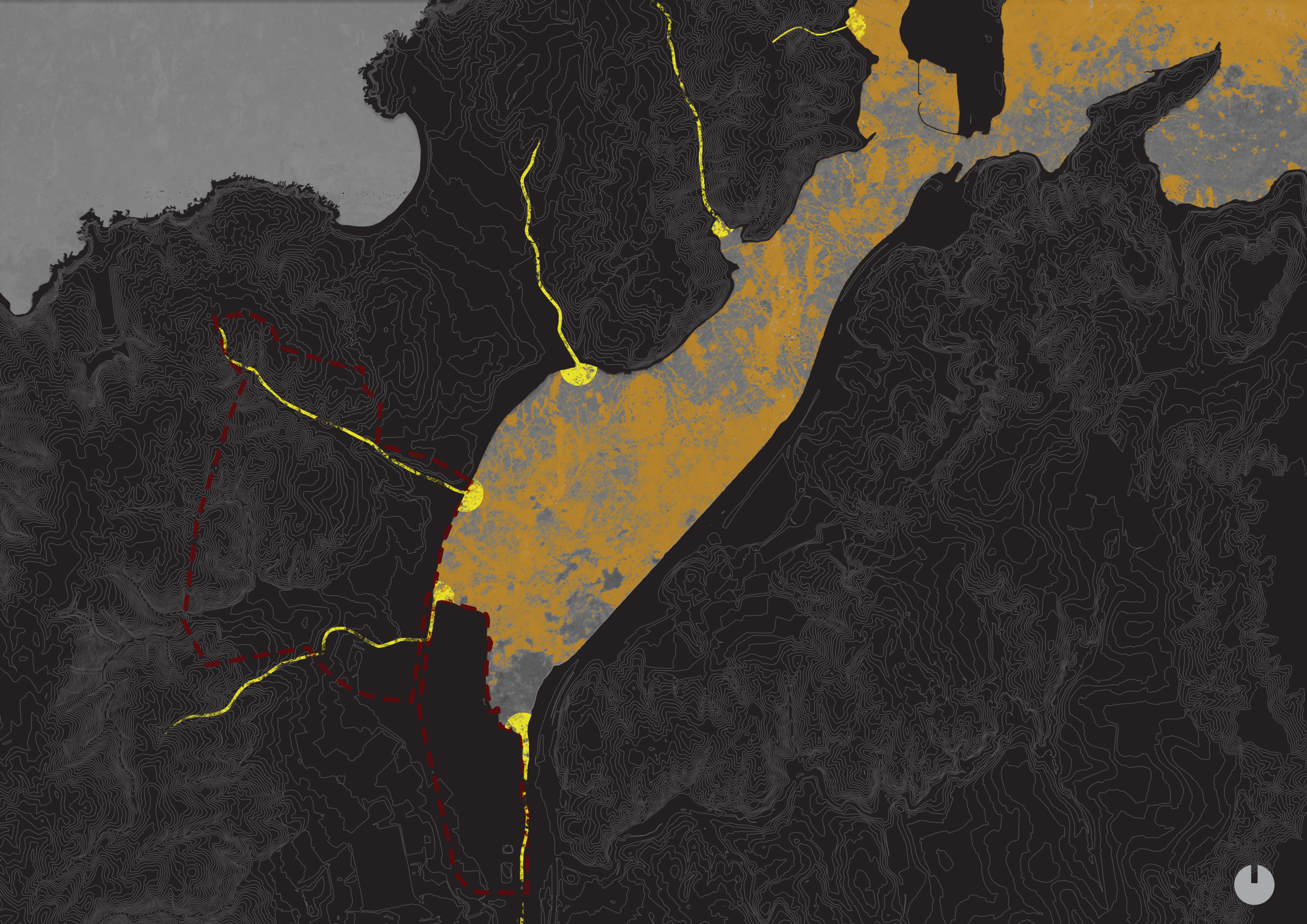
1. Introduction



Takapuwahia/CBD

Mana

Land measurement of connection to the land and the physical health of rohe and tangatawhenua

Porirua Harbour

Kaitiakitanga

Protection and guardianship within community and environment of Te Awarua-o-Porirua harbour

Waterways

Whakapapa

Stories depicting natural status of land yielding the original mana/spiritual connectivity to a place

1.1 Introduction
Te Po, Te Whaiao, Te Ao Marama. . .

The history of New Zealand was inscribed by a group of Polynesian seafarers exploring the south of the Pacific Ocean (Taiao). Their encounter with New Zealand was unexpectedly successful as they discovered new species of flora and fauna (see fig. 1.1), forms of life living in harmony with the land. They soon recognized the potential of this rich ecology and biodiversity and connected with the natural environment through their tales and stories, seeking origin and peace with this new environment. Their place of identity was altered and embedded within their lives to deepen their connection between the human and spiritual world. They had carried traditions with them along the sea and symbolize their

"the natural world forms a cosmic family, in the traditional Maori view. The eweather, birds, fish and trees, sun and moon are related to each other, and to the people of the land".

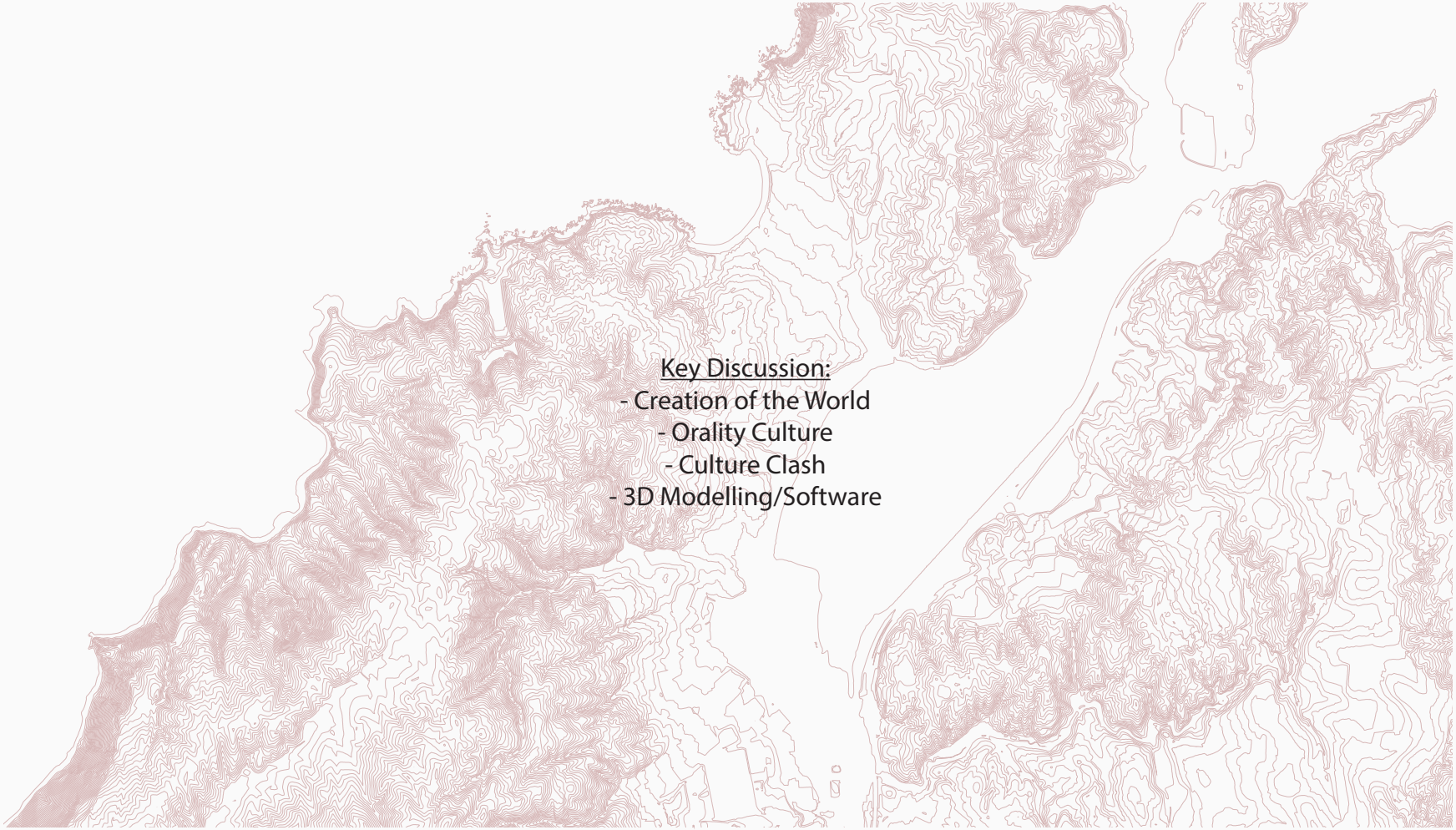
(Figure 1.1 Fresh Waters Depiction Pre Colonial Landscape)

As long-lived seafarers and travellers of oceans, their pasts were not scripted and policy was not noted nor written on paper, rather the stories told by Kaumatua (elders) were shared with Tamariki (children). The genealogy of Tawhirimatea and his control over his children representing the weather and wind (see fig. 1.2). This depiction of the land would certify their place of origin and the stories behind their ancestors. This orality of Maori culture and bridging of whakapapa via Kaumatua, affords a generation of heritage and sovereignty for New Zealand and therefore it is crucial to maintain this holistic view in order to epitomize an indigenous culture that continues to achieve a holistic view in a world with a rapid population growth and high demand for land development.

(Figure 1.2 Tawhirimatea and his children)

The arrival of European Settlers initiated the dynamic shift in land operation following the Treaty of Waitangi, leading to the distribution of land resources between both cultures, although the Maori and European had contrasting views on resource management and economic growth leading to a culture clash. This required collective agreement between both cultures about what natural resources were used for and how they would occupy the environment. With the demand for further development there is also a prominent demand for the progression of technology. And with technology, as a landscape architect it is my responsibility to manage a toolkit of digital equipment, which I will be using to design practical simulations and manage locally sourced resources to atone for both cultures whilst increasing community engagement and public awareness. With the emergence of newer and more accessible 3D software, it has become realistic to produce more accurate representations of New Zealand environments and enable interactivity through more immersive digital landscapes utilizing live feeds from monitoring sensors to give accurate real-time data input.

From out of the darkness, a world of being, to the world of light.



Key Discussion:

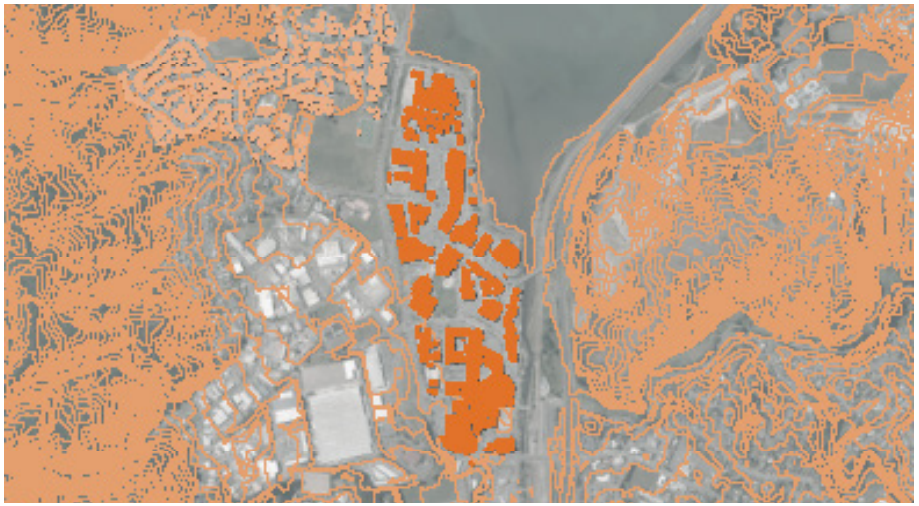
- Creation of the World
- Orality Culture
- Culture Clash
- 3D Modelling/Software

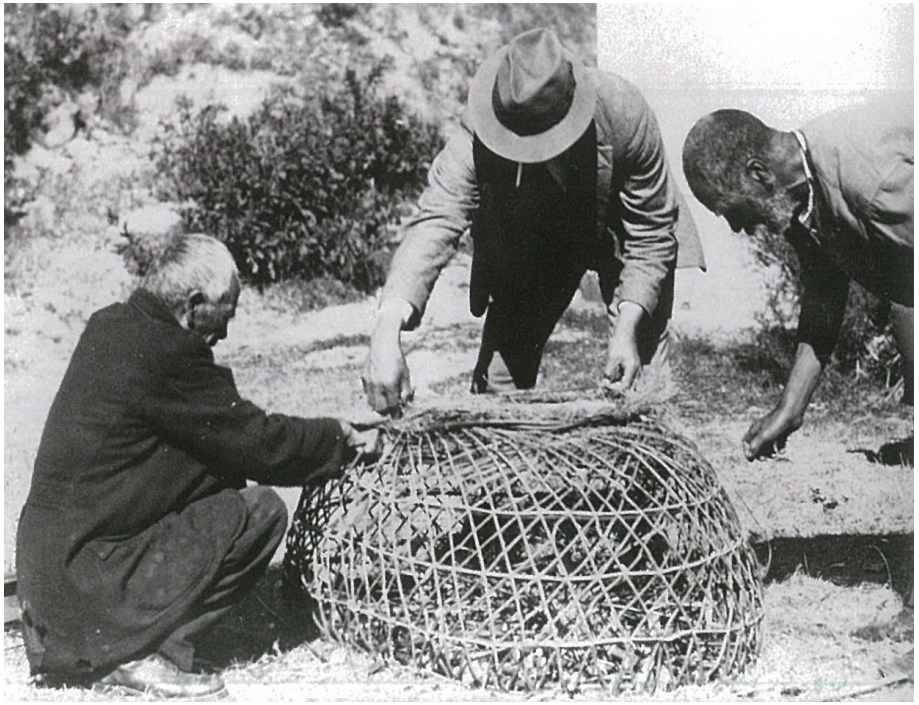
1.2 Scope

Between Green and Grey

The scope of this research encompasses Porirua harbour and its attributed waterways such as connected streams and rivers and its surrounding environment and forest catchment, which have highly influenced the degradation of the harbour's health and mana within Maori Culture. The Iwi (indigenous group) of Porirua known as Ngati Toa arrived in the 19th century following the inhabitance of Ngati Ira. According to Iwi tradition, Nagti Toa and Te Rauparaha valued Porirua harbour due to it having the richest ecology in terms of kaimoana and were able to relate to its resources that were once found south of Kawhia (Rangatira). Ngati Toa occupied the land treading lightly on the fragility of nature, incorporating tradition of land management in order to conserve and sustain the natural resources. The aim of this thesis is to develop a work flow of design and resource management that abides the kaupapa (policy) of Ngati Toa through working with the existing features and built environments familiar and sacred to their whakapapa as well as cross culture adaption between the current community of Porirua and the Porirua City Council.

A Catalyst for Cultural Engagement and Future Community Development





(Fig 1.3 Tradational cray fish pot)

This research will also identify the demographics of Ngati Toa along with environmental characteristics. Porirua's landscapes have endeavored occupational change such as hard surface environments, farming and residential dividing sectors of the public.

Traditional roles of the Maori culture endure limitation as natural resources became scarce. Traditions such as catching crayfish (see fig. 1.3) and eel fishing have also began to shed light in areas that were once full of mauri (life force) and kaimoana.

This has resulted in the awareness of restoration and the prevalence of environmental concern in today's society inaugurating professional assistance outside of the local Iwi. My role is to apply a landscape architecture perspective thorough the utilization of up and coming digital software.

The growth of digital paraphernalia will provide new and innovative techniques from crowd sourcing methods to 3D data representation. Adequate geo location of resources is also compulsory in order to identify the natural relationships between the natural occupancy of the land and the relationship that people have with it.

Key Discussion:

- Porirua Harbour
- Ngati toa
- Landscape Architecture
- Digital Instruments

1.3 Problem
Our Waters...

Following the Treaty of Waitangi, Maori lands were overlooked when western ideology entered New Zealand. The increase of infrastructure and farm lands lead to the deterioration of New Zealand's ecologies and environments.

The increase of population post colonization stripped the land of its forests and wildlife in order to promote built environments and economic growth. Although in the process of creating a western society, Maori sovereignty faced cultural decay and with the development of built environments brought hard surfaces and pastured landscapes, both exhibiting efficient ways of production, however overlooking future scenarios affecting the natural environment and thus displaying a great degree of ignorance towards the existing culture of the indigenous people of New Zealand.

