



Symbiotic Architecture

An architecture that must coexist symbiotically within a fragile system.

by Ryan Janks



declaration

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acknowledgements

The name, Ryan Janks, will appear at the end of this document, however, anyone who has gone through this process, will know that one name cannot do justice to the many who have worked with and supported me every step of the way. For this I would like to thank:

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Ilan and Jami, I love you both.

Mom and Dad, for everything and anything, without you, this would never have been possible.

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Abstract

The world's oceans, seas and coastal areas are today, in a critical state of distress, facing a greater array of problems and dangers than ever before imagined. With over half of the world's population living along coastal areas, there has been unprecedented commercial and residential over development. Pollution from cities and industry, anthropogenic waste disposal, oil spills, and intense over fishing, increasingly threaten living and non-living resources in the coastal and ocean environments - adversely impacting and fundamentally changing natural ecosystems, and even threatening human health. Marine life and vital coastal habitats are straining under the increasing pressure of deteriorating sea water quality and the cumulative effects of excessive human use.

The ability of marine ecosystems to produce the economic and ecological goods and services that we desire and need, have been substantially reduced. In some instances there has been a significant decline of ocean wildlife and even collapses of entire ocean ecosystems. It is clearly evident that what we once considered to be inexhaustible and resilient is, in fact, finite and fragile.

It is however, only through a high level and intense form of research and understanding, that we as human beings can begin to understand the ways in which we can help conserve such a system. Only once we understand the effect we are having on such an ecosystem, can we begin to understand the ways in which we need to change. It is only through research, and consequently conservation, that we will be able to identify how a relationship between human beings and the natural world can exist in a sustainable and symbiotic relationship.

This thesis will explore how a man-made artificial intervention can and must have a significant impact on the environment in which it sits, both directly and indirectly. Through the establishment of a rich research and conservation hub within a bio diverse ecosystem, a symbiotic relationship, whereby two completely different systems work together to ensure the sustainability of the whole, is established.



An aerial photograph showing a dark, winding river flowing through a dense, green forested area. The river has several sharp turns and meanders. The surrounding land is covered in thick vegetation, with some lighter green patches indicating different types of trees or possibly cleared areas. The overall scene is a natural, undisturbed landscape.

section 1_ introduction

sym·bi·o·sis

- noun; 'sym' - together 'biosis' - life

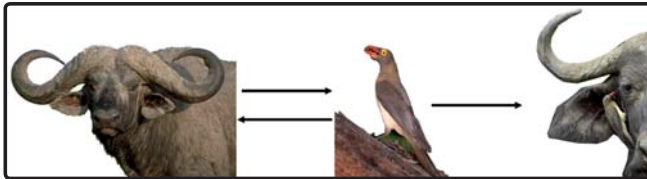
'the intimate living together of two dissimilar biological organisms in a mutually beneficial relationship'

Coral vs. Algae



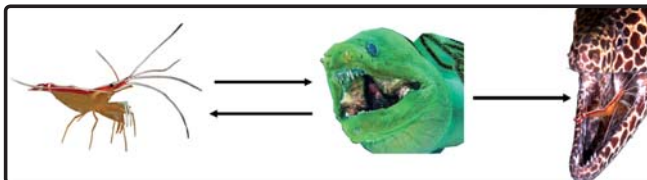
Coral lives a symbiotic life. Inside the sac of each coral polyp lives a one-celled algae called zooxanthellae. The algae gives off oxygen and other nutrients which the coral polyp needs to live, and in return the polyp gives the algae carbon dioxide and other essential substances the algae needs. The one cannot exist without the other.

Oxpecker vs. Buffalo



The relationship between the Oxpecker and the Buffalo is a type of symbiosis called mutualism; the Oxpecker feeds from the supply of ticks and fleas on the buffalo's body, which the buffalo can not reach. By this the bird obtains food and nutrients, while the buffalo is relieved of the discomfort caused by the parasites.

Cleaner Shrimp vs. Eel



The cleaner shrimp is a crustacean found on many coral reefs around the world. Its habitat is very similar to that of the sea eel, which lives in and around crevices of reefs. A symbiotic relationship is formed between these two creatures, as the eel allows the shrimp to clean its body, by feeding on parasites and food, in and around the gills, simultaneously, relieving the eel of the discomfort the parasites may cause.

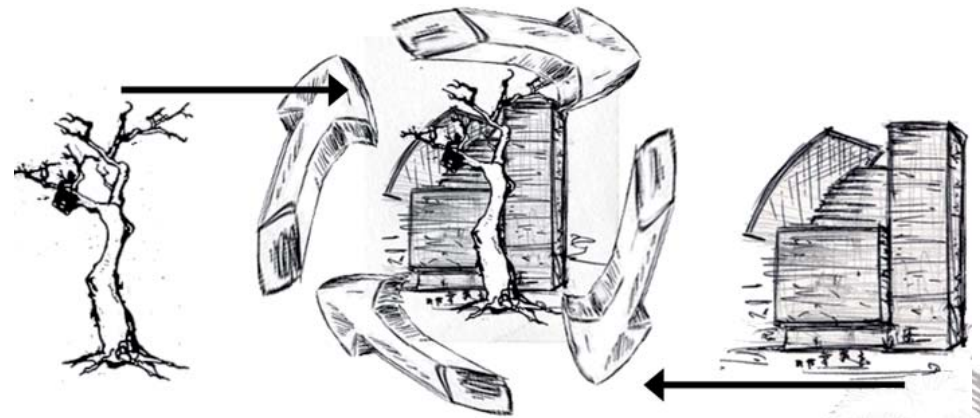
Proposition

A symbiotic relationship is a biological system which is essential to the survival of many ecosystems. A system which incorporates different parts and structures to ensure the survival of the whole.

It is, however, these symbiotic relationships that form the basis of many larger relationships in the natural world. Symbiosis occurs naturally within the biological structure of nature and allows for the sustainability of the natural systems of life. In order to understand the importance of such relationships we must look at the systems which they form, and identify how, through all of the individual parts, a working programme can be achieved to ensure the survival of that system.

Therefore, why can we not apply these rules of symbiosis to the relationship between architecture and its environment? At this moment, sustainable architecture seeks to minimize the negative environmental impact of buildings, by enhancing efficiency and moderation in the use of materials, energy, and development space. Most simply, the idea of sustainability, or ecological design, is to ensure that our actions and decisions today do not inhibit the opportunities of future generations.

Why can we not look at architecture as a way to not only sustain itself, but to sustain the environment in which it exists? An architecture that symbiotically exists within its site, ensuring the sustainability of its surroundings, as well as creating an environment for us as humans to interact, learn and experience.



*'An architecture that must coexist symbiotically,
within a natural fragile system'*



An aerial photograph showing a dark, winding river flowing through a dense, green forested area. The river has several sharp turns and meanders. The surrounding land is covered in thick vegetation, with some lighter green patches indicating different types of plants or possibly cleared areas. The overall scene is a natural, undisturbed landscape.

section 2_ Symbiotic Systems

Systems in the Natural World

The ecosystem of the natural world, is a prime example of any working system, where individuals work together to ensure the functionality of the whole. These systems must be analysed to understand how a large system functions, but at the same time understand that for any system to survive it must rely on the smaller individual parts which make up the whole. These smaller systems can not be looked at in isolation either, as each part is a system within itself. It survives through interactions with others and the environment in which it exists, to be able to sustain further growth.

"Above all we must remember that nothing that exists or comes into being, lasts or passes can be thought of as entirely isolated, entirely unadulterated.

One thing is always permeated, accompanied, covered or enveloped by another; it produces effects and endures them."

Johann Wolfgang von Goethe (Hensel 2008:16)

What is an ecosystem and how does it function?

Definition: The term 'ecosystem' refers to the combined physical and biological components of an environment. An ecosystem is generally an area within the natural environment in which physical (abiotic) factors of the environment function together along with interdependent (biotic) organisms, such as plants and animals, within the same habitat, to create a stable system. There are two types of ecosystems

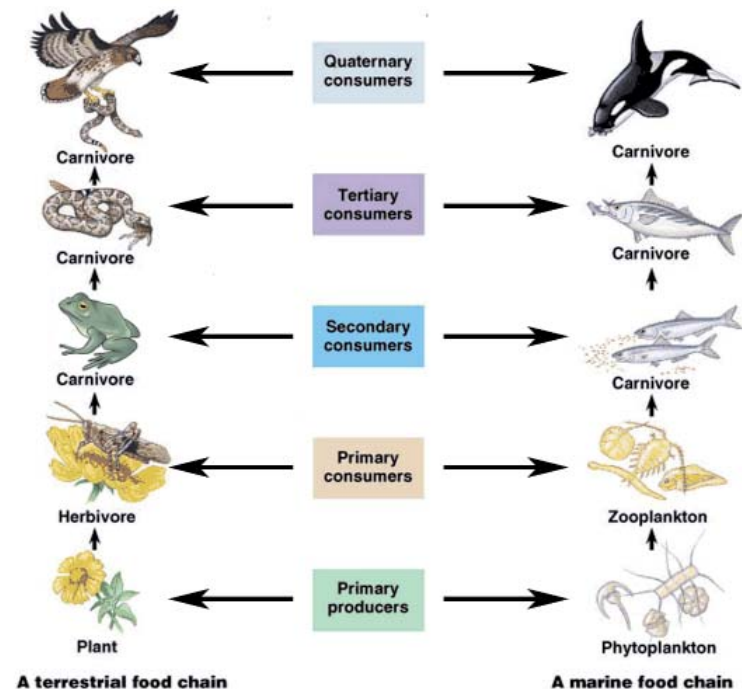
1.Natural

Terrestrial ecosystem
Aquatic ecosystem

2.Artificial, environments created by humans.

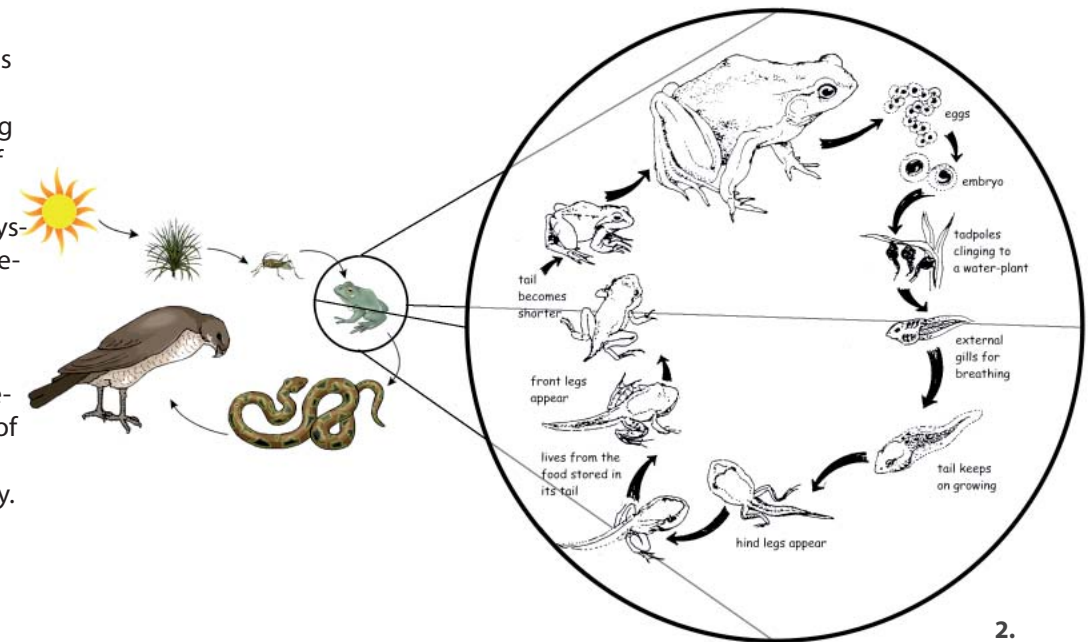
Throughout any primary school career, we are taught about the natural ecosystems which occur in nature. The diagrammatic representation of the food chain, seen in most biology text books, has become common place. Corn is eaten by the rat, the rat is eaten by the snake, the snake is eaten by the hawk, and so on. We are taught to understand that there is a top and bottom within these chains, the human usually being perched on the top.

We are also then taught about sub-systems within these chains and how they function, and what effects they have on the whole. An example of these sub-system which occur within the chain is the system of 'metamorphosis', the biological process by which an animal physically develops after birth or hatching, involving a conspicuous and relatively abrupt change in the animal's body structure through cell growth and differentiation. This system is incorporated into the major system and is imperative to the sustainability of the whole.



An ecosystem is, however, very fragile. As we know, if one of the links of a chain is disturbed or weak, it could result in the failure or breakdown of the entire process. However, each link in itself is a complex combination of sub-systems working together. These sub-systems can be further divided up into microscopic levels of functions. If there is a disruption even at a microscopic level, it can result in the failure of the entire system. It is for this reason that we can say that any natural system is fragile. Any disruption caused either by a natural occurrence or the involvement of man, will cause a domino effect, affecting every part of the system.

It is here, where symbiotic relationships between various sub-systems become important. As mentioned before symbiosis can be defined as the relationship between two or more biological organisms which aim to ensure the sustainability of the whole. It further strengthens the idea that within these ecosystems, no individual can exist in isolation. Each part must rely on the other to function properly.



Architecture as a System

Ecology is the study of the relationship between organisms and their environment. This definition, also suits the discipline of architecture surprisingly well. One of the central tasks of architecture is to provide opportunities for habitation, through specific material and energetic interventions in the physical environment. (Hensel, 2008:16)

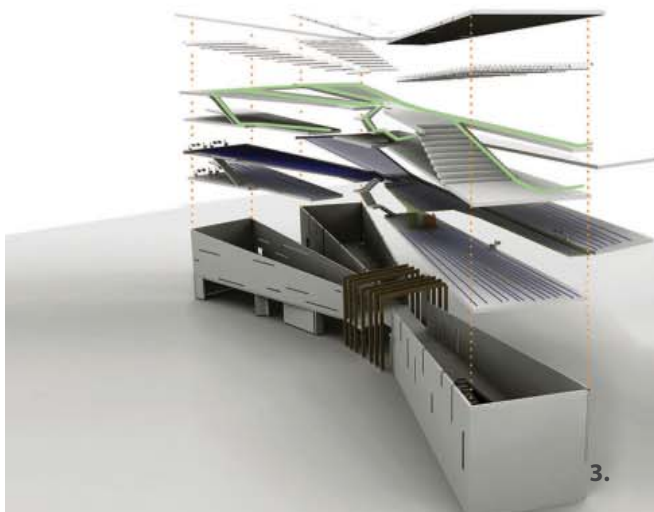
Architecture can therefore be described as an artificial ecosystem; a system that involves different parts and processes with each working as individual components contributing to the functionality of the building and the environment which it creates. One can look at architecture as a combination of parts contributing to the functioning of the whole.

Similar to the food chain diagram of the natural world, we can break down the structure of a building and look at how each part functions, and how each individual part is not isolated. The foundation of a building supports the walls, walls align to support roofs, the roof covers the functions within, and so on.

As with natural systems it is important to look deeper into these systems, to discover that each component is a system within itself, which allows for the main structure to function as it should. For example, the system of foundations is a result of the relationship between concrete and steel, concrete supplying the compressive forces needed in the building and steel supporting the tensile forces which would be applied. Bricks used in the walling system can only achieve their structural properties when mortar is used to secure them. Windows allow light, warmth and ventilation into a space, simultaneously protecting that space from the elements. It is therefore the relationship between the individual systems that aid in the functioning of the structure. Each part is affected by the others and by working together, a stable and functional building is created.

However, architecture today can be described as a closed system. It forms its own environment and does all it can to sustain itself and its function. Every building has a specific programme and the architecture is created to house that programme, in a sense creating a new artificial environment. When architecture is designed as a closed system, various negative affects begin to be evident, most notably, in the natural environment.

It is therefore our role as architects today to design architecture not as a closed system, but as an integrated and informed part of the natural environment. It is our approach to architecture that must change.



Ecological approach to Architecture

An ecological approach to architecture is ultimately about environmental integration. If we are able to integrate an architectural design system, and everything we do or make in our built environment, with the natural environment, in a seamless and thoughtful manner, we could resolve the problems we face regarding both architectural and environmental sustainability. We can thus say, that, an ecological approach to architecture is designing for bio-integration. (Yeang 2006: 43)

To create an architecture that is integrated with the environment we must start by looking at nature as a system. The natural world has existed for millions of year in a state of stability. It is when humans begin to interfere with the natural processes of life that these natural systems start to degrade. Ecological systems, through their structure and function are inherently sustainable. By examining these structures at various levels of function, one might be able to incorporate such systems into the way we design the built environment.

An example of this can be seen in the way ecosystems deal with waste. Within any ecosystem the idea of waste is almost non-existent, as everything that is produced is either reused, or redistributed. Recycling is an automatic process. Thus by imitating this, our built environment would produce no waste. All emissions and products would be continuously reused and recycled within and eventually reintegrated with the natural environment, in tandem with efficient use of energy and material resources. Ken Yeang refers to 'designing to imitate ecosystems' as 'ecomimesis'. This is the fundamental premise for eco-design. Our built environment must imitate ecosystems in all respects.

Our built forms are essentially closed systems, designed to protect us from the external elements, and house programmatic functions. (Yeang 2006: 56)

"We start by looking at nature. Nature without humans exists in stasis.

Can our built environment imitate nature's processes, structure, and functions, particularly of its ecosystems?"

Ken Yeang, architect & author: ECODESIGN A Manual for Ecological Design

An example of recycling in nature

The hermit crab

Sea snails are protected by an external shell, which grows with the snail as the snail develops. When such creatures die, their body will be eaten by other creatures or decompose within the environment. The shell of such a creature, being made from calcium obtained from the water and diet, is the only part of the animal which remains, and because of the structure of a shell, it can last for many years with minimal deterioration or damage.

The hermit crab is a crustacean which needs to cover its soft exoskeleton with a shell-like structure, to prevent attacks from other carnivorous species. However, the hermit crab does not have the ability to produce its own armour, and therefore must find any object, available within its environment, to protect itself. Therefore, any shell which has been discarded, or left behind, is a potential new home for this crustacean. As the crab grows and develops, it will discard its current armour in search of a larger more appropriate structure.



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The hermit crab: exoskeleton of a hermit crab, out of its shell. hermit crab in shell

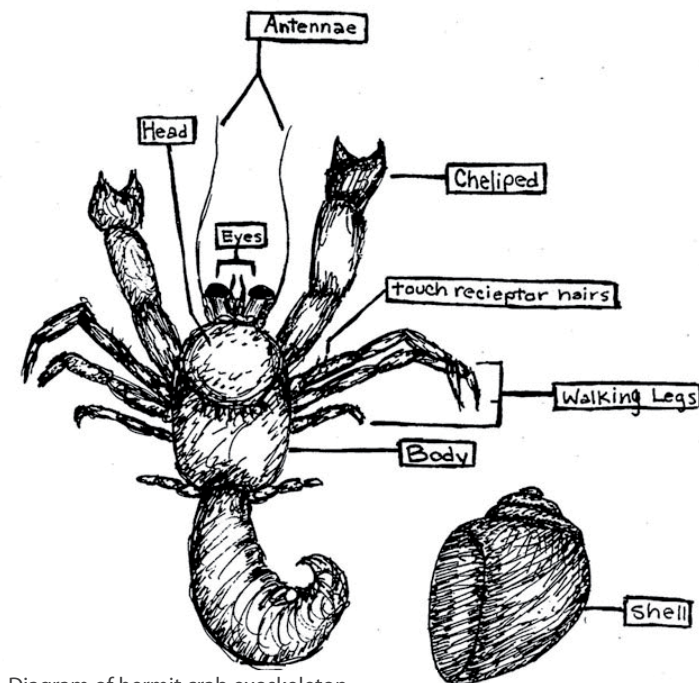


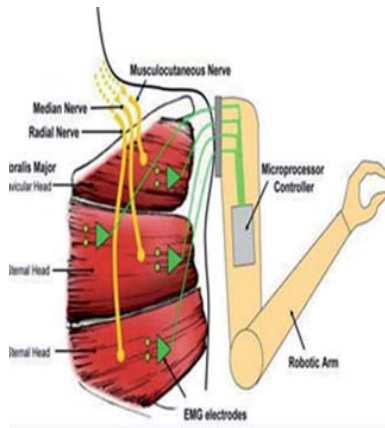
Diagram of hermit crab exoskeleton

Integration: Architectural design and nature

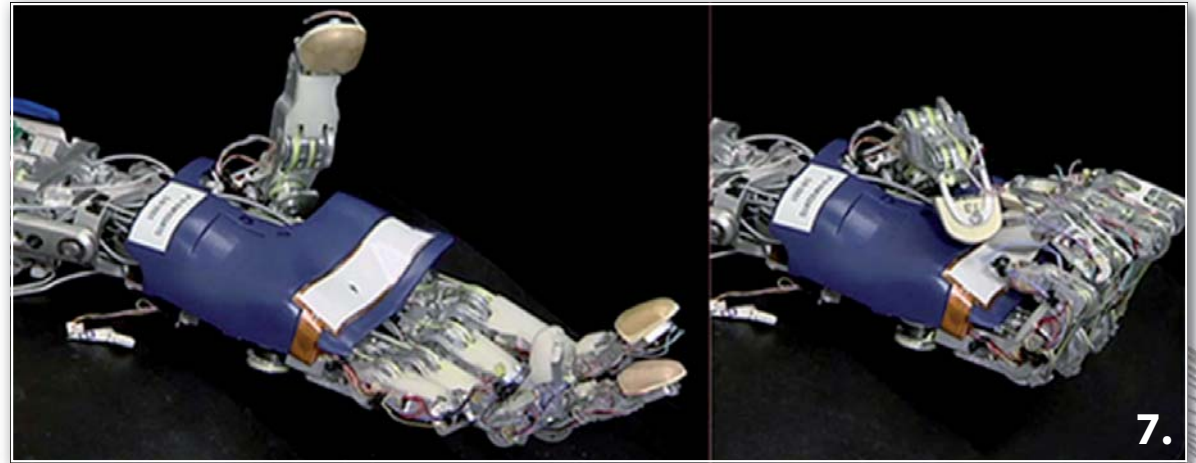
Another major design issue is the systemic integration of our built forms and its operational systems and internal processes with the ecosystems in nature. This integration is crucial because if our built systems and processes do not integrate with the natural systems in nature, they will remain unrelated, artificial items and potential pollutants. Their eventual integration after their manufacture and use is only through biodegradation. Often, this requires a long-term natural process of decomposition.

We might draw an analogy between eco-design and prosthetics in surgery. (Yeang, 2006: 76) Eco-design is essentially design that integrates our artificial systems both mechanically and organically, with its host system being the ecosystems. Similarly, a medical prosthetic device has to integrate with its organic host, the human body. Failure to integrate well will result in dislocation in both.

In order for a **robotic prosthetic limb** to work, it must have several components to integrate it into the body's function: Biosensors detect signals from the user's nervous or muscular systems. It then relays this information to a controller located inside the device, and processes feedback from the limb and actuator (e.g., position, force) and sends it to the controller. Examples include wires that detect electrical activity on the skin, needle electrodes implanted in muscle, or solid-state electrode arrays with nerves growing through them. Mechanical sensors process aspects affecting the device (e.g., limb position, applied force, load) and relay this information to the biosensor or controller. The controller is connected to the user's nerve and muscular systems and the device itself. It sends intention commands from the user to the actuators of the device, and interprets feedback from the mechanical and biosensors to the user. The controller is also responsible for the monitoring and control of the movements of the device.
(<http://docinthemachine.com/2007/08/09/darpaarm/>)



Robotic prosthetics: integrating technology within the human body



A Natural Design System

Eco-design is designing the built environment as a system within the natural environment. The built system's existence has ecological consequences and sets of interactions, being its inputs and outputs. These must be seamlessly integrated with the natural environment. (Yeang 2006: 78)

Ecosystems in a biosphere are definable units containing both biotic and abiotic constituents acting together as a whole. From this concept, our built environment should be designed according to the ecosystem's physical content, composition and processes. For instance, besides regarding our architecture as just art objects or as serviced enclosures, we should regard it as artefacts that need to be operational and eventually integrated with nature.

As is self-evident, the material composition of our built environment is almost entirely inorganic, whereas ecosystems contain a variety of both biotic and abiotic constituents, or of inorganic and organic components.

Our methods of construction, manufacturing and other activities are, in effect, making the biosphere more and more inorganic, artificial and increasingly biologically simplified. To continue without balancing the biotic content means simply adding to the biosphere's artificiality, thereby making it increasingly more and more inorganic. This results in the biological simplification of the biosphere and the reduction of its complexity and diversity. We must first reverse this trend and balance our built environment with greater levels of biomass, biodiversity and ecological connectivity in the built forms. (<http://www.thefifthestate.com.au/archives/1446>)

We should improve the ecological links between our design processes with the surrounding landscape, horizontally and vertically. Achieving these links ensures a wider level of species connectivity, interaction, mobility and sharing of resources across boundaries. Such real improvements in ecological nexus enhances biodiversity and further increases habitat resilience and species survival. (Yeang 2008 :)

We must biologically integrate the inorganic aspects and processes of our built environment with the landscape so that they become mutually ecosystemic. We must create "human-made ecosystems" compatible with the ecosystems in nature. By doing so, we enhance human-made ecosystems' abilities to sustain life in the biosphere.



The masterplan by T.R Hanzah & Yeang for a mixed residential and commercial development in Bangalore. A key feature is an ecological corridor that weaves across the 86.75 acres in a continuous ecological nexus with green bridges and tunnels linking all green spaces and enhancing ecological biodiversity.



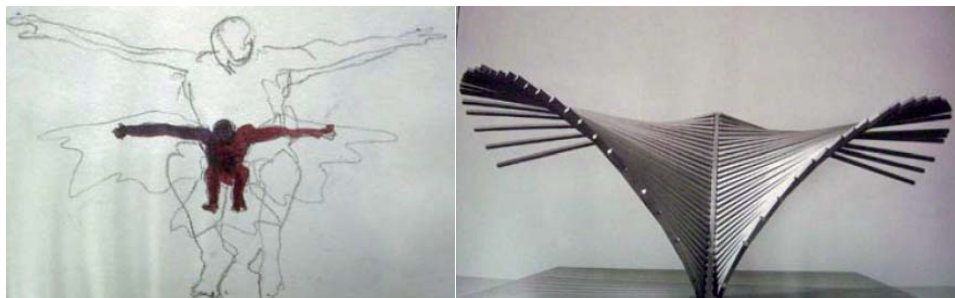
The proposed IT Park Millenium Spire Office Tower by T.R Hamzah & Yeang Sdn. Bhd for an IT park in Manesar, Gurgaon India. Ascending green ramps create ecological terraces and gardens

When looking at the subject of integrating design and nature, it is important to focus on the work of architect Santiago Calatrava. It is his designs that form structural and functional systems that work on a grand scale in many of his civic buildings and design. It is, however, his influence of a natural system that makes his works so interesting. 'In my Ph.D thesis on Foldability of Structures, I was guided by the motto, 'Natura mater et magistra'- Nature is both mother and teacher, this motto has guided all my works'. (Calatrava, 1998: 7). There are many lessons that Calatrava draws from nature, which he has learnt by observing natural systems like plants and animals. For him, there are two overriding principles to be found in nature which are most appropriate for building: one is the optimum use of materials, and the other is the capacity of organisms to change shape, to grow and to move.

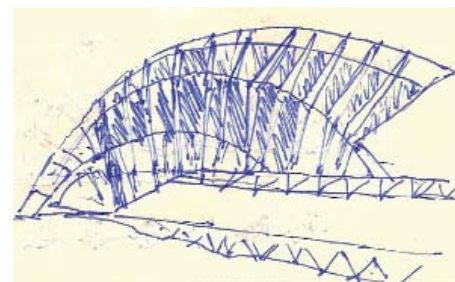
By analogy, this is what eco-design in our built environment should achieve: a total physical, systemic and temporal integration of our human-made, built environment with our organic host in a positive way. Investigating some of these key issues, will help us approach the ecological design of artefact by making them environmentally more responsive (Calatrava, 1998: 29).



Santiago Calatrava's TGV station in Lyon, France.



Calatrava's design development of the TGV Station

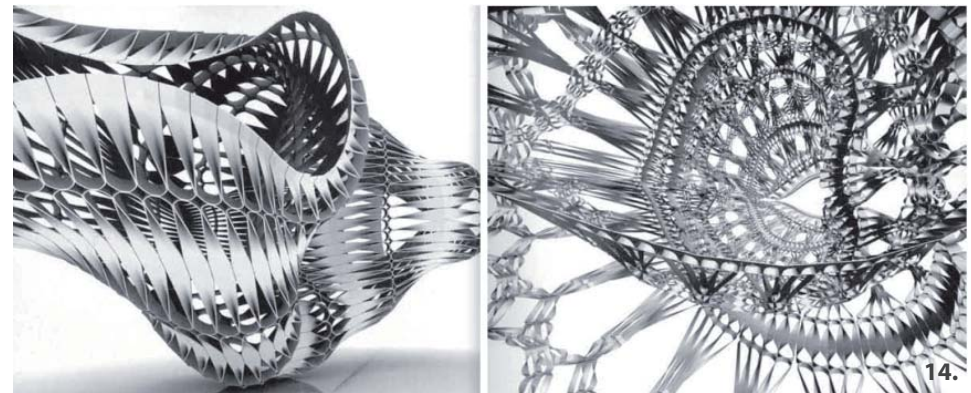
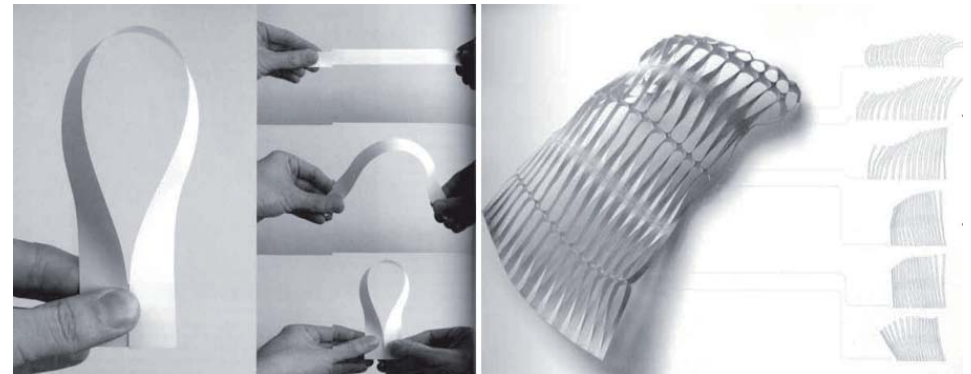




Morphology, The study of forms

Johan Wolfgang von Goethe defines morphology as the 'study of forms.' (Hansel, 2008:19) In doing so, he lays a foundation for contemporary 'comparative morphology', the scientific method that delivers phylogenetic, ontogenetic and systematic knowledge of nature. Goethe posited a crucial distinction between 'Gestalt', or structured form, which refers to that which is already formed, and the process of 'Bildung', or formation, which changes structured form in an ongoing process. 'When something has acquired a form it metamorphoses immediately into a new one.' (Hansel 2008: 19) This raises the question as to how form emerges and how it continually differentiates and transforms in relation to its specific environment.