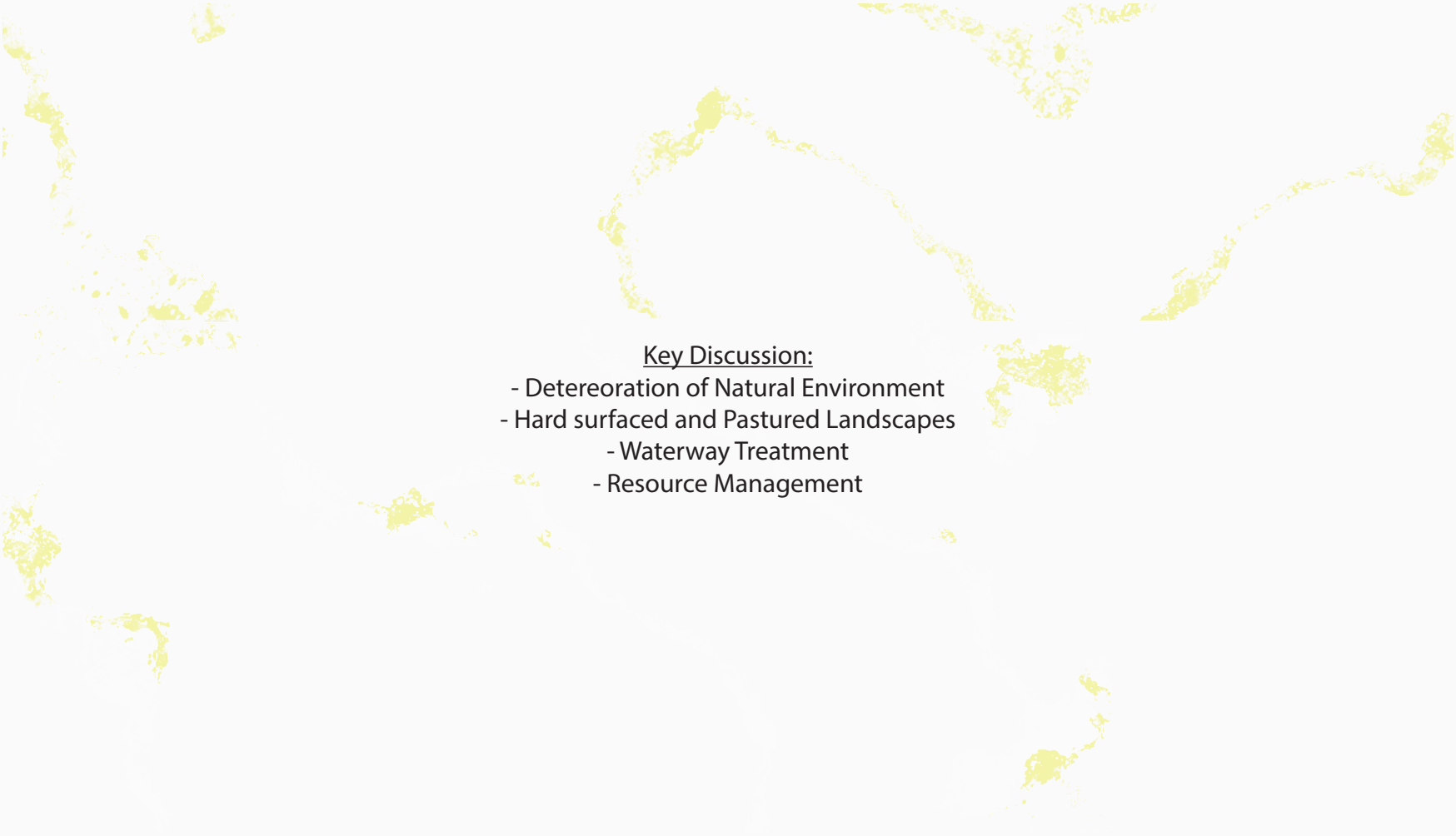
Built Environments and Untreated Water Runoff from Farming are Polluting Porirua Habour and its Waterways

Over the last 150 years, Ngati Toa's natural features such as the rivers and streams connecting to the Porirua Harbour have experienced pollution and rejection as urban and city development disconnected the inclusion of the harbour entirely (Paul Blaschke). This issue was confronted by the decision to transform Porirua into a transport corridor and resulted in the divorce of many Tangata Whenua (people of the land) from their Rohe reducing their cultural understanding of the harbour and its tributaries. Pollutants and water run-off from earthworks and hardscaped environments lead to the decline and abandonment of natural resources associated with Ngati Toa and their kaupapa.

This neglect of Porirua Harbour and its connected waterways emanates the current dilemma within Porirua in need of revitilization and reconstruction thorugh improved resource management techniques.

(Fig 1.4 Porirua transport corridor)

The development of state highway 1 and Titahi bay road have both contributed to the detachment of cultural identity with Ngati Toa and Porirua harbour (see fig. 1.4). The highway runs parallel with porirua cbd divorcing access to the western suburbs whilst Titahi bay road has physically seperated the harbour with Takapuwahia. The spatial structure of the cbd has also fturned its back on the harbour negleecting the awareness that it requires.



Key Discussion:

- Detereoration of Natural Environment
- Hard surfaced and Pastured Landscapes
- Waterway Treatment
- Resource Management

1.4 Proposition

My approach to fixing this crisis of indigenous land degradation and ignorance to Maori cultural values within Porirua includes targeting the traditions of Maori people for a clearer understanding of indigenous methods of resource management and how utilizing digital tools within the field of landscape architecture can assist inthe management structure and offer new and alternative representations of the environment to test, simulate and collaborate design ideas.

Reconnecting the importance of Porirua harbour by establishing a system for the purpose of collaboration between Ngati Toa and Porirua council. In hope to restore the kaitiaki and mana within Porirua harbour.

Kaitiakitanga – This term refers to the guardianship and protection of the land itself and is based on the holistic world-view that everything is interconnected.

Kaupapa – The Maori people use this term to embed policy within their culture, which is closely associated with another term called 'whakapapa'. Whakapapa refers to Maori genealogy and signifies their position in this world.

Rahui – Rahui is the Maori term for resource/or land restriction. Through this method of preservation, all natural resources are conserved and controlled by Iwi to allow for the consistent populace of flora and fauna and well-being of the natural environment.

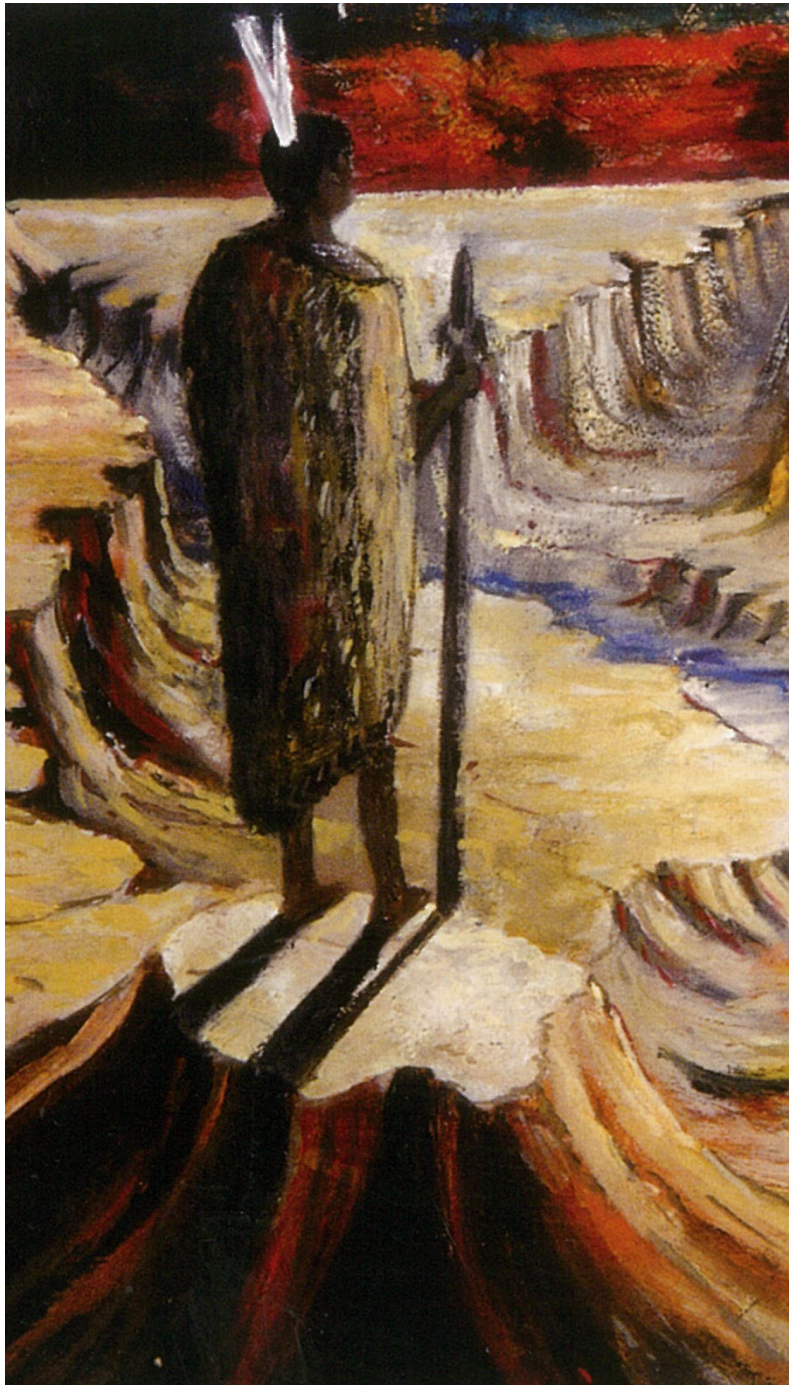
(Fig 1.5 Drawing of Takapuwahia marae)

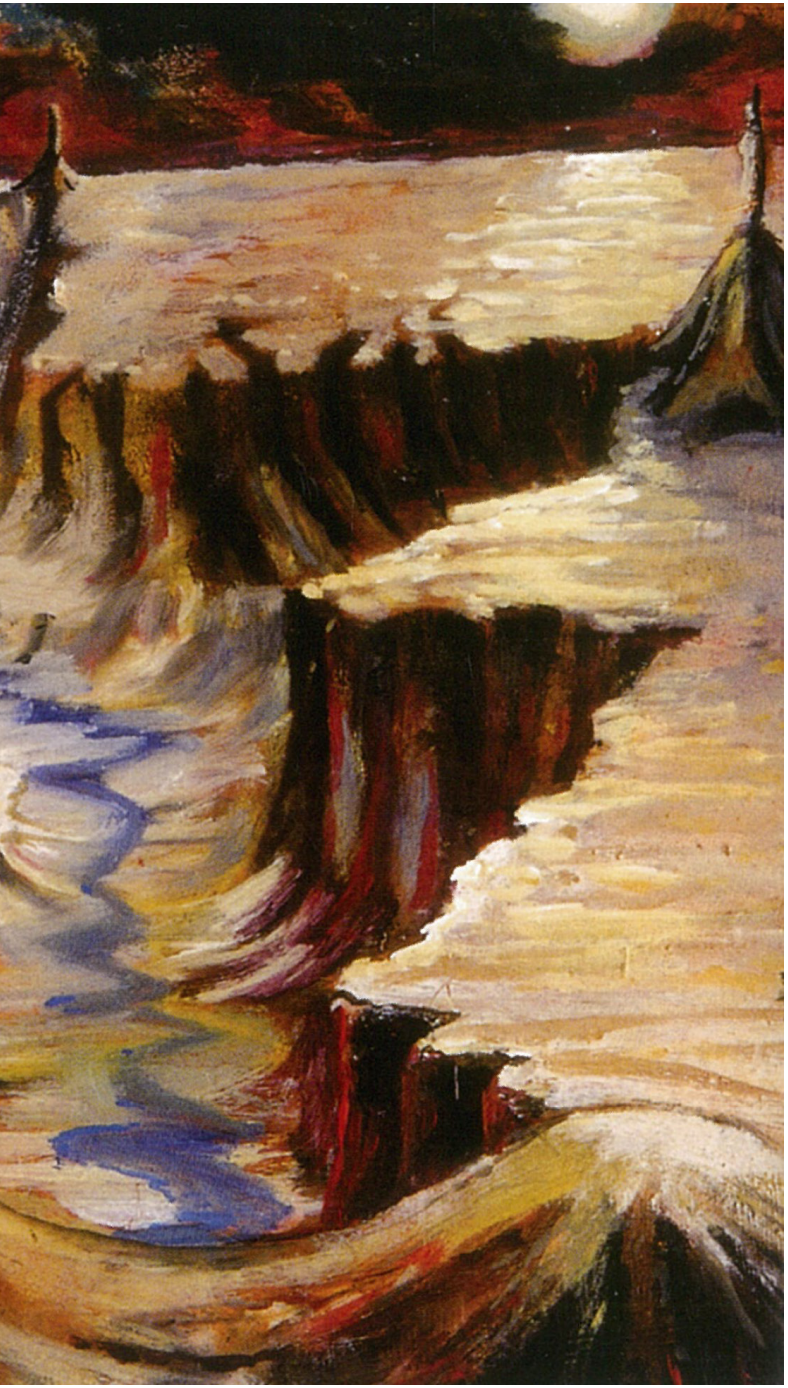
2. *Mana in Architecture*

2.1 Mana within the Landscape

Mana is the definition of life within all living organisms. It is the essence of energy that flows within the natural environment, and all living beings that live within the confines of Papatuanuku and Ranginui (Earth and Sky). It is the enduring and indestructible power of the atua and is given to a person, place or object since the day of it's birth (see fig. 2.1). The mana of a place, object or person is measured by its age and existence within the world, the more senior the descent, the greater the mana.

Porirua harbour has lost the mana it once prized as its surrounding environment and waterways have become less regulated and monitored having inadequate enforcement of public awareness up until recent years. The quality and status of Porirua harbour relies greatly on its connected rivers and streams. Due to the development and growth of hard surfaces and built environments the potential and future for the mana of Porirua Harbour will be highly dictated by the management and mutual agreement of Ngati Toa and the Porirua City Council.





(Fig 2.1 Battle of mountains, mana intertwined with the landscape)

2.2 Mana in Landscape Architecture

Landscape architecture epitomizes the understanding of land management through a design lens. Therefore, through the process of resource management and design-based opportunities, landscape architecture offers versatile and dynamic solutions for strategic planning that complies with both the local council and indigenous peoples.

The notion 'Mana in Landscape Architecture' is a term I use to expose the similar ethical principles between culture and design and an emphasis on community lead design rather than individual.

Landscape Architecture prioritizes the spaces people occupy and culture integrated within that space. Therefore, mana can potentially be recovered with the aid of landscape architecture design.

(The potential to harness digital software and implicate the immersive aspect of virtual reality will enhance the cultural experience of an environment in order to give a sense of mana within that area.)

(Fig 2.2 Indigenous group of men performing the haka)

(Fig 2.3 Depiction of Porirua harbour before colinization)

2.3 Architect/Engineer

The role of a landscape architect is ultimately to encapsulate the aesthetics of nature and resolve the addition of mankind upon it as it once was before colinization (see fig. 2.3). Traditionally, landscape architects adhered to the drafting of design rather than the physical production. Therefore, the process necessary to complete and represent the design requires the skills of engineers in order to formulate simulation/3D models of the designed area. This method of workflow is becoming out-dated due to the rise in software development and accessibility. This skillset of the engineer is becoming more apparent to the landscape architect. Living in the digital age has presented the designer with a toolkit that incorporates production into design and a steady digital workflow that is constantly supervised by the architect. Thus, the engineer's position within landscape architecture has become more redundant, allowing the landscape architect to engage and collaborate through all stages of design and manufacturing processes.

2.4 Reflection (Restoring Mana through Landscape Architecture)

As a landscape architectural graduate, my time spent analyzing any specific environment has also been used carefully to attempt to understand and embrace the culture relative to that landscape. Growing up associated with the Maori culture, I have learned that it is compulsory to understand the relationship between Tangata whenua and the respect we owe to our Atua. Without this awareness of achievement and accomplishment, mana within oneself will unconsciously disintegrate, therefore it is to be conscious and aware, to be in touch with the mana of that land.

I believe that as time goes on and the array of software and hardware continue to inundate the discipline of architecture, landscape architecture can revolutionize the way we design in order to perceive culture and indigenous restoration through a digital telescope.

. . . This literature review explores the indigenous values of New Zealand and its indigenous peoples through their holistic view on the world. It elaborates on the Maori views and sovereignty of the landscape and the management of natural resources by tradition that closely tie people with the land. This thesis also mimics the Maori theory of Kaitiakitanka or guardianship of the land applauding the work of Nganeko Minhinnick associated with the Manakau region. Lastly, design solutions and processes within landscape architecture take influence from the demographics of a community, therefore this thesis looks at the theory of 'Design by Nature' by Ian Mcharg on his view of a collective skillbase toolkit, and it becoming extension of the designer...

3. Literature Reviews

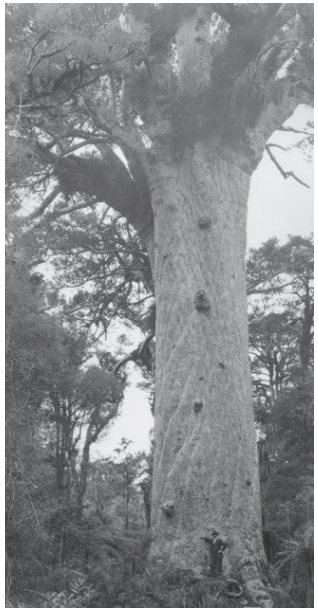
3.1 Maori Holistic World View

Maori culture is expressed as an entity that believes all people, flora and fauna are related through patterns of the landscape entailing a strong acknowledgment to their ancestry, assigning the natural world with the spiritual. It has long been known that the Maori people linked all life within their Korero and Whakapapa (stories and genealogy) such as Maui and the upbringing of the North Island (see fig.3.1), passed down generations by kaumatua (elders) via orality rather than script. Because of this interconnectedness, Maori define the world as a complex network of stories throughout the universe and land. Through this understanding of the world, details of resources such as location and quantity are shared in order to maintain a healthy seasonal harvest.

Whakapapa allow people to express the need for kinship and family whilst some tribes such as Ngati Toa have a strong connection with wai-maori signifying the strong relationship between themselves and Toangaroa where other tribes for example are decedents of Wainui-a-Tane and relate to birds and insects of the forest. Korero, being the story behind the origin of a person or tribe, or the stories signifying great landmarks can influence ones heritage and describe

The book 'Te Taiao' Maori and the Natural World explains the essence of Maori culture and their productivity spiritually and physically.

(Fig 3.1 Korero of Maui and the North Island)

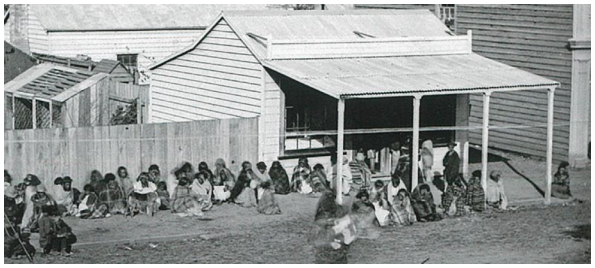


(Fig 3.2 Tane Mahuta, Northland)

Tangata Whenua are known as the people of the land, or tamariki, the children of the earth and sky. Their presence in this world is respected throughout landform and natural features of the landscape, therefore when being asked who they are, they will answer not directly of themselves but rather the environment they associate themselves with (Taiao).

Maori traditions rely on the knowledge passed down from their ancestors whom were said to have travelled via waka(-canoe) carrying stories and practices with them (see fig. 3.3), whilst some tribes believed their ancestors emerged from the New Zealand landscape. This also accounted for the change of the environment over time and how to function accordingly when there is a dynamic shift of resources or ecosystems. This holistic view is seen amongst many cultures across the globe, yet the Maori have shown their capability to live alongside and adapt to an indifferent culture (see fig. 3.4) that believes progression of the built environment is more important than the natural features of the existing landscape.

(Fig 3.3 Women practicing traditions)



(Fig 3.4 Tangata whenua utilizing western buildings)

Key Discussion:
- Whakapapa + Korero
- Tangatawhenua
- Orality

3.2 The Principle of Kaitiakitanga

Within all communities, there is a large concern for the methods used to conserve locally obtainable or locally significant resources. Although in today's society more often than not there is less concern for resources and larger interest in development. This has resulted in the exhaustion of natural wealth, and is leading towards the collapse New Zealand's natural environments.

Kaitiakitanga is the term referring to the protection and guardianship of local resources attributed to a particular Maori tribe and their relationship with the land having a more symbiotic nature rather than disjointed. It is the principle of land use and resource management through the lens of whakapapa and korero. By understanding and incorporating Kaitiakitanga, whakapapa has the capability of safely traversing generations allowing for the same resources of the past to be present today. It is used as a method of teaching kaupapa (policy) and conservation to Tangata whenua. ing Kaitiaki into a tribal community, it is compulsory to achieve an agreed decision by both natural and technical scientists to entail that Papatuanuku regains health and mana in order to nourish the forces surrounding her.

'Establishing Kaitiakitanga' is an article by Nganeko Minhinnick and justifies the affordability of Kaitiaki practices. She entails that Kaitiakitanga is a system complex values being social, cultural, economic, and spiritual. It is a system that regulates the lands and waters of the Maori people. "To know Kaitiaki is to know the Maori world" (Minhinnick).

Kaitiaki is not only adjunct to the physical world but spiritual as well. Such as the guardians of waterways perceived as Taniwha and protectors/guardians of all tribal toanga. Physical Kaitiakitanga is the work of tangatawhenua whom associate whakapapa with their roles of inherited responsibility such as an instruction or direction. This being said, Kaitiaki is assigned through kaumatua or Maori elders and can only be understood and practiced by tangatawhenua.

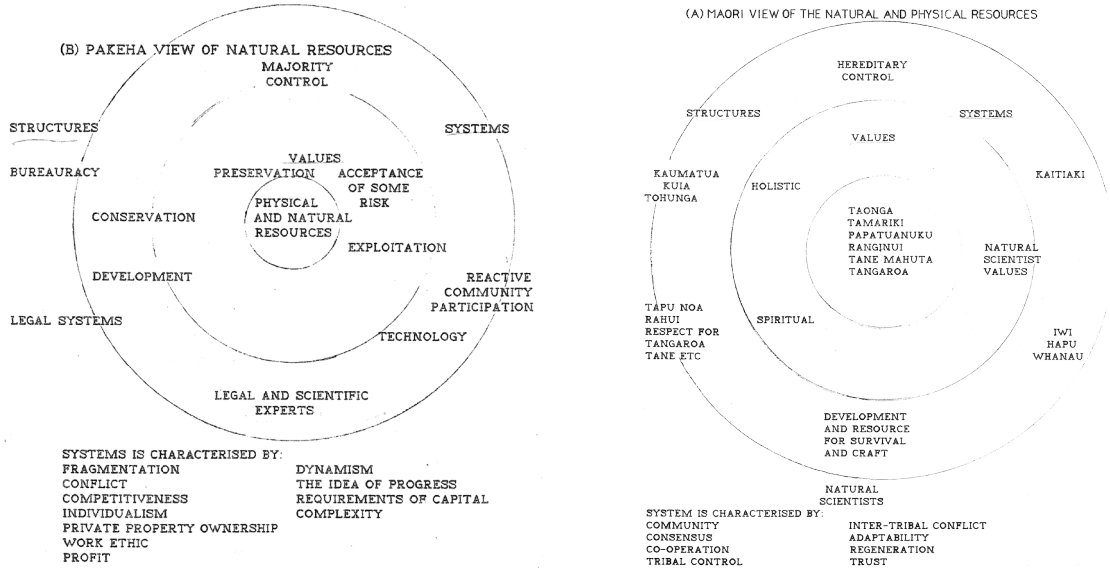
When dealing with death/drowning within an Iwi or on tribal lands, Kaumatua declare certain areas as 'tapu'. Kaitiaki declares what is tapu immediately within a community. Kaitiaki organizes the necessary rituals from kaumatua in order to help declare tapu lands. All areas declared tapu means that, the area is forbidden to operate and all activities will be placed on hold until the tapu has been lifted.

Traditional methods of resource conservation and sustainability are practiced by Maori communities and involve the restriction of using or accessing certain resources throughout certain times of the year. This is known as Rahui and is heavily monitored by technical and spiritual scientists whom declare the ban of resources by presenting a range of information identifying issues associated with the Iwi and their consumption of that particular resource.

Kaitiakitanga is compulsory within a Maori tribe, without it there would be no policy among Tangata whenua and no arrangement in the occupation of land. Kaumatua share stories with tamariki to enrich future generations with knowledge of their landscape (see fig. 3.5).

Kaitiakitanga Objectives:
- *Restore mana Moari*
- *Protect sensitive features of the aquatic environment*
- *Plan long term usage of toanga*
- *Plan provision of kaimoana for future generations*

(Fig. 3.5 Kaumatua sharing stories with children)



(Fig. 3.6 Pakeha and Maori Differences in Values)

A Kaitiaki world view amends to a more protective role in environmental decision making. This contrasts with the 'Pakeha' view of the natural resources where physical and natural resources are sought for development and exploitation rather than having a spiritual connection to those recourses and the land, as do the Maori people (see fig. 3.6).

3.3 DESIGN WITH NATURE

The book, 'Design with Nature' written by Ian McHarg in 1967 depicts the future/current generation of design techniques and approaches that have outdated the previous methods of design. McHarg's perception of designing cities through community involvement, cartographic representation of landscapes through mapping to decipher demographic relationships and disconnections allow the architect to translate issues and problems associated with the economic and natural structures that currently exist or are soon to be emerging within the urban environment.

The collaboration of the architect and engineer is seemingly under constant surveillance following the analytic approach of the engineer where design was neglected rather than synthetically designing a world that encompasses an ecological world view.

An example he shares to better describe his view single-minded engineering is that of the 'highway'. The highway distinctively revolutionized the way people operate in terms of efficiency and convenience which encouraging the production and usage of motor vehicles. In this case, the transportation model inundated the ecological, natural, and sustainable processes and its trail of anti-ecology is seen today can be seen such as scars upon our land and our cities (see fig. 3.6). (McHarg)

(Fig. 3.6 Highway development as scars on the earth)

The argument this thesis aims to clarify and peruse in order to accurately design for the consideration of indigenous peoples and cultural landscapes is the inability to approve those outside of the indigenous community to design and manage such landscapes without the collaboration of indigenous people and coordination of knowledge. This book identifies the reality that just because a single individual/profession has been approved of designing for the function of diverse landscapes or community structures, does not mean the production can be completed without the assistance of those who relate personally with the heritage, culture and spirituality between themselves and the land. To reinforce this notion, Ian McHarg clearly describes how the function of infrastructure is composed of two very distinct values, so too do cultural and indigenous landscapes. When designing highways, engineers are crucial to the knowledge of construction, material distribution and physical limitations in order to safely provide for the transport of vehicles etc. Although this is more vital than the utility of the finished design, the engineers translation of design ends with the structure itself. This implies that there are values that don't comply with the knowledge of the engineer and rather the inhabitant/passenger and the natural environment being factors that determine the life of the structure. Highways scrape and demean the essence of the natural environment, hence it is perhaps more crucial to involve the recipient in the design process.

This research explores how the landscape architect has the potential to operate as both the designer and the engineer through the process of analyzing cultural and natural environmental aspects and engaging with indigenous societies and their relationships with their landscape. Ngati Toa's operations under kaitiakitanga are engineered through waterway and resource management and designed according to traditional and cultural values.

Key Discussion:
- Engineers and Architects as one
- Revitilizing the landscape through community collaboration
- Using existing cultural values/traditions as guides to designing

3.4 Reflection

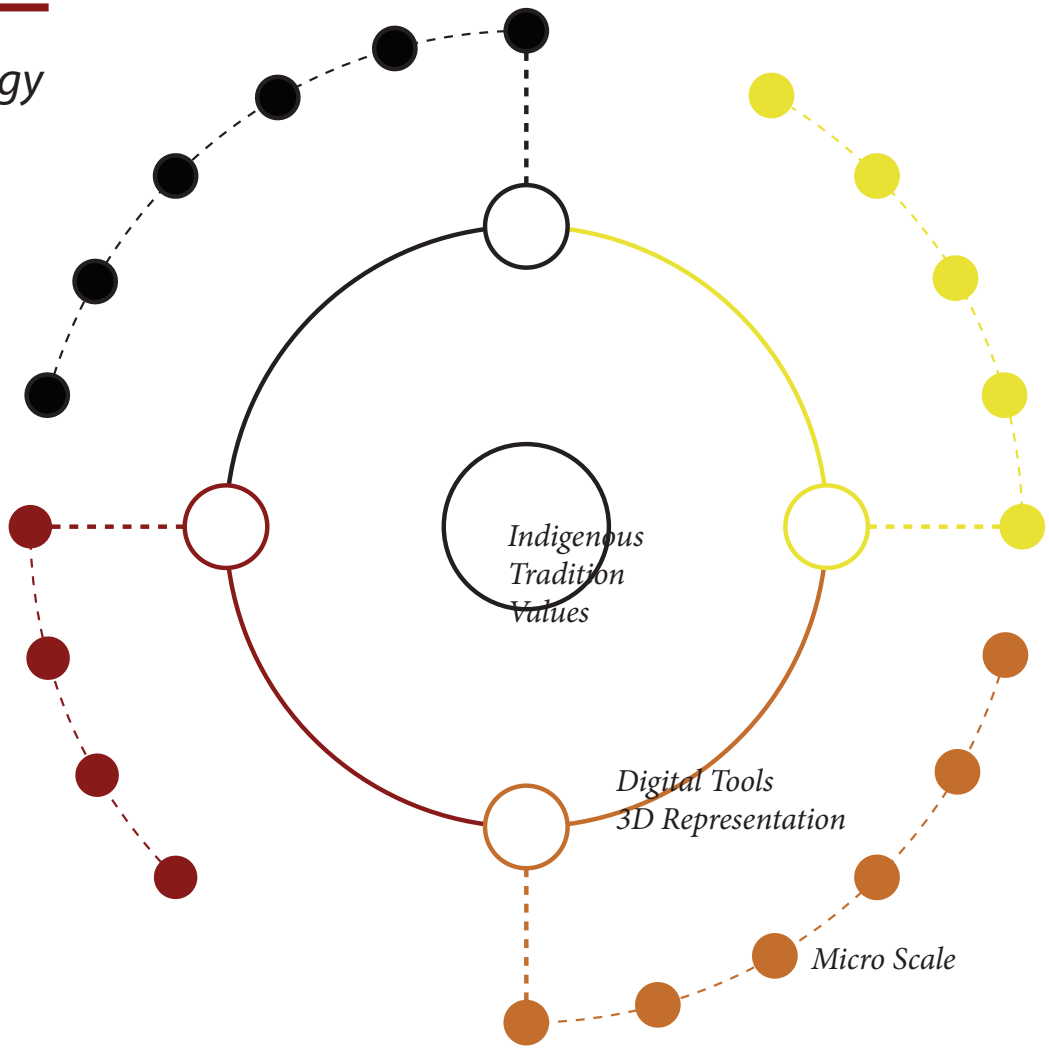
This research was constructed upon the fundamentals of indigenous values of New Zealand and is crucial that the design outcome reflects on the health and protection of indigenous landscapes. Te Taiao depicts the world view approach of Maori peoples and their existence of spiritual connectivity between atua, whakapapa and kaitiakitanga. To view the world in a holistic view allows the understanding of natural proccesses and how we look at producing communities that coexist in harmony with the natural environment. Nganeko Minhinnick's view of kaitiaki acts as a driver for environmentalism and the approach Maori use to ensure protection and guardianship of their environment. Due to the colonization of New Zealand, conservation has been limited and therefore it is required that cultural values adapt to technological solutions in order to provide an advantage when managing resources exposed to the development of urban environments. As a landscape architecture graduate, having access to up and coming digital technologies provides a kit which can be used to target the development of indigenous communities engaging through collaboration to optimize cultural benefits upon their lands.

4. Digital Workflow/Methodology

The aim of this thesis is directed towards a producing a catalyst for the landscape architect and their inventory of tools through the inheritance of digital technologies in order to develop conventional methods of mapping and data collection that affords mana tupuna and kaitiaki among Maori people in Porirua.

'How can landscape architecture utilize emergent 3D technology and crowd-sourcing methods in order to restructure the management of resources within waterways and harbours in order to produce a collaborative tool between indigenous and designer through the lens of Kaitiakitanga?'

4.1 Methodology



In order to initiate the field study, there is an array of tools required for the collection and organization of recorded data from Porirua Harbour and it Waterways. The first stage of this research methodology looks at how data is gathered and geo located by using GPS tracking hardware and software.

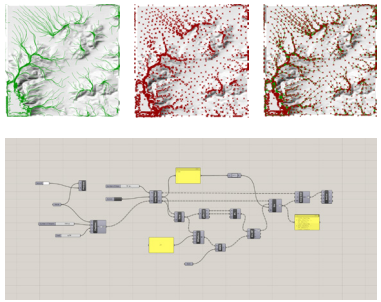
Methods of collecting data involve the collaboration of tangatawhenua. This approach is called crowd sourcing which affectively gathers data from each individual of the community and uploads this data into a database of local resources with descriptions of that particular resource such as native flora and its health and status. This method contributes to the education of tangata whenua and their knowledge of local whakapapa and kaitiaki.

With a database of local values/resources, the data will be utilized within a digital workflow in order to represent local issues, warnings and uncertainties via 3D modelling and immersive environmental simulations. The method of data collection includes:

- GPS Tracking
- Harbour and Waterway Monitoring
- Crowd-Sourcing
- Virtual Information Modelling
- 3D Cad Software

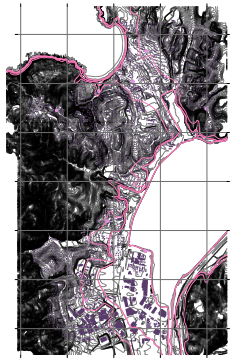
4.2 Digital Workflow

GRASS HOPPER

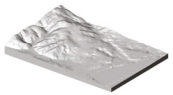


PHOTOGRAMMETRY

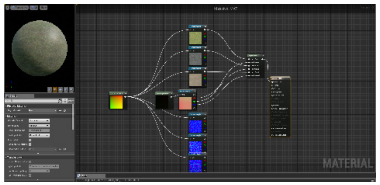
ARC GIS



RHINO 3D



UNREAL ENGINE 4



VR PLATFORM

4.3 GPS Geo Location

Tracking data requires navigation through natural terrain and wildlife exploring new environments, all whilst logging data in the most efficient way possible. New and improved GPS tracking devices will be utilized in order to determine geo locational specific data and climate analysis. Therefore, for this research I will be using the GPS-Map by Garmin. This device allows for accurate locational recording while using its own default base maps (see fig. 4.1), which include coverage over most of New Zealand's forests and waters. After the collection of data identifying the locations of resources within the environment and hydrology and climate data of land and waterways further use will involve the production of a 3D immersive landscape and geo-location mimicry.