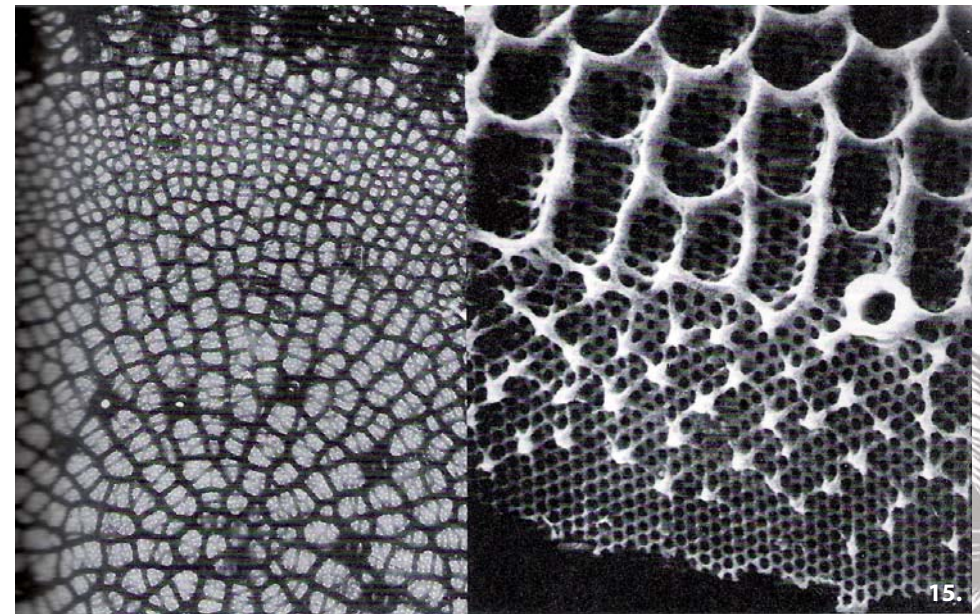
Developmental biology tackles some of these questions in three interrelated domains: Cell growth, Cell differentiation and Morphogenesis. Cell growth encompasses increase in both cell numbers and cell size. Cellular differentiation describes the process by which cells acquire a type. Morphogenesis concerns the processes that control the organized spatial distribution of cells which arise during the development of an organism, producing the characteristic forms of tissue organs and the overall body anatomy. (Hansel 2008: 20)



a paper strip element defined through a simple manipulation of aligning one strip end with the other, provided the basic system component for the 'Paperstrip Morphologies' conducted by Achim Menges, 2004-05

It is during these processes that the functioning of any organism develops. However, within each different species, a different type of morphology occurs. As in humans, when a fetus is in the womb it is neither male or female, and only through the addition of an x or y chromosome, do the cells in the fetus begin to develop in different ways. It is this microscopic alteration to an already functioning system that can change the morphology of the structure to transform in such a distinctive direction.

When looking at this idea in the context of this thesis, one can note that it is at a microscopic level of function that causes such diversity and differentiation between organisms and habitat. It is the development of different organisms at different stages in the process of life, that directs the structure of the entire ecosystem. What must be realized is that by introducing an artificial structure in any environment, the morphology of the site may mutate. This can either be an important and much needed change in the natural system, or can result in the complete devastation of the natural processes. Therefore, it is imperative that any ecological design must make educated and informed decisions with regards to any intervention, by this ensuring the sustainable and a productive integration with the natural system.



colonial aglae cells under microscope



**section 3_
an ecosystem in distress**

Section_3

An Ecosystem in Distress

As mentioned before ecosystems are in a critical state of fragility. These incredibly sensitive systems can easily be disrupted by the smallest and most seemingly insignificant intervention. Any intervention, whether it be natural or by the hand of humans, can cause entire systems to collapse. The earth today is facing major issues regarding the sustainability of our planet and its ecological systems. Habitats are being disintegrated, as the effects of industry, pollution and climate change are beginning to become evident. Most notably, these problems are affecting one of, if not, the most important natural resource on our planet, the oceans.

A staggering 80 percent of all life on Earth is to be found hidden beneath the waves and this vast global ocean pulses around our world, driving the natural forces which maintain life on our planet. The oceans provide vital sources of protein, energy, minerals and other products of use the world over and the rolling of the sea across the planet creates over half our oxygen, drives weather systems and natural flows of energy and nutrients around the world, transports water masses many times greater than all the rivers on land combined and keeps the Earth habitable. Without the global ocean there would be no life on Earth. (<http://animals.nationalgeographic.com/animals/>)

It is worrying, then, that we are damaging the oceans on a scale that is unimaginable to most people. We now know that human activity can have serious impacts on the vital forces governing our planet. We have fundamentally changed our global climate and are just beginning to understand the consequences of that. As yet largely unseen, but just as serious, are the impacts we are having on the oceans. A healthy ocean has diverse ecosystems and robust habitats. The actual state of

our oceans is a far cry from this natural norm. A multitude of human pressures are being exerted both directly and indirectly on ocean ecosystems. Consequently ecosystems are collapsing as marine species are driven towards extinction and ocean habitats are destroyed. Degraded and stripped of their diversity, ocean ecosystems are losing their inherent resilience.

Many activists and organizations have started various campaigns which set out to protect and preserve our oceans now and for the future by setting aside areas of the global oceans from exploitation and controllable human pressure, allowing these areas the respite they so desperately need for recovery and renewal. Building on a protection and recovery system established to manage land based over-exploitation, Marine Reserves are the ocean's equivalent of national parks. Marine Reserves are a scientifically developed and endorsed approach to redressing the crisis in our oceans which work alongside a range of other measures designed to ensure that the demands we make of our oceans are managed sustainably.

Beyond Marine Reserves we need to tackle a great many threats to the oceans' viability and find better ways of managing their resources. It is also imperative to become more aware of the acts which have brought the oceans to this point. The key threats which must be addressed are:



Climate Change



Over Fishing



Pollution.

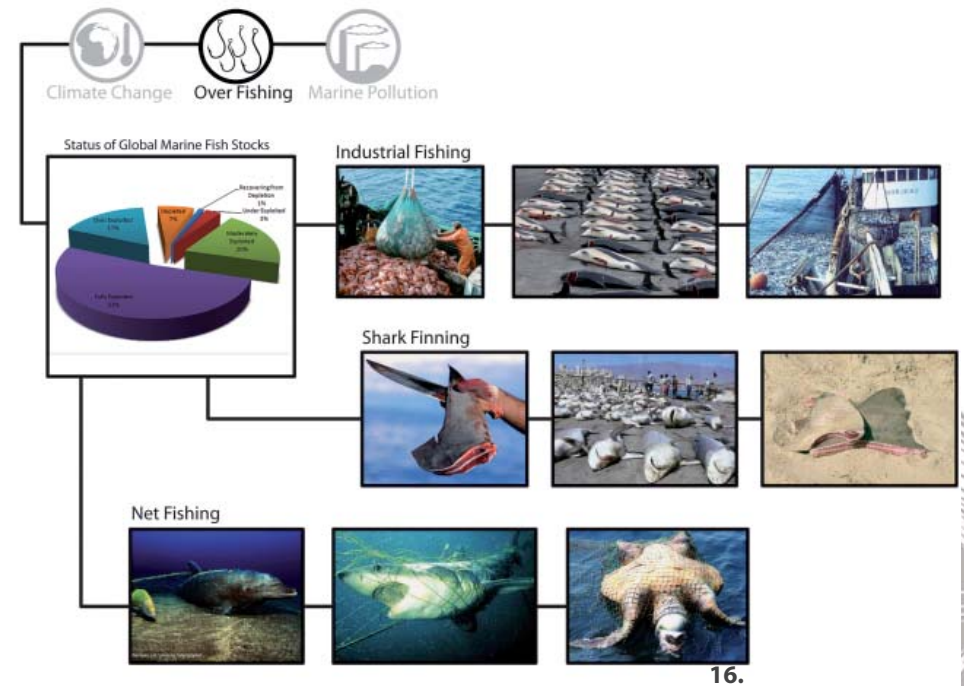
Key threats:

Over Fishing

Giant ships, using state-of-the-art equipment, can pinpoint schools of fish quickly and accurately. These industrial fishing fleets have exceeded the ocean's ecological limits. As larger fish are wiped out, smaller fish species are targeted and so on. Simply put, more and more people are competing for less and less fish, intensifying the strain on global fish stock.

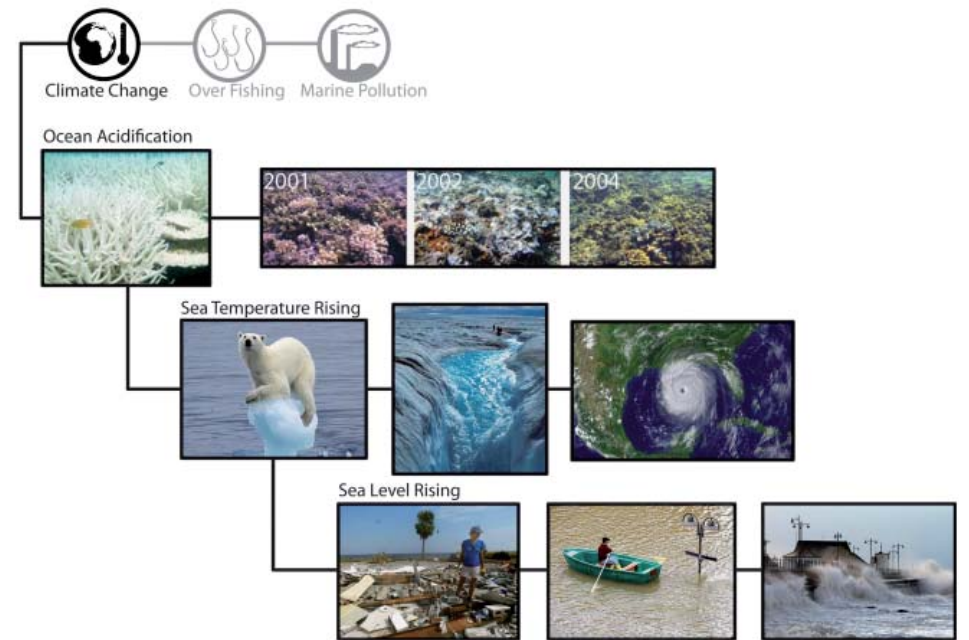
Modern fishing practices are incredibly wasteful. Every year, fishing nets kill up to 300,000 whales, dolphins and porpoises globally. Entanglement is the greatest threat to the survival of many species. Moreover, some fishing practices destroy habitat as well as inhabitants. Bottom trawling, for example, destroys entire ancient deep-sea coral forests and other delicate ecosystems. In some areas it is the equivalent of ploughing a field several times a year. (<http://animals.nationalgeographic.com/animals/>)

As traditional fishing grounds in the north have collapsed, fishing capacity has increasingly turned to Africa and the Pacific. Industrial fisheries that ignore regulations and effectively steal fish are denying some of the poorest regions of the world much needed food security and income, and those fleets fishing legally are only giving a small percentage of the profit to African or Pacific States.



Climate Change

The ocean and its inhabitants will be irreversibly affected by the impacts of global warming and climate change. Scientists say that global warming, by increasing sea water temperatures, will raise sea levels and change ocean currents. The effects are already beginning to be felt. Whole species of marine animals and fish are at risk due to the temperature rise - they simply cannot survive in the changed conditions. For example, increased water temperatures are thought to be responsible for large areas of corals turning white and dying (bleaching). (<http://www.greenpeace.org/international>)

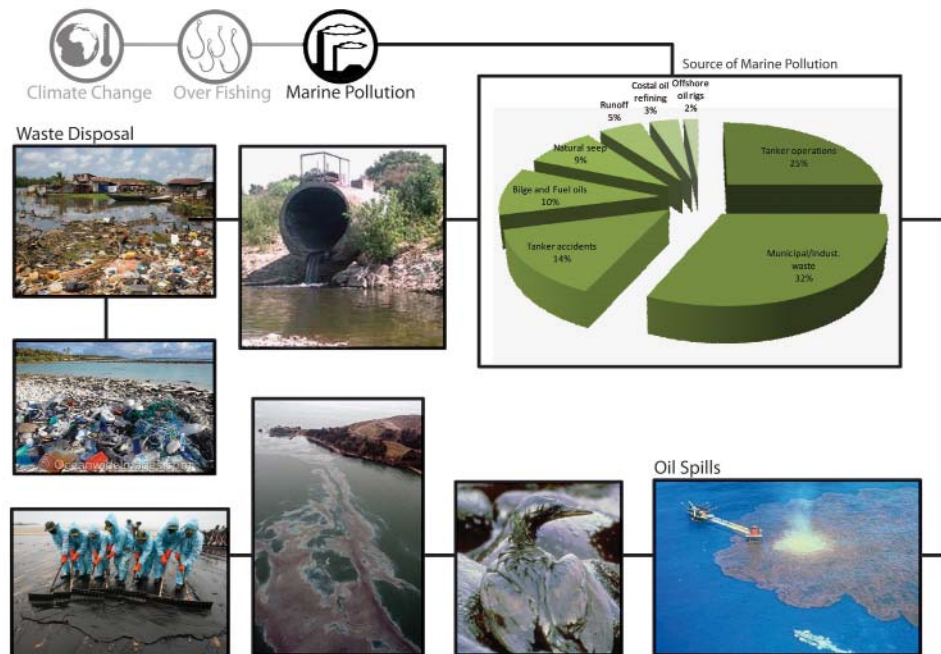


17.

Pollution

Another significant impact of human activity on the marine environment is pollution. The most visible and familiar is oil pollution caused by tanker accidents. Yet despite the scale and visibility of such impacts, the total quantities of pollutants entering the sea from oil spills are dwarfed by those of pollutants introduced from other sources. These include domestic sewage, industrial discharges, urban and industrial run-off, accidents, spillage, explosions, sea dumping operations, mining, agricultural nutrients and pesticides, waste, heat sources, and radioactive discharges.

Fundamental changes need to be made in the way our oceans are managed. This means that we must act to make sure that human activities are sustainable, in other words that they meet human needs of current and future generations without causing harm to the environment.



section 4_
Programme

Section_4

Programme

In order for any type of conservation facility to exist, with regards any natural ecosystem, it is important that a clearly defined programme be identified. The main objective, however, is the conservation and sustainability of the selected ecosystem or environment.

However every ecosystem in existence is unique within itself, and is formed by the combination of specialized systems and individuals. Each of these systems or individuals need to be treated in a unique manner and a clear understanding of how they function must be present, before any type of intervention can exist. However, the basic principles of a conservation programme can be applied to any intervention within the natural world. The four main principles that need to be addressed are:



Research



Conservation

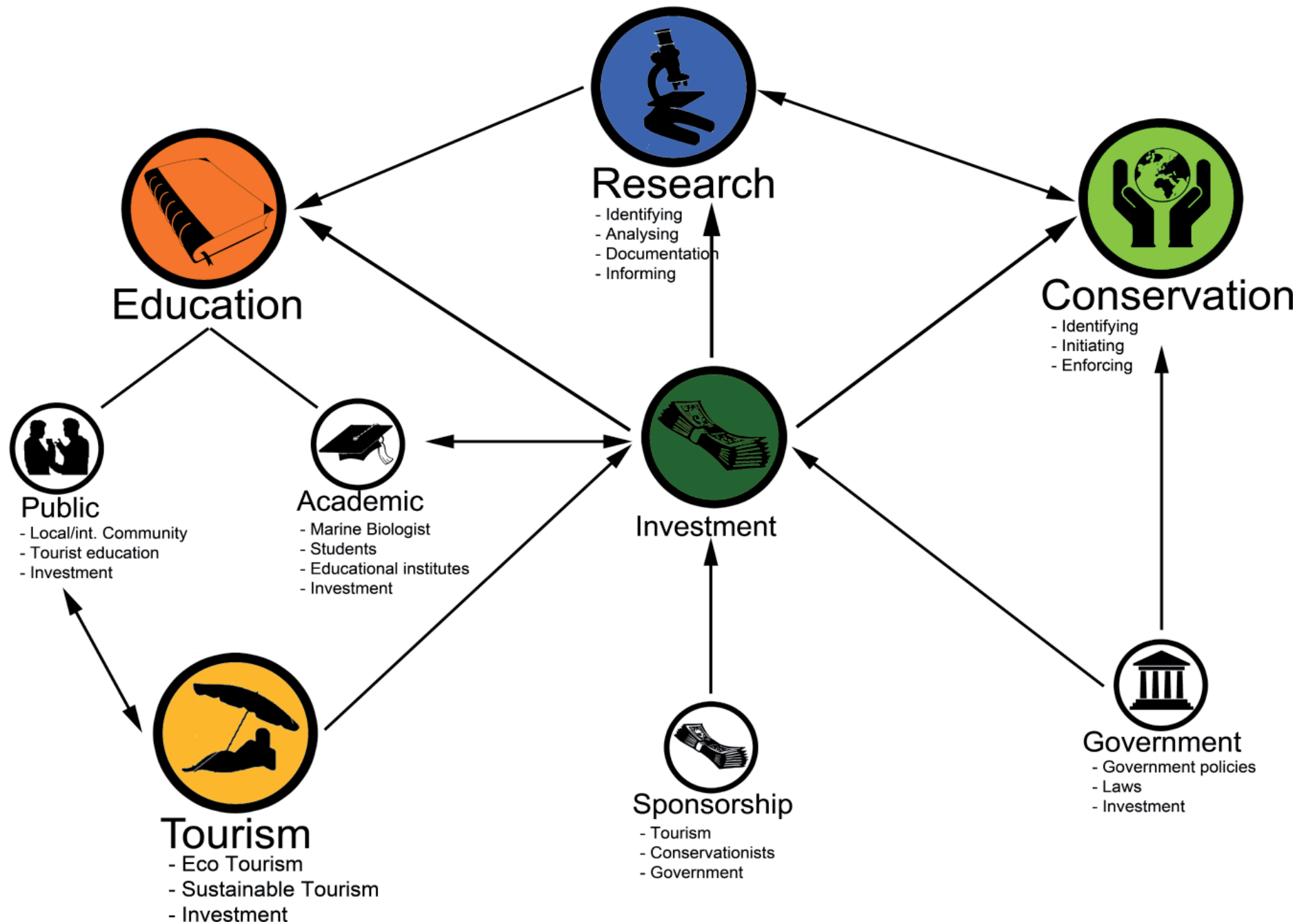


Education



Tourism

For the purpose of this thesis the following programme is aimed at the marine ecosystem and the sustainability of this environment.





Research

Research forms the primary element in any conservation programme. It is only through the in depth research and analysis of an environment that conservation can begin. Through research, biologist are able to understand how a specific environment functions, what critical issues need to be addressed and what interventions are necessary to ensure a sustainable future. This can only be achieved through the study and analysis of every part of such a system. Specific facilities, equipment and manpower is needed in order to initiate such functions.

The programmatic objectives regarding any research programme can be divided into four main steps

1. identifying - to identify critical habitats, species and zones for research
2. analyses - in depth and cohesive analysis and study of such habitats, species and zones
3. documentation - to document, and compile the research findings
4. informing - use the information acquired to inform the global communities

Research facilities

Accessibility:

Diversity of habitat and species
Sea water/fresh water

Analysis facilities:

Laboratory
Wet labs/aquaria
Dissection room
Refrigeration/cold room
Media/tracking lab
Workshop

Scuba facilities:

Scuba equipment/ Storage
Preparation deck
Wash basins
Transportation - land/sea

Administration facilities:

Admin office
Meeting room
Reception/info desk
Accommodation





Conservation

At this point in time a vast majority of our natural resources have limited restrictions and laws regarding their conservation. Areas such as the Mozambican East coast, and the South China Sea hold some of our planet's most biologically diverse ecosystems, yet are largely unprotected by the law and therefore are vulnerable to many of man's destructive activities. With regards to marine conservation only small sections of the ocean have been identified as nature reserves and are protected by environmental organisations and governmental policies. However these areas are still vulnerable to poachers and intruders who continue to abuse such areas for monetary gain.

Once biologists have a documented understanding of the issues regarding the specified environment, steps to protect and conserve such an environment can begin to be put in place. Zones and individual species will be identified for specific interventions. It is therefore the responsibility of any conservational facility to ensure that their presence sustains and conserves the selected areas. These responsibilities can be divided into three main objectives:

1. **identifying** - identify habitats, species and zones in need of conservation
2. **initiating** - to set up and facilitate the conservational interventions
3. **enforcing** - to implement and enforce such intervention

Conservation facilities

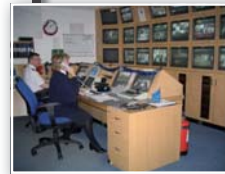
Facilities:

Surveillance facilities
Communication hub
Media/tracking lab
Security points
Mobile units

Administration facilities:

Admin office
Meeting room
Reception/info desk

Conservation Facilities



Surveillance room



Media/Tracking Lab



Communication



Security points



Mobile Units



Transportation

Administration



Admin Office



Meeting Room



Reception



Education

The programmatic response to the issues of education can be defined as twofold:



Public Education

Public Education

The future of the sustainability of the world oceans, as well as any other natural environment on our planet, rely on the proper education of the global community. As biologists begin to understand the cause of the deterioration of these environments, as well as the methods and interventions needed, they can begin to educate us on the way forward. Many of the obstacles which we face with regards to environmental sustainability can be attributed to the lack of accurate knowledge and information available to the public. Education of the local fishing community as well as visiting tourist would become the focus of the educational programme.

Academic education

Any student or educational facility which focuses on environmental study and research needs adequate facilities and studying opportunity within close proximity and constant availability to their subject of study. For aspiring marine biology students, as well as qualified professionals in the field, access to the marine environment is key. Any on site facility will attract students and academics in the field, as it would give them a unique opportunity to learn and explore their passion directly within the selected environment.



Academic Education

Public facilities:

Lecture/class rooms
Presentation/media rooms
Seminar rooms
Mobile units
Workshop

Academic facilities:

Laboratory
Wet labs/aquaria
Dissection room
Refrigeration/cold room
Media/tracking lab
Workshop

Scuba facilities:

Scuba equipment/ Storage
Preparation deck
Wash basins
Transportation - land/sea

Administration facilities:

Admin offices
Meeting rooms
Reception/info desk
Accommodation

Public Facilities



Lecture/class rooms



Media/Presentation rooms



Seminar rooms



Mobile units

Academic Facilities



Dissection room



Refrigeration

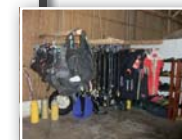


Laboratory



Wet Labs / Aquaria

Scuba Facilities



Scuba Equipment

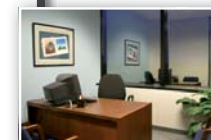


Preparation deck



Transportation

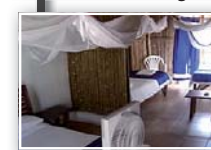
Administration



Admin Office



Meeting Room



Accommodation



Reception
21.



Media/Tracking Lab



Workshop



Tourism

Tourism plays a large role in the success of any conservation facility within most environments. As human beings, most of us have an intense fascination with the natural world and use it as a way to escape the pressure of our daily lives. The oceans, forests and wildlife of this planet attract millions of tourists each year, and therefore has become one of the world most active and profitable industries. It is this industry that also brings in the financial support needed to sustain environmental conservation and research.

It is the oceans, however, that provide opportunities for one of the most popular and lucrative tourism activity, SCUBA diving. It is through the aid of SCUBA equipment that we as land based mammals get a chance to experience life beneath the sea. However, due to the lack of education within the diving community, this activity can begin to cause a serious disruption within the marine ecosystem. The programmatic response to this issue would be to educate tourists about the environment which they are in, and the manner in which they must conduct themselves while visiting.

Tourist facilities:

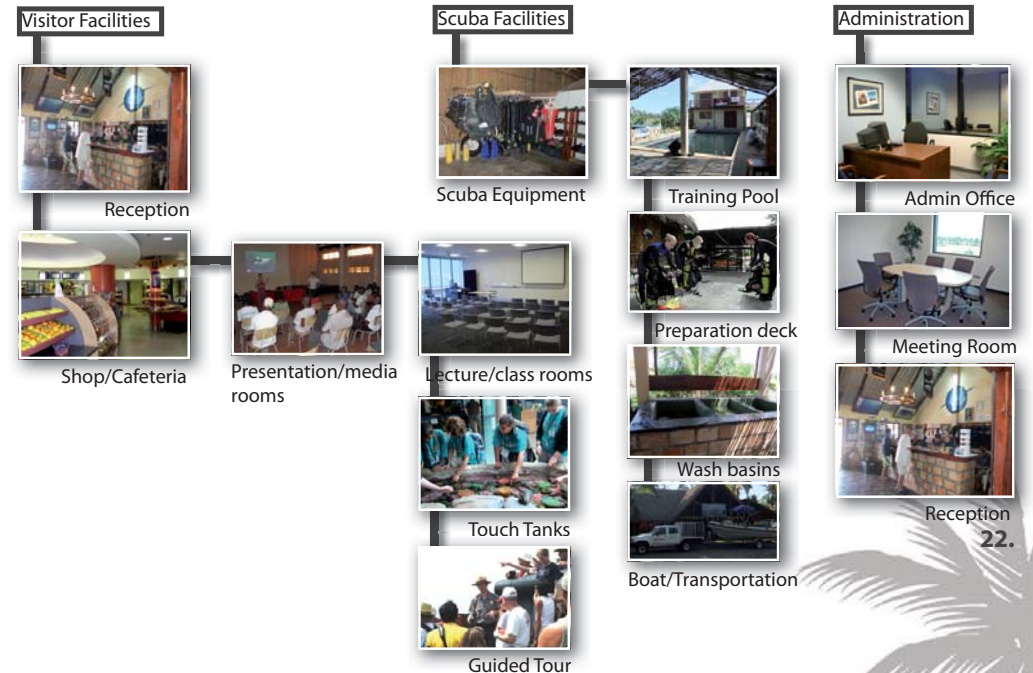
Reception/info desk
Booking desk
Shop/cafeteria
Presentation/media room
Lecture/class room
Touch tanks
Guided tour

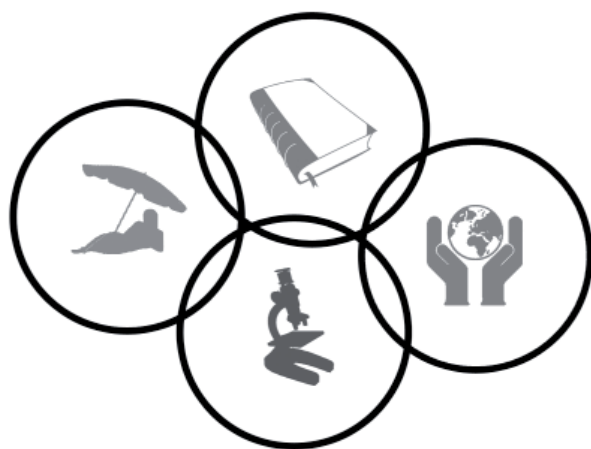
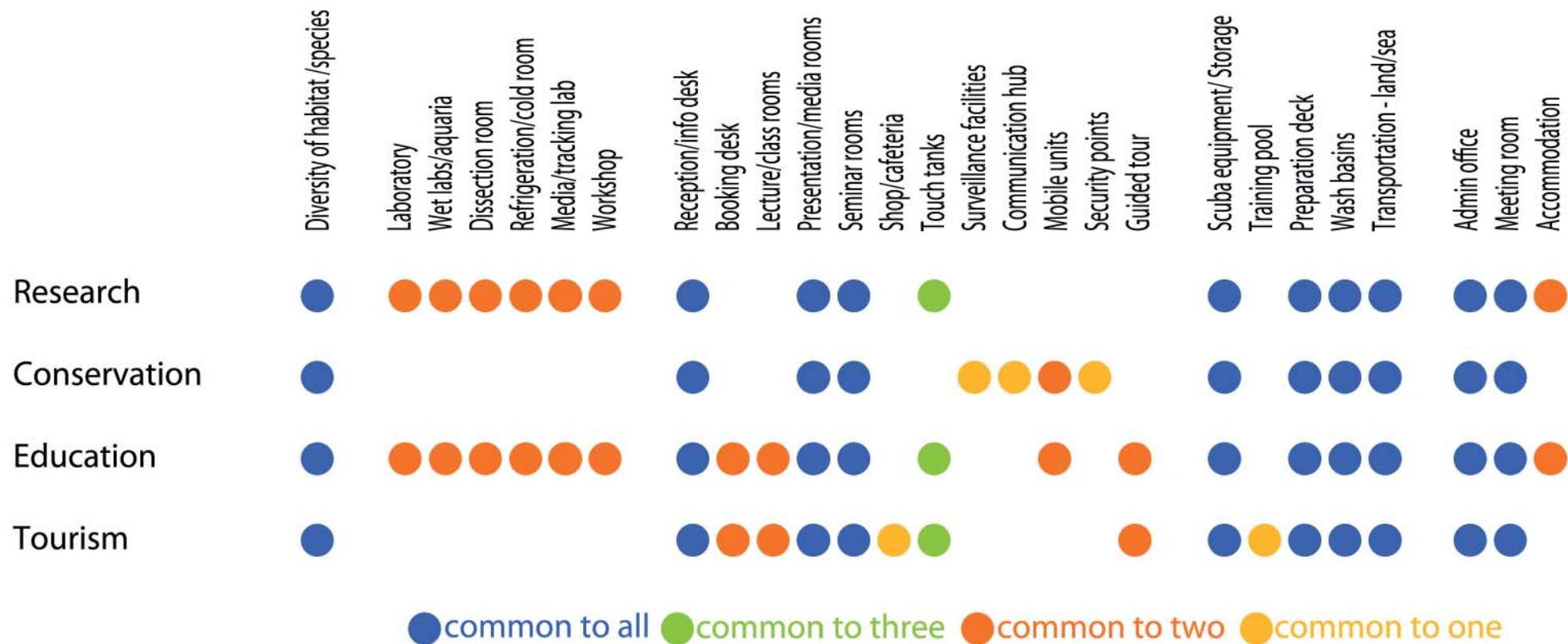
Administration facilities:

Admin offices
Meeting rooms
Reception/info desk

Scuba facilities:

Scuba equipment/ Storage
Training pool
Preparation deck
Wash basins
Transportation - land/sea







An aerial photograph showing a dark, winding river flowing through a dense, green forested area. The river has several sharp turns and meanders. The surrounding land is covered in thick vegetation, with some lighter green patches indicating different types of trees or grass. The overall scene is a natural, undisturbed landscape.

section 5_ case studies



The Sydney Institute of Marine Science (SIMS) Chowder Bay, Sydney, Australia

The Sydney Institute of Marine Science (SIMS) is a not-profit unlisted public company founded in 2005 by four universities (Macquarie, NSW, Sydney and UTS) as a collaborative research institute bringing together scientists from the universities in the greater Sydney region and from several state and federal government departments, The Australian Museum and the Australian Defence Science & Technology Organisation. SIMS conducts multidisciplinary marine research on impacts of climate change and urbanisation, biological diversity, fisheries, tourism, coastal development, and marine disease. By bringing together NSW's leading marine scientists at one collaborative site, SIMS maximises the efficient use of resources for research on Australia's critical coastal environments.(<http://www.sims.org.au/>)

It is the principal marine research institute on the South-East Australian coast providing a focal point for:

World class collaborative marine research;
Provision of marine research for policy makers and managers;
Research training and teaching in the marine sciences
National and international collaboration.

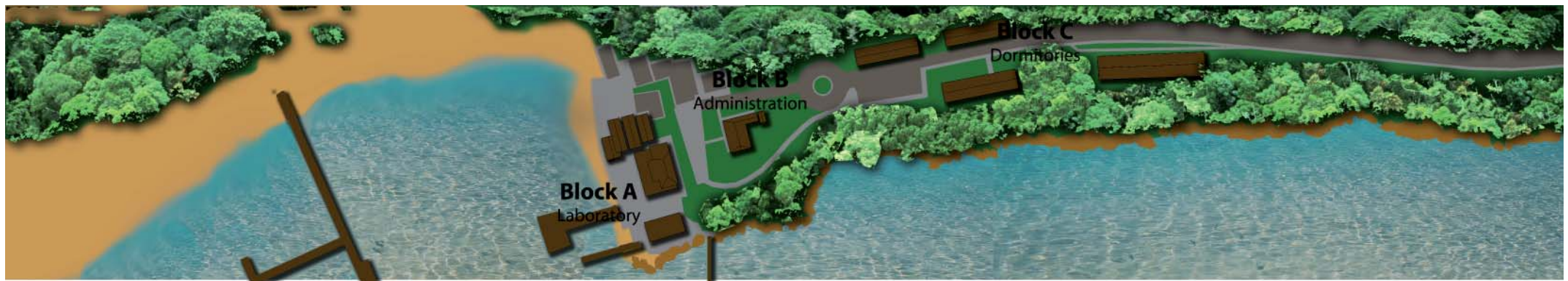
SIMS makes a major contribution to global marine science. Much of its work have world-wide applicability. The SIMS model is for a single collaborative campus bringing together the diverse skills from all of the institutions associated with SIMS. This is the best possible model for world-class marine research. The scientists who work at this facility cover a broad spectrum of the marine sciences, and will carry out multidisciplinary research that will encompass a broad range of the challenges facing us.



Sims location: sydney heads, chowder bay.



23.



SIMS Facilities

The institute is located in Chowder bay which is part of the Sydney harbour. It is in close proximity to the Sydney heads, connected to the Tasman Sea. This area has escaped the urbanization of Sydney, as well as the development and trade in the Sydney harbour. Chowder bay is still home to a variety of temperate marine species, some that have not even been named. The advantages of these facilities location is that there is an abundant flow of clean, nutrient rich sea water brought in by the Tasman Sea. This water can be pumped and filtered by state of the art equipment straight into the research aquaria, providing a stable environment to study live species in house.

The buildings which house this institute are the refurbished shells of the 19th century Australian Sub-marine Core. The buildings today have been up graded with modern marine science equipment and aquaria, which are close to the water's edge, allowing constant accessibility to sea water pumped directly from the harbour. It is here that the main laboratories of the institute are situated, where key analysis and research can take place. Just above these buildings is the main administration block, which houses the information desk and main reception as well as offices, meeting rooms, classrooms and presentation/media equipment. There are also dormitory accommodation to the right of the administration block which houses students, scientists and staff. The layout of SIMS is fairly disjointed and spaced out, however still forms an ideal facility for the programme of the institute.(<http://www.sims.org.au/>)

Block A

Wet Labs
Aquaria
Laboratory
Workshop
Pump room

Block C

Dormitory accommodation
Offices
Study Rooms

Block B

Reception
Information Desk
Offices
Meeting rooms
lecture/ class rooms
Study rooms
Presentation/ Media rooms



Block A



Block B



Block C

Programme

Research

Research at SIMS covers a broad spectrum of the marine sciences, including the sustainability of our oceans and estuarine marine environments, the development of new marine technologies and protection against invasive pest species and diseases that can cause great harm to our marine ecosystems. SIMS is also the manager for the NSW node of the Australian Government's Integrated Marine Observing System - IMOS

SIMS research covers many aspects of marine science. The following examples give an idea of the scope of this research.

Effects of Urban and Industrial development
Status of The East Australian Current
Monitoring harbour water quality
Endangered and vulnerable species
Fish Population

Education

A cross-disciplinary and multi-institution research facility, SIMS is host to some 55 marine researchers working on issues critical to the sustainable management of coastal and oceanic environments. SIMS plays a vital role in helping to produce the next generation of researchers and managers of the marine environment by encouraging significant numbers of PhD candidates to pursue their research at SIMS and by conducting a broad range of post-graduate speciality marines courses.

Informing the Public

SIMS is open to the public 6 days a week, and encourages a variety of visitors and students to visit the center. Guided tours throughout the institute are available as well as seminar and public presentations on the research and findings carried out on site. SIMS aims to educate the public community on both the relevance and importance of marine research and conservation, and inform the local community of ways they can make a difference to the sustainability of the oceans.



Sims facilities

Sydney Institute of Marine Science wins \$19.5m grant in Budget 09

During the 2009 Australian Federal budget address, The Sydney Institute of Marine Science was awarded a \$19.5m grant to set up the first protected marine aquarium and associated research laboratories in southern Australia. SIMS scientists will now have access to state-of-the-art equipment and facilities at its Chowder Bay site to combat threats to marine ecosystems arising from climate change, urbanisation, changing coastlines and marine microbes.

"The new funding will help to transform SIMS into a unique research aquarium facility. It will provide new laboratories for modern molecular and chemical work, increased research training capacity via a research teaching laboratory, and new accommodation for research students and visiting researchers from around the world." SIMS Chairman, Professor Frank Talbot(http://www.afloat.com.au//Sydney_Institute_of_Marine_Science)

What this funding will buy:

- Aquarium and seawater laboratory
- Aquarium pumps on the naval wharf
- Research training facility
- Vessels and vehicles
- Climate change and geomorphology
- Computer and communications equipment
- Security





26.

Parc Ivoloina Project Toamasina, Madagascar

Madagascar is legendary for its levels of biodiversity and endemism, and many of its species are so bizarrely beautiful that the whole island seems improbable, a mythical biological wonderland. However, today Madagascar is one of the world's highest conservation priorities, with only 10% of the island's forests remaining. (<http://www.savethelémur.org/ivoloina-main.htm>) Protected areas have been introduced; forcing local communities to be relocated to the peripheries of these reserves in order to protect the natural heritage and major tourism draw cards of the country such as the forests.

The Madagascar Fauna Group (MFG) is an international consortium of zoos and related organizations that pool their talents and resources to work together in one of the world's most endangered places. The aim of this organization is to unite the country's zoos, aquariums, botanical gardens, universities and related conservation organizations. The consortium realized that by combining each institute or organization into one facility, their combined opportunities could be more beneficial for both conservation and education in the country. The primary objectives of the MFG projects are:

Environmental education
Community outreach.
Conservation
Tourism

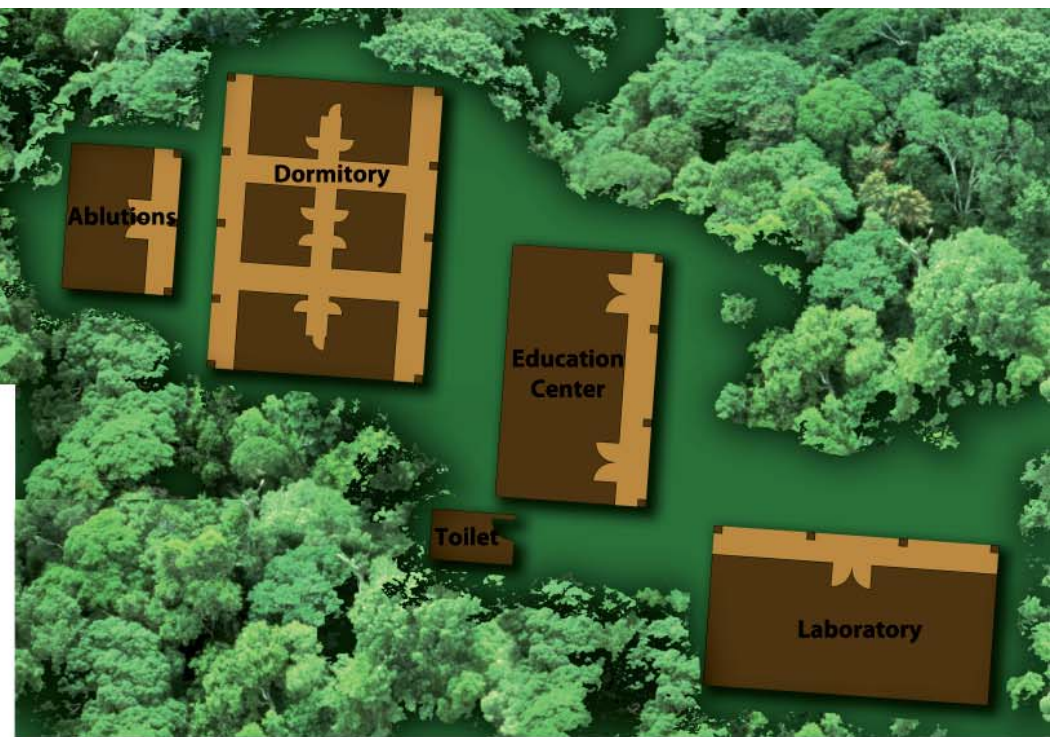
As a result, the MFG has established various projects which incorporate the forementioned objective to address these environmental issues. One of these projects is the Parc Ivoloina Project, in north eastern Madagascar.



27.



28.



During the initial establishment of the project, the primary objective was a lemur breeding programme, with an educational component incorporated within it, in the form of a visitor's center. This centre facilitates the education of visitors about the breeding programme and its purpose. Initially, the project was not only targeted at tourists, but also at educating school pupils in the environment and conservation. However, having noticed the deep need for education within the local communities, MFG extended the education programme into the surrounding areas in hope of empowering and equipping the community for future sustainability.

The zoo and educational facility are placed in close proximity to one another. This allows a unique opportunity for tourists and students to interact, as well as exploring both the programme within the buildings and the surrounding environment. The educational training facility is located together with the laboratory and dormitory facilities. Accommodation within the facility is crucial due to the isolation of the site. By having dormitories on site, education can become more accessible to the local Malagasy community. By involving the local community in the education programme, new forms of careers opportunities and employment becomes viable, injecting a variety of new skills and knowledge into the community.

Through the structure of this project, as well as the integration of local manpower, a unique relationship is formed between visitor, students and locals, bridging the gap between them. Students working with the tourists provide an educational and enthusiastic experience, rather than simply a visit to a zoo within a forest. Local staff will bring with them the cultures and identity of the Malagasy people, enhancing the visitors experience and broadening their knowledge of this environment.

Parc Ivoloïna is located on a site which has already felt the effects of deforestation in the area. The presence of this facility provides the opportunity to reforest the site as surrounding fauna is free to grow and expand into the facility, enveloping it into the forest. The architecture over time becomes part of the landscape, and as the majority of the education is conducted in the field, the line between classroom and habitat is blurred.



Facilities

Zoo

Lecture/class rooms

Educational training facilities

Laboratory

Dormitory



29.

The design of this facility needs to respond to the climatic conditions of the area. The climate is that of extremes, with high year round temperatures, humidity, rainfall and winds. This area is also susceptible to annual cyclones which can cause wide spread devastation. The success of the climatic design of the facility allow the relationship between 'architecture and environment' to be expressed in a number of ways.

The buildings are restricted to single story. Large beams and columns are used to add stability to the structure and large gutter systems are used to discharge the water from the buildings roofs. In allowing circulation within the facility, the walls of the buildings are pulled back, creating external covered walkways that shelter the users from both rain and the intense heat, as they move around the facility. The large covered walkway also act as multipurpose spaces, allowing classes to extend their boundaries out of the classroom and in to the surroundings.

Communal external courtyards are created by the positioning of the buildings, a hierarchy of spaces becomes visible as the user moves in stages between the inside and the outside. A system of manoeuvrable louvres protect the interior spaces from cyclone winds and debris. Interior spaces are well ventilated through air vents located in the walls and roofs, allowing a constant flow of cooler air through the buildings.

The climatic responsive design of this facility not only results in a well functioning programme and high comfort levels. Because the architecture throughout Madagascar responds to design and materials in a similar way, the architectural identity of the region is evident within this facility, further strengthening the relationship of architecture and its environment.



Parc Ivoloiana staff member feeding the lemurs





Tambopata Research Centre

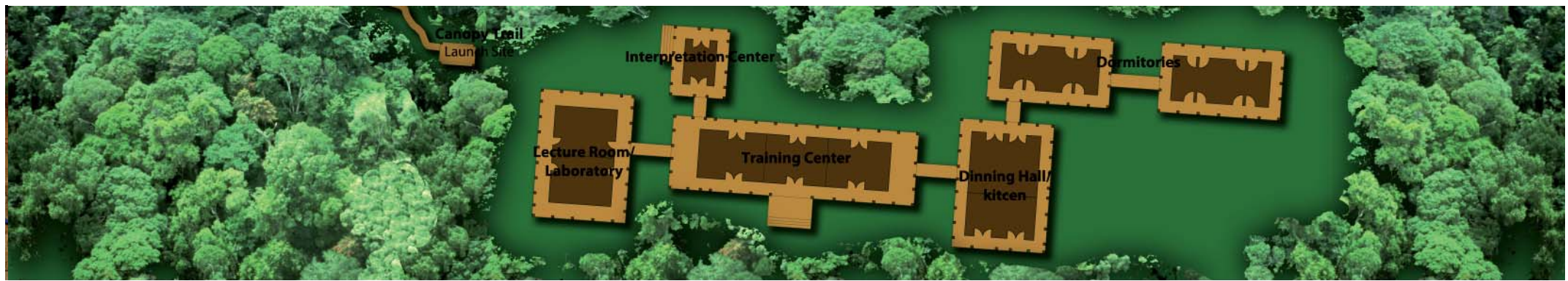


The Tambopata Center Puno, Peru

In relation to the topic of this thesis an interesting case study to investigate is that of the Tambopata Centre in Peru. It is here that the Amazonia Centre for Environmental Education and Research (ACEER) is based. This project was made possible through a \$3 million grant from the National Geographic Society, as well as contributions from other environmental organization such as Inkaterra, who provide housing and accommodation within the area for visiting tourists and scientists. The facility was set up as an educational centre for the local communities, international visitor and researchers, thus covering a wide spectrum of people requiring varying degrees of education in conservation. By integrating students, locals and tourists, each with a variety of different interests and skill levels, a rich educational programme is developed, where individuals interact and learn from each other.

The educational programme of the Tambopata Centre is aimed at the environmental issues impacting on the rain forests of the area. Various other research and educational programmes are also offered in conservation. Workshops and courses are made available to local teachers and community members, as well as visiting tourists, and last from a one day to a three week programme.





Programme

Education

The Nature Interpretation Centre educates and informs individuals about the physical, biological and cultural elements of the region. The facilities include meeting rooms, class/lecture rooms and presentation/media rooms. Course work is designed to allow for part of the education to be given through lectures, and part through experiencing the surrounding environment and site visits. Fully equipped laboratories and workshops provide students and scientist the opportunity for in-depth research and analysis of their finding in the area.

Interpretation Trail Systems consist of foot trails and elevated walk ways which takes individuals on guided tours in and around the surrounding forests. These trails serve as a 'living classrooms' to visitors and students, and give them a greater understanding of the surrounding environment. The elevated walk ways and canopy trails weave through the maze of trees, passing important ecological components and natural structures. These raised trails also protect the forest floor from the disturbances and negative effects large groups may cause.

Integrating with the local communities

Not only does the Tambopata Centre offer a variety of courses and workshops to local teacher and community members, but it encourages them to become an active part of its programme. The centre is staffed with many local individuals, who serve as workers, as well as tour guides and speakers, thus providing local employment and skills development. Through this, important information can be passed to the local communities the conservation and sustainable living in such environments, expanding the level of knowledge throughout the region. It is through this integration that a mixing of cultures and experiences begin to occur. This facility is structured to encourage the interaction between tourists, students and locals, resulting in a constant flow of knowledge between all parties concerned.



34.



35.

Architectural Responses

The construction of this centre draws upon locally sourced material and construction methods such as timber and thatching. This adds to the visual authenticity of the surrounding Amazonian vernacular. Because of the use of such materials, the building also begins to integrate with the surrounding environment creating the illusion that it has emerged from the site rather than being placed there. The main structure rests on thin columns and sits lightly within the site. This sensitive treatment of the site enforces the ideas of the centre's objectives. Through this, the relationship between the architecture and its surroundings is intensified. Walls and roofs are broken down to allow a constant association with the surrounding environment, drawing the landscape into the building and vice versa. This strengthens the idea of a connection with the surrounding and allows learners to be in constant contact with their subject of study.

Climatic Responses

The architecture of this centre responds successfully to the climate and draw it's identity from the responses to the climate and in so doing matches with the surrounding vernacular's climatic design. Walls become semi-permeable allowing a constant flow of cool air through the interiors. Similar to the approach taken in the local architecture, a hierarchy of external covered spaces are created at the entrances to the buildings, with verandas opening on to the landscape. As the building is suspended off the ground, air and water can move underneath the buildings. Water is directed away from the building by means of large overhangs stretching away from the semi-permeable walls and openings. Through this type of design the Tambopata Centre become a space of comfort allowing it's programme to function without being disturbed by the extreme climate of the area.







Flamingo Bay Lodge

Ponto do Barra, Inhambane, Mozambique

Flamingo Bay Lodge is a holiday resort located on the lagoon of the Barra peninsula. This project was the idea of David and Jill Law, a couple who frequently visited the area many times. Their love for the natural environment, and surrounding wild life of the area sparked the idea for an isolated and romantic luxury lodge, catering exclusively for couples. The construction of this resort was not an easy process for many reasons, firstly the isolation of the site poses many problems with regards to accessibility. Building supplies were constantly stopped and held at the boarder delaying deadlines and increasing costs. The tidal fluctuation also disrupts construction as spring tide would completely cover the area with water. This process took 2 years to complete, and flamingo bay was finally completed on 17th December 2004.

However, on the 5th march 2005, the grand opening to the public, tragedy struck as the entire main building was completely destroyed by a fire. The re-building of the lodge began in April 2005 and was completed and ready for its second opening in October of that year.

Building materials and labour

What is important about this project with regards to its construction is the building materials and labour used. Most of the materials are sourced locally, either from the immediate area, or manufactured within Mozambique. For example the building materials for the roof of the lodge was acquired directly from the local community of Barra. Most of the labourers working on the construction were used to staff the lodge following its completion. These points makes this build a sustainable project for the local community.



38.



Facilities

Administration building

Lobby
Reception desk
Conference centre
Restaurant/bar
Kitchen
Swimming pool/deck
Spa

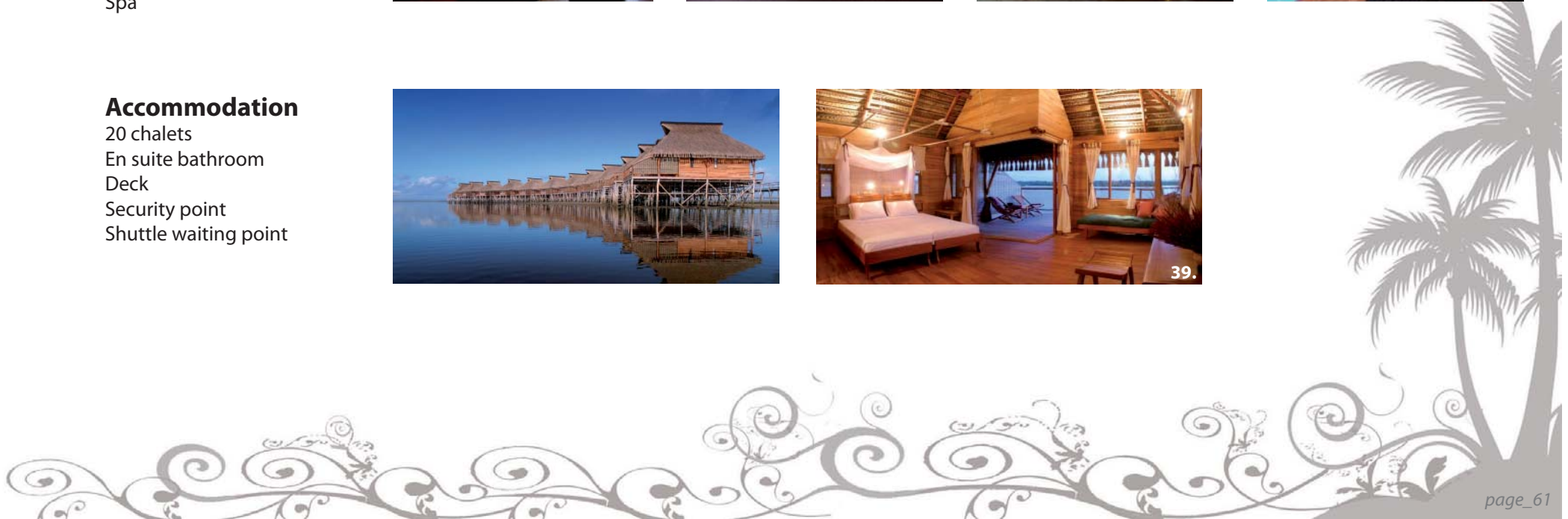


Accommodation

20 chalets
En suite bathroom
Deck
Security point
Shuttle waiting point



39.



Tidal effect on Flamingo Bay Lodge

Low Tide

The main building is located on the high tide boundary of the lagoon. However during low tide, this building is ± 320 meters from the water. The chalets are located on the low tide boundary of the lagoon. During the low tide period, the entire structure and support system of the chalets are exposed, as is the sandy estuary floor. The board walk and chalets are 2.8 meter above the ground.



High Tide

During high tides the main building is completely surrounded by water, depending on the time of the month. During spring tide the water can rise ± 600 mm around the main building, and 2.5 meters around the chalets, completely submerging the support structures.



A Symbiotic Relationship: 'Architecture vs. Ecosystem'

It is here that one can start to understand the relationship between a man made intervention and the ecosystem of the surrounding area. It is, however, during the high tide periods that the significance of the existence of this piece of architecture becomes evident. The rising water levels brings with it an array of diverse marine life. Thousand of juvenile marine and reef fish, as well as a variety of other species, are attracted to the matrix of columns and supports, which provide an ideal source for food and shelter from larger carnivorous species. The material used for the support systems, as well as plastic piping for plumbing and electric services, act as a host for the development and growth of micro organisms and vegetation. Species such as barnacles, muscles, algae and sea weeds which attach themselves to the materials, provide an important source of food and nutrients for any passing creature. Although only lasting as long as the high tide period, this area is transformed from a seemingly barren sandy bed, into a labyrinth of movement, colour and life. It is through the intervention of this architecture, that a unique and ecologically important bio-diverse 'artificial' habitat is created.

The existence of this 'artificial' habitat is not only beneficial to the marine species that inhabit it, but also provide unique opportunities for us as human beings. Because of the influx of fish around the architecture, this area can become an ideal fishing location, not only for tourists but for local fisherman as well. As this architecture brings in schools of fish by the thousands, fishermen take this opportunity to catch smaller fish, which they later use as live bait during ocean fishing excursions. Another advantage of this 'artificial' habitat is the opportunity for one to experience a close encounter with marine life. By simply diving into the water from the platforms above, one can snorkel in and around the structure, providing tourists with a unique and fascinating experience



An aerial photograph of a river delta, showing a complex network of water channels and land. The water is a dark, muted green, while the surrounding land is a lighter, textured green. The channels meander and branch out across the landscape. At the bottom of the image, there is a decorative border consisting of white, swirling vine-like patterns.

section 6_ Site Selection

Section_6

Zone selection

Ideal zones for Interventions

In order to identify an ideal location for any intervention regarding marine research and conservation, certain criteria need to be constantly available on a permanent basis. With regards to any study on a natural environment one needs to have constant access to a diverse range of species and habitats. The more intense the bio diversity level of a individual zone is, the more opportunities will become available for study and analysis. (interview: Marshall, A)

It is important for one to realize that in order to establish a hub for research and conservation within a natural environment, the conditions and stability of such an environment are imperative, especially concerning the oceans. It is also important to realize that if we wish to understand and conserve any marine ecosystem, we must work in a proactive manner. Therefore, with regards to conservation and research in the marine world, it is not viable to concentrate ones efforts within a zone where degeneration of the that ecosystem is rife. Unfortunately, areas that already have a high level of disruption, with regards to industry, climate change and pollution, are not ideal locations to incorporate such intervention. Rather, we must look at ecosystems which are in a relatively stable state. Areas which have not yet felt the full force of man's destructive behaviour.

"...in terms of marine conservation, the only way to make a difference for the things that are happening today, is to be proactive. Trying to do things in reverse, has been found to be completely unsuccessful!"

Dr. Simon Pierce, researcher - The Manta & Whale Shark Centre

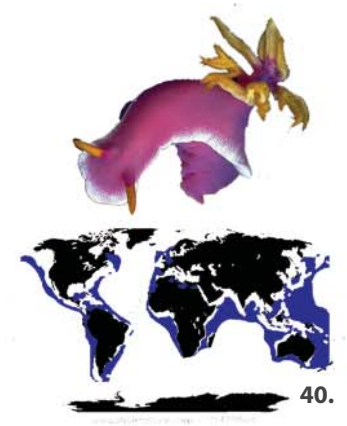
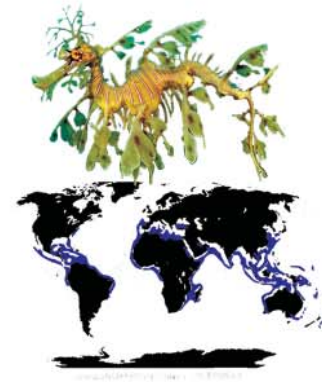
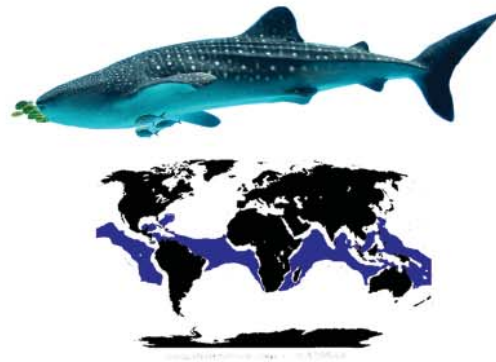
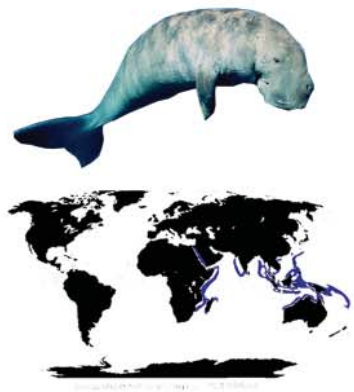
By making an educated selection of an ideal site, the processes of research and investigation will become an important and sustainable programme which can be incorporated symbiotically within the existing structure of the site. Through this, the marine biologists and scientists working in the selected environment will be able to obtain an understanding and knowledge of how such an environment functions, how each different system has an impact on each other, and what is causing these systems to fail. Once this understanding is established, further intervention can be put in place to ensure the conservation and sustainability of the selected environment.