(Fig. 4.1 Garmin base map)

(Fig. 4.2 Garmin GPSMap 62s)

Hardware Specifications (see fig. 4.2):
Size: 6.1 x 16 x 3.6 cm
Weight: 260.1 g with batteries
Waterproof: IPX7
Interface: high-speed USB and NMEA 0183 compatible
Basemap: yes (ability to add)
Memory: 1.7GB
Tracklog: 10,000 points, 200 saved tracks
(GPSMAP 62s)

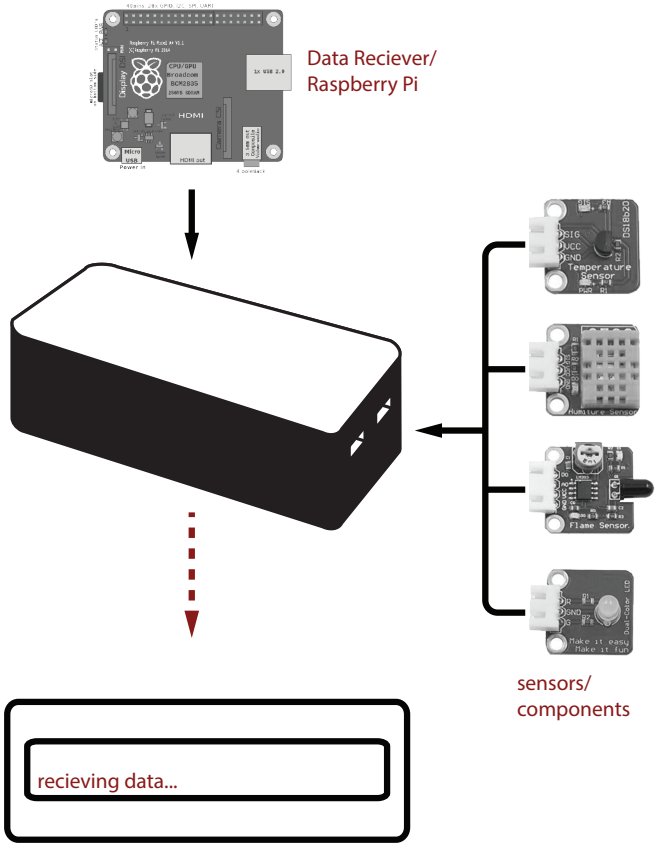
4.4 Monitoring - Raspberry Pi

The first stage will be most practical for long-term changes in the environment and requires the assembly of electronic components to create and use safely.

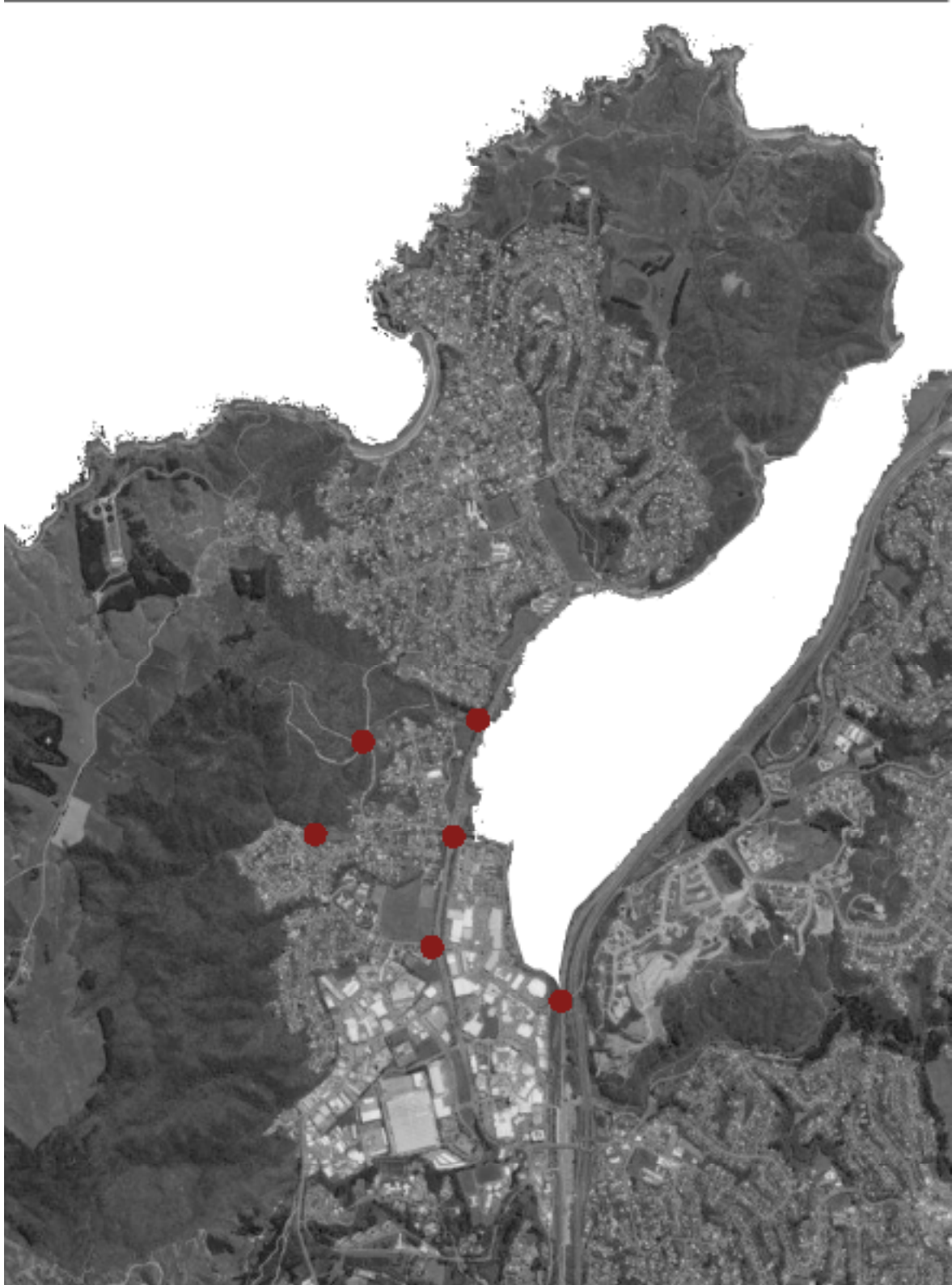
Raspberry Pi is a tiny computer system that fits in the palm of a human hand. Due to the appearance of more up to date computer peripherals and components, the raspberry pi utilizes adequate performing componentry (see fig. 4.3) whilst minimizing the size of the hardware itself becoming portable for frequent relocation and/or requirement for locational setup (ease of fit in most environments). (Eben Upton)

In order to record, upload and control data from distant locations such as within the forest or near coastal environments, the raspberry pi acts as an efficient substation, and with the addition of sensor hardware, it will produce climate data etc ready for uploading to a cloud such as GISCloud or transferring to a computer via memory stick.

The data received will be translated to become compatible for further visualization through downstream software such as game engines.



(Fig. 4.3 Raspberry Pi assembly)



4.5 Monitoring - Crowd-sourcing

The second technique of monitoring data over a long-term period of time involves the efforts of individuals called **Crowd-sourcing**. (Thenkaball)

Crowd sourcing is a sourcing model in which individuals and/or organizations collaborate in order to obtain data as well as the ideas and thoughts of the people. This technique strongly complies with the involvement of native people and their connection towards managing the land. Crowd sourcing in a digital sense mimics Kaitiakitanga through management and opinions of the individuals. My role is to providing the technical assistance and resolve issues with kaumatua and Maori organizations to enrich the feasibility of a digital kaitiaki, a step into the 'Maori digital world'.

In order to successfully implement a crowdsourcing approach to monitoring data, individuals will be required to have access to a cellular phone with geo locational services such as Google maps and also have access to the application GIS cloud MDC (GIS Cloud). Mobile Data Collection is an application made for the purpose of crowdsourcing, and the intention of helping communities revitalize landscapes and monitor their own landscapes.

Mobile Data Collection Portal:

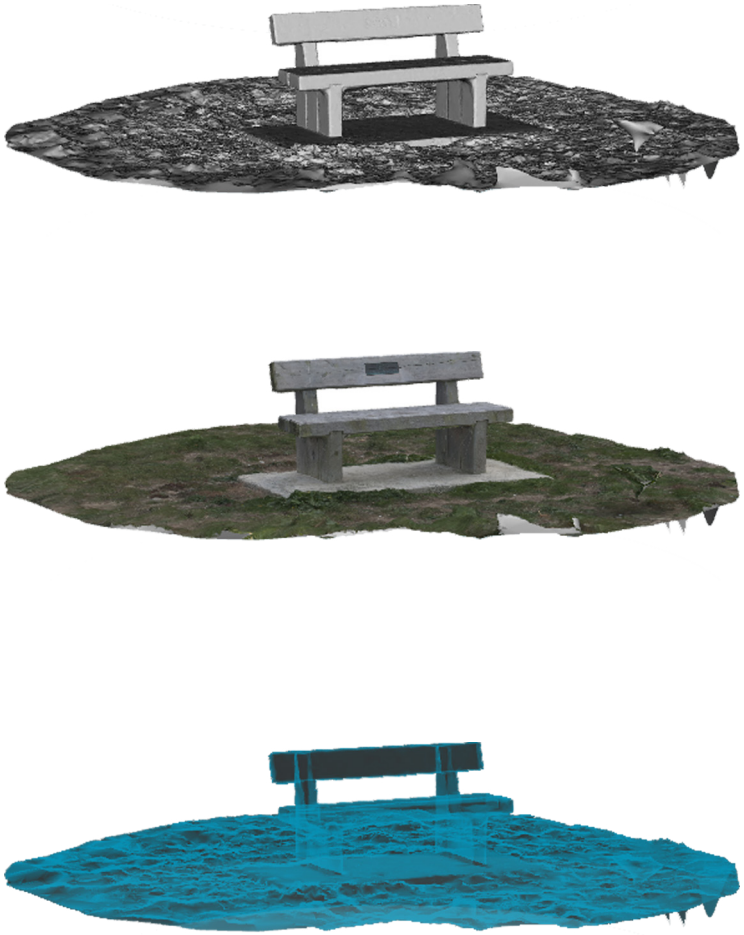
Gis Cloud offers a service of data management enabling an efficient process of sharing data amongst a network of users. This platform encourages the connectivity of land information and divorced Tangata Whenua land by bridging the main factors causing gaps such as distance and the transparency of contribution. MDCP aims to aid such communities through providing a live database entailing their vital values including important resources, meaningful land marks and all things associated with the good of the iwi, relevant to the past, present and future.

Map Editor:

The map editor will enable the basic functionality in order to add or remove layers upon satellite imagery and topographic terrain projections. (see fig. 4.4). Individual users will be represented as symbols and hold the ability to record data which is further visually represented by vectors creating additional layers relative to that category of data. This data allows for a collective matrix of landscape values recognized by the targeted community and affords reasonable solutions to be made appropriately through the visualization and analyzation of organic patterns and dynamic shifts over time. (GIS Cloud)

(Fig. 4.4 GISCloud MDC map editor and template form)

The second stage of this methodology involves the representation of the land and the ability to encapsulate an accurate and surreal digital representation of the environment through virtual reality. In order to do so, I will be implementing an approach called photogrammetry. This utilizes photography in surveying and mapping to represent the distance between objects and formulate a point cloud coordinate system of the environment. The programme used for this approach is called Remake, an end-to-end solution offering a server-based client for converting high-resolution images (Raw file format) and scans into high definition 3D meshes. (see fig. 4.5)



(Fig. 4.5 3D mesh of chair)

4.6 Photogrammetry

Photogrammetry allows for the downstream workflow of photo imagery and data coordination through the surveying of landscapes and mapping ascertain measurements between objects.

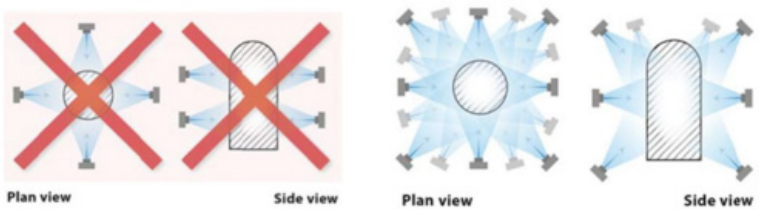
This process is enabled through the software called Autocad Remake which provides a platform for uploading collected imagery and outputting high quality 3 dimensional objects to represent virtual counterparts of certain areas. Remake is compulsory in developing a virtual environment that will afford immersive experiences in detailed 3D environments.

Health issues with Porirua harbour and connected waterways can be compensated for the lack of monitoring through digital representations provided the current status of the environment. To capture cultural experiences to analyzing corrosion and other natural processes, Remake offers the potential for optimization of current landscapes and the ability to clean, fix, texturize, compare, decimate and other editing functions in order to visualize design decisions before physical implication.

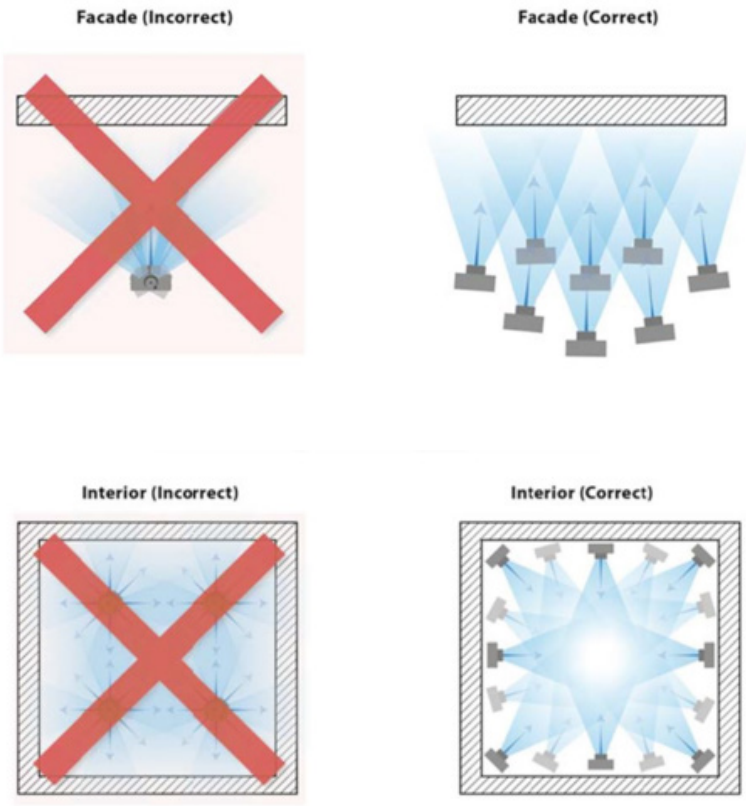
Capturing the real world is now becoming more affordable and accessible to be practiced which results in the enhancement of experiential aspects within the virtual world.

Strategies and Equipment Set-Up

When capturing imagery, it is important that precautions are taking to ensure the highiest quality of the final mesh when supplying the remake server with raw photos (see fig. 4.6). This includes taking photos at certain angles to cover all surfaces of the object/landscape (Vidanom).



(Fig 4.6 Taking the right photos to produce the best output for the mesh)



(Fig. 4.7 Taking photos for photogrammetry)

- The target/object should always be centred in the frame of the picture being taken and should fill most of the photo. The reasoning for this is to sup ply a majority of pixels for the remake engine to use when developing a 3D mesh (see fig. 4.7).

- Diffused light is also preferred as the object will pro duce shadows otherwise leading to the loss of consistency across that object.

- All objects should be stationary to ensure that the final reconstructed model is not distorted.

- It is suggested that the more photos, the better the quality of the object. To do this, photos should be overlapped and alternative heights where the position of the camera is to be parallel with that object at all times. The shift in the angle of the camera's position is only to be changed when capturing imagery at different heights. The target should be photographed at different angles focusing on the centre point of that object (Vidanom).

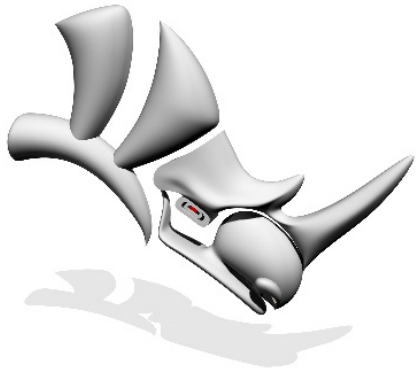
4.7 Gamification - Unreal Engine 4

The output model from remake will be compatible with many game engines to allow simulation for testing current environmental issues to educate tangata whenua of their rohe and experience a cultural sense for that place.