It is for these reasons that the two most important criteria in choosing an ideal zone for intervention are:

Bio-diversity and **Relative stability**



bio-diversity_mapping



The above diagrams map the distribution range of four of the world most rare and endangered species from the four main marine species group, being:

marine mammal: dugong

sharks and rays: whale shark

fish: leafy sea dragon

invertebrates: nudibranch

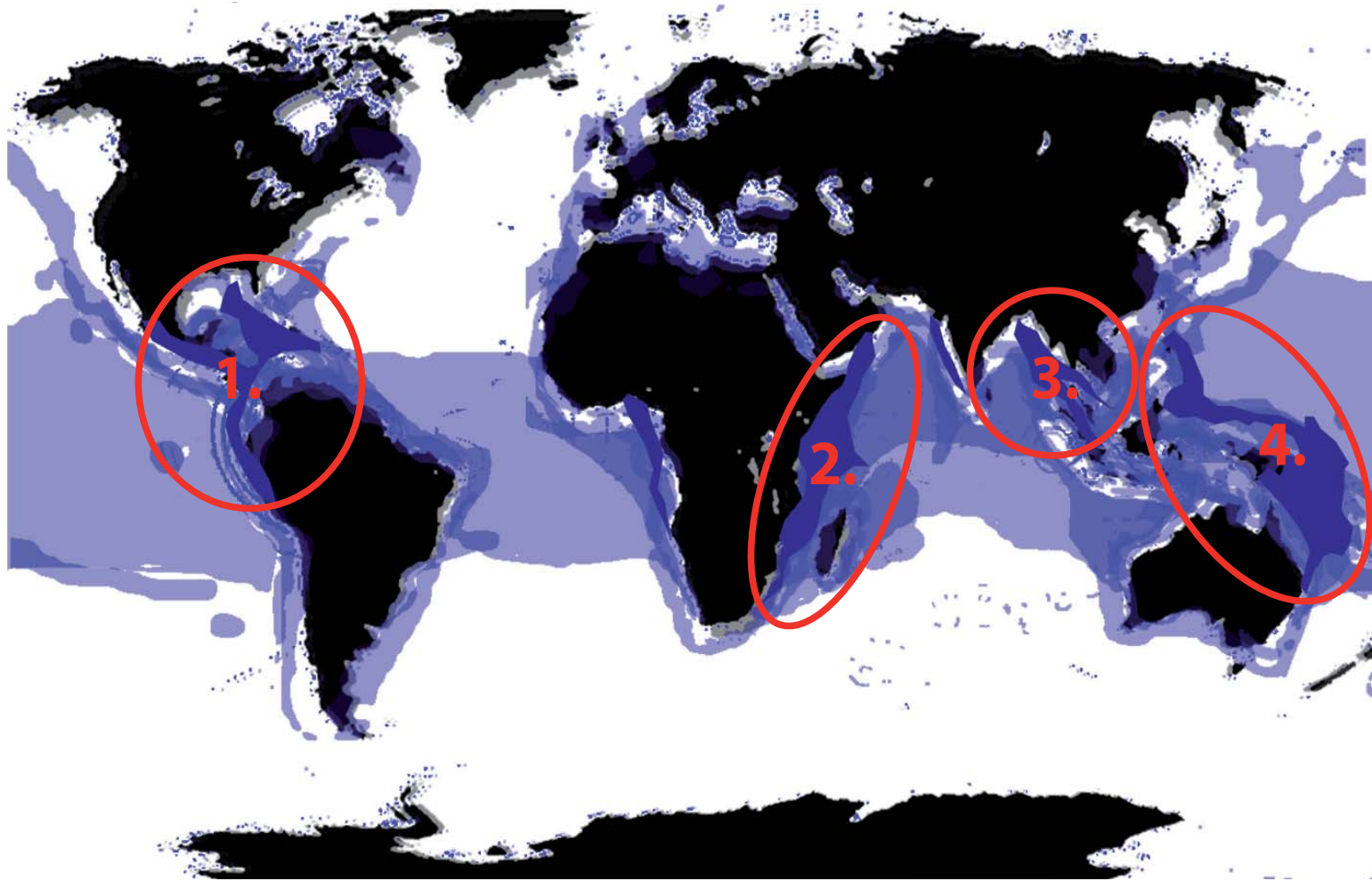
By overlapping the previous five diagrams, once can identify hubs of bio-diversity. It is through this that four main areas of bio-diversity emerge:

1. The Gulf of Mexico

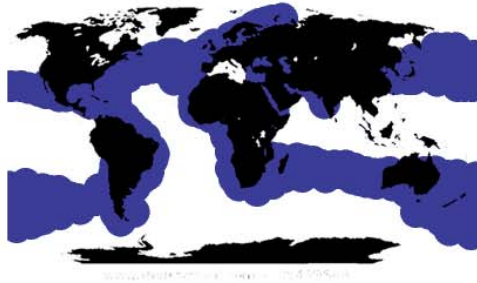
2. The Mozambican East Coast

3. The South China Sea

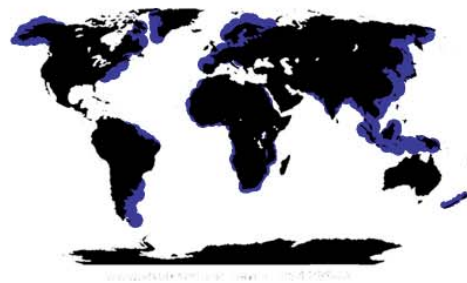
4. Australian East Coast



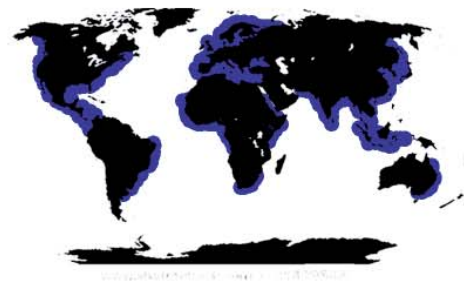
relative stability_ mapping



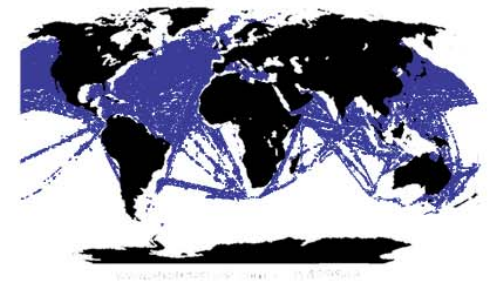
ocean acidification



industrial fishing



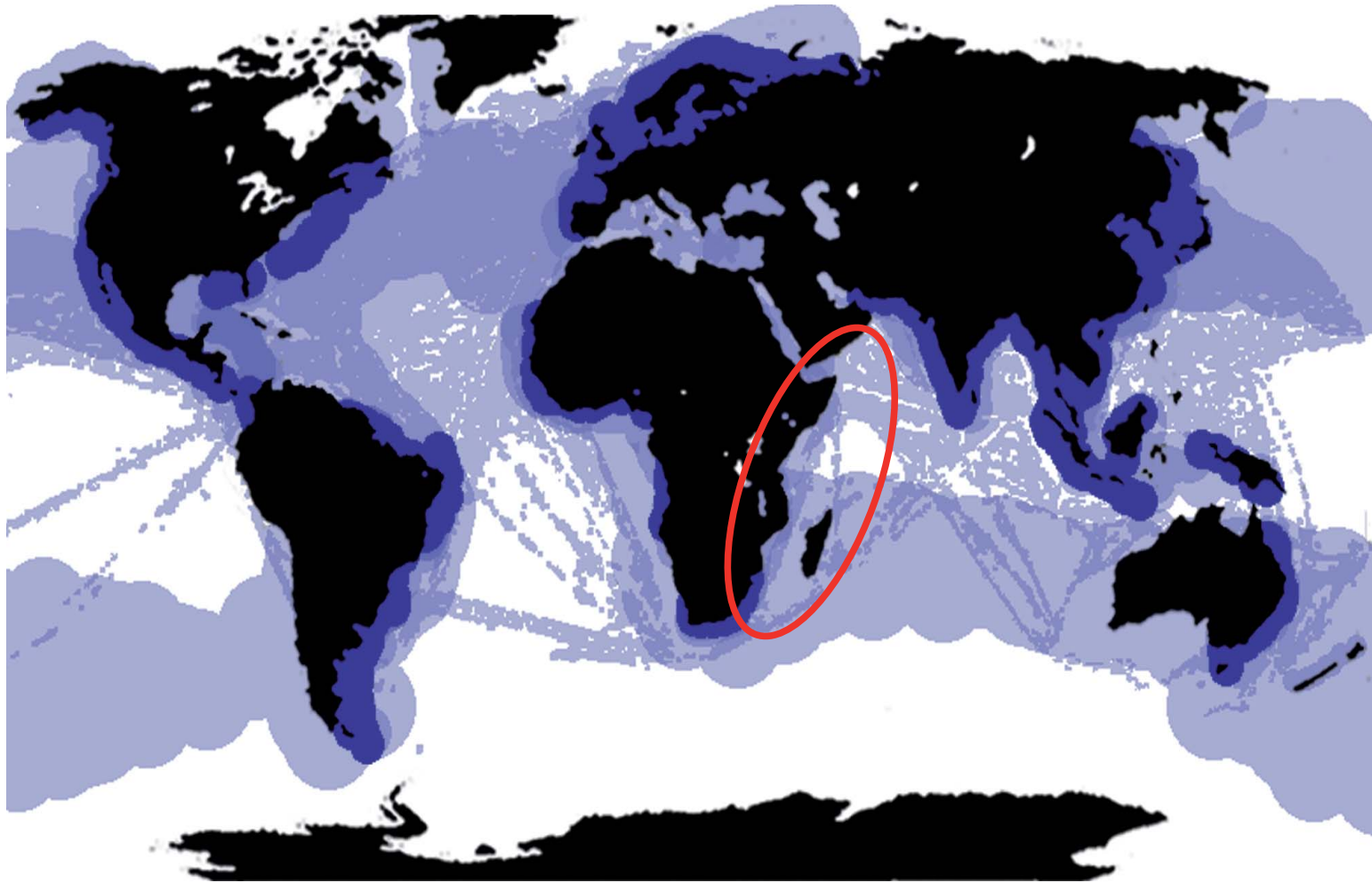
inorganic pollution

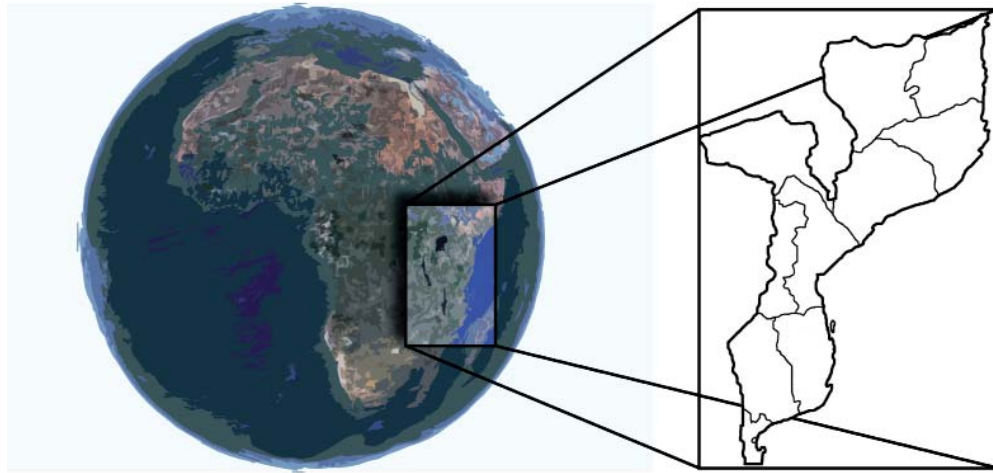


commercial activity(shipping)

The above diagrams map various types of destructive activities contributing to the degeneration of our oceans and its resources. These four activities fall under the three main causes of degeneration of this ecosystem: **climate change over fishing pollution**

By overlapping the previous four diagrams, it is alarmingly evident the extent of marine degeneration along the worlds coast lines. However through this mapping it is clearly evident that the Mozambican East Coast is still in a relatively stable and untouched state.





"This is, in fact, one of, if not, the most important and bio-diverse coastlines in the entire Indian Ocean!"

Dr. Andrea Marshall, director of The Manta & Whale Shark Centre

Through the analysis of the above mapping, and for the purpose of this thesis, The Mozambican East Coast has been selected as an ideal zone for intervention

The Mozambican East Coast

The Mozambican East Coast can be said to be one the most important and bio-diverse coastline in the entire Indian ocean. It is this coastline that is home to a diverse variety of marine fauna and flora, including ocean mammals, sharks and rays, reef and stock fish, invertebrates and vegetation. It is also along this coast that one would have the opportunity to encounter some of the oceans most rare and endangered species including whale shark, manta ray and dugong all of which have a year round presence in the area. It is also within the warm water of Mozambique that large communities of rare and understudied species exist, some of which have not yet been named. For example; pipe fish, moth fish and nudibranchs occur in large numbers within this area but are still listed with the IUCN Red List of Threatened Species as Data Deficient, which means that not enough data or information has been obtained regarding these species to assess their numbers, breeding habits or conservation status.

It is for this reason, the diversity of marine life along this coastline, that makes the Mozambican East Coast an ideal zone for the intervention of research and conservation. Year round accessibility to such a diverse variety of species provide ample opportunity for researchers and biologists to further their studies and knowledge about our oceans, and give them a wider spectrum of different individuals and species to concentrate on.

This coast line has been able to escape large scale urbanization and industry and is not as heavily affected by human encroachment and pollution, as are other bio-diverse zones like the Gulf of Mexico, and the South China Sea. Because of this, it's waters are in a relative state of stability.

Although this zone is relatively stable, in relation to the rest of the world's oceans, it is important to note that it is beginning to see the effect of climate change, over fishing, and pollution. As water temperatures rise and acidification within the water increases, coral bleaching is beginning to become prominent in many of the reefs along the coast. However, the most significant impact which we as human are having on the area, is the effect of over fishing, both industrial fishing and local fishing. A single local fisherman, aided with only a small boat, and hook line, can catch up to 70 sharks per week, and as shark finning is become more and more lucrative (up to \$70 per fin), this type of fishing is on the increase.

Ideal site for Intervention

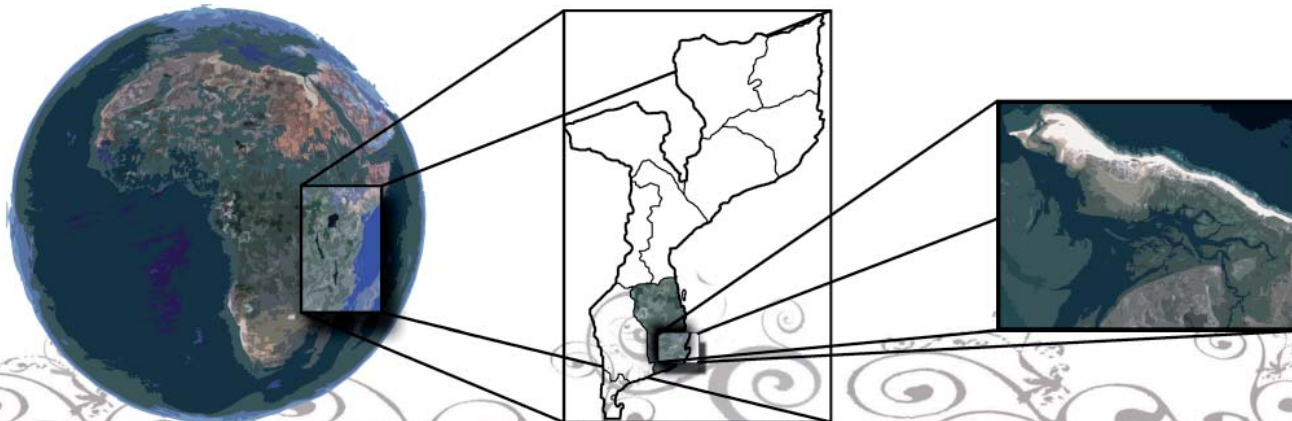
Following the selection of an ideal zone, one must now focus on the selection of an ideal location to site such a project. As discussed previously, the Mozambican Coast is an ideal zone for intervention, however, it is this coastline that is one of the longest on the globe, stretching approximately 2 470 km from north to south. It is therefore a challenge selecting one site throughout such a large area. However, as with the selection of an ideal zone, **bio-diversity** and **relative stability** must still act as the main criteria. However when selecting a site the most important criteria that needs to be met is **accessibility**.

Accessibility

In order for any research facility to function in an efficient way, accessibility to the environment which is being studied is imperative. As most work regarding analysis and documentation of specific species is done on site and within the natural environment, direct access to such habitats need to be established. Being in close proximity to these habitats is therefore an important objective when selecting a site, and will result in reducing travel costs and time, to and from the selected habitats on a daily basis.

Therefore, with the criteria of **bio-diversity**, **relative stability** and **accessibility**, in mind, Ponta da Barra, a small coastal village in the southern province of Inhambane has been selected as an ideal site for intervention.(Further analysis to follow)

As much research is also done in house, by means of observation aquaria and micro laboratories, being in close proximity to such habitats becomes an advantage. A large amount of stress is placed upon live species and samples when transferring them to an in house observation aquaria. By being in close proximity to these habitats, the stress levels of the live specimens is greatly reduced, resulting in a higher success rate when studying species outside their natural environment. What is also a key advantage of having direct access to such habitats is the accessibility to fresh sea water on a permanent basis. The success of any marine aquaria, relies mainly on the water quality of the tanks. Because the volume of water in an observation aquaria can be equated to a 'drop in the ocean' water quality can fluctuate on an hourly basis, and therefore needs to be monitored constantly. Direct access to a regular inflow of fresh sea water, will eliminate the need of expensive water quality equipment and chemicals, and will also aid in the acclimatization of species from their natural environment to an artificial one.



An aerial photograph of a river delta, showing a complex network of water channels and land. The water is a dark, muted green, while the surrounding land is a lighter, textured green. The channels meander and branch out across the landscape. At the bottom of the image, there is a decorative border consisting of white, swirling vine-like patterns.

section 7_ Site Analysis

Section_7

Site analysis

Inhambane: A brief history

Inhamabne is one of the oldest settlements on the east coast of Mozambique, with a trade history dating back to as early as the 11th century. The first outsiders to arrive in the area were the Muslim and Persian sailors, trading in pearls and ambergris. It was, however, because of the local cotton spinning industry of the Tonga tribe, that this area became known. Later, the southern Karanga tribe invaded Inhambane, and dominated the Tonga cotton workers, reaping the benefits from this already established and thriving trade.

In the late 15th century, during his exploration around Africa, Vasco da Gama first arrived in the city, using it as a resting stop to replenish stocks and find fresh food. While here, da Gama began exploring the area, and took an immediate liking to it, eventually giving it the name Terra de Boa Gente or 'Land of the Good People'. In 1505, it was however Francisco de Almeida, a Portuguese explorer, who was

shipwrecked just south of the town, that first established negotiations with the then dominant Karanga tribe established a permanent trading post in the area. Inhamabne was then chosen by the Portuguese as the first Jesuit mission to east Africa in 1560.

Over the next three centuries the port of Inhambane thrived, becoming an established ivory and slave trading centre. During the 20th century, as Maputo (Lourenco Marques until 1975) became the main economic centre of the country, the status of Inhambane began to decline, as the main industries and trade which supported it moved to the capital. Today, Inhambane still trades in locally farmed produce such as cashew nuts, coconuts and fruit, as well as its seafood, however the city's focus has shifted from a prominent trade post to one of the country's most important and dominant tourist attractions. This shift can be accredited to the adjacent beaches of Ponta de Tofo and Ponta da Barra.

The local pollution of Inhambane.

The local community's life style in this area can be described as a truly sustainable and symbiotic way of living, as every aspect of life relies on what they have within their surrounds. With a population of 63, 837 within Inhambane, the majority of the local people live in and around the surrounding palm tree forest area, in small widely distributed family groups. As one drives from the town to the coastal villages of barra and tofo, the living structure of the people becomes evident. Located along the main transport routes and the water's edge, small villages are established and can range in numbers from two to twenty huts which form individual family villages. These homes are all constructed using locally sourced materials and building methods, such as palm tree thatching and reed walling.





As this community can be described as a predominantly fishing community, they rely mainly on the resources of the ocean for both food and income. Each family group will allocate male family members as the gatherers who become responsible for the fishing and income.

Local Fisherman: Daily Processes (interview: Alex)

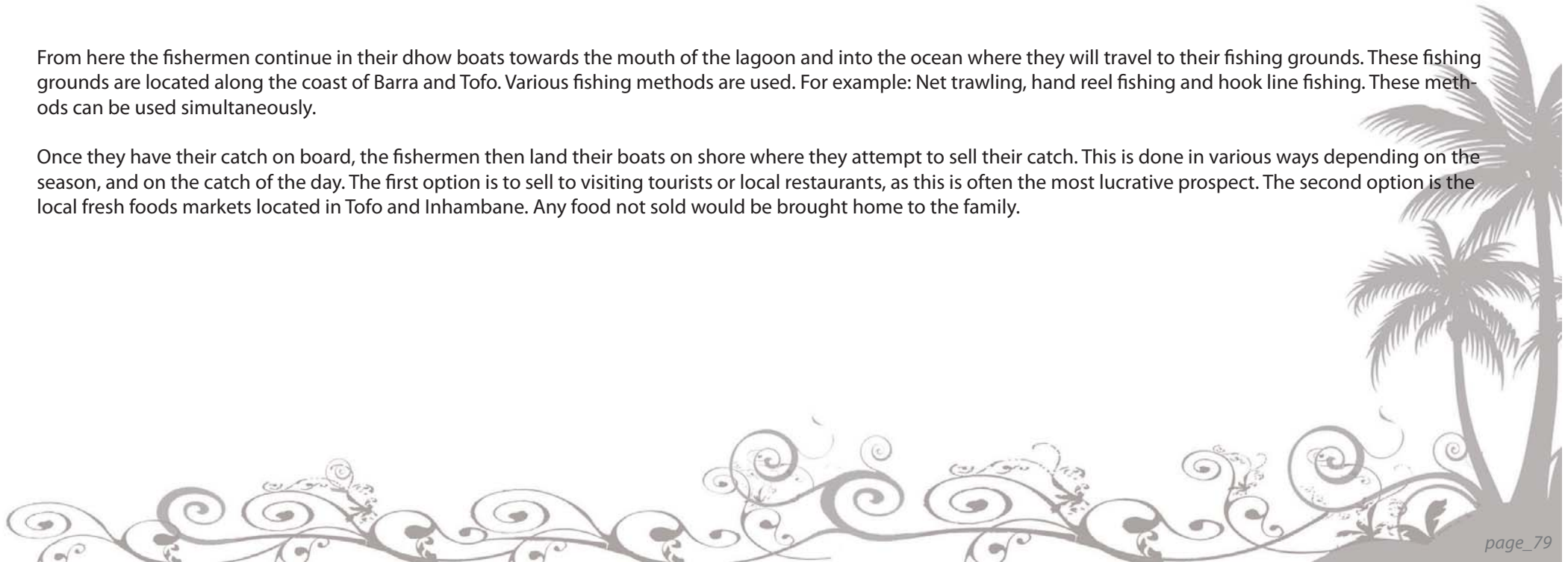
The fishing process for local fishermen begins at low tide on any particular day. The starting point for this process is the main harbour of Inhambane, or at the closest access point to the water. Here, groups of 3-5 men in small wooden boats, known as 'Dhow boats', begin the fishing process by sailing towards the Barra lagoon. Equipment needed is very simple and basic, and include, trawling nets, hand reels, hook lines and anchors.

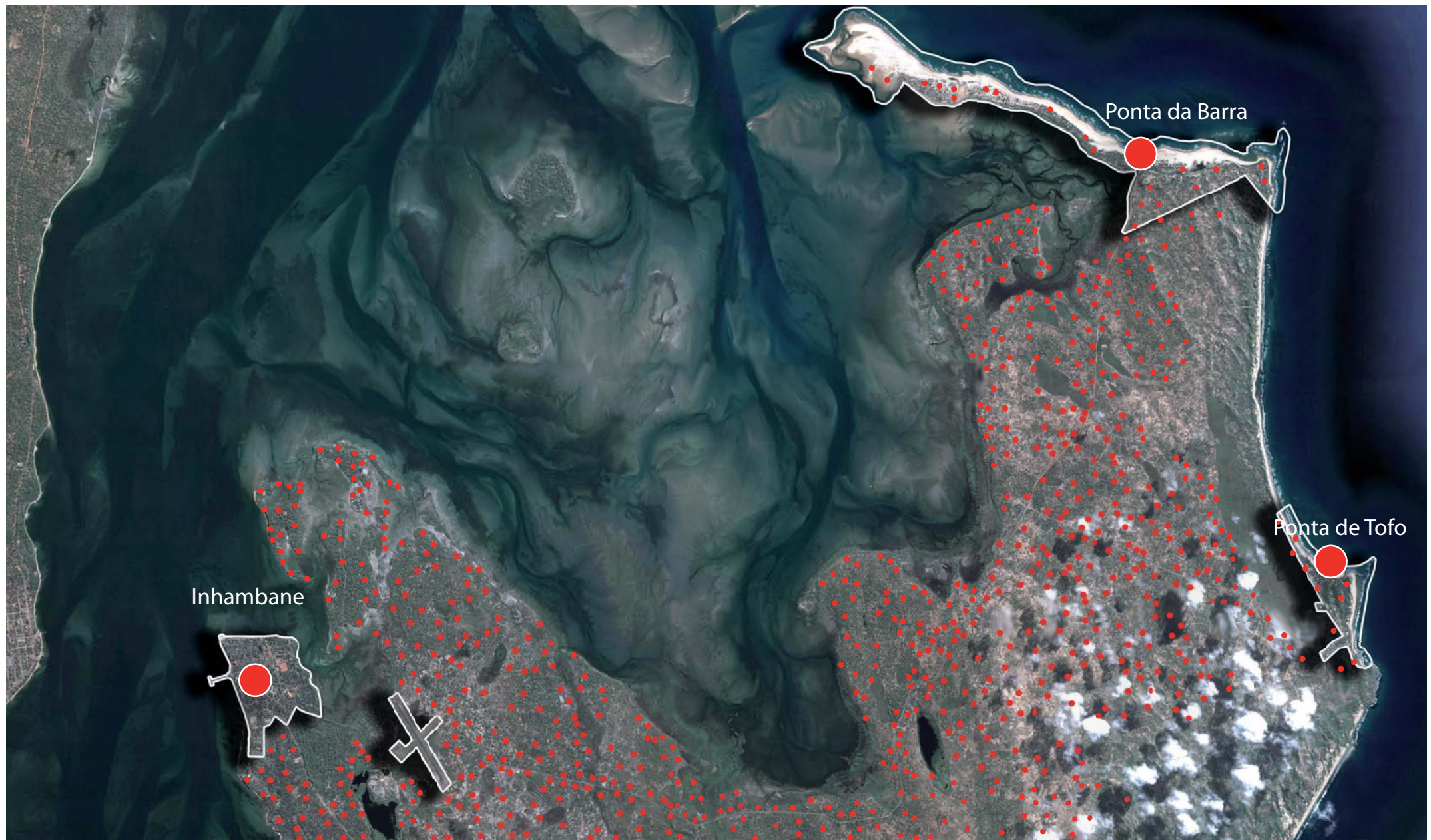
Once the fishermen arrive in the lagoon, travelling along the low tide boundary, they will fish for live bait. Nets are spread out within a selected area, and are trawled along the lagoon floor for small fish. Unfortunately, these areas are most often prime habitats for many other species, species that are not intended to be caught by the fishermen. As the nets are dragged over these habitats any creature in its path is caught. This often includes the capture of many threatened and vulnerable species such as seahorse, pipe fish, sea moths, and nudibranchs. The aim of this process is to catch small fish which will be used as live bait during their fishing expedition in the ocean.

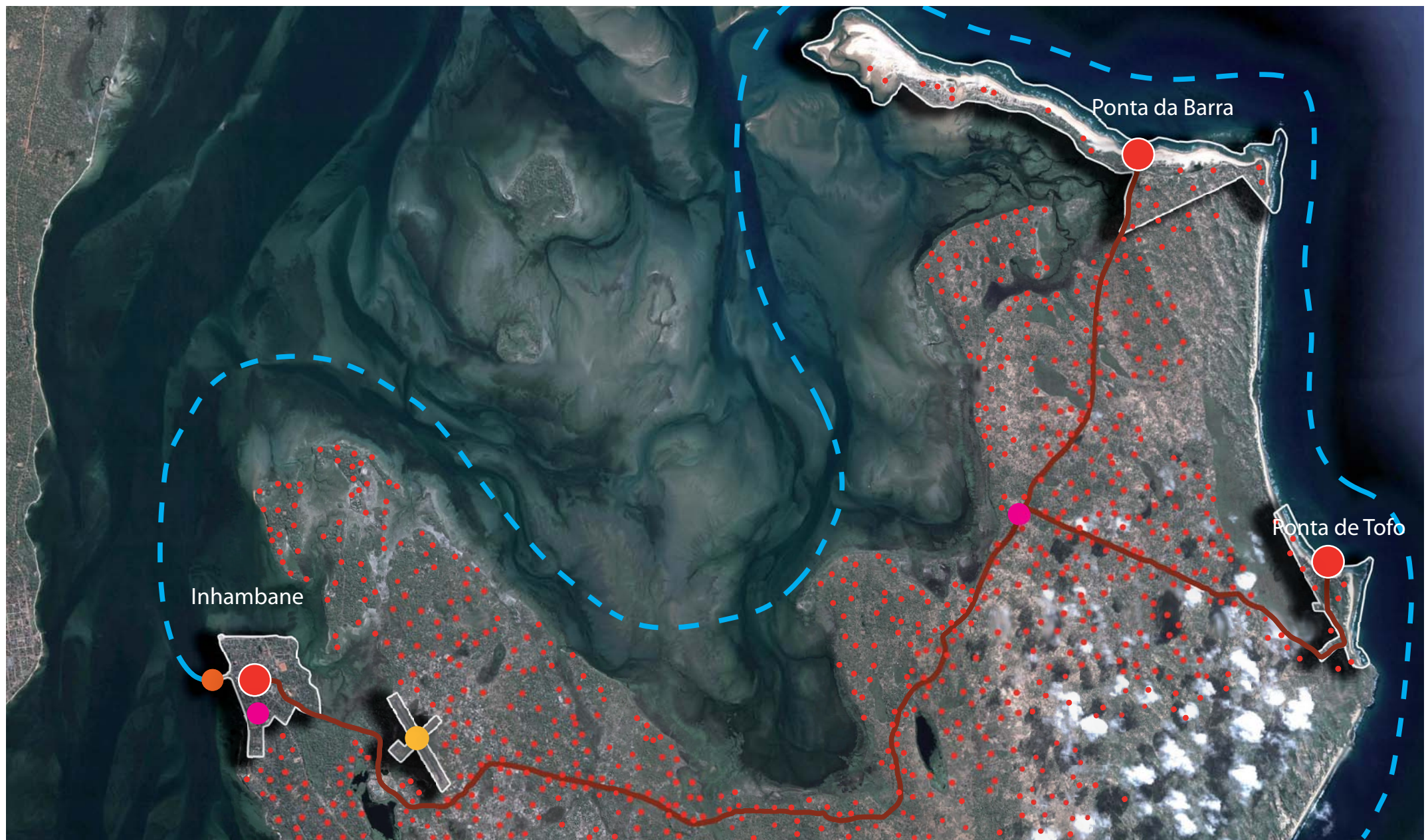


From here the fishermen continue in their dhow boats towards the mouth of the lagoon and into the ocean where they will travel to their fishing grounds. These fishing grounds are located along the coast of Barra and Tofo. Various fishing methods are used. For example: Net trawling, hand reel fishing and hook line fishing. These methods can be used simultaneously.

Once they have their catch on board, the fishermen then land their boats on shore where they attempt to sell their catch. This is done in various ways depending on the season, and on the catch of the day. The first option is to sell to visiting tourists or local restaurants, as this is often the most lucrative prospect. The second option is the local fresh foods markets located in Tofo and Inhambane. Any food not sold would be brought home to the family.







key



town/village



harbour



airport



petrol station



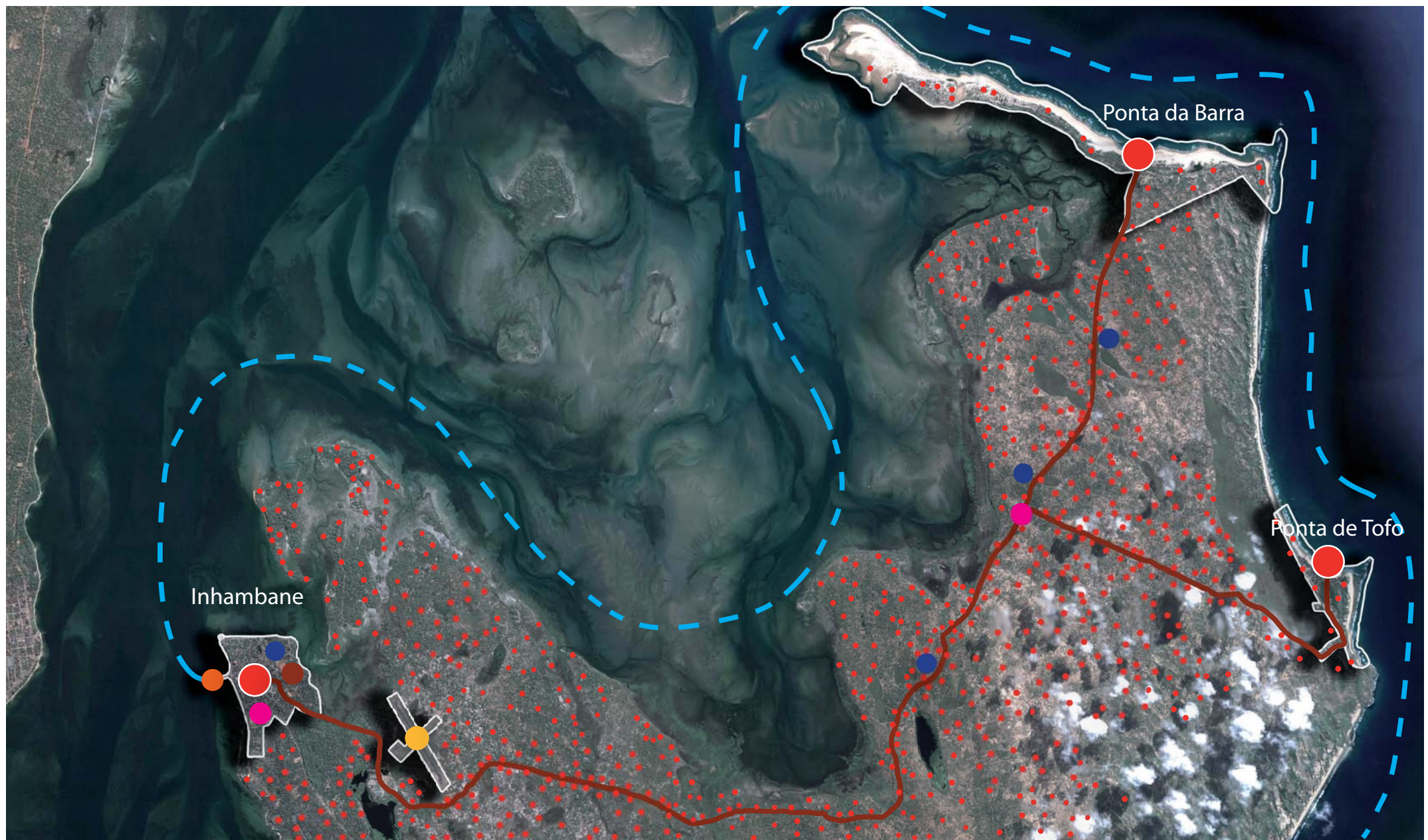
family village



water access route

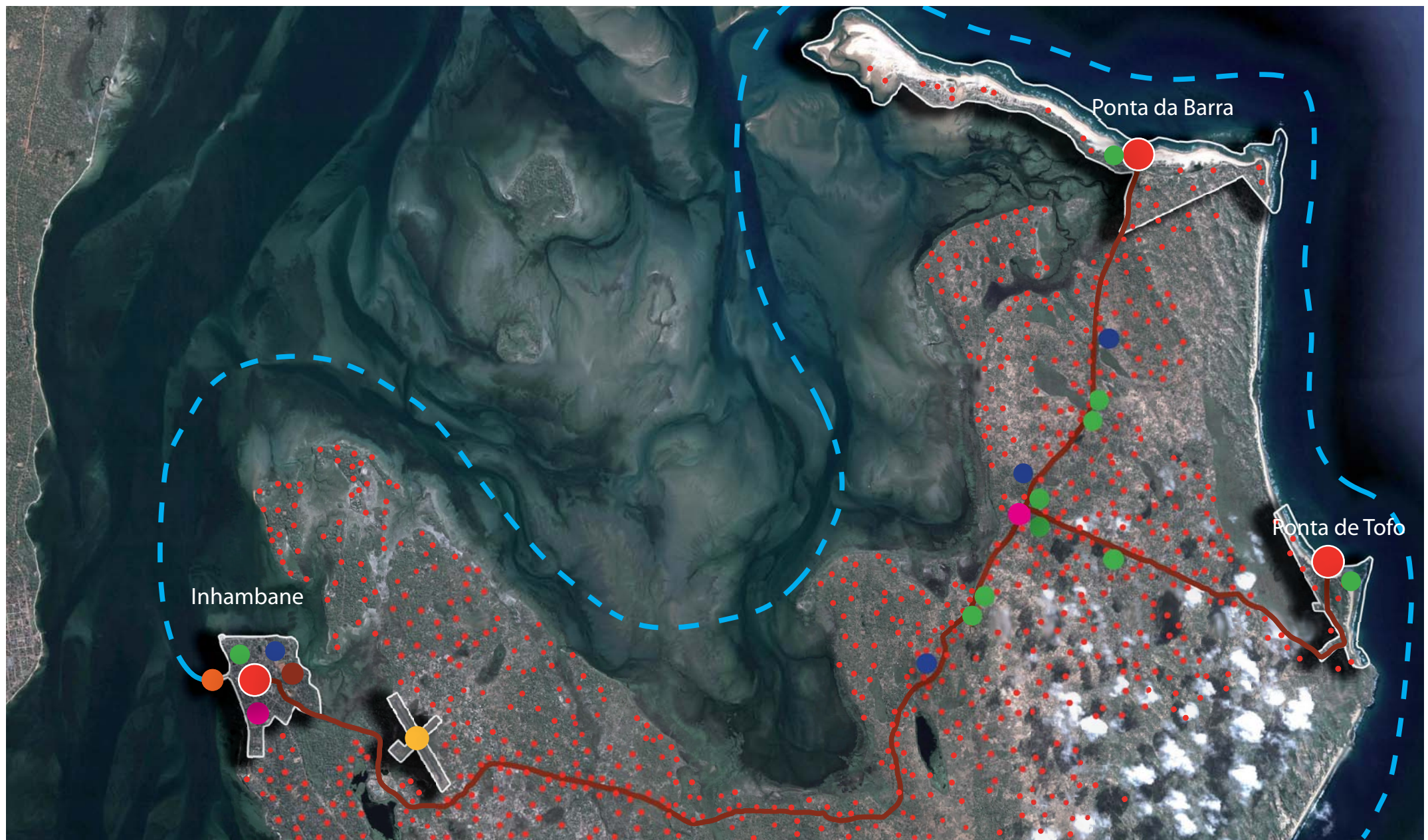


main road access route



key

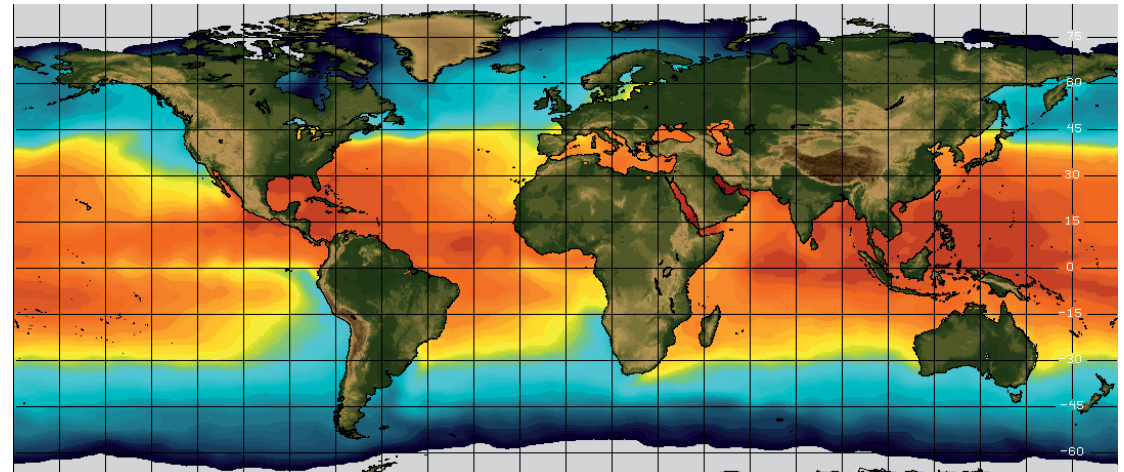
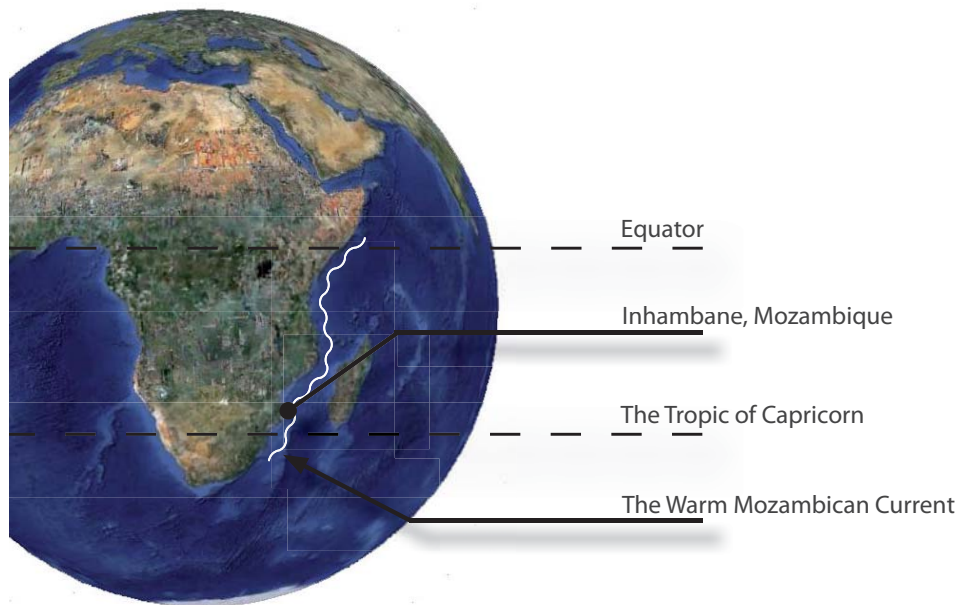
- town/village
- harbor
- airport
- petrol station
- primary school
- hospital
- family village
- water access route
- main road access route



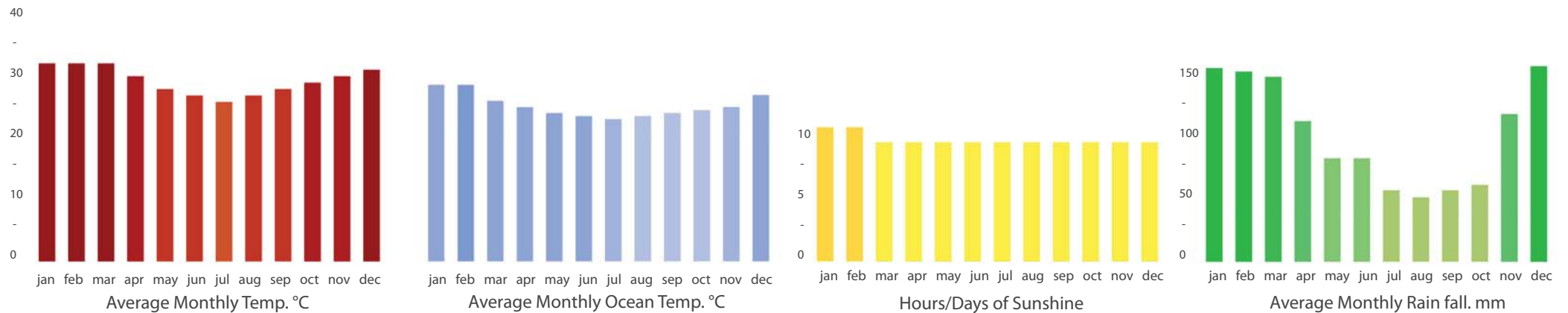
key

- town/village
- harbour
- airport
- petrol station
- primary school
- hospital
- markets
- family village
- water access route
- main road access route

Climatic conditions of site



Inhambane is located just north of the Tropic of Capricorn (Latitude: 22° 35' 47 S, Longitude: 35° 6' 45 E) and therefore fall within the tropical region of our globe. This results in the area experiencing climatic conditions associated with tropical regions, a climate of extremes.



There are two main seasons, one wet and the other dry, dividing the climatic year. The wet season, from November to March, has a monthly average.

Temperature of between 26.6°C and 32.4°C, with cooler temperatures in the interior . The dry season lasts from April to October and has June and July temperatures averaging 18.4° to 20°C



Local vernacular architecture

Within the coastal villages of Inhambane, the local vernacular building methods and techniques become a key feature in any construction or building in the area. What is interesting about this is that every building or structure, from the local family villages to the five star resorts and hotels, all use the identical materials and techniques in the construction of their structures. These structures may vary according to the different uses or programmes, however, the basic form and architectural language is always very similar.

Another key feature of this type of architecture, is that the majority of the materials used in construction, are all found and produced locally within the immediate site. These methods and techniques have been used by the local community for generations, and are common place to any local living in the area. It is also this use of locally sourced material that makes this type of architecture a truly sustainable way of building, and at the same time, forms a symbiotic relationship between the architecture of the site and it's surrounding environment.



Local building materials and techniques

Materials

The local building materials can be found in the immediate surroundings of the site, and are both naturally grown and farmed by the local population. The materials include: palm tree leaves, coconut hide, and swamp reed(stems and leaves).

These materials can be used for the two main structural elements within any building: roofing and walling.



41.



Roofing

Roofing of any structure within the coastal area is achieved through the layering of two locally sourced natural materials: palm tree leaves and swamp reed leaves. This technique is based on the concept of thatching, where the layering of materials form a water tight structure, protecting the interior spaces from the elements.

A simple weaving process alters the basic principles of the palm tree structure, and transforms it into a functional building material. Every alternate leaf is folded in an opposite direction and then weaved together with the remaining leaves. This weaving process provides stability to the leaf, but at the same time retains its permeable structure, allowing the natural flow of air through the material, aiding in natural ventilation and cooling. For roofing purposes, these woven leaves are then triple layered to form the base structure of the roof.

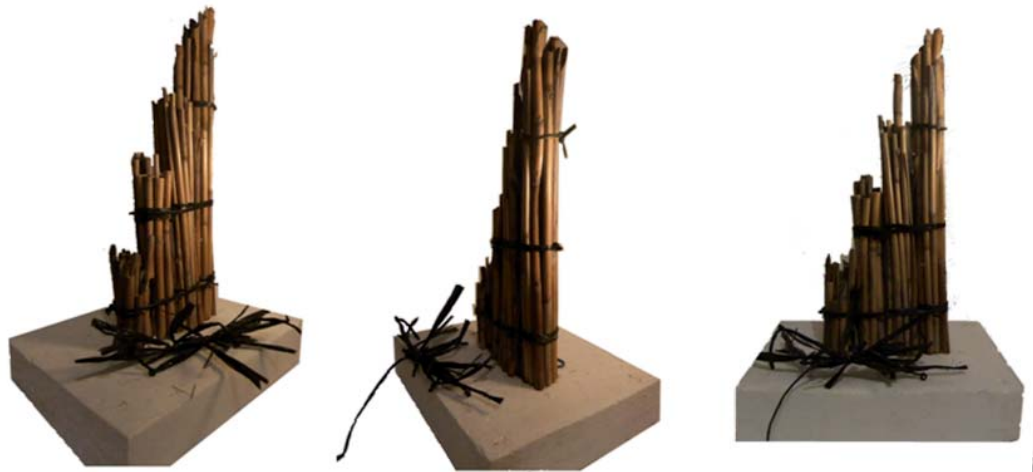
Although this triple layering of the woven palm tree leaf form an ideal roofing system, it cannot provide the water proofing that many of the structures need. It is for this reason that an additional layer of swamp reed leaves are used as thatching to water proof the structure.



Walling

This method of walling is a simple combination of swamp reed stems and recycled plastic bags. The strong stem of the swamp reeds are bunched together to form individual reed clusters. These clusters are secured together with thin strips of recycled plastic bags which are stripped down, and twined to form a plastic string. This plastic string is then used to secure each individual cluster of reed stems to one another

This walling is an ideal system to use in an area such as this. The tightly packed clusters of reed stems, protect interior spaces from the elements, but at the same time are still a permeable membrane, allowing air to move through the clusters promoting natural ventilation and cooling.



Architectural responses to climatic conditions.

As concluded above, the climatic conditions of this area exist in extremes, with temperatures ranging from 25' to 42' c. It is therefore the main objective of any structure within the area to regulate heat, provide adequate shade and allow a constant flow of air through the building. This is achieved through various building techniques and methods.

Through the use of the above mentioned building materials such as palm tree thatching, a minimum pitch for these roofs will be at a 45 degree angle, which results in high pitched roofing systems used throughout the region. Not only does this respond to the materiality of the structure, but it results in high volume spaces within the structures.

With the use of permeable walls and open spaces, natural ventilation can occur, allowing hot air to rise, and be drawn out of the building. Permeable walls and membranes are also an effective technique used to control temperatures, allowing air to filter through spaces but block out harsh sun and heat.

Large covered verandas are also used significantly within this region, as shade becomes the most important requirement. These large covered spaces can be used for a variety of different functions and programmes, as they define a comfortable shaded spot protecting the user from the extreme conditions of the area.





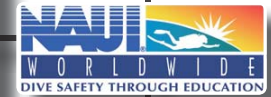
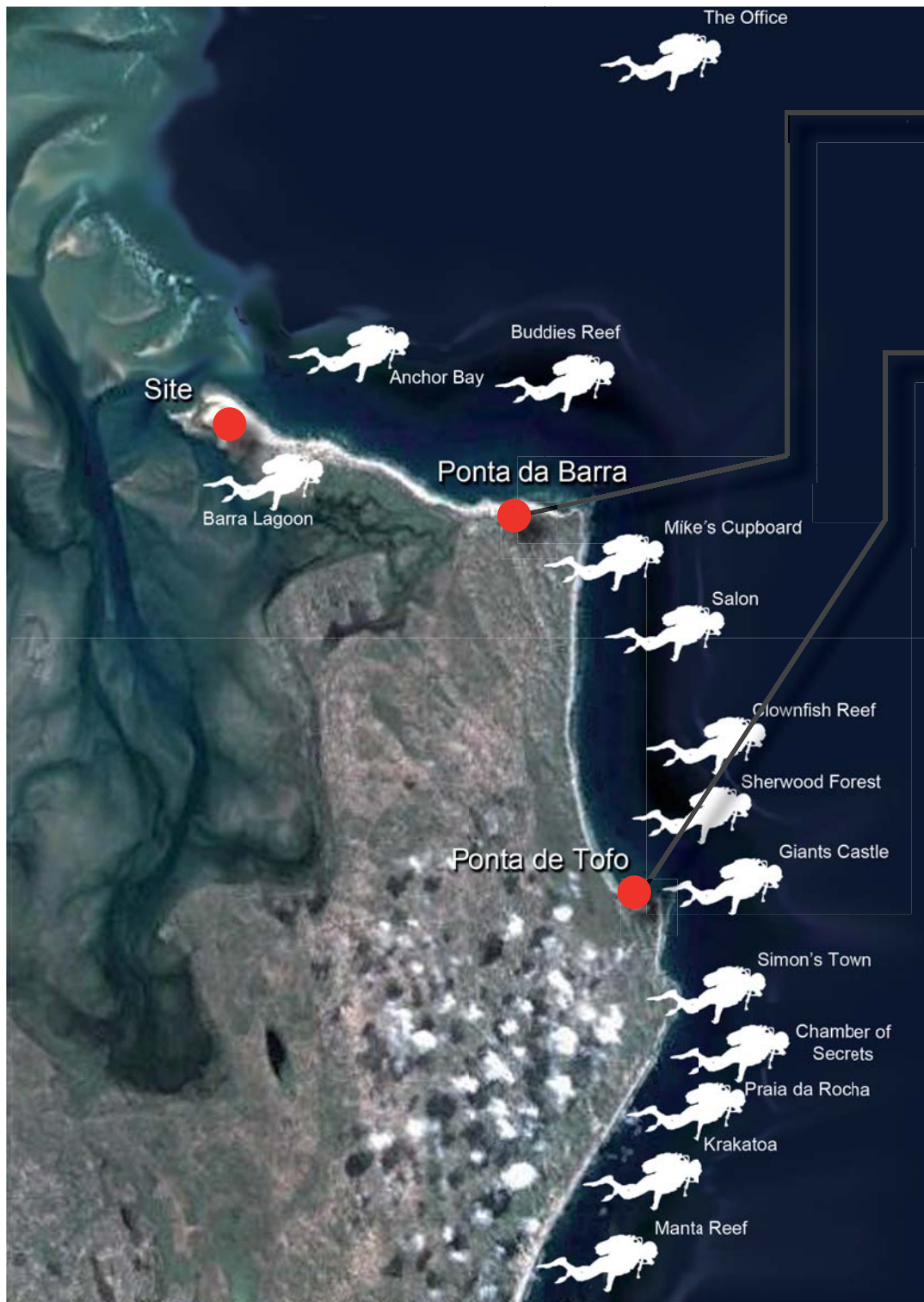
Ponta da Barra / Ponta de Tofo

A relative small stretch of coastline within Inhambane, attracts much of the attention from the international tourism community, receiving 1.2 million visitors per year. Ponta da Barra and Ponta de Tofo have become highly sort after holiday destination, the world over. With their breathtaking beaches and warm seas, this place is the perfect destination for any tourist looking for a relaxing tranquil holiday, within one of the world most beautiful and untouched environments.

However, it is what lies beneath the ocean surface that has made this area world famous. The diving and snorkelling opportunities which Barra and Tofo provide are truly remarkable, attracting millions of marine and scuba enthusiasts from around the world, each year. As established in the previous sections of this document, this coastline is known for it's diversity of marine life, which is clearly evident in the 14 main dive reefs available in the area. One of these, 'Manta Reef', is listed within the top five reefs in the world.



42.



43-44.

However it is the large marine mega fauna, found in these waters that make this area so unique. Barra and Tofo have become known as the Whale Shark, and Manta Ray 'Mecca' of the world, giving tourists an almost year round opportunity of getting up close and personal with these massive creatures. Daily ocean safaris take visitors up and down the coast in search of whale sharks, which spend much of their time warming themselves just below the surface. Once found tourists are able to dive into the water and swim alongside the shark. Being a filter feeder, (which means its diet consists mainly of plankton and krill), these animals are completely harmless to humans, which is in contrast to the fact that they are the

largest fish in the ocean. One can have a similar experience with Manta Rays, as daily scuba diving excursions are made to manta reef, a marine cleaning station which attracts these giants. The mantas come to this reef to be cleaned by cleaner fish and scavengers who pick at the parasites on their skin and gills. This type of symbiotic relationship attracts large groups of up to 20 mantas at any time, which makes such an encounter a truly unbelievable experience.

It is also these large creatures that have attracted a permanent presence of individuals dedicated to the research and conservation of such marine mega fauna and the surrounding environment.



The Manta & Whale Shark Research Centre (MWRC)

The Manta & Whale Shark Research Centre was founded in 2005 by visiting marine biologists, who identified the need for such a facility in the Inhambane area. The centre is home to marine biologists and students who wish to further their education and research in this field. It is species such as the manta ray, whale shark and marine turtles that have formed the focus of this centre. These animals are key components of marine ecosystems but, as they are long-lived and have low reproductive rates, their populations are usually the first to be reduced by human pressures. Fortunately, they are also amongst the most charismatic animals on the planet and generate a high degree of public interest in their biology and conservation, making them useful ambassadors for the whole marine environment. (<http://marinemegafauna.org/>)



Marine biologists and Students

Andrea Marshall, director of the centre, has been based in Mozambique since 2003. Her PhD research on the population ecology of manta rays, conducted through The University of Queensland in Australia, was the first ever doctorate thesis to be completed on this species, giving her the nick name 'Andrea, Queen of the Mantas'. Andrea's ground-breaking field research on the ecology and biology of Mozambican manta ray has led to several major new discoveries. She was also the senior author of the first worldwide conservation assessment on manta rays for the IUCN. Her current manta ray research includes systematic, phylogeography, individual movements and conservation ecology.

Another member of the staff at the centre, Simon Pierce, has been researching whale sharks in Mozambique since 2005, while concurrently working on his PhD research on stingray and shark conservation biology at UQ in Australia. Simon's whale shark research examines the ecology, biology and conservation of these enormous fish. His current work involves the study of whale shark movement patterns, demography and feeding ecology. Simon's interests also encompasses marine protected area design for large and highly-mobile fishes (i.e. whale sharks and manta rays) and the assessment of Mozambican fisheries.

The centre also accommodates many students from universities around the world, who have an interest in marine ecology and 'megafauna'. These students visit the centre for an extended period to complete their research, and compile their PhDs, theses and dissertations, on a variety of different subjects concerning the marine environment. Under the guidance of the resident biologists, this centre provides a unique opportunity for the education of future professionals in this field.



49-51.

Location

The Manta & Whale Shark Research Centre is located in Ponta de Tofo, the neighbouring village of Ponta da Barra, at The Cassa Barry Lodge. However, the facilities available at the centre today are very limited. This limits the type of research able to be done on the selected species as equipment for micro-analysis and cold storage is nonexistent. The main building was erected by the marine biologists themselves, using local building techniques and methods. These buildings act as a base for the resident biologists and students to carry out their research, as well as provide facilities for lecture and presentations given to visiting tourists three times a week.

Facilities

- offices
- Media/ computer lab
- Presentation Room
- Lecture room

The presence of this centre enforces the idea of the need for such a facility in the area.



Ponta da Barra

Ponta da barra, a small fishing and holiday village has been selected as the ideal site for an intervention regarding this thesis.

This village, only 7.3km in width, and 0.7km in depth, attracts holiday makes from around the world, (predominantly South Africans and Portuguese), to it's simple rustic accommodation and it breathtaking beauty and scenery. It holds a variety of resorts, beach chalets, private holiday homes and restaurants, which are littered along the beach front in between the natural vegetation and palm tree plantations. Not only does this village cater for divers, but provides an array of different activities and experiences for any other visitor to partake in.

Within the village there are two PADI/NAUI certified dive centres, located at the two main resorts, Barra lodge and Palm Grove Lodge. Both centres are equipped with full Scuba equipment, class / video rooms, and land and sea transportation. The centres offer up to 6 dive trips per day, depending on demand and weather conditions, as well as various other activities such as ocean safaris and kayak/quad bike rentals, amongst others.

Although the majority of the local community live within their own family villages on the outskirts of the main village, a few families still reside within Barra itself.

Between the resorts and homes, one will still find areas with family villages of up to 10 individual huts. As more space is taken up by development, these families are beginning to retreat inland, and are slowly being driven away from this beach front.

The locals do, however, utilize this village as a main source for employment, income and fishing activities. The Barra estuary is an ideal location for bait fishing and prawn farming, and the small reefs just 100m off shore provides ample fishing, and shell fishing opportunities. There is also the constant presence of tourist along this beach to whom locals can try to sell their catch. Many offer locally produces, handmade arts and crafts, jewellery and clothing to tourists, hawking their good up and down the beachfront daily.

Many of the resorts and restaurants also employ local workers as staff, as well as local labour for construction. An example of this is the case study of Flamingo Bay, who employed local labour when constructing the resort. The developers also included locally produced building materials and methods in the construction. On completion of the resort, those involved in the construction were given the opportunity to stay on as staff.(refer to case study)









Local residential hut
2 x residents



Areia Branco Resort
Self catering chalets
Camping facilities



Private beach homes



Local residential huts
6 x residents



Flamingo Bay Resort
12 x hotel chalets
Resturant/bar
Swimming pool
Spa
Conference room



Neptunes Resort
Self catering chalets
beach bar & resturant



Barra Lodge
Hotel
Self catering chalets
Restaurant / bar
Swimming pool
Craft market
Activity center
Dive center
Conference room



Makolo Bay Resort
Self catering chalets
bar
kiosk





Palm Grove Lodge
Self catering chalets
Activity center
Restaurant
Dive center



Anda Ca Lodge
Self catering chalets
Restaurant/bar



Dorado Lodge
Self catering chalets
Bar



Maa Mozzies
Restaurant and Bar



Cowrie Lodge
Self catering chalets



Makisure Lodge
Self catering chalets



Barra Estates
Semi Private
Self catering chalets
Restaurant/bar



Barra Lighthouse 4x4
Campsite
Camping facilities
Restaurant/bar



Site access

All areas within Barra can be accessed in a variety of different ways. The four main methods of transportation in Barra are:

Road Beach road Beach Water

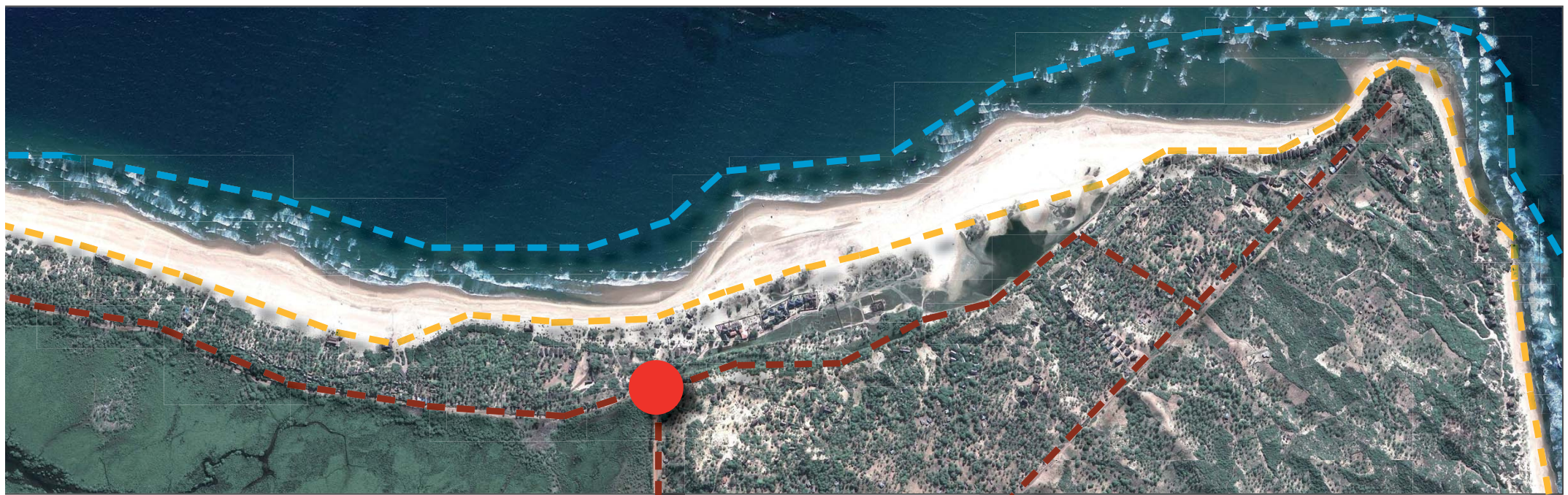
By Road

The main form of access connecting most of the resorts along the beach front is by the main dirt road. This road, which links Inhambane to Barra, runs directly parallel to the beachfront and mangroves. Although not tarred this road stays dry throughout the month and is not effect by tidal fluctuations.

By Beach road.

This road connects the last set of accommodation to the west of the site, with the main dirt road running through Barra. Although an established route designated by the village, it is affected by the tidal fluctuation of the site. During spring tide periods the road is completely submerged in water and prohibit any vehicle from driving on it. The road consists of beach sand, preventing the use of standard motors cars which can gets stuck.

Vehicle allowed: 4x4 vehicles, quad bikes



By Beach.