Unreal engine 4 was developed by game developers for those aspiring to create virtual worlds for navigation and experience (Epic Games). This research looks at the potential to utilize this game engine towards developing a system in which Iwi and city councils have the ability to engage and collaborate through design decision making and the operations of resource management. This system tool will also be means of a way to get in touch with detached tangata whenua and members of ascertain iwi. With game developer tools, the capability to create a virtual replica of an environment which supports a real time data feed, is now possible with a range of tools for the user can engage with.

The format of this tool will enable accessibility to distant iwi members with access of the internet and/or a cellular device. It will enhance the visual representation of that environment and engage the user by sharing thoughts and questions to other users within the same client.

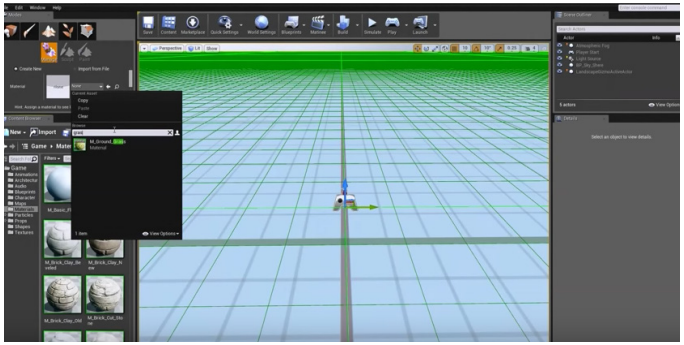
Rhino 3D import into Game engine

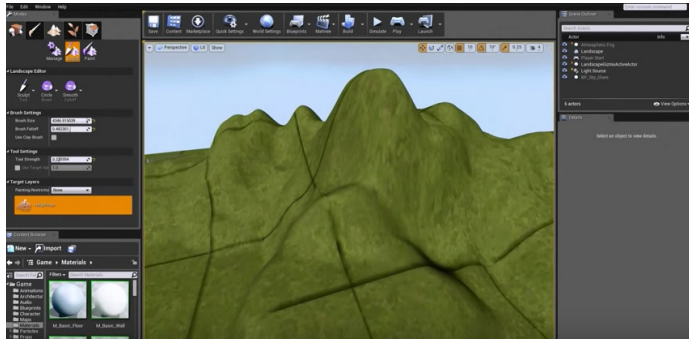


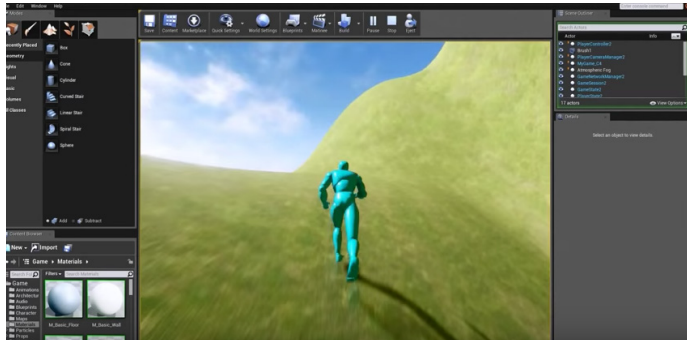
(Fig. 4.8 Rhino Logo)

Unreal Engine provides a consistent work-flow with Rhino 3D (see fig. 4.6) where meshes can be optimized to support editing of photogrammetry models.

In order to provide a navigable surface/terrain for immersive interaction, mesh outputs from rhino are imported within the game engine to create a topographic surface that anchors the avatar.

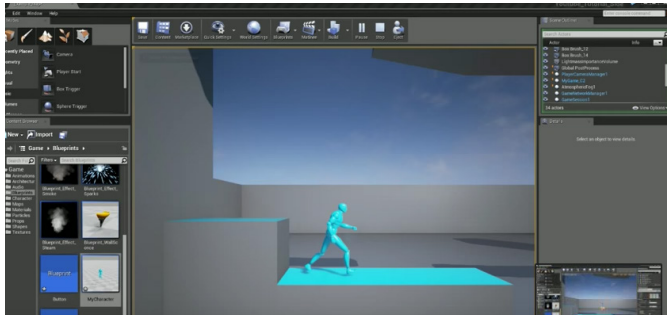


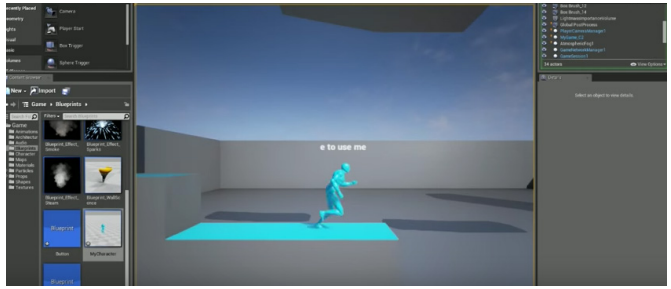




left: The Landscape creation tool offers a solution to generating a topographical mesh either manually drawn or imported from online topographical data. Once created into a mesh, the world can be viewed in third person at a one-to-one scale in order to perceive the current environment.

below: The avatar is the user and it is important that the user engages with the environment. Therefore, interactive buttons can be made within the game engine to allow interactivity.





4.8 Developing the Model

By following this methodology, it is important to drive kaitiaki to alleviate the opacity of mana tupuna in Porirua. Collection of local data will be the foundation to provoke awareness through engagement and knowledge. It is vital that this stage continues in order to provide compatible real time data for further down stream software.
From the emergence of digital tools is it only now possible to compose virtual realistic counter-parts for topographical landscapes and i believe this method of landscape architectural design will eventually replace the current form of mapping and the representation of data.

5. Design Project

5.1 Site Context

From more of an indigenous perspective, New Zealand streams and rivers hold the most significance in terms of spiritual connectivity between maori people and the realm that lies between Ranginui and Papatuanuku. This project will analyze values of kaitiaki within Porirua and the afflicting causes of harm towards the natural environment.

Ngati Toa's relationship with porirua harbour is a primary concern to the Iwi its resources. Therefore, it is worth identifying all aspects of heritage and significance to their rohe while understanding the life and values share that land and establish kaitiakitanga and whakapapa between tangata whenua and their rohe.

The iwi tradition of Ngati Toa is that kaimoana is said to have been the richest in the harbour of Porirua and was utilized for multiple day to day activities. The decimation of the natural environment has restrained such traditions from taking place due to the built environment and the blindness in their impacts of managing waters and resources.

I will be investigating the 'Onepoto arm' of the harbour and its attributed streams and rivers in order to assess the health of kaimoana and traditional roles of the iwi.

(Fig 5.1 Takapuwahia 1958)

(Fig 5.1 Takapuwahia, Eldson 1956)

Indigenous Forest
Titahi Bay Road

(fig 4.1Tane Mahuta, Northland)

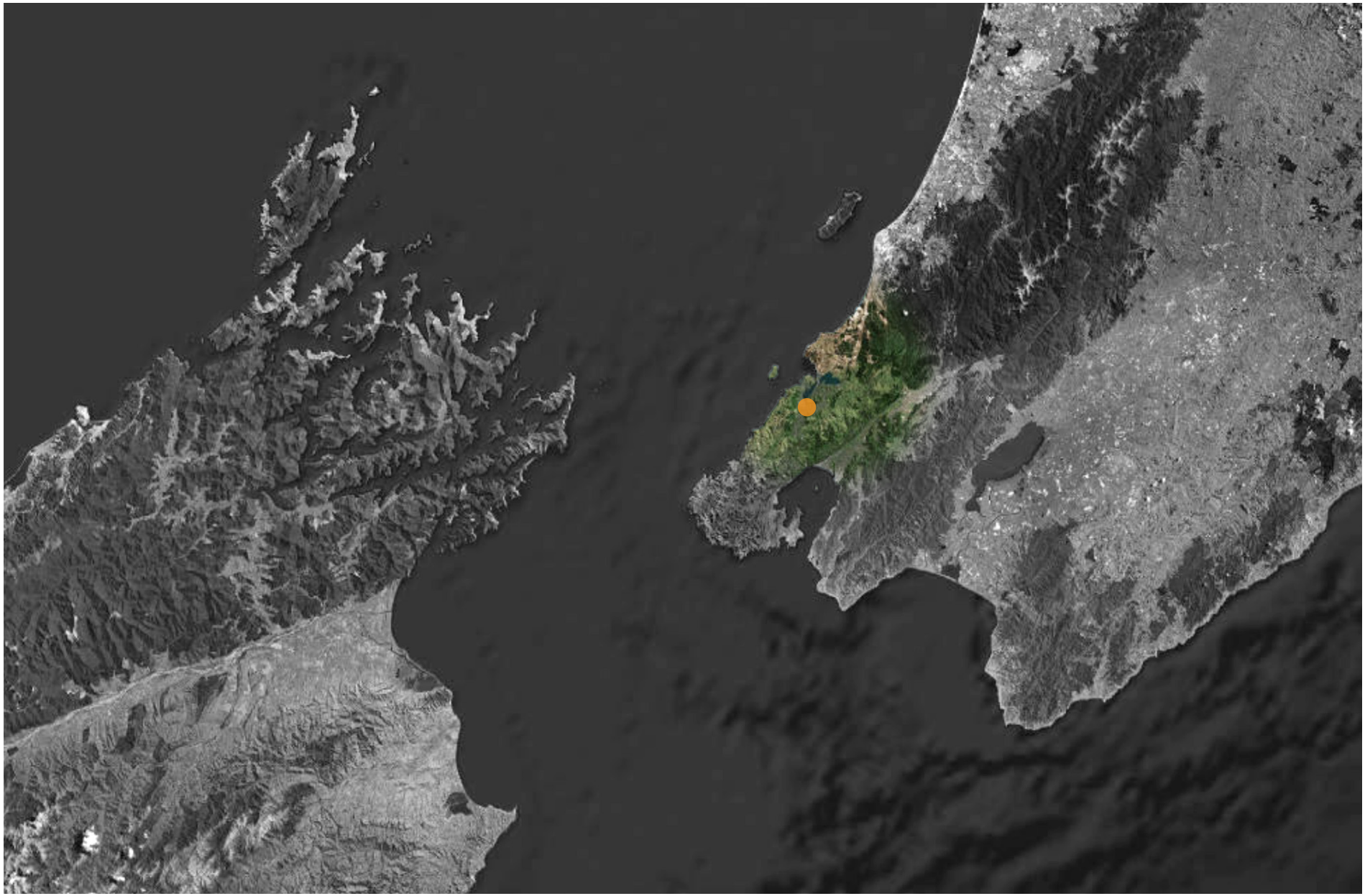
5.2 Site Analysis

This section looks at the fundamental aspects of the natural environment and the issues currently existing such as:

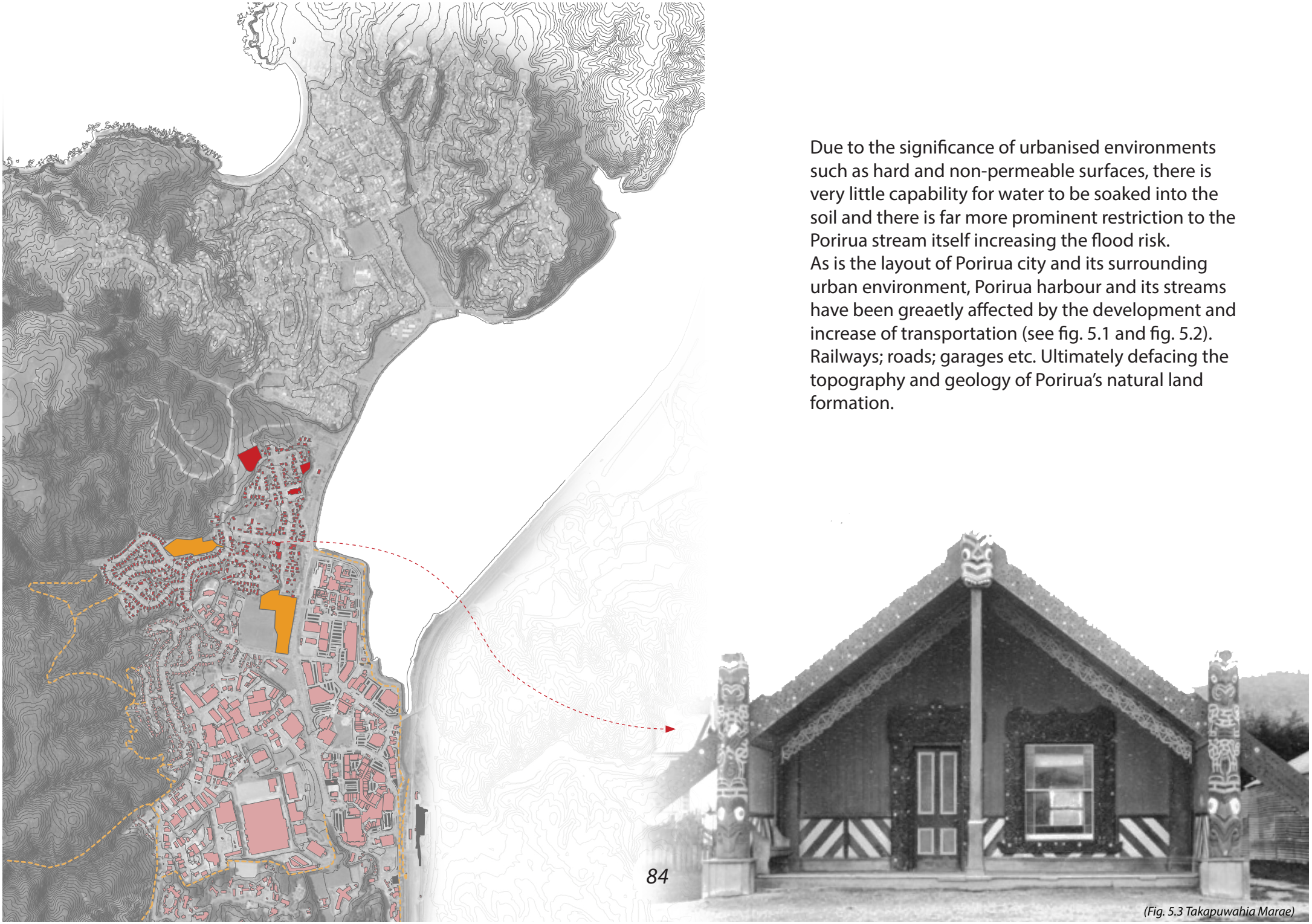
- Waterways/Catchments/Wetlands
- Pollution/Hardscapes/Coastal Erosion
- Native Species of Flora/Fauna
- Pastures/Deforestation
-Heritage/Recreation
- Urban Development/Built Environment

The kaitiaki of these values will be assessed based on the prominence of whakapapa and mana with certain traditions according to Iwi genealogy.

Designing for the impression of indigenous revitalization is priority here before the implication of the digital methodology will begin.



Due to the significance of urbanised environments such as hard and non-permeable surfaces, there is very little capability for water to be soaked into the soil and there is far more prominent restriction to the Porirua stream itself increasing the flood risk.
As is the layout of Porirua city and its surrounding urban environment, Porirua harbour and its streams have been greaetly affected by the development and increase of transportation (see fig. 5.1 and fig. 5.2). Railways; roads; garages etc. Ultimately defacing the topography and geology of Porirua's natural land formation.



(Fig. 5.3 Takapuwahia Marae)

Heritage/Amenity

Takapuwahia Marae (see fig. 5.3) lies in the centre of Ngati Toa's Rohe being the most influential structure through the history of Ngati Toa's existence within Porirua.
Other Culturally significant buildings are seen to the left and such as Urupa and Church.

Current Issues:
- Access to harbour is cut off due to Titahi Bay road
- Connectivity between heritage and significant public amenities lacks in narrative

Iwi Buildings

Low density housing is dispersed throughout Takapuwahia. Majority of population demographic are families and local tangata whenua. Their contribution to the Porirua Harbour is limited and rather attire for the water waste/runoff which influences the health of Porirua Harbour.

Current Issues:
- Pastured land-cover
- Water treatment
- Urban runoff

Porirua City Buildings

Porirua CBD comprises of industrial factories along with retail stores, supermarkets and other public amenities. Its development has progresses in order to accompany the rise in population whilst attempting to restore the natural environment from decay and further harbour deterioration.

Current Issues:
- High density built environment including industrial and residential environments
- Harbour side urbanism neglects Harbour as buildings face south
- Porirua Stream in need of restoration to increase natural environmental statues and visual aesthetic

Parks/Reserves

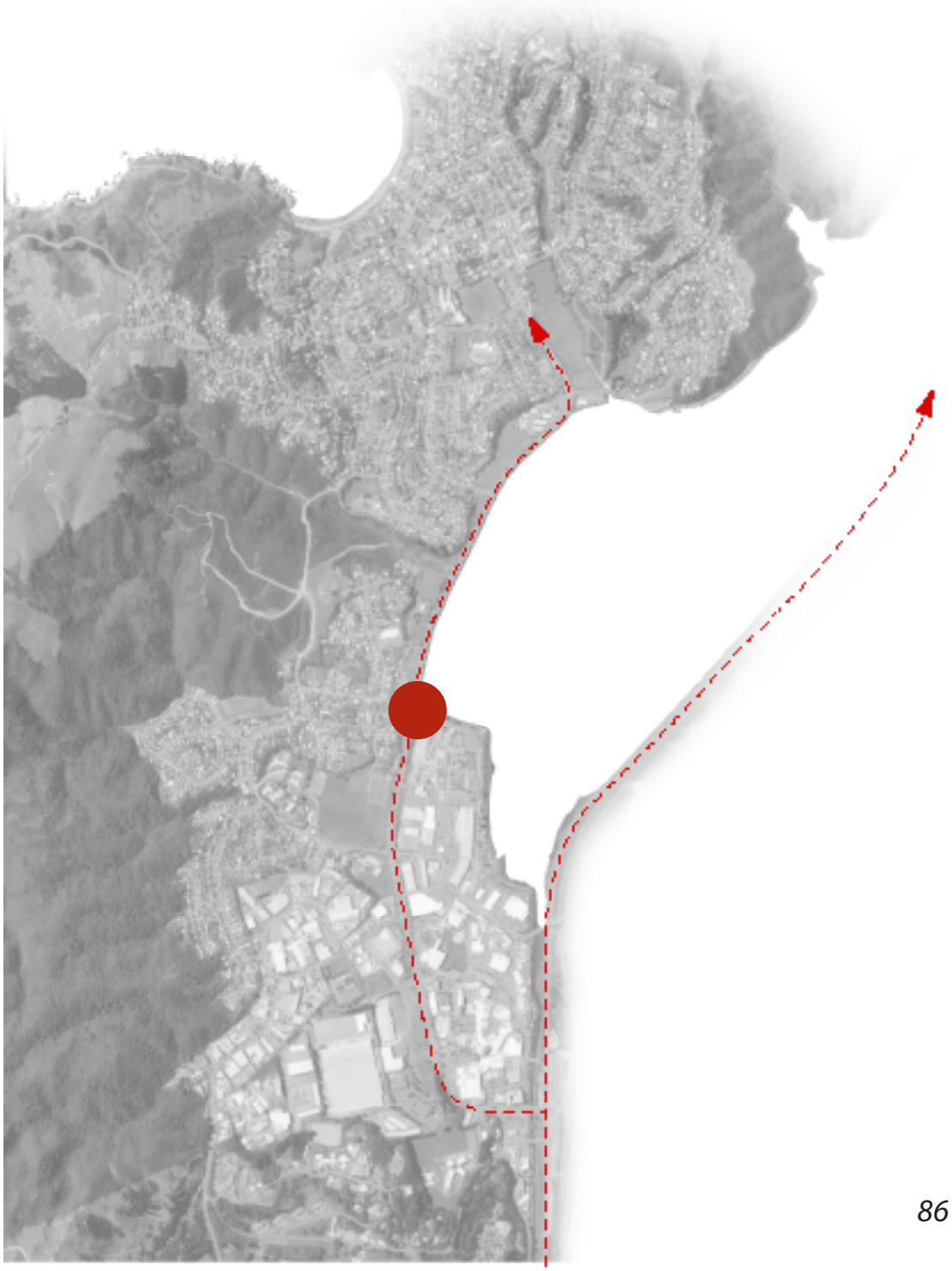
Public parks and reserves have replaced deforestation of certain areas in order to revitalize the natural environment. Most reserves are situated within existing urban environments to afford accessibility to the residents of Porirua and Takapuwahia.

Current Issues:
- Existing and future parks/ reserves require more influence on the restoration of the natural environment
- Connectivity between residential and heritage built environment needs to be more vivid for the local tangata whenua to utilize

Public Walkways

Walkways throughout Takapuwahia are distributed accordingly to provide access from the CBD to western suburbs and vice versa.

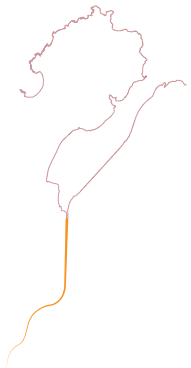
Current Issues:
- Public walkways need to intervene with the natural environment to promote awareness
- Better distribution within Takapuwahia village settlement should be enacted to increase safety and protection of public and natural environment



The result of highway and transportation development is leading towards cultural decay therefore consideration to optimize connectivity occurs upon reversing the affects this has had.

Such approaches include the significance of Ngati Toa and landmarks (see fig. 5.4) in order to create a narrative across the built and natural environemnt.

(Fig 5.4 Takapuwahia Pou)

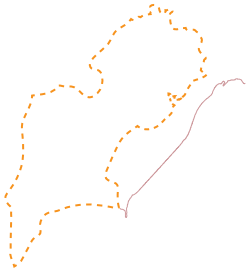


Porirua Stream

- South of Onepoto Arm
- Main Stream that collects water from the Whaitua catchment
- Natural environment heavily influenced by built surroundings

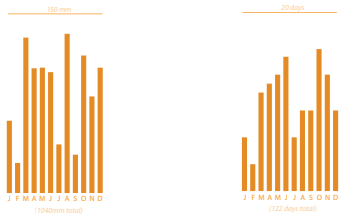
Secondary Streams

- Direct runoff from topography of Takapuwahia
- Pasture land with low vegetation causes streams to degrade losing connection with Iwi

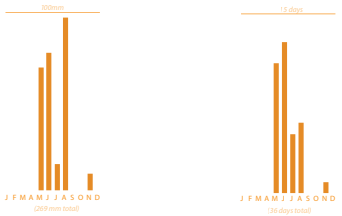


Whaitua Catchment

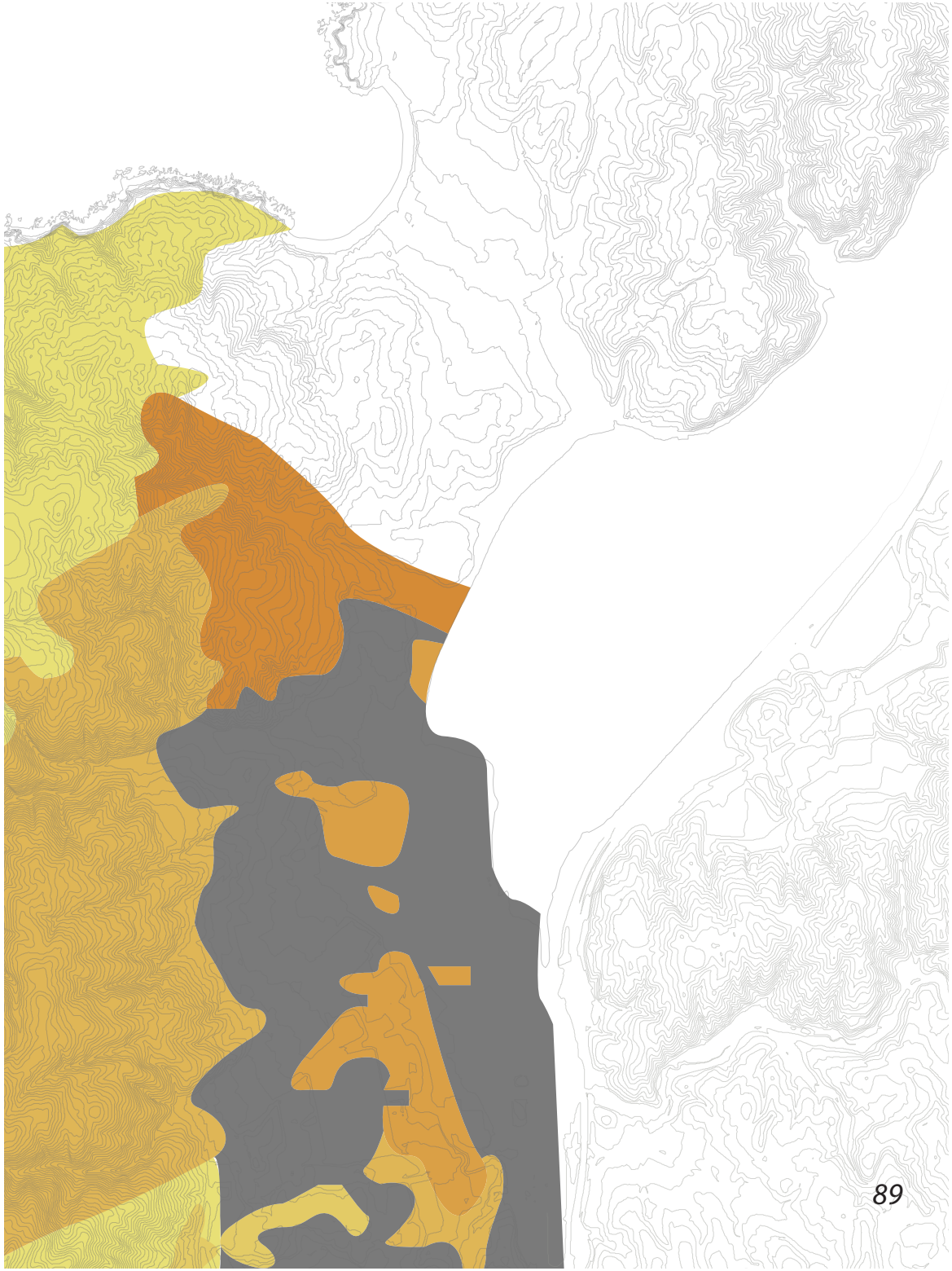
- Western suburbs of Porirua catchment.
- Affected by urban environment
- Loss of indigenous forest and vegetation cover resulted in unsustainable resource management



Rainfall data 2016



Water Runoff 2016



Porirua Region was said to have been covered with impenetrable forest during pre-colonial New Zealand. Between 1850 and 1885 this was mostly converted into grazing pasture which lead to hillside and stream bank erosion issues (Ammundsen).
Today, there is small remnants of natural forest/vegetation scattered throughout Porirua (mostly around edges and coast) with the majority being pastures, parklands (fields and reserves).

Urban

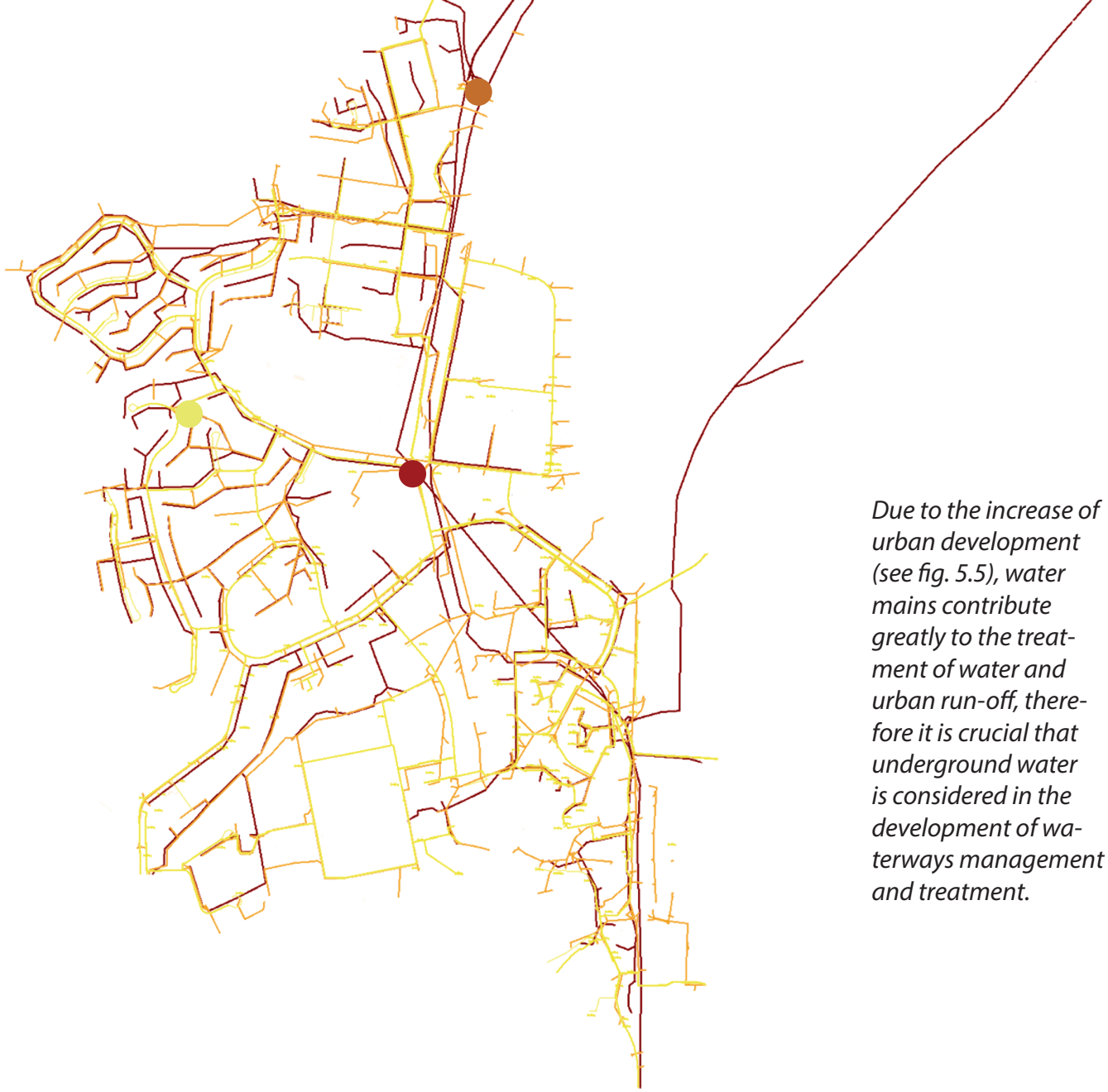
Shrub

Parkland

Indigenous Vegetation

Exotic vegetation

Grassland



Due to the increase of urban development (see fig. 5.5), water mains contribute greatly to the treatment of water and urban run-off, therefore it is crucial that underground water is considered in the development of waterways management and treatment.

Sewer Mains

Stormwater Mains

Water Mains

(Fig. 5.5 Urban infrastructure of Takapuwahia)

Sewer Mains

Stormwater Mains

Water Mains

Trees

Small <10m

Forest Cabbage Tree
Cordyline banksii

Rohutu
Neomyrtus pedunculata

Marble-leaf
Carpodetus serratus

Kowhai
Sophora microphylla

Wharangi
Melicope ternate

Heketara
Olearia paniculata

Medium 10 - 15m

Pigeonwood
Hedycarya arborea

Kanuka
Kunzea ericoides

Tree fuchsia
Fuschia excorticata

Big >15m

Kamahi
Weinmannia racemosa

Kohekohe
Dysoxylum spectabile

Tawa
Beilschmiedia tawa

Grasses

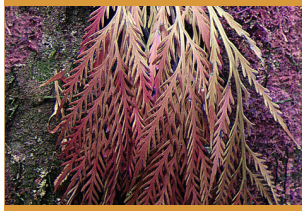
Toetoe
Cortaderia richardii

Glen Murray Tussock
Carex flagellifera

Ferns

Regular

Black Tree Fern
Cyathea medullaris



Hanging Spleenwort
Asplenium flaccidum

NZ Maidenhair
adiantum cunninghamii

Hen and Chicken
Aspleniuim bulbiferum

Kiokio
Blechnum novae
-zealandiae

Tree

Silver Fern
Cyathea dealbata

Wheki Ponga
Dicksonia fibrosa

Shrubs

Kawakawa
Macropiper excelsum

Mahoe
Melicytus ramiflorus

Coastal Tree Daisy
Olearia solandri

Rangiora
Brachyglottis repanda

Ribbonwood
Plagianthus divaricatus

Poataniwha
Melicope simplex

5.3 Kaitiakitanga

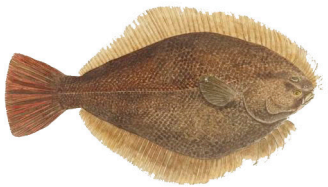
Due to the scope of this research, Ngati Toa and their Rohe require the assistance in managing previous values and monitoring local climate and resource data to further their database of natural resources and better develop a framework for future decisions within design processes.