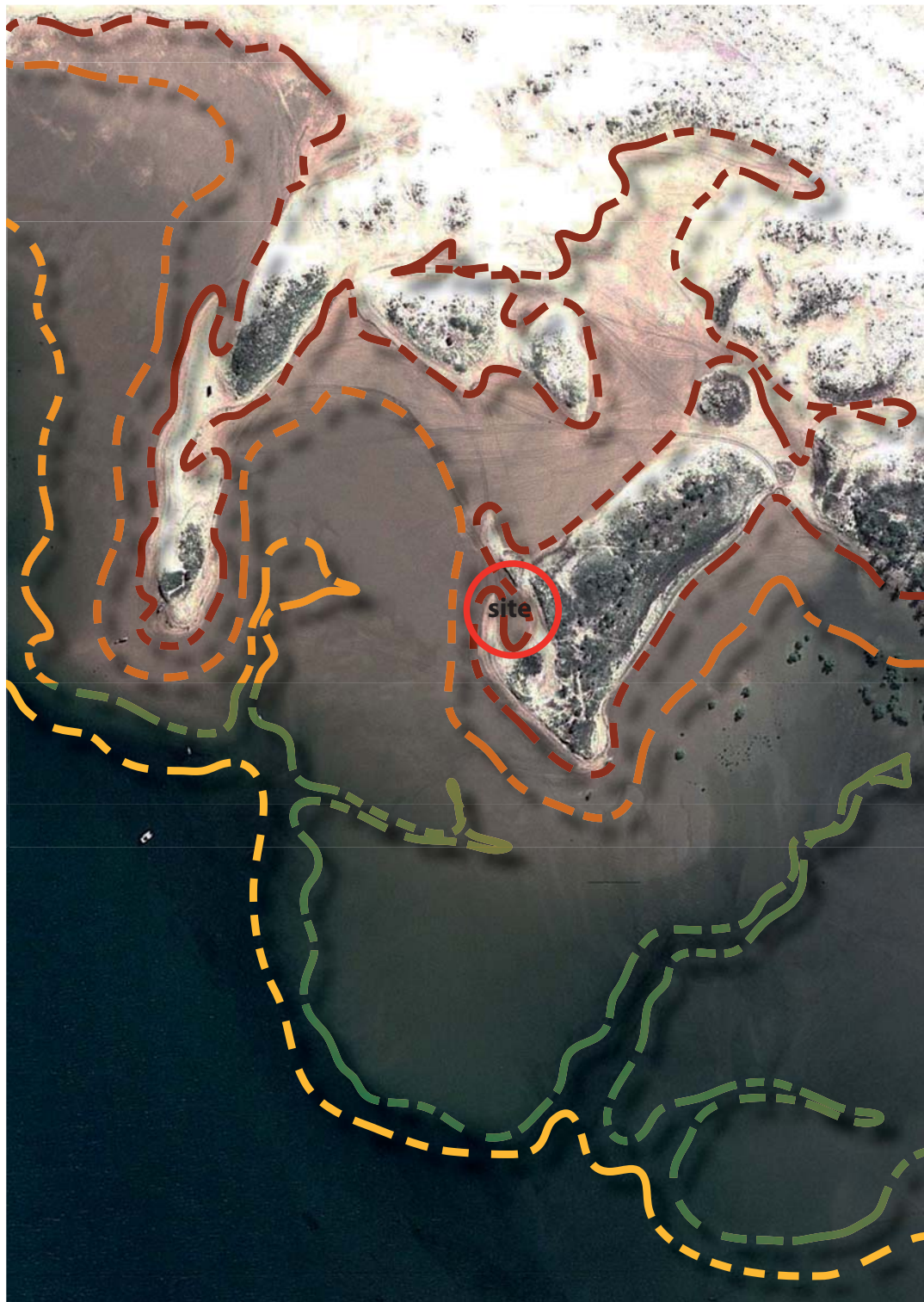
Vehicles that have obtained specific permits from the local authorities are allowed to use the beach front as a source of transport. However, even though encouraged to drive as far up the shore as possible, many individuals use this route as a way to launch boats and jet skis, including the dive centers. Any vehicle activity on the beach can cause destruction to the beach habitat when driving on it, as many species live just under the sandy surface, as well as use the beach to lay eggs. This route should only be used when necessary, and traffic should be kept to a minimum.

Vehicles allowed: licensed 4x4 vehicles, licensed quad bikes.

By Water.

As Ponto da Barra is almost completely surrounded by water, this becomes one of the main access routes within the village. Predominately used by the locals, this method of transportation has little negative effect on the surrounding environment and is a constant link between Inhambane Ponto da Barra and Ponto da Tofo. It is also the only link from the land to the surrounding diving reefs.





Tidal conditions of the site

One of the most important and influential aspects for the chosen site would be the tidal fluctuation and conditions. This phenomenon has great affect on the site and it's conditions throughout the month's lunar cycle. Because of the tides the site will experience varying conditions throughout a 24 hour period. For a large portion of the day the site will be completely submerged.

Spring High

Neap High

Neap Low

Spring Low

Tides are the rise and fall of sea levels caused by the combined effects of the gravitational forces exerted by the Moon and the Sun, and the rotation of the Earth. The different tides occur within a period of approximately twelve and a half hours and are influenced by the shape of the near-shore bottom.

Most coastal areas experience two high, and two low, tides daily. This is because at the point right “under” the Moon (the sub-lunar point), the water is at its closest to the Moon, so it experiences stronger gravity and rises. On the opposite side of the Earth (the antipodal point), the water is at its farthest from the moon, so it is pulled less; at this point the Earth moves more toward the Moon than the water does—causing that water to “rise” (relative to the Earth).

The semidiurnal tidal range (the difference in height between high and low waters over about a half day) varies in a two-week cycle. Around new and full moon when the Sun, Moon and Earth form a line (a condition known as syzygy), the tidal force due to the Sun reinforces that due to the Moon. The tide’s range is then at its maximum: this is called the spring tide. When the Moon is at first quarter or third quarter, the Sun and Moon are separated by a 90° angle when viewed from the Earth, and the solar gravitational force partially cancels the Moon’s. At these points in the lunar cycle, the tide’s range is at its minimum: this is called the neap tide, or neaps. Spring tides result in high waters that are higher than average, low waters that are lower than average, and stronger tidal currents. Neaps result in less extreme tidal conditions. There is about a seven day interval between springs and neaps.

What is also important and very influential with regards to the changing tides, is the shape of the tidal zone bottom. This will influence how far the water will rise and how far it will fall during the low tide period.

Tidal affect on site

What is interesting about this area is the tidal boundaries. Because of the shape of the estuary floor, there is huge difference with regards to the high and low tide zones. This area consists of a large plateau of beach that covers most of the site. As one moves towards the water, this plateau take a large drop and fall +- 4m toward the bottom of the estuary, the lagoon has a maximum depth of 6 meters.

Because the majority of the site is a large flat plateau, water will fill most of this area during high tide. The water depth does not show huge fluctuations, however the range of the high tidal zone is vast. Huge areas of flat land that is dry during low tide, is later completely covered by water. This creates a huge shift in the environments of the site from tide to tide. The site experiences a complete transformation throughout the day.

Through this natural phenomenon, a very interesting relationship is formed between land, water, and creatures of the area. For certain periods of the day the boundary of an environment which is constrained by the movement and flow of water is altered, and results in a complete transformation of the existing habitat. The boundaries disappear and a new territory is identified and explored. However this does not last for long, and within a six hour window, the habitat receded back to its original state.

This fluctuation makes construction on the site very challenging.



Ecosystems of Ponta da Barra

As mentioned previously Ponto da Barra has been selected as the ideal site to locate the architectural intervention of a research and conservation centre within the Inhambane province. Although this stretch of coastline consists of mainly of holiday resorts and tourist accommodation, it holds a unique relationship with the fore mentioned criteria of **bio-diversity**, **relative stability** and **accessibility**.

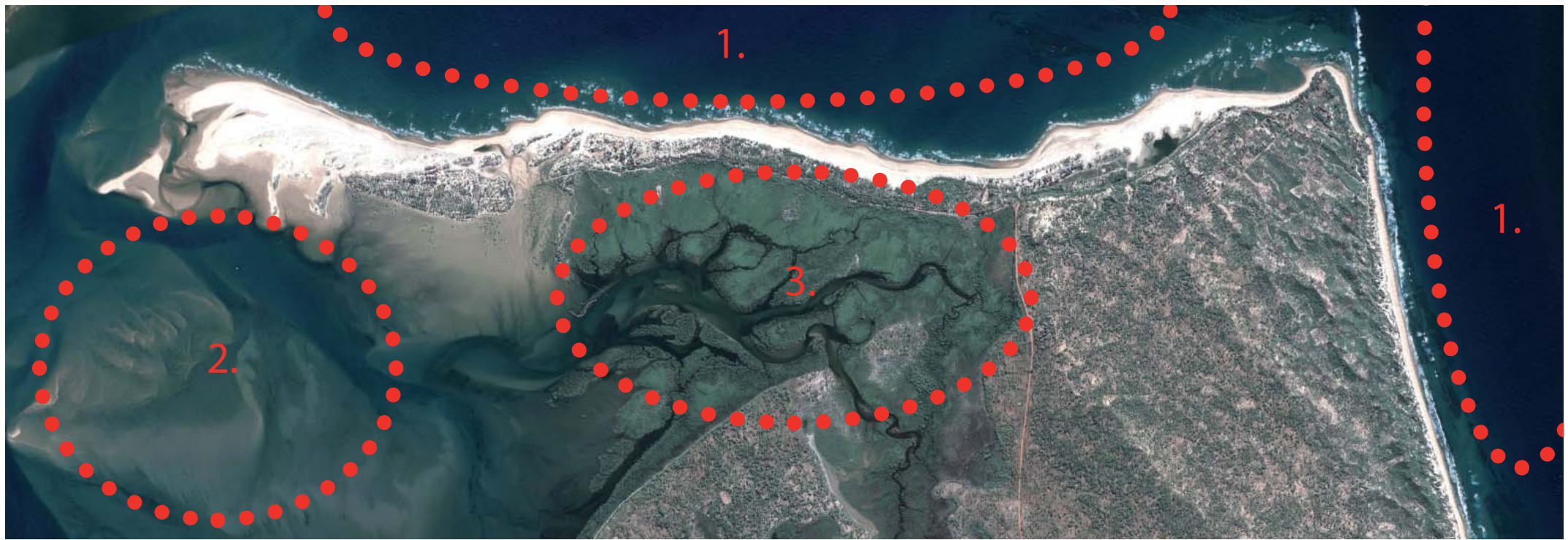
It is here that one has direct assess to, not only the ocean environment, but also to two of the worlds most important aquatic ecosystems. This provides an additional layer to the success of a research and conservation intervention in the site, as it gives biologists and researchers a wider spectrum for identifying subjects to study, and does not limit them to only the marine environment.

The three aquatic ecosystems resident to Ponto da Barra are:

Ocean

Estuary

Mangrove swamp



1.The Ocean

The ocean forms the dominant ecosystem of this environment. It is within the ocean that the larger aquatic species exist, such as marine mammals and sharks and rays. This ecosystem holds the majority of life which exists on the planet, as well as a diverse variety of habitats and conditions.

2.Estuary.

The estuary has become known as the 'nursery to the sea', as it forms an ideal habitat for many species to reproduce and feed. Because of the relatively calmer conditions than the ocean, as well as shallower depth, the estuary restricts larger carnivorous species from entering. This results in a much safer area for juveniles to develop, and provides ideal habitats for the smaller, more sensitive species to hide and feed.

3.Mangrove swamps

The mangrove swamps are a vital form of habitat within the Barra estuary. The high concentration of such swamps in this area is a result of their ability to tolerate high salinity levels in the water as well as the tidal fluctuations of the estuary. It is the structure of these plants that provide an important habitat for fresh water and salt water species, as the roots protrude from the ground, ideal crevices and spaces are created. The mangrove forests are therefore a unique and highly bio-diverse environment and form the bridge between the ocean and fresh water systems.





Existing Habitats of the site.

As this site lies within the tidal boundaries of Barra, various different types of habitats occur around the area. These habitats are all affected by the tidal fluctuation of the site, which influences the species that live within them, the boundaries of such habitats and the size to which they can grow.

The three main habitats which exist within this site are:

-  **Sandy beds**
-  **Sea grass gardens**
-  **Sea urchin communities**

Sandy beds

The sandy beds attribute to a large portion of the habitats on site. Although, it might not seem so at first glance, this habitat support a large variety of species and vegetation, most of which, live below the surface of the sand, protected from predators. During high tide, most of these species hide below the surface, but it is during low tide that they will emerge to rebuild their homes and hunt for food. This habitat also attracts much bird life and terrestrial creatures which come here to hunt during low tide periods.

It is this habitat that is mostly affected by the tidal fluctuation, but has adapted to exist in both a submerged and exposed state.

Sea grass gardens.

This habitat only occurs beyond the spring low tidal boundary of the area. The reason for this is that the inhabitants as well as the vegetation cannot survive out of the water. Sea grass gardens thrive in this environment and exist in patches along the estuary floor. As mentioned above, sea grass cannot survive out of water, but needs to be shallow enough to absorb the energy from the sun for photosynthesis to occur.

These gardens provide an excellent source of habitation for a variety of different species. Because of the structure of such vegetation, an ideal source of protection and camouflage is provided. The grasses stems and roots, intertwine to provide

excellent hiding places, crevices and anchors for many smaller or juvenile species. Here fish can hide between the stems and roots, and have ample hiding spaces when under attack. Because of the nature of sea grass, these habitats also provide a constant supply of food and nutrients for the many species which inhabit them. Microscopic organisms can grow on the roots and stem developing a diverse range of food for many species.

Sea urchin communities

Also below the spring tidal boundary of the area, a unique and influential form of habitat occurs. Submerged sandy beds attract large number of individual sea urchins, which cluster together in search of food and nutrients within the sand. Hundreds of urchins hunt in large groups, feeding off each other, as well as acquiring protection through safety in numbers.

As these invertebrates congregate together, a form of sub habitat is established inadvertently. Smaller species and juvenile fish can live amongst the long spines of the urchins which provide protection from larger carnivores. As the urchins feed, these smaller species also have the opportunity to scavenge on remains, resulting in a constant source of nutrients and food.

As sea urchins are water based they cannot survive exposed for long period of time, and therefore can only exist below the spring low tide boundary. However, as this habitat is made up of live nocturnal individuals, these communities become nomadic and will move to a different position each night.



An aerial photograph showing a dark, winding river flowing through a dense, green forested area. The river has several sharp turns and meanders. The surrounding land is covered in thick vegetation, with some lighter green patches indicating different types of plants or possibly cleared areas. The overall scene is a natural, undeveloped landscape.

section 8_ design development

Design development.

Designing a symbiotic system

As mentioned in the proposition of this thesis the purpose of this design is to create an architecture that must coexist symbiotically within a fragile system. This thesis has defined the fragile system as the marine environment, within the context of Ponta da Barra, Inhambane, and with the intervention of a research, education and conservation facility, a symbiotic relationship, where each component is benefited by the others presences, must be established.

It is therefore the systematic integration of the **environment**, the **site** and the intended **programme**, which forms the main driver in the design methodology of this thesis.

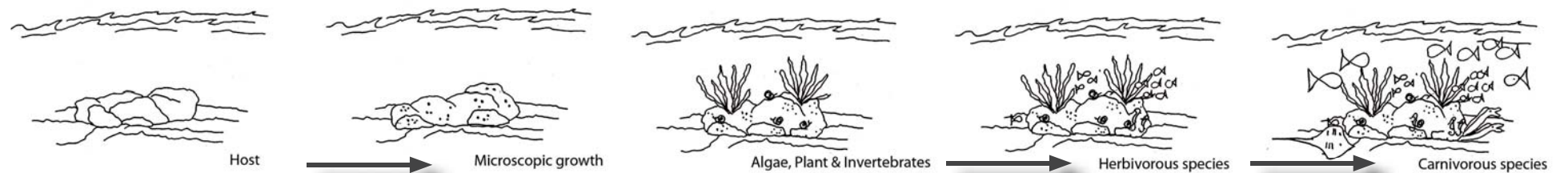
Integration of the natural environment and the artificial intervention

The process of habitation occurs only when an organism is provided with the opportunity for shelter, food and growth. The primary need for any habitat is a source of stability or permanency, this can be in the form of any object or structure found within an environment, for example an out crop of rocks on a sandy bed, or a patch of vegetation growing on the sea floor.

A rocky out crop exposed on a sandy bed will have a direct influence on the surrounding habitat. Any floating organism in search of a space to inhabit will land on this rock and begin to develop. This will cause a chain reaction of systems and organisms all attracted to this source of permanency. Microscopic organisms will begin to bloom, attracting other larger organisms like vegetation and inverte-

brates. This in turn will attract a diverse array of life all in search of habitation and food.

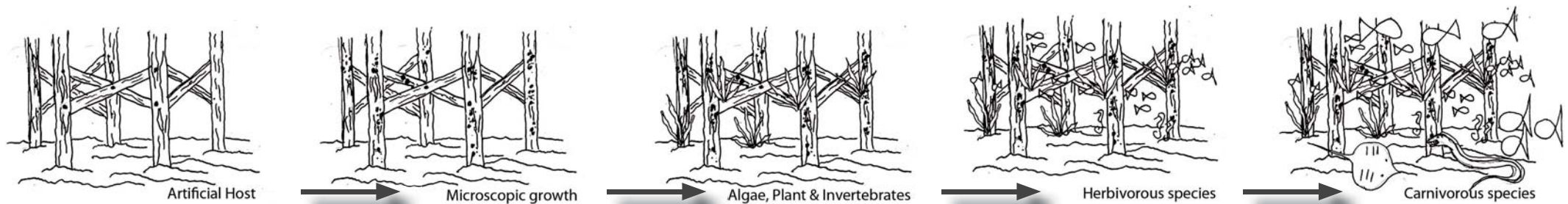
This type of habitat development can be purposefully initiated by the introduction of any object into an existing ecosystem. By introducing an artificial element into an existing habitat the same chain of events, as mentioned above, will occur. The simple concept of permanency which is established in an environment, will result in automatic habitat development. This type of habitat development, although artificial, can become an important biodiverse system, providing a unique opportunity for habitation, growth, and a constant source of food and protection.



Establishing an artificial habitat

By introducing a systems of columns and supports which will provide a platform for the programmatic functioning of a research, education and conservation facility, the spontaneous development of habitat will occur. The intention of this design is to have as little negative impact on the surrounding environment as possible, but by introducing a system of a supporting structure, which is constantly affected by tides and changing water levels, a unique and important artificial habitat will be established, providing all the necessary infrastructure needed to sustain any habitat.

The development of such an artificial habitat will result in the symbiotic integration of the marine environment and the architectural intervention. As the architecture attracts a diverse array of species and organisms, the opportunity for in-depth research and analysis is intensified. The more habitat available, the more diverse that environment will become, the more opportunities for research become available.





The images above are examples of artificial reefs located in various areas around the world. This intervention has become popular in reefs which have begun to experience high levels of deterioration, and habitat destruction, and are placed upon deserted sandy beds close to shore. Almost any material can be used for this purpose and with time can attract a diverse range of marine life.

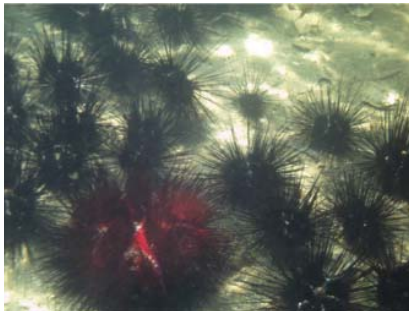
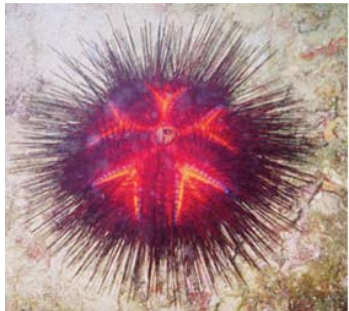
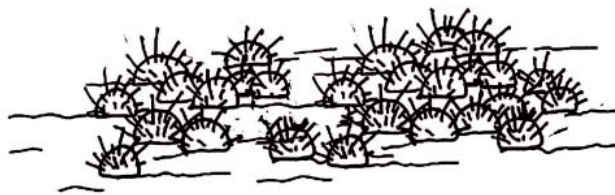
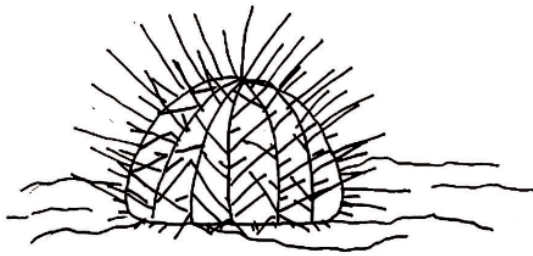


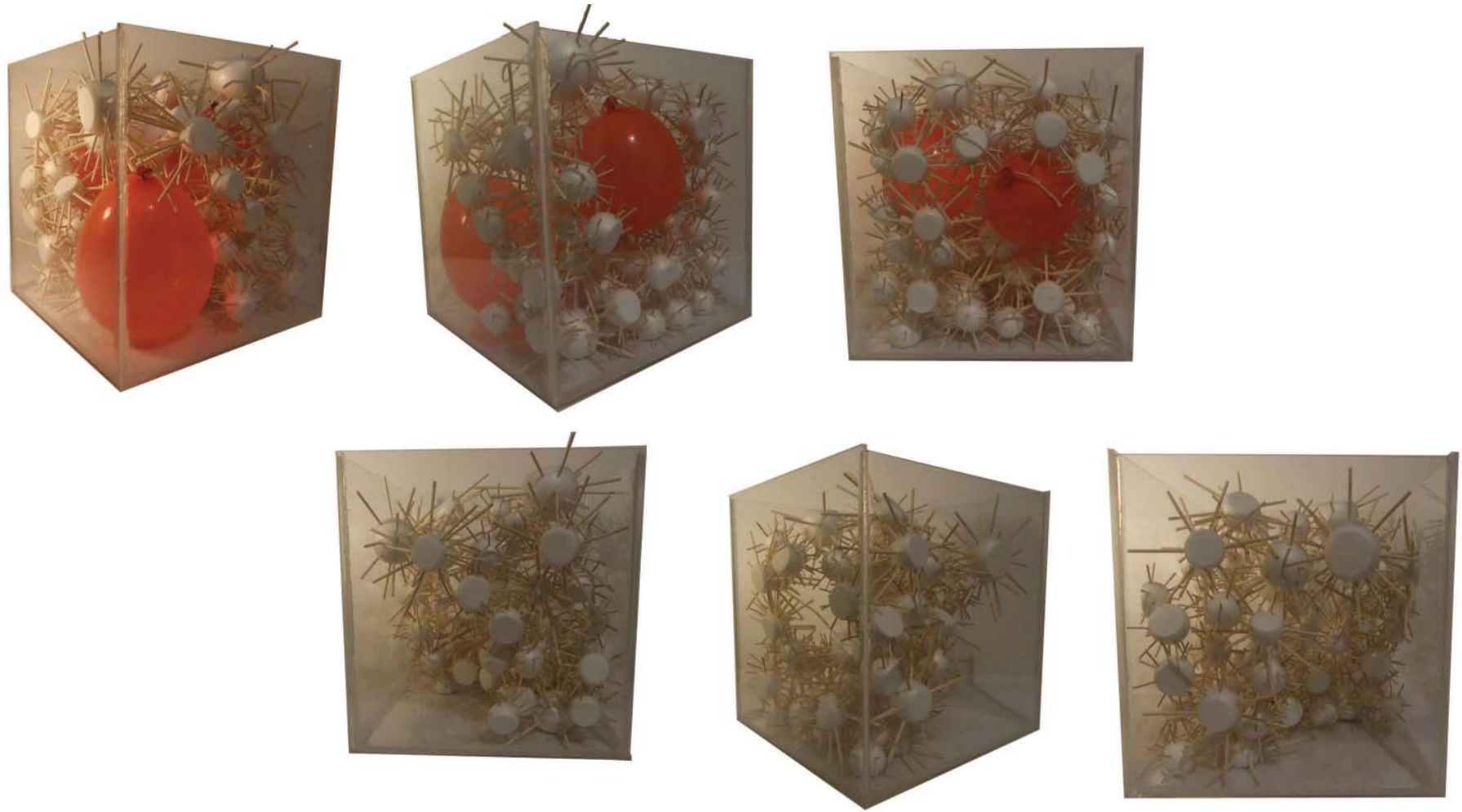
Model of habitat structure

The model below investigates the structure of an existing habitat within the surrounding ecosystem. By looking at the sea urchin communities, found beyond the low tide boundary of the site, one can begin to identify how this habitat functions and extract clues which can be used in the design process of this thesis.

These urchin communities establish a unique and highly functional form of 'living' habitat within the Barra estuary. As these creatures gather together in search of food, and safety in numbers, their long pointy spines, provide a ideal structure for many other species to hide and hunt. As these species are nocturnal, much of their hunting and movement occurs during the night, during the day they will

cluster together to form large communities of up to 200 individuals. It is during this time that the structure of such species become highly functional. The long spines of each individual interlock with its neighbour, forming a stable linking system within these clusters. This interlocking of spine provide stability during rough seas and stormy weather, preventing individuals from being swept away. It is also this interlocking of spines that provide an excellent form of habitat.

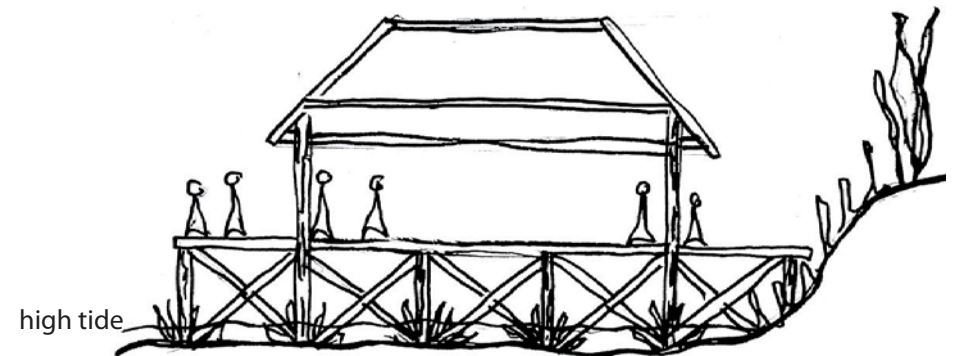
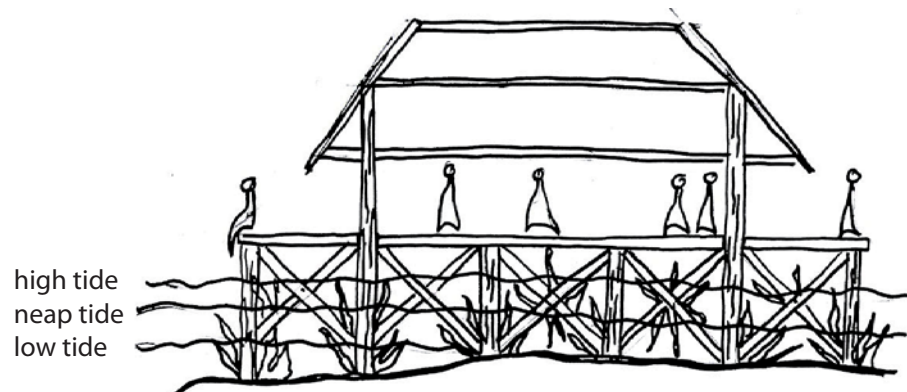
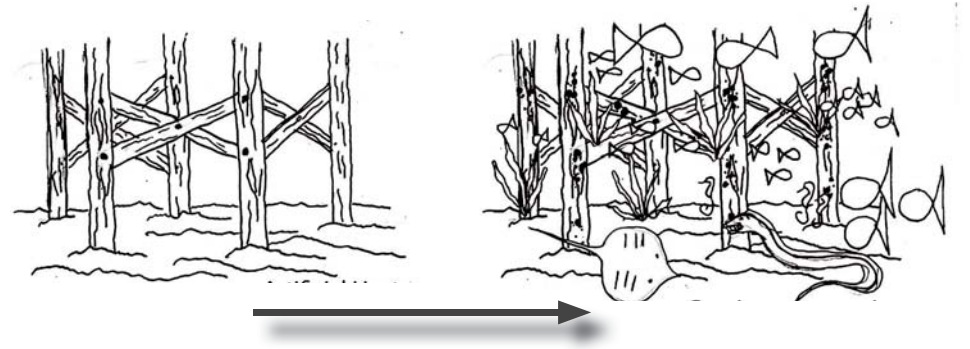




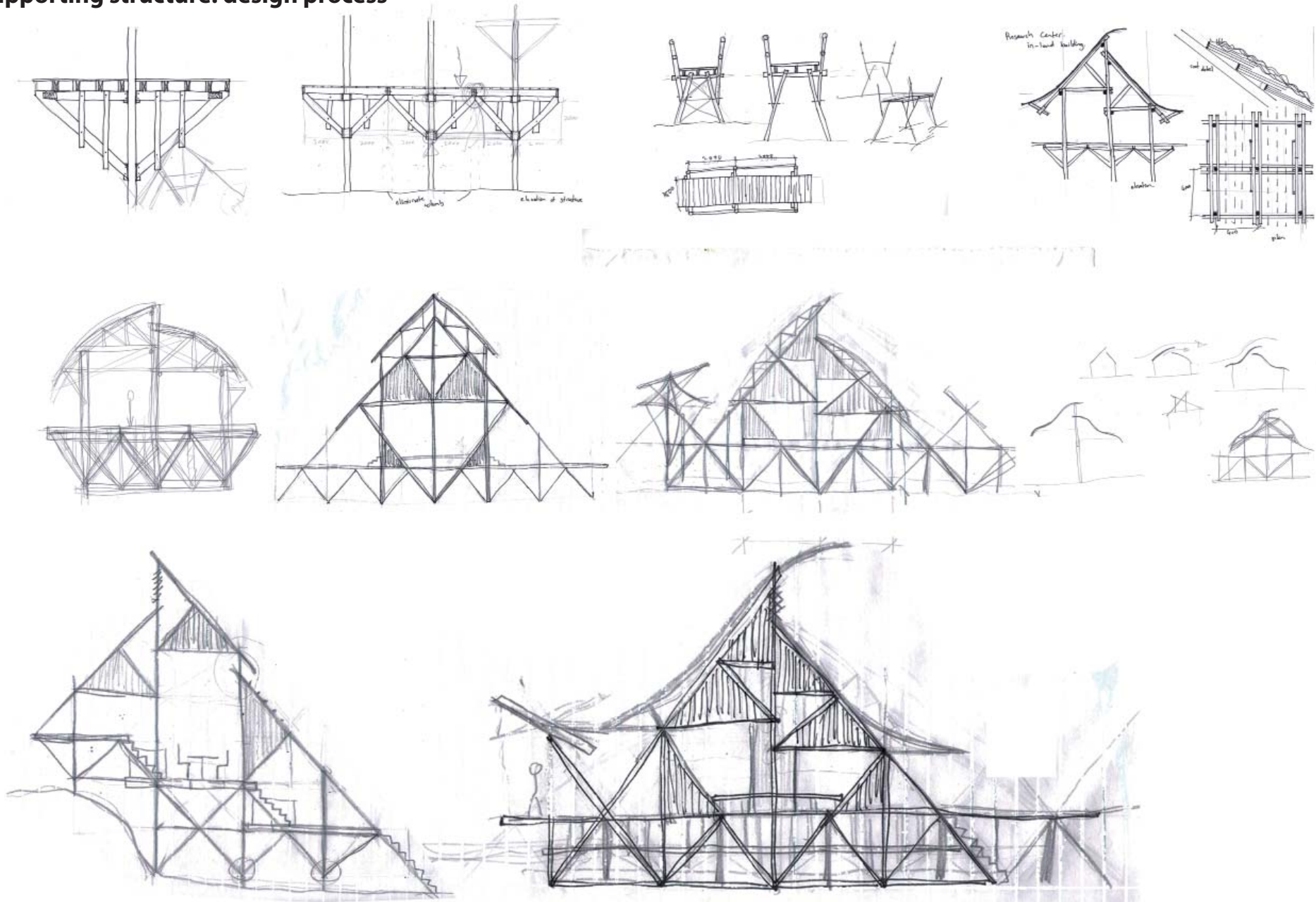
This model explores the relationship of void and in-between spaces. Placing similar models to that of a sea urchin around semi permanent objects (balloons), a structure is created. It is the interlocking of the spines which produce such forms, and as the semi permanent objects are removed, the urchin like models retain their position. Here a structure is formed creating void spaces in alternative positions. It is, however, the in-between spaces that are of interest regarding this thesis. It is this interlocking structure that produces 'habitat like spaces', ideal for many species within the marine environment.