Heritage/Recreation:
Takapuwahia marae and surrounding iwi buildings are essential to the spiritual connection between Ngati Toa and whakapapa and must be protected and conserved to establish proper kaitiaki

Waterways/Harbour:
Fish species within onepoto arm with affiliation to kaimoana must be preserved through rahui in order to supply future generations with native food resource

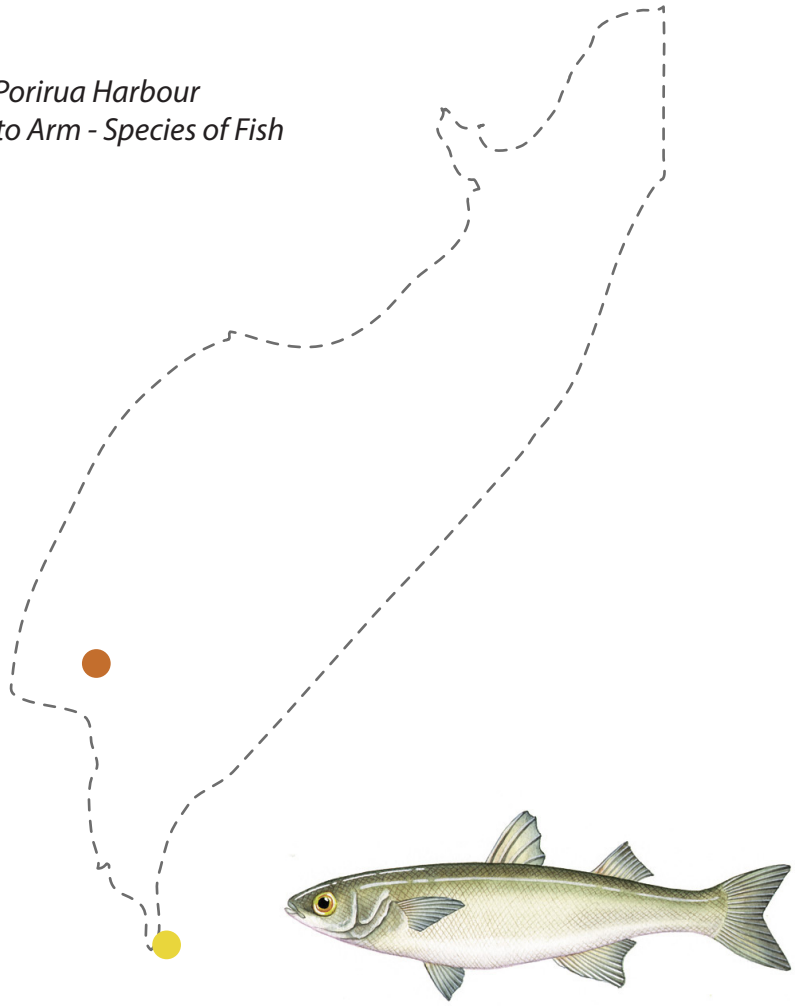
Vegetation/Wildlife:
Flora and fauna will be accounted for within a database that is accessible within the system tool for analysis to ensure a healthy future and population within Takapuwahia

The result of this analysis leads towards the practicably to assist in conservation and kaupapa identified with Porirua Harbour. Ngati Toa prize the harbour for its rich ecology, therefore, how will this research direct Ngati Toa towards their vision of protecting the natural environment and restoring mana in waterways and the harbour to better populate resources such as kaimoana in order to afford a traditional environment that was once present. How can such principles operate and function alongside current digital instruments to coordinate resource management and how education can revitalize the loss of culture within Ngati Toa and their distant relatives whom have no access to their land and resource informations.



(Fig. 5.6 Yellow-belly Flounder)

Porirua Harbour
Onepoto Arm - Species of Fish



(Fig 5.7 Yellow-eyed mullet)

Grey Mullet
Occurrence: Common in summer as juvenile; adults visit at high tide.
Habitat: Mud flats and deep channels.

Sand Flounder (most abundant species)
Occurrence: Abundant resident as juvenile and adult.
Habitat: Mudflats near stream mouths, larger flounder widely distributed.

Yellow-Belly Flounder (see fig. 5.6)
Occurrence: Common resident as juvenile and adult
Habitat: Juvenile prefer mud flats adults prefer sea-grass beds

Snapper
Occurrence: Common in summer as juvenile
Habitat: Juvenile thrive harbours. Sea-grass meadows, kelp forests

Trevally
Occurrence: Abundant resident as juvenile; adults visit at high tide.
Habitat: Shallow sandy areas

Kahawai
Occurrence: Abundant resident as juvenile; adults visit at high tide.
Habitat: Clear water with a firm substratum.

Yellow-eyed Mullet (see fig. 5.7)
Occurrence: Abundant resident as juvenile and adult.
Habitat: Mud flats and deep channels.

Spotty
Occurrence: Abundant resident as juvenile and adult.
Habitat: Shelter of algae, rocks, boulders and logs.
(Francis)

(Fig 5.8 Tamariki/children learning)

Kaitiakitanga is the objective in which we need to aim to achieve and help educate local tangata whenua and tamariki of future generations.

In order to develop a practical model for local tangata whenua, the system tool must contribute to the unconscious learning through use of collaboration (see fig. 5.8).

6. Design Description

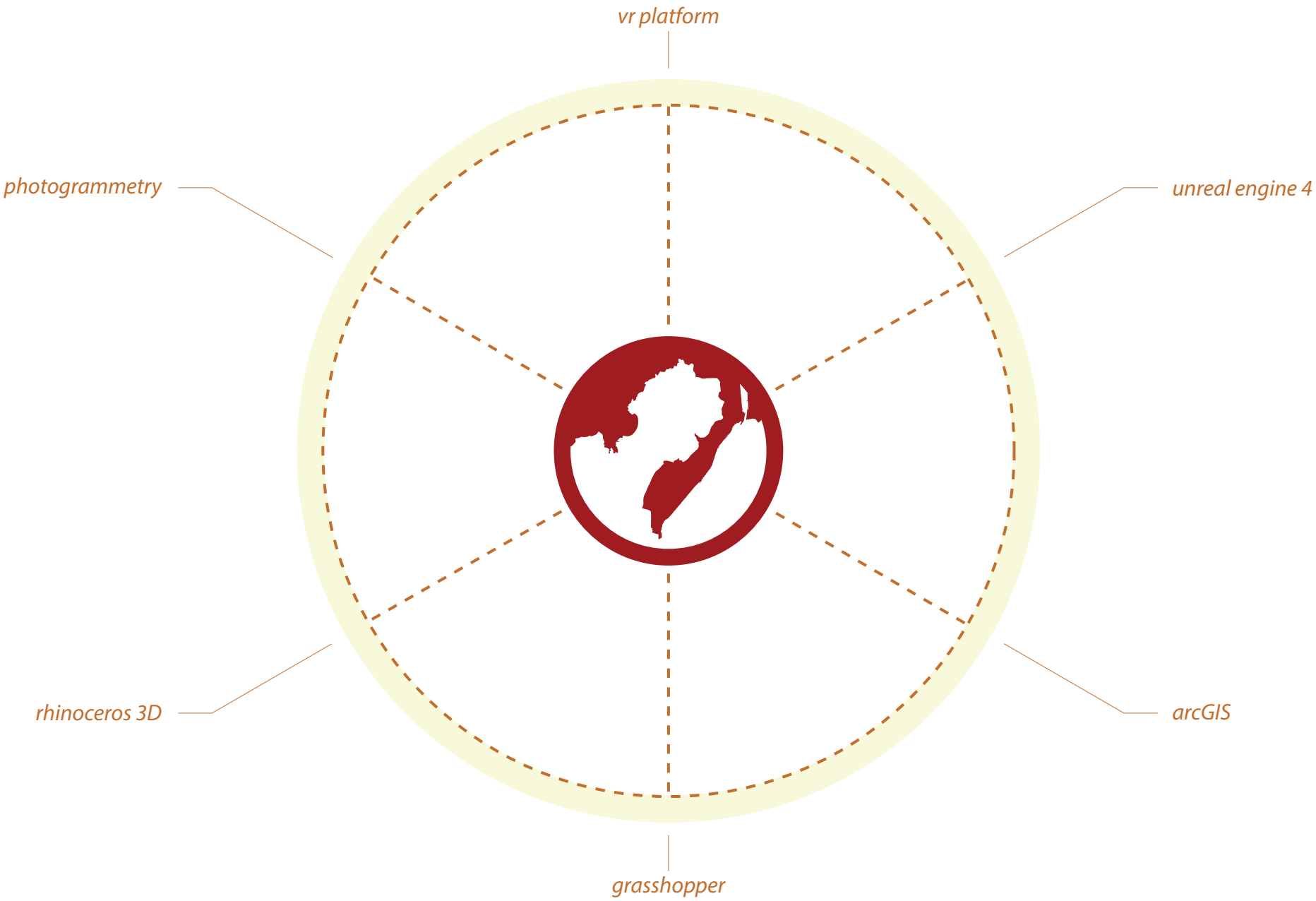
This section details the process of developing the system tool and how Ngati Toa's Rohe can be used to input local data and values within the system in order to encapsulate their environment virtually and have access to a local database comprising of current issues and affairs between the land and tangata whenua.

The following steps will reflect the vision of restoring and establishing kaitiakitanga and educating local Iwi of their land holdings and whakapapa in order to identify their place of origin within the natural world.

This workflow will be beneficial to Indigenous people whom will have access to their own data input. This affords a certain degree of self education whilst contributing to the overall outcome of their environment.

6.1 Tools for Kaitiaki

The following tools will be developed in relation to traditional values and principles among Ngati Toa's landscape in hope to provide a new approach to resource management, design strategies and collaboration between distant Iwi members, Porirua council and architects.


vr platform
unreal engine 4
arcGIS
grasshopper
rhinoceros 3D
photogrammetry

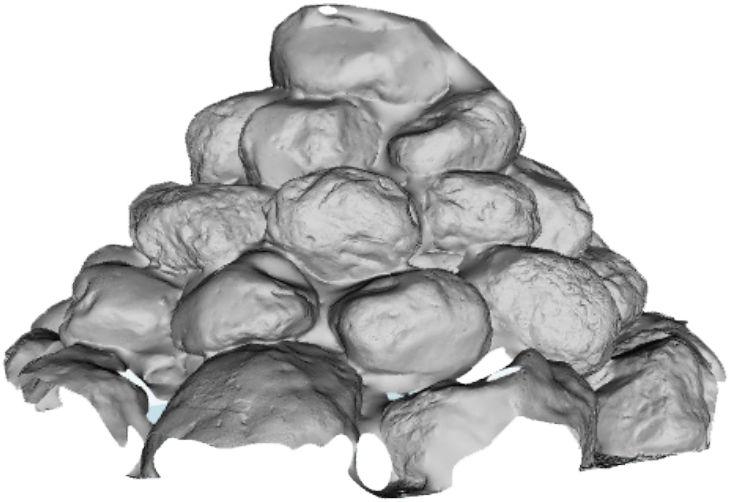
Photogrammetry

Rhinoceros 3D

Grasshopper

Unreal Engine

VR Platform

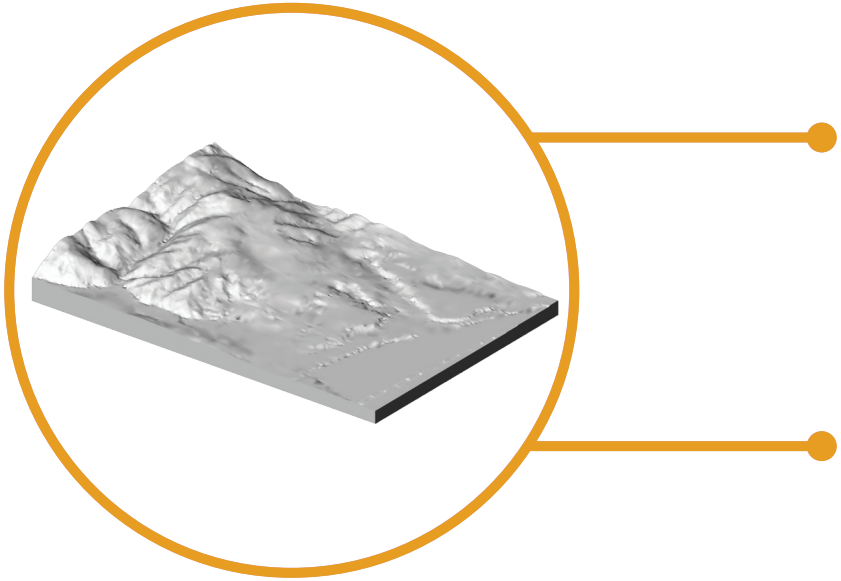


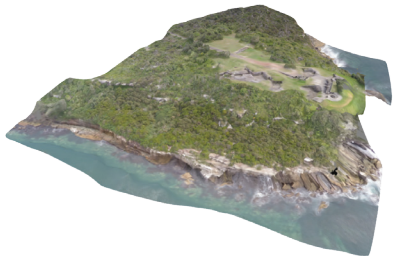
(fig 4.1Tane Mahuta, Northland)

Models made through the method of photogrammetry will help populate the in game system to give a sense of scale and materiality

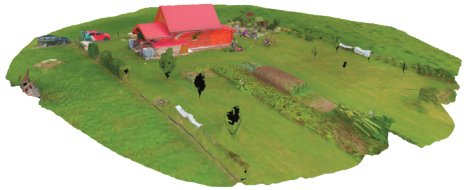
The quality of the object relies greatly on the number of images taken as well the angles used on the target (see fig. 6.1)

(Fig. 6.1 Quality/Detail of Rocks)





Large Scale/
3D model



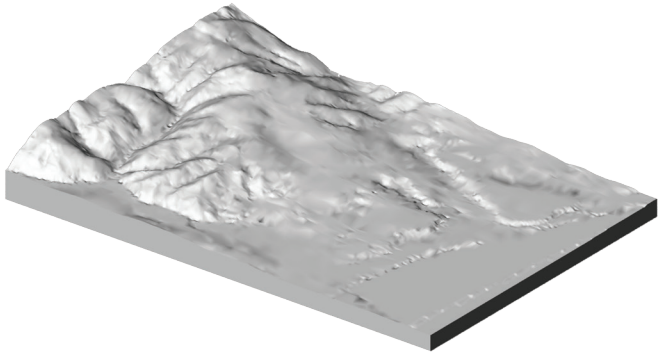
Small Scale/
3D model

50m

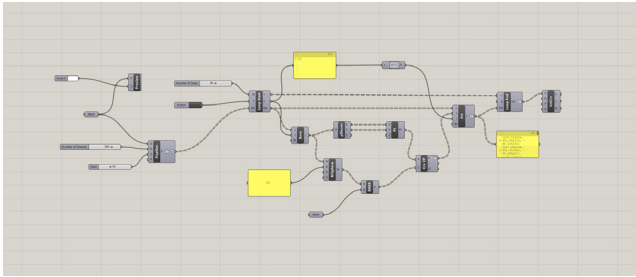
- Larger context to observe
- Environmental layers
- Good sense of scale

30m

- Larger model requires more RAW photos
- Difficult to identify smaller objects
- Lower quality zoomed in

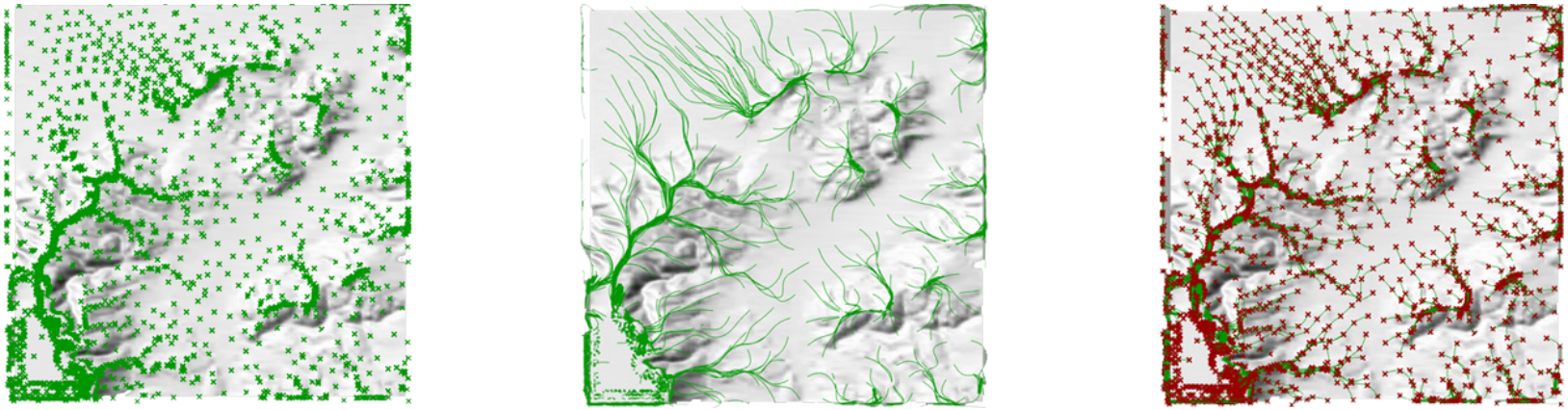


(fig 4.1Tane Mahuta, Northland)



(fig 4.1Tane Mahuta, Northland)

3D meshes from rhino will be excersized with grasshopper to program visual data input that will help represent processes of the land and natural formations

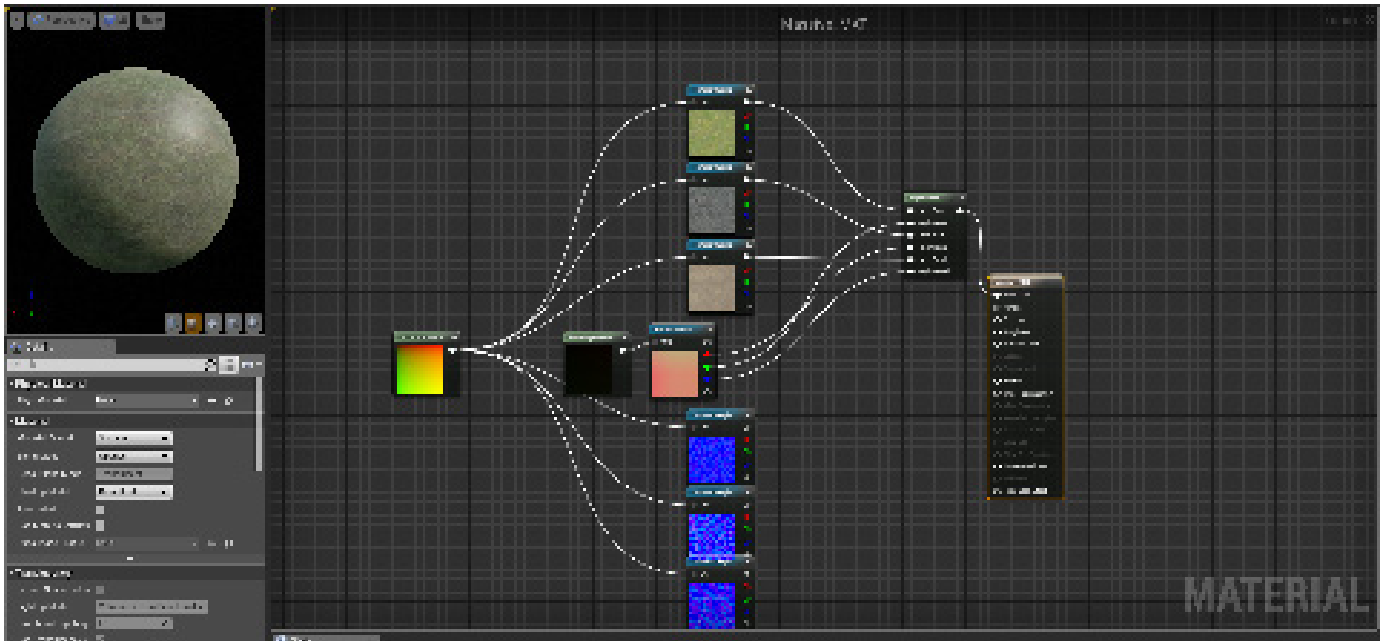


(fig 4.1Tane Mahuta, Northland)

Grasshopper example of downstream waterflow from higher altitudes which will simulate where water starts and ends

- Waterway management
- Taongaroa Awareness

In-game model of Takapuwahia navigable through an avatar of choosing where first person is optional. This will allow a working screen for a larger scale to better orientate the user whilst engaging at a closer scale (lower right).

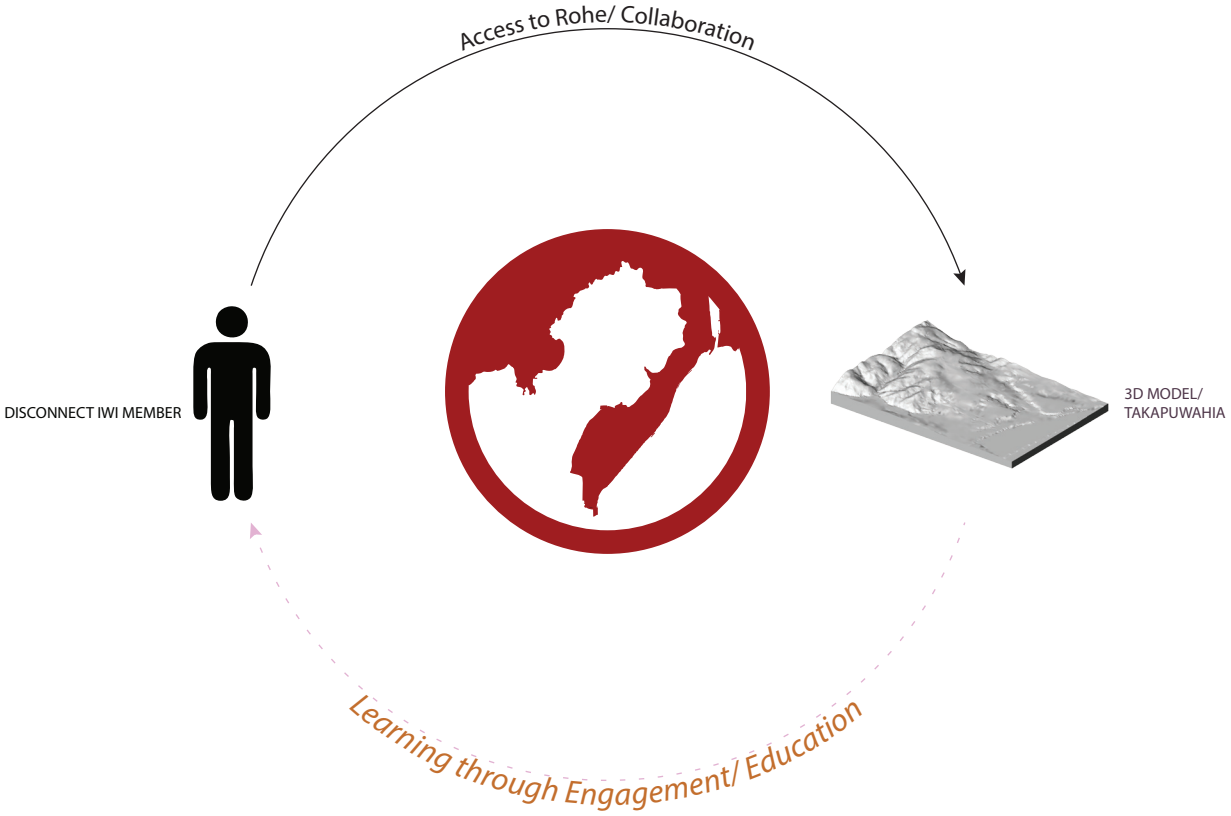


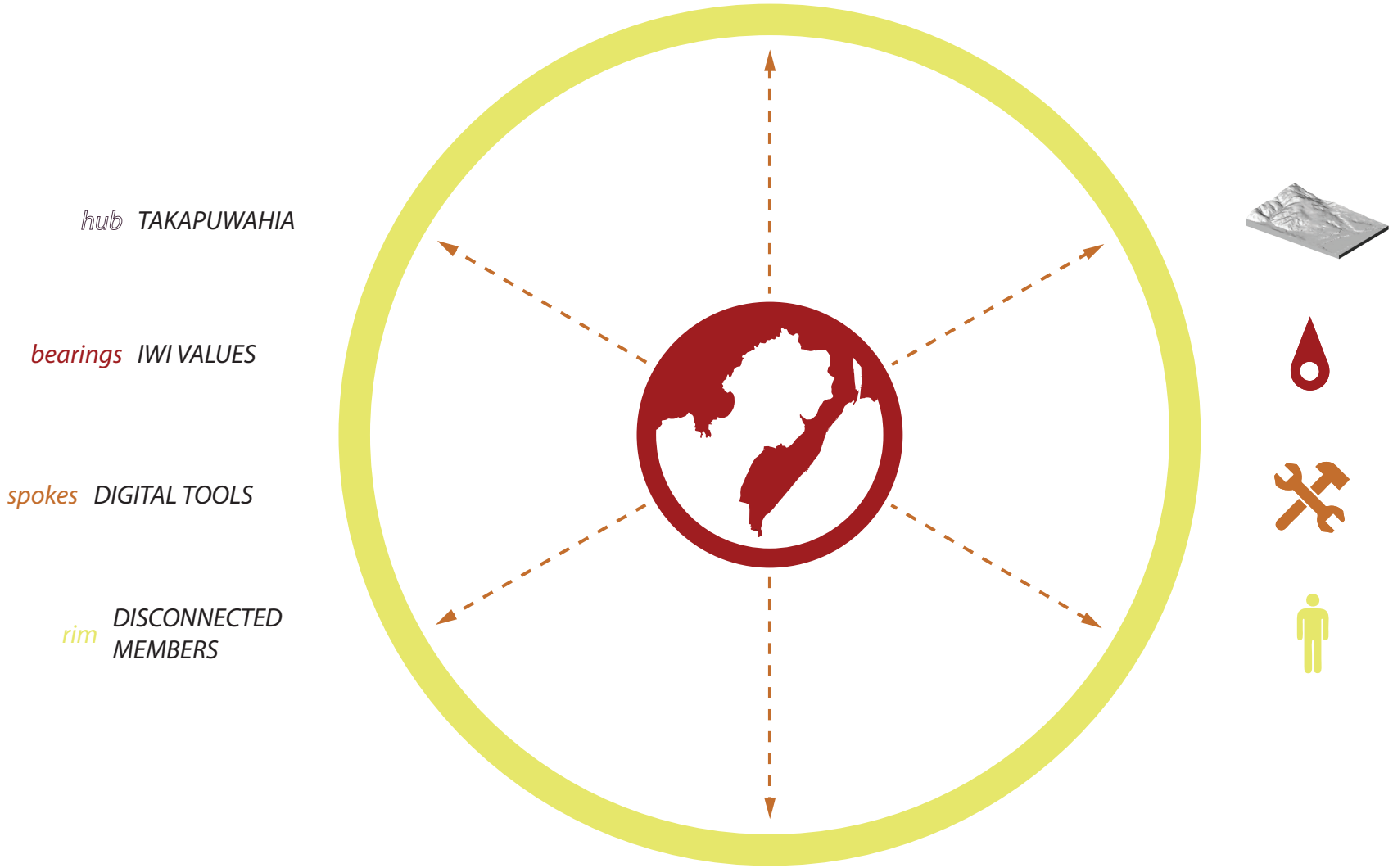
Unreal Game engine offers a workflow enabling material creation and optimization. This compliments the natural feel to the environment and cultural experience.
(It is important to enhance the immersiveness as it is crucial that the user experiences a realistic environment).

6.3 System Tool

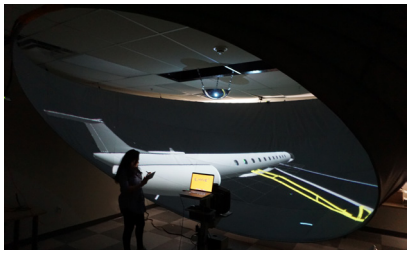
The system tool is to be used to provide a bridge for connecting Iwi and their domain, especially in the case of relinking detached iwi members whom live afar. This tool will help enable the access to land information such as natural resources, important amenities and other culturally significant values in order to reestablish kaitiaki over the land.

As a member living distant (overseas), kaitiaki is greatly restored through means of informing divorced tangata whenua to reinstate whakapapa into their lives.


Access to Rohe/ Collaboration
DISCONNECT IWI MEMBER
3D MODEL/
TAKAPUWAHIA
Learning through Engagement/ Education


hub TAKAPUWAHIA
bearings IWI VALUES
spokes DIGITAL TOOLS
rim DISCONNECTED MEMBERS

7. Future Directions



(Fig. 7.1 Hyve 3D in use)

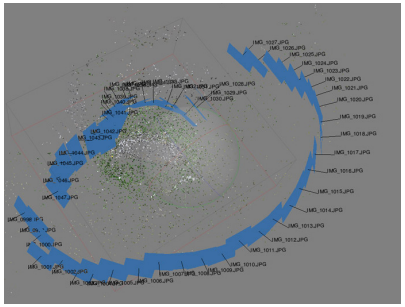
Hyve 3-D

The Hyve 3D is a collaboration tool that depicts 3D spatial data to allow designing a sketching within 3D (see fig. 7.1). With full scale immersion, this tool provides for the end user to operate under supervision of the architect. The workflow for Hyve 3D utilizes cad software in order to input reference to real-environments.
This tool offers vast potential in terms of collaboration between architect and iwi at a 1:1 Scale.

(Fig 7.2 Oculust Rift headset)

Oculust Rift

This headset supplies an in-game immersive reality that projects game engine output in order to become fully immersed without any vision of the outside world (see fig. 7.2). The practicability of this piece of equipment lies with its portability and capability of being fully immersive within a matter of seconds.
This tool can also support game engine output and may potentially drive the fully immersive scale of a realistic environment.



(Fig. 7.3 Drone imagery flight path)

Drone-Photogrammetry

Photogrammetry has limitations when it comes to encapsulating larger landscapes. The addition of a drone has the potential to capture aerial imagery from a great distance, scanning larger surface areas to depict life size landscapes with attention to detail (see fig. 7.3).
Access to drones are becoming more frequent as technology evolves exponentially. This means in a matter of years, the affordability will allow for councils and small organizations to be equipped with the potential to capture 3D landscapes.

8. Conclusion

Conclusion/Reflection

The issue of cultural sensitivity within indigenous societies and how their roles and values affect the landscape dictates the symbiotic longevity, will continue to be infinetly discussed inside the realm of Architecture and more specifically, Landscape Architecture. Managing the design phase of indigenous landscapes conflicts with the ideals of modern infrastructure and cultural principles. New Zealand's cultural progenation is heavily retained within the present society, and remains of vital significance in today's people which the Maori culture relies on in order to properly narrate and translate the genealogy accurately to the public. It is for this reason that traditions, whakapapa and korero of Maori people be prioritized over future built environments to ensure the protection, kaitiaki and involvement of Iwi be sought with mutual agreement.

The history of the Maori people has not been a pleasant journey, yet the identification with many maori people across New Zealand deams it compulsory to operate in traditional ways. Adapting to a modern environment which utilizes the potential of future technologies and softwares to better organize cultural spaces will afford traditional recognition and function alongside the progression of population growth and urban development.

From this research's positioning, Kaitiakitanga now requires the involvement with current technologies in order to successfully design in collaboration where a synthetic approach rather than analytic is perused.

This system hopes to provide a pedastool for the future of architects and landscape architects and their involvement with indigenous communities around the globe.

9. Appendix

Ahi Kaa ..... *People whom live on their land*
Atua ..... *Gods or Spirits*
Awa ..... *River/Stream*
Iwi ..... *Maori Trive*
Kai Moana ..... *Sea Food*
Kaitiakitanga ..... *Guardianship/Protection*
Kaumatua ..... *Maori Elder*
Kaupapa ..... *Policy/Principle*
Mana ..... *Inherited Supernatural Power/Energy*
Mana Whenua ..... *The Right to Manage Land*
Matua ..... *Adult/Grown-Up*
Papatuanuku ..... *Earth Mother*
Rahui ..... *Restriction of Specific Resource*
Ranginui ..... *Sky Father*
Raupatu ..... *Confiscation of Maori Land*
Rohe ..... *Land Holdings*
Tamariki ..... *Children*
Tane Mahuta ..... *God of the Forest*
Tangaroa ..... *God of the Sea*
Taonga ..... *Natural Resource of High Value*
Tapu ..... *Sacred*
Turangawaewae ..... *A Sense of Identity with a Home Base*
Whakapapa ..... *Genealogy*
Whanaunga ..... *Relations/Relatives*
Whanau ..... *Family*

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Fig 1.2. Whiting, Cliff. Tawhirimatea. *Te Taiao: Maori and the Natural World.* Te Ara. Auckland, Bateman, 2010: 27. Print
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Fig 4.2. Garmin GPSMap 62s. Author's own image. 2016
Fig 4.3. Raspberry Pi assembly. Author's own image. 2016
Fig 4.4. GISCloud MDC map editor and template form. Authors own image. 2016
Fig 4.5. 3D mesh of chair. Author's own image. 2016
Fig 4.6. Vidanom. What makes photos good for photogramme try?, 2016. Autodesk Community. 20 September 2016 <fo rums.autodesk.com>
Fig 4.7. Vidanom. What makes photos good for photogramme try?, 2016. Autodesk Community. 20 September 2016 <fo rums.autodesk.com>
Fig 4.8. Rhino Logo. Author's own image. 2016

Fig 5.1. Whites Aviation. View of the Porirua suburb of Takapuwahia with Porirua Harbour and Titahi Bay road in foreground with Eldson Park to scrub covered hills beyond, Porirua District, Wellington Region, 1958. Porirua District, Wellington. 21 July 2016. Web. <https://natlib.govt.nz/records/30654422?search%5Bpath%5D=photos&search%5Btext%5D=Takapuwahia>

Fig 5.2. ATL. Aerial view of housing and development in Titahi Bay and Porirua [Elsdon? Takapuwahia?], including Porirua Harbour, 1956. Titahi Bay and Porirua, Wellington, New Zealand. 20 July 2016. Web. <https://natlib.govt.nz/records/22402702?search%5Bpath%5D=photos&search%5Btext%5D=Takapuwahia>

Fig 5.3. ATL. Toa Rangatira Meeting House, Takapuwahia-Porirua, 1990-1940. Takapuwahia-Porirua. 20 July 2016. Web. <https://natlib.govt.nz/records/22782786?search%5Bpath%5D=photos&search%5Btext%5D=Takapuwahia>

Fig 5.4. Takapuwahia Pou. Author's own image. 2016

Fig 5.5. Urban infrastructure of Takapuwahia. Authro's own image 2016

Fig 5.6. Clarke, Frank. Yellow-belly Flounder, 1870. New Zealand. 26 August 2016. <tepapa.govt.nz>

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. . .te mutunga

Dylan Tariau