By establishing a platform where programmatic functions can be carried out above the water, a system of supports and structural elements must exist below. It is here where an artificial habitat can begin to develop.

As the tidal fluctuations are influential within this site, they will form the boundaries of such habitats. Although the boundaries of the tides cover a vast percentage of the site, the depth to which they rise is minimal in many places. As one moves inland, the water will only rise $\pm 600\text{mm}$, but it is at the low tide boundaries that the water level can rise up to 1800mm . Although the rise and fall of the water levels alternate throughout a 24 hour period, they still provide the opportunity for artificial habitats to develop around such supporting structures.



Supporting structure: design process

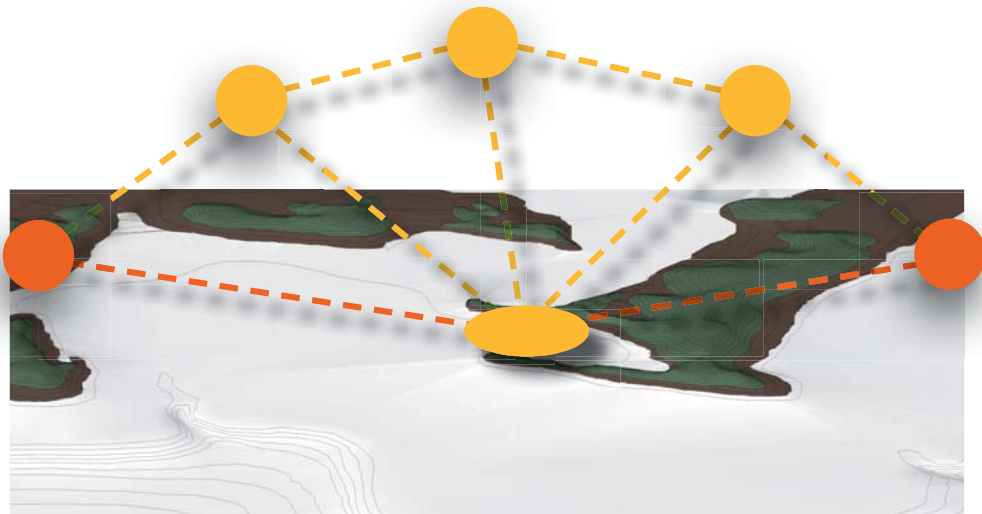


Response to climatic conditions of the site

As already established the climatic condition of this site exists in extremes. The most extreme condition being the intense heat and humidity which is present almost all year round. It is therefore an important design objective to create a constant source of comfort for the users of such a facility. Although direct sunlight is always the most intense on north facing facades, light and heat is accessed from all directions. It is therefore the concern of this design to create areas which are completely shaded at all times, allowing a constant flow of air through these shaded spaces, providing relief from the intense heat.

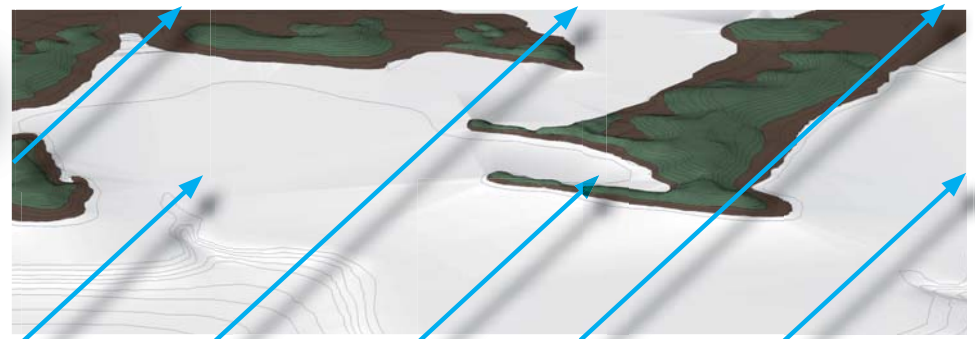
Solar study

The sun's rays hits the site at an angle of 65-73 degrees, depending on the time of year. However, because of its isolation and minimal light obstruction, light will penetrate the site from all direction, bring with it the intense heat which cause much discomfort in the area. By this, the orientation of the buildings have minimal impact on climatic comfort level. Protection from the sun needs to be addressed in all direction.

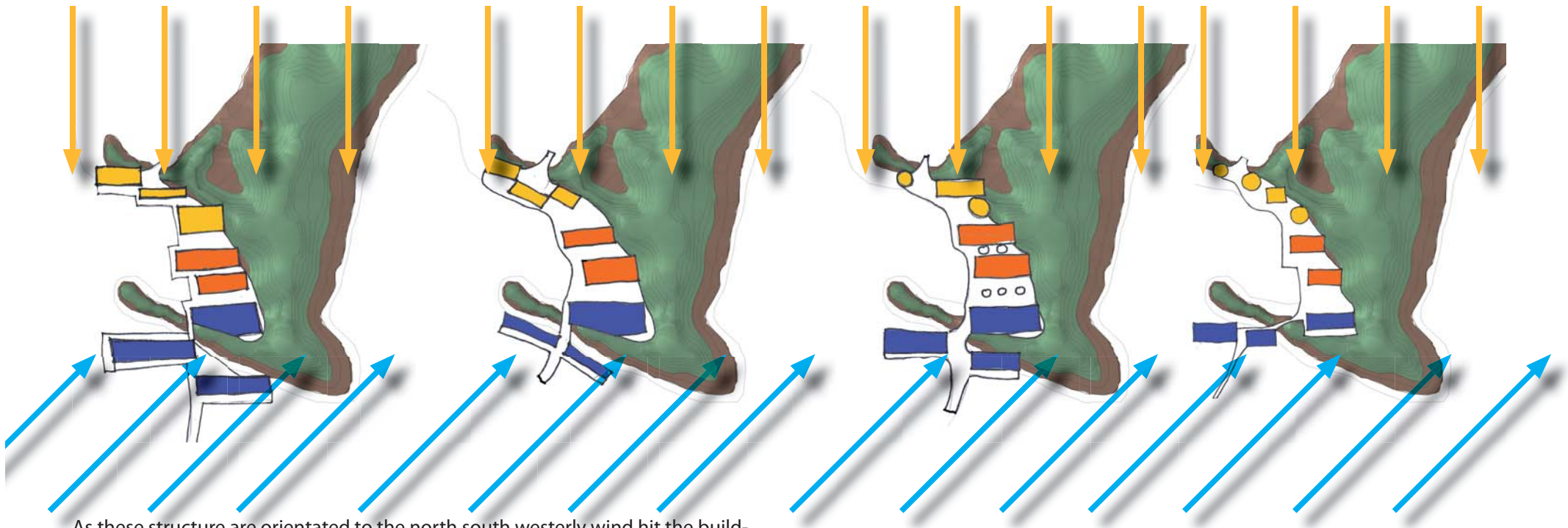


Air flow analysis

It is the south westerly winds which flow from the main lands that will have a large effect on the design process for this thesis. It is during the day that these off shore wind are most prevalent and therefore, must have a large influence on the orientation of the buildings. Ideally, building should be position at an oblique angle to such winds, resulting in ideal conditions for natural ventilation and air flow

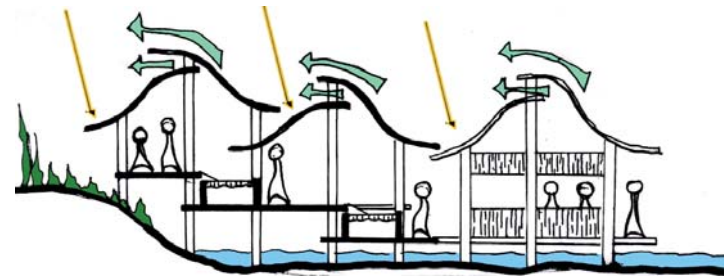
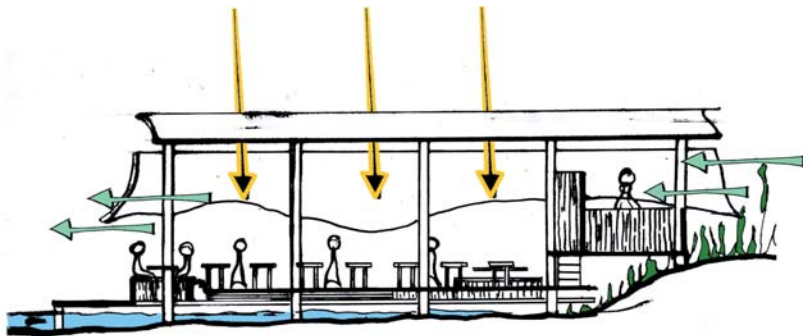
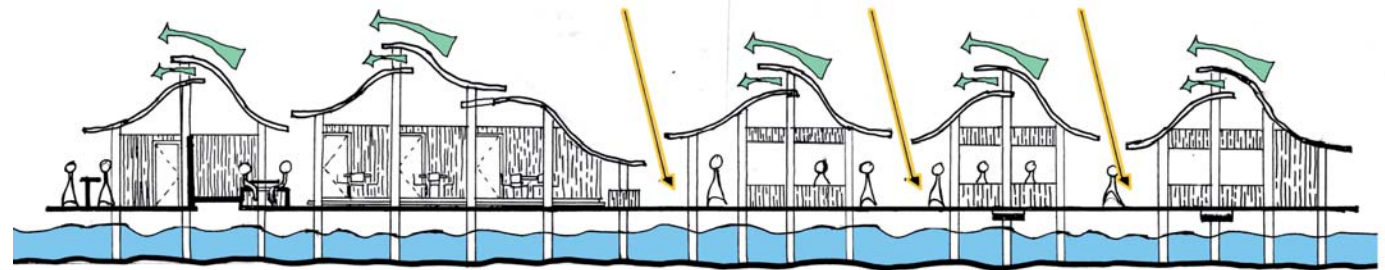
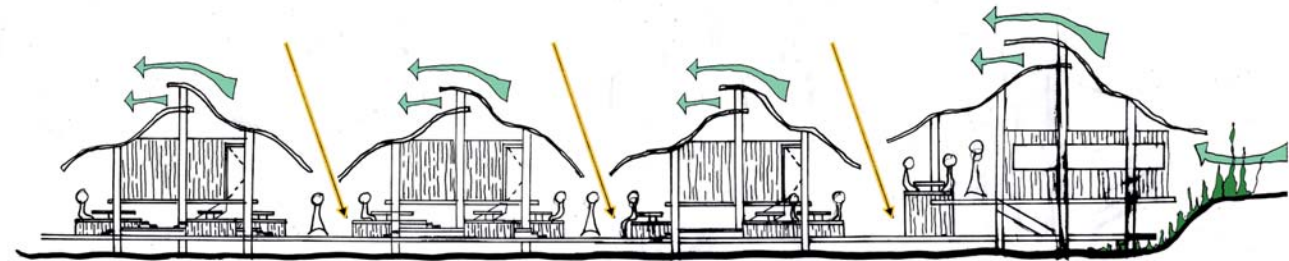


Layout development



As these structure are orientated to the north south westerly wind hit the buildings at an oblique angle, thus resulting in the constant flow of cooler air through the buildings. Building located in front of the existing island will also be cooled through an evaporative cooling system, as winds will travel through the surrounding vegetation and into the spaces.

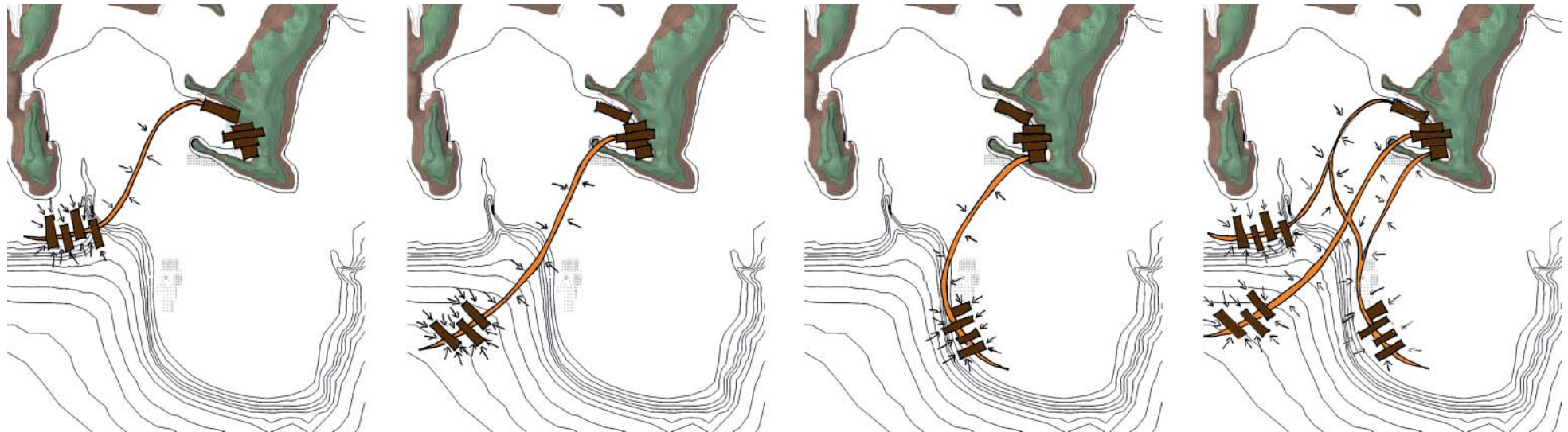
Ventilation and light sketches



Programmatic influences on design

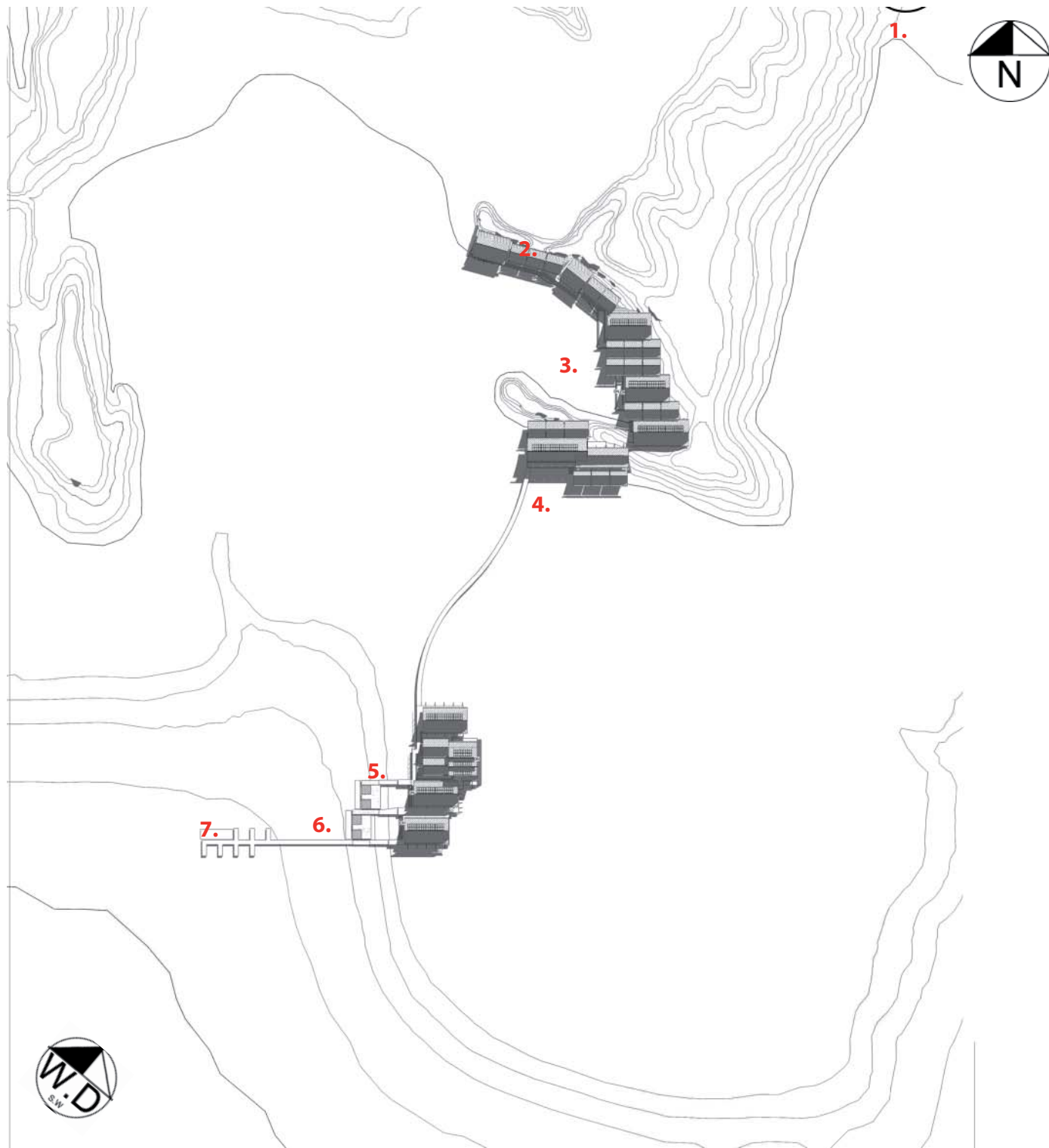
As mentioned previously for a facility focusing on research and conservation, the most important criteria needed to support such a programme is the accessibility to the subject of study. To optimise the success of such a facility, links need to be established between these spaces. This can be achieved by creating passages to and from the surrounding habitat, allowing research to collect specimens and sample and quickly move them from their natural habitat to in-house aquaria and laboratories.

This can be achieved by a system of boardwalks and passages. These boardwalks will not only provide the access need for such a programme, but with the integration of their support structure with the site below, ideal conditions for artificial habitats will emerge.





section 9_
Design drawing,
'The Barra Research and Conservation Centre'



Site Plan

- 1. shuttle drop-off
- 2. entrance/reception
- 3. education centre
- 4. laboratory
- 5. dive centre
- 6. dive platform
- 7. jetty

Ground Floor Plan

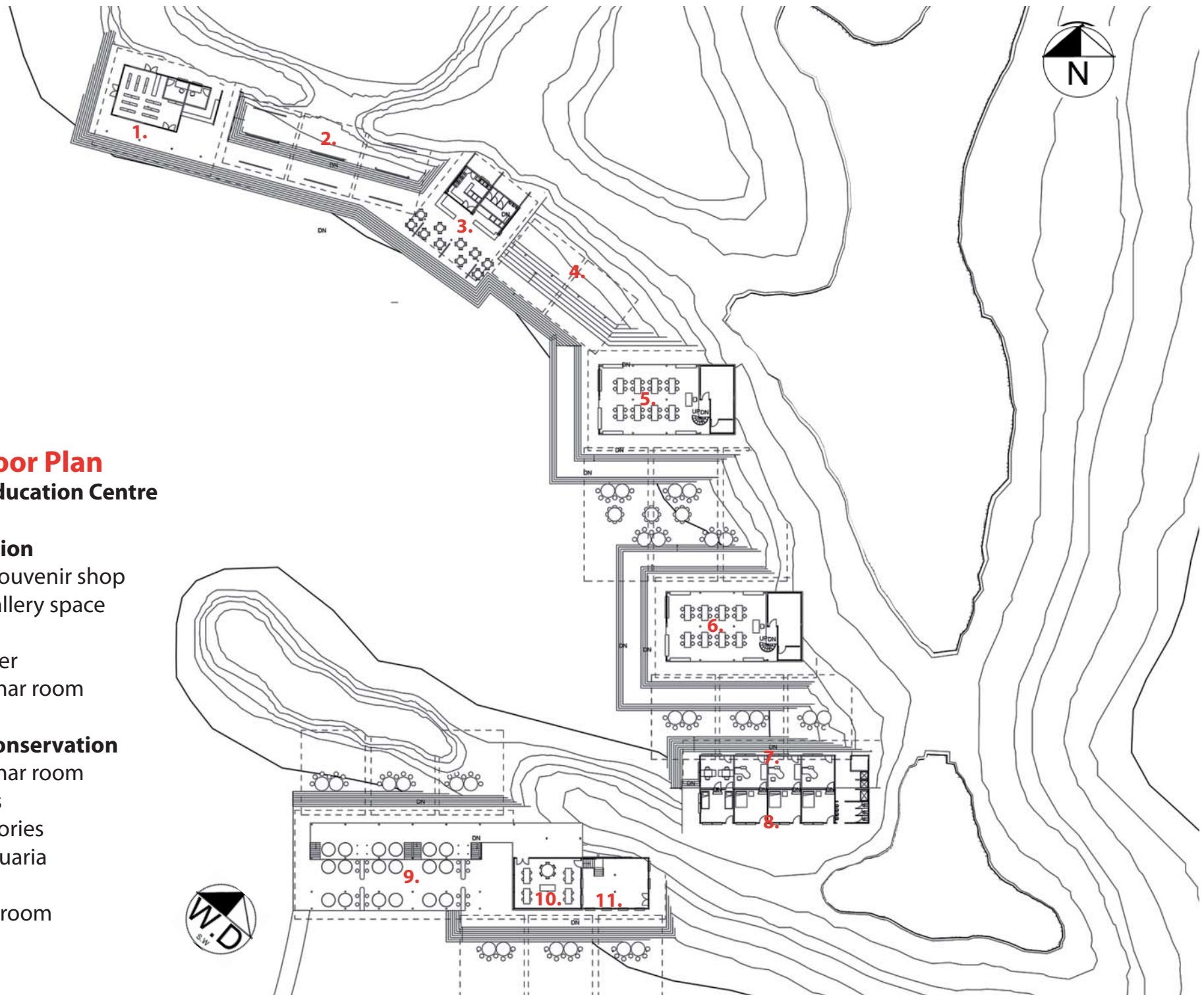
Research & Education Centre

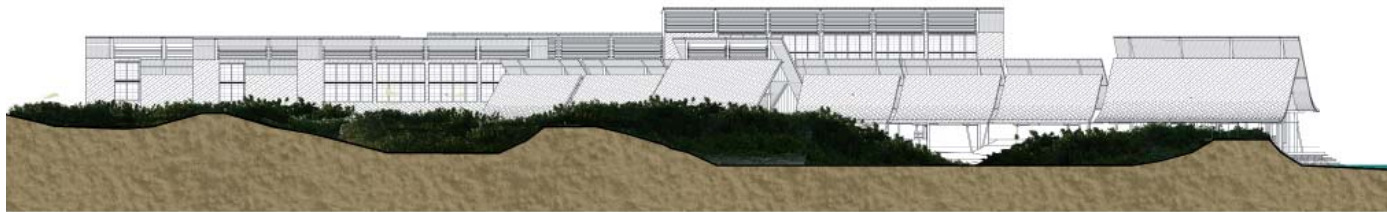
Public education

1. reception/ souvenir shop
2. entrance/Gallery space
3. Resturant
4. Amphitheater
5. study/ seminar room

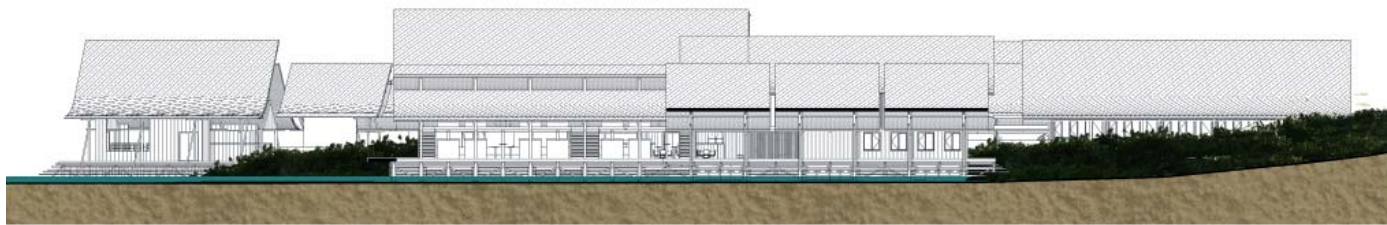
Research & Conservation

6. study/ seminar room
7. Amin offices
8. Staff dormitories
9. Research aquaria
10. Micro lab
11. Dissection room

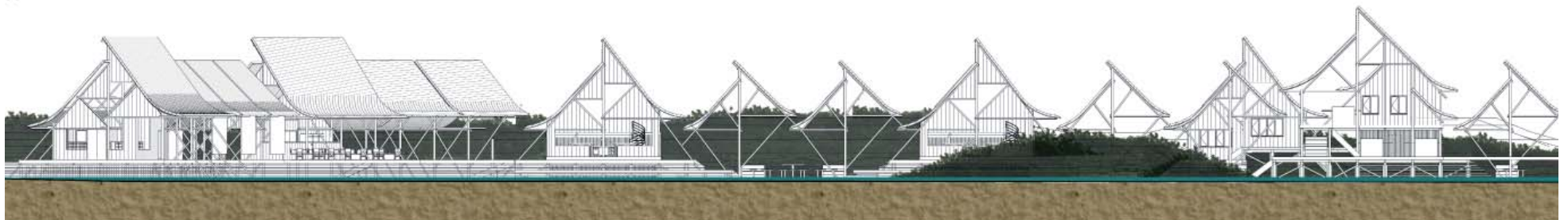




North Elevation



South Elevation

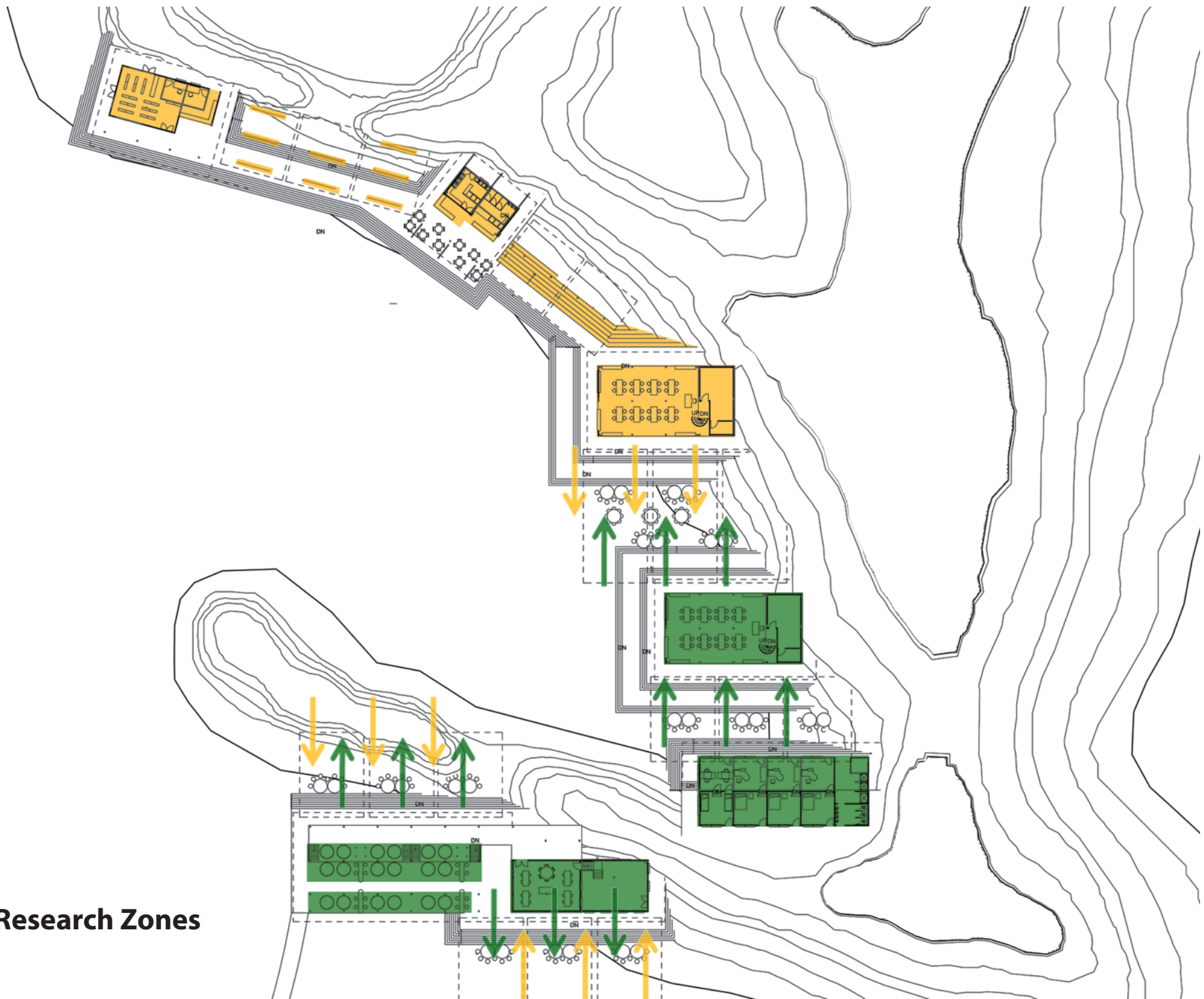


West Elevation

key:

- public
- research

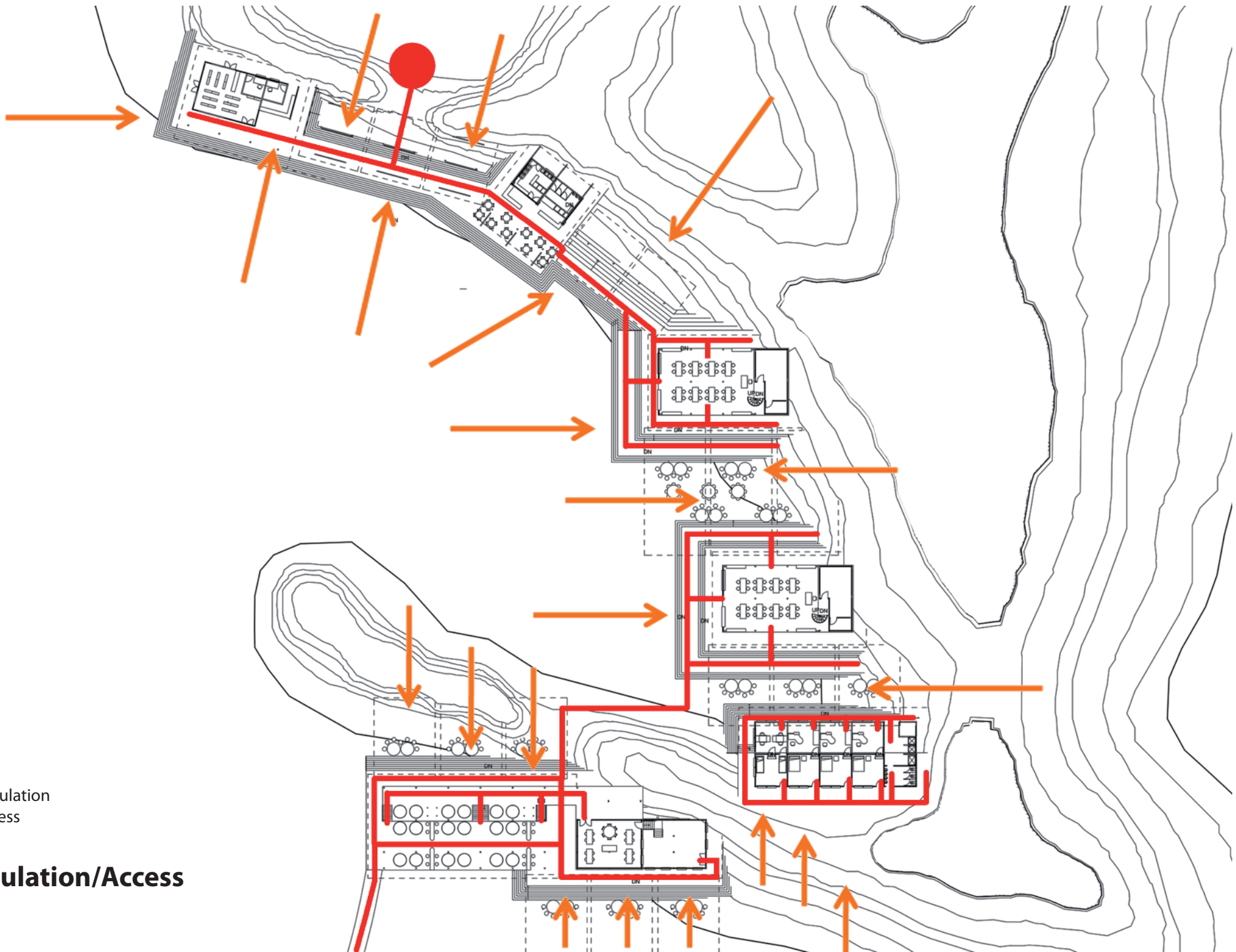
Public vs. Research Zones



key:

- circulation
- access

Circulation/Access



key:

- spring high
- neap high

Tidal Fluctuation

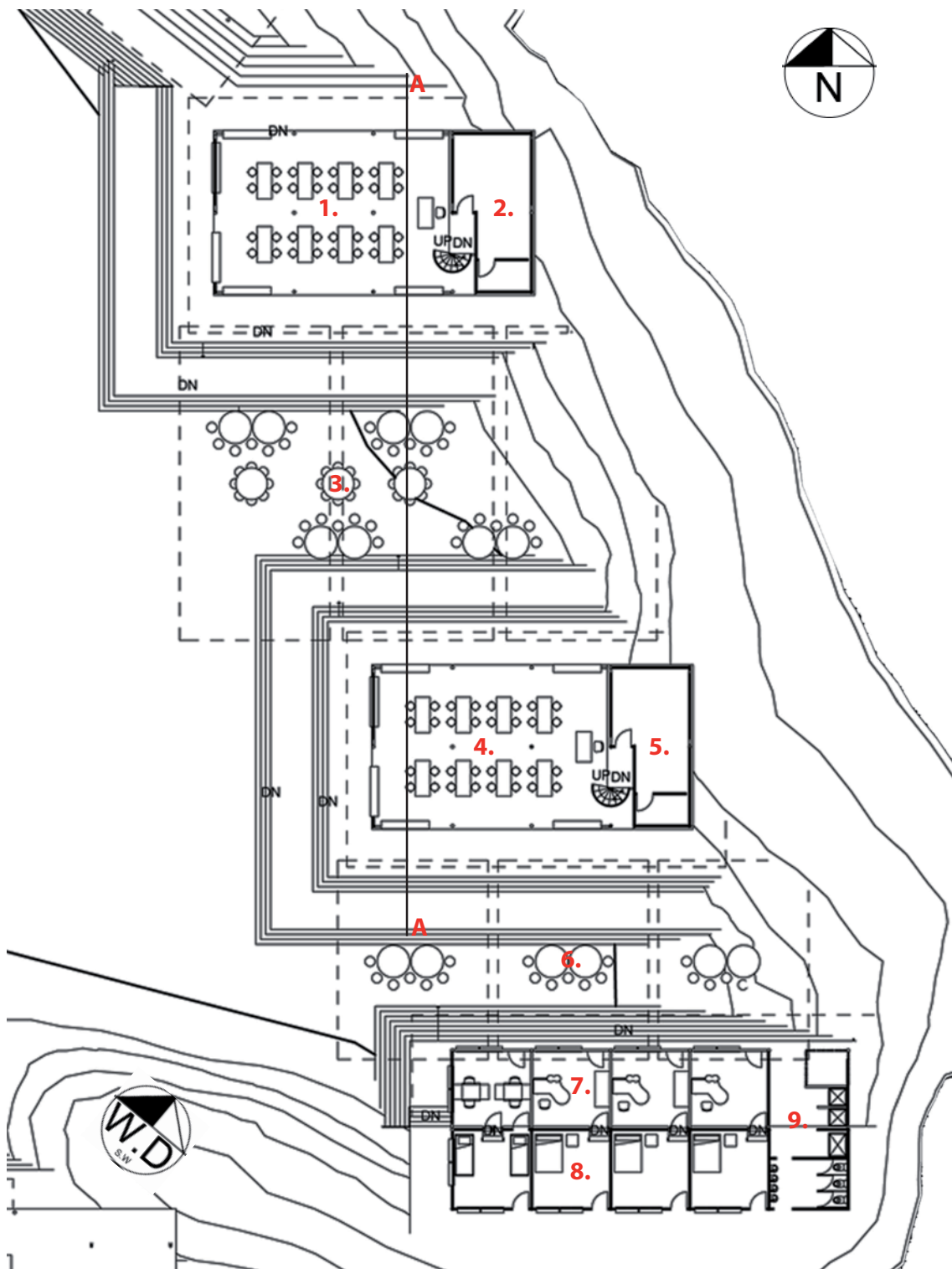




Low Tide conditions



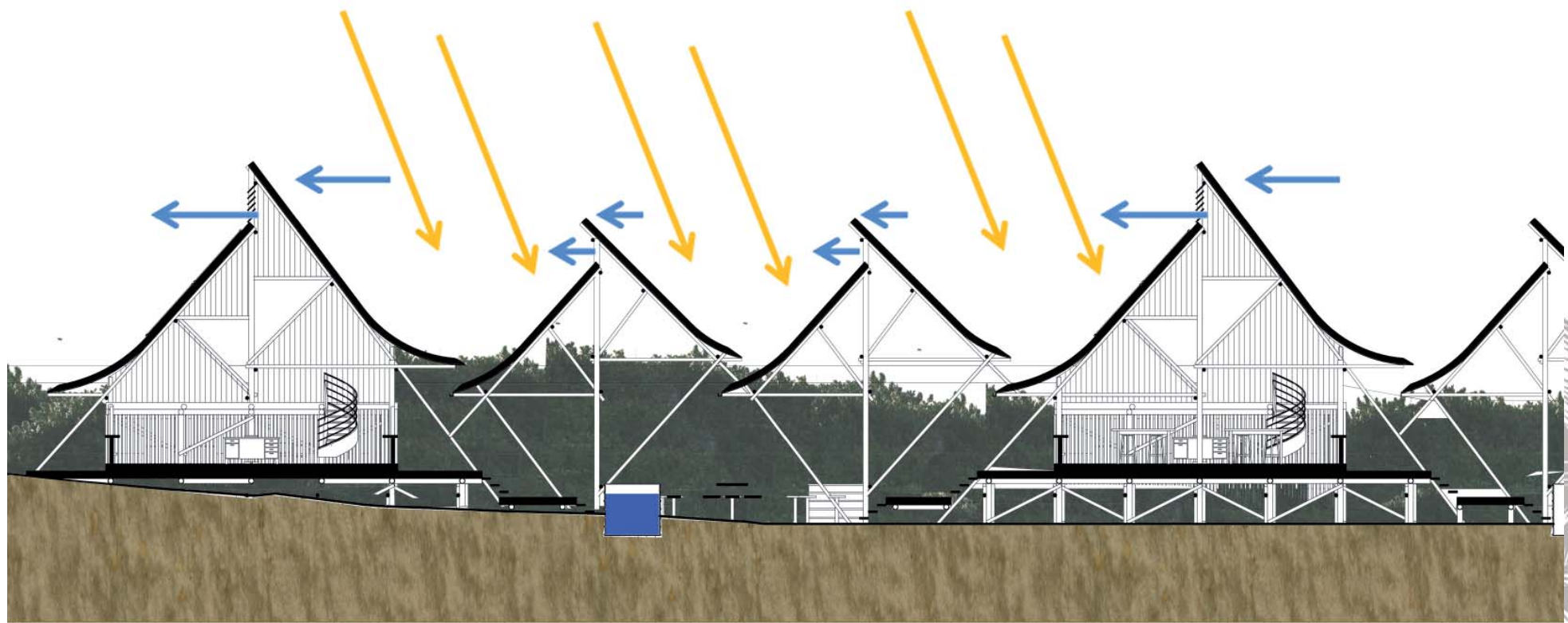
High Tide conditions



Ground Floor Plan

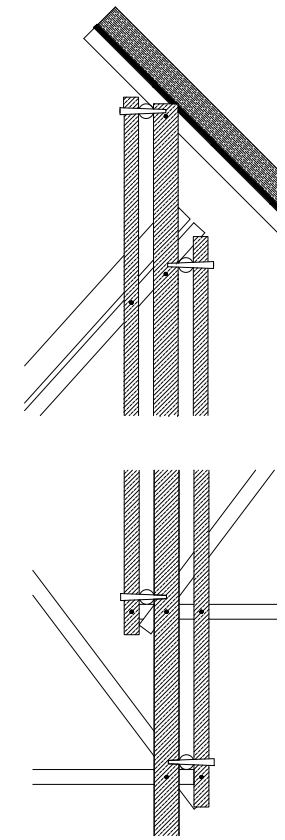
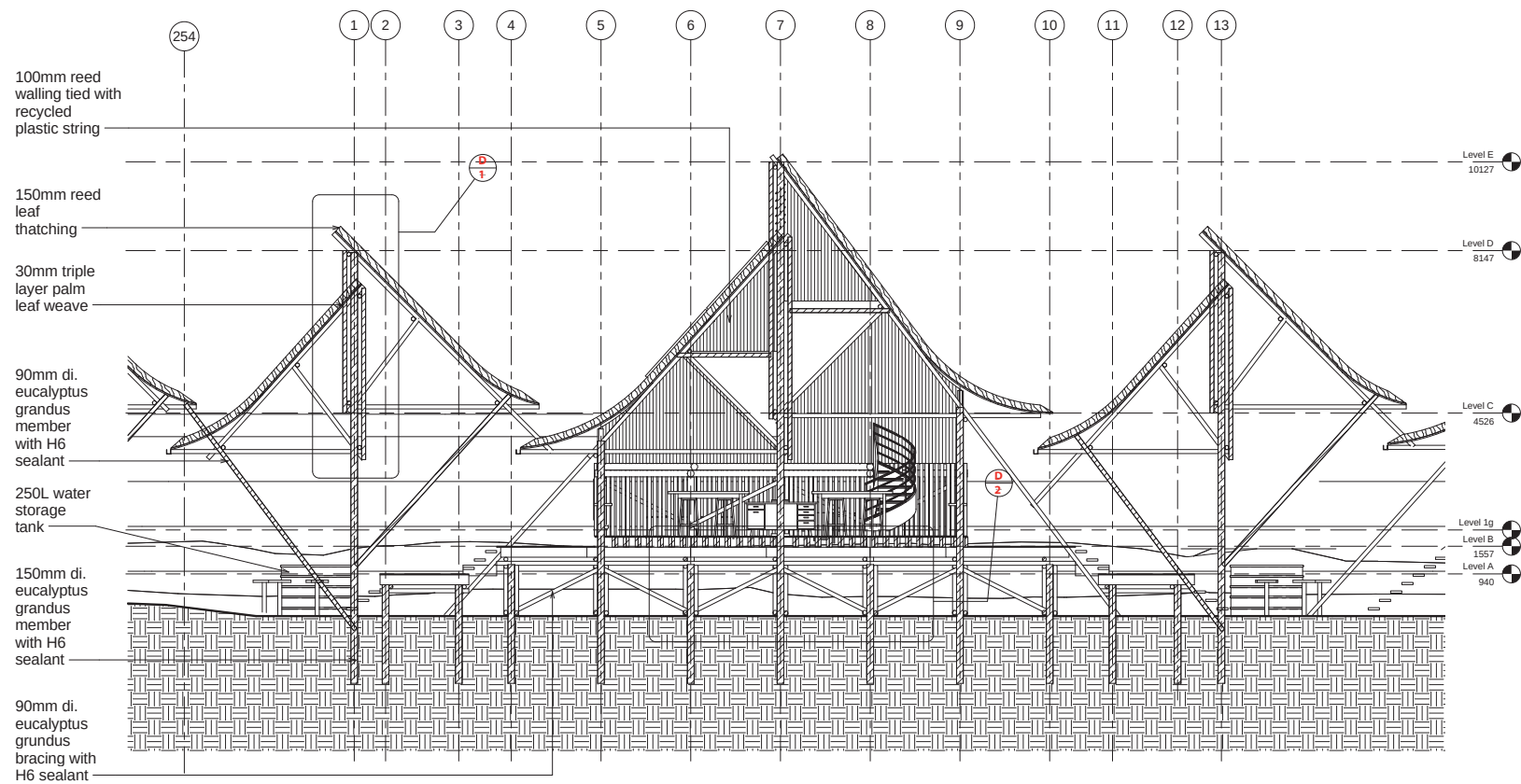
Study/research room & admin block

1. study/seminar room
2. Office/storage
3. Comunal meeting/work space
4. Study/research room
5. Office/storage
6. Comunal meeting/work space
7. Admin offices
8. Staff dormitory
9. ablutions

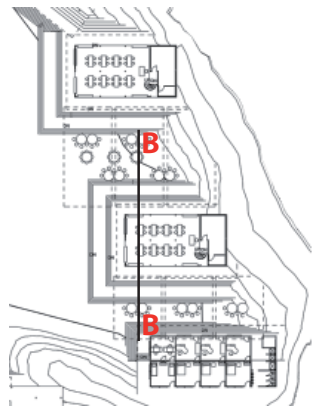


Section A-A

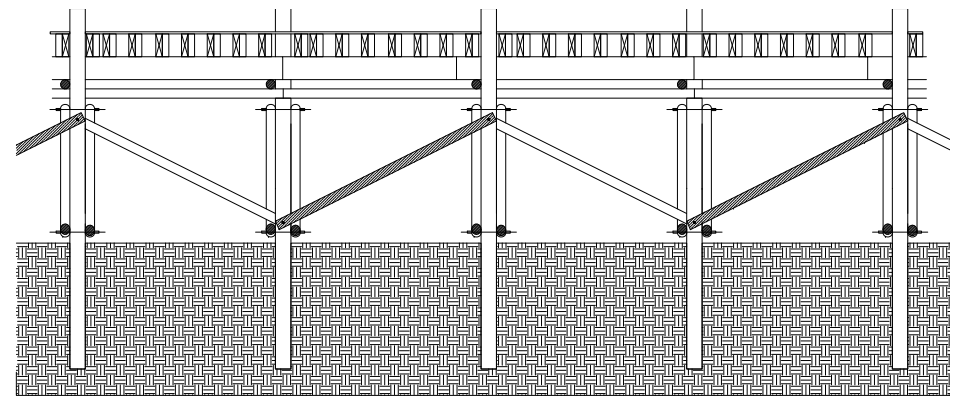




Section B-B



Detail 1

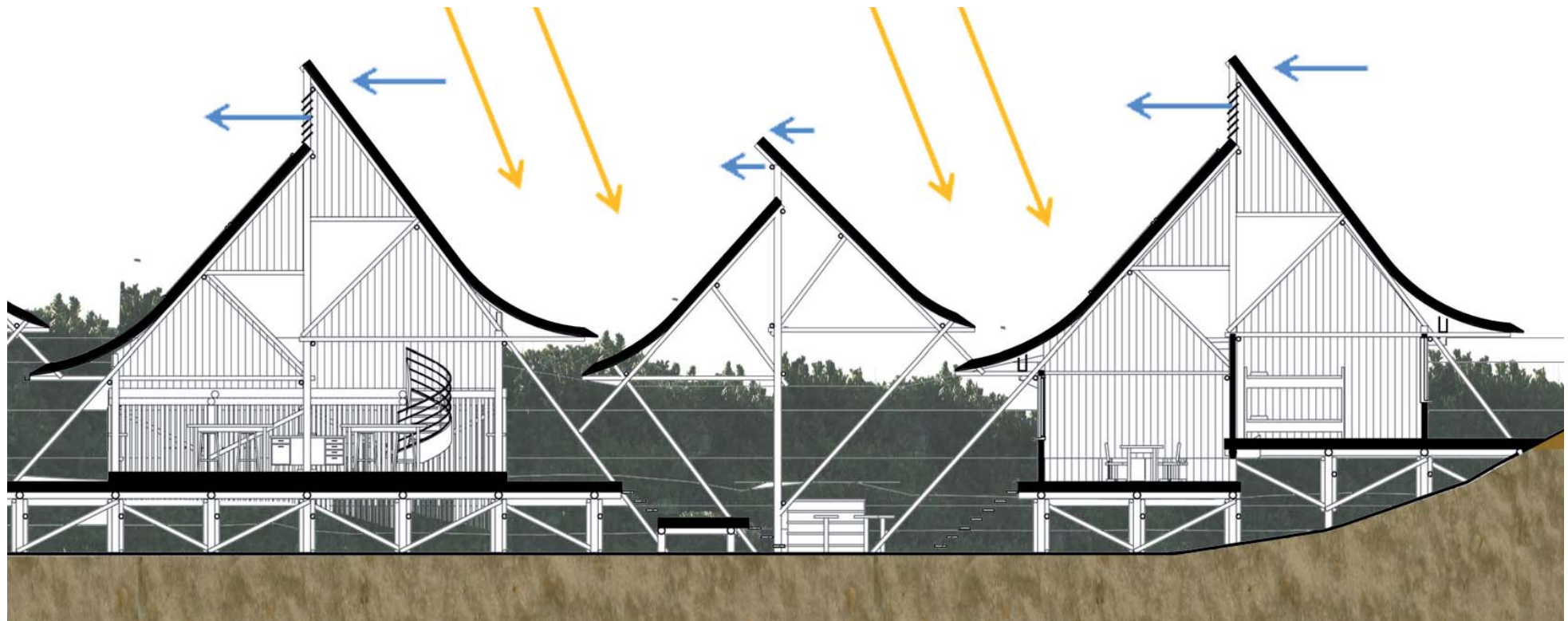


Detail 2

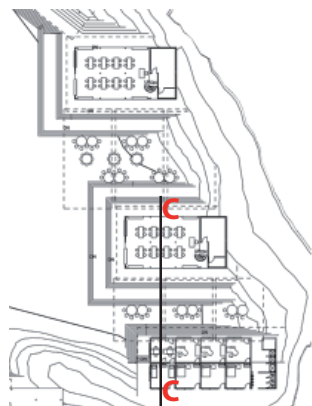


Communally work / meeting spaces

These shaded meeting spaces allow the programme of the classrooms to bleed out of the interior spaces into the surrounding landscape. Water storage tanks provide platforms for individuals to sit around, and discuss issues or lessons learnt within the classrooms, and also serve as a place for visitors as well as researchers to meet and interact. As these areas sit on the sand, they are affected by the rising and falling tide, creating an important interaction between the architecture, the site, the programme and the users.



Section C-C

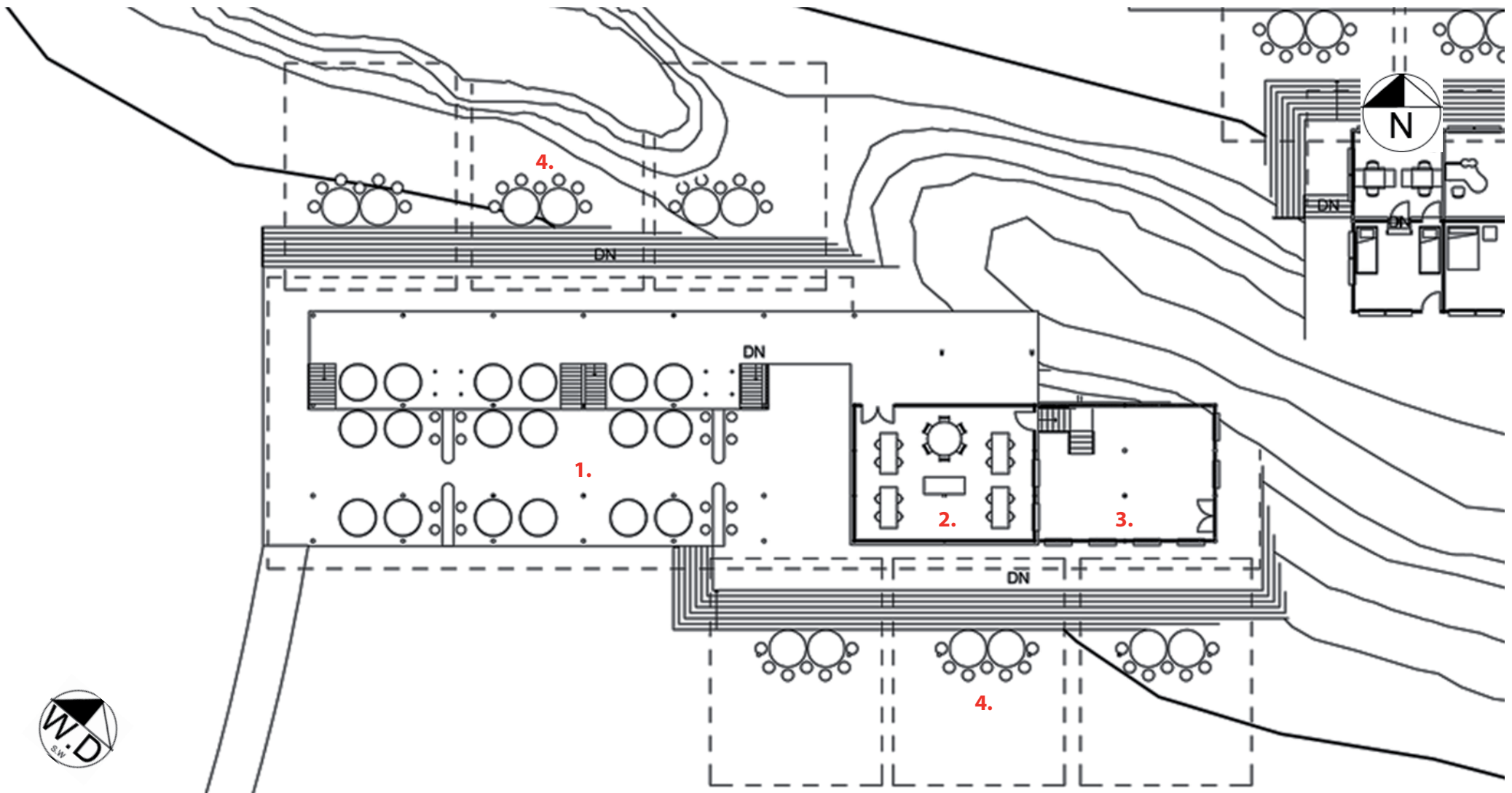


Admin Dormitory

Study / seminar room

Within these rooms, educational classes and seminars will take place, education both the resident researchers and the visiting public. Although these spaces are completely covered and shaded, they are not enclosed. This allows a constant flow of air through the space creating an ideal space for learning.





Ground Floor Plan Research Laboratory

1. Research aquaria
2. Micro laboratory
3. Dissection room
4. Work/meeting spaces

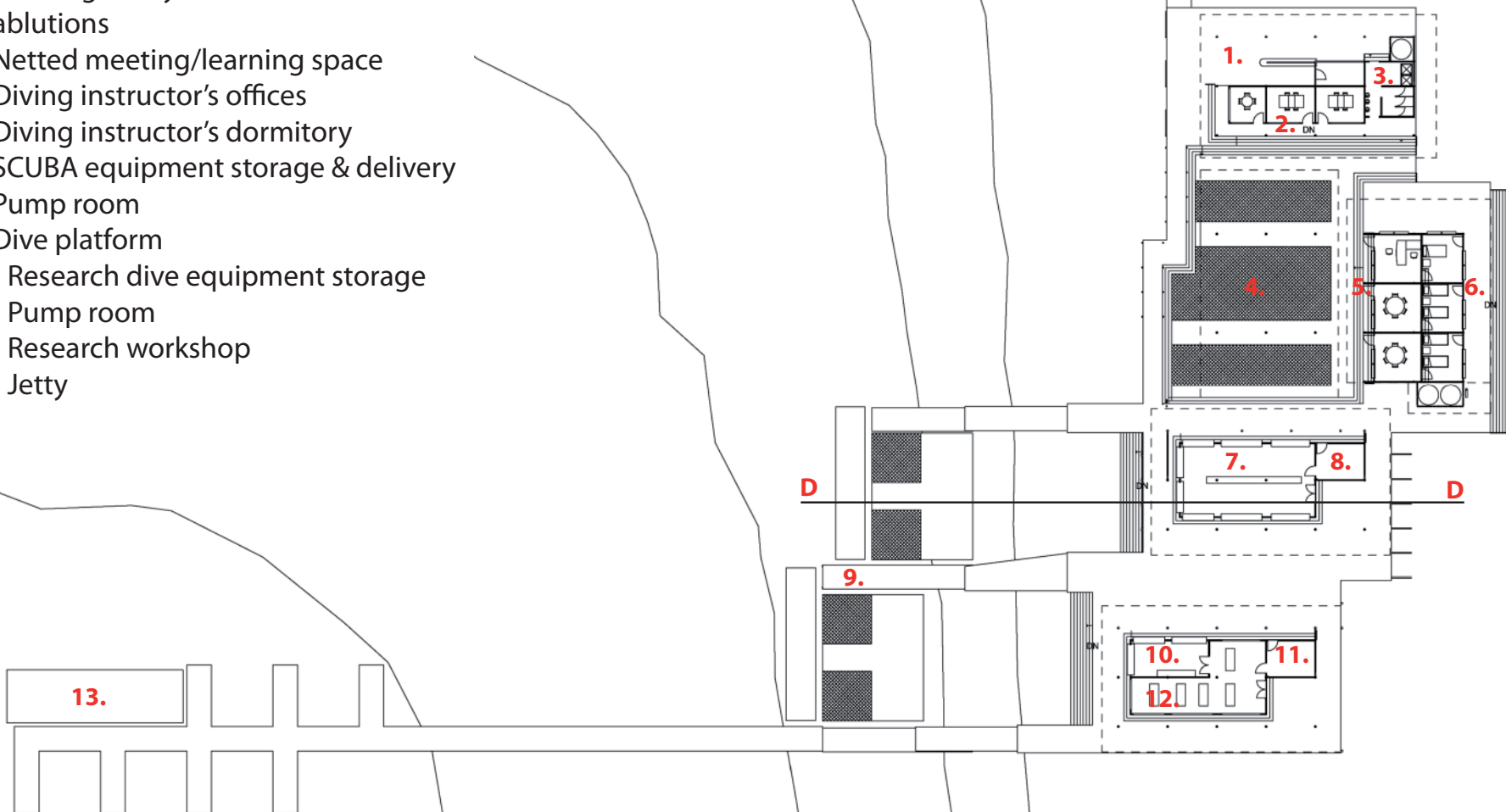


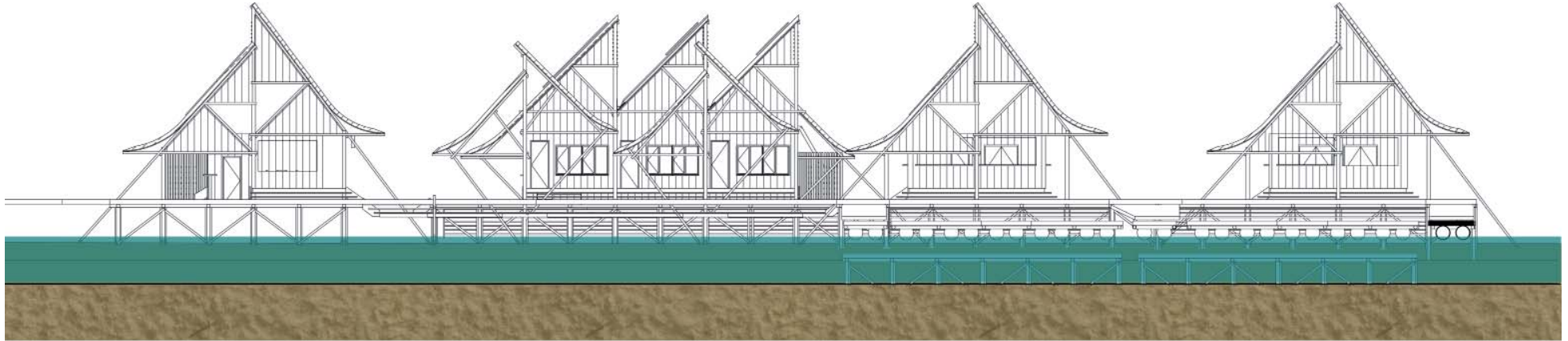
Research Aquaria

This open air platform hold 18 research aquaria, which will house a variety of live specimens which have been selected for analysis purposes. Although completely shaded, an absence of walls allow a constant flow of cool air through the space, providing an ideal space for researches to analyse the live species and document their findings. This platform can also be accessed by any visitor who will be able to move through the platform, and observe this research processes.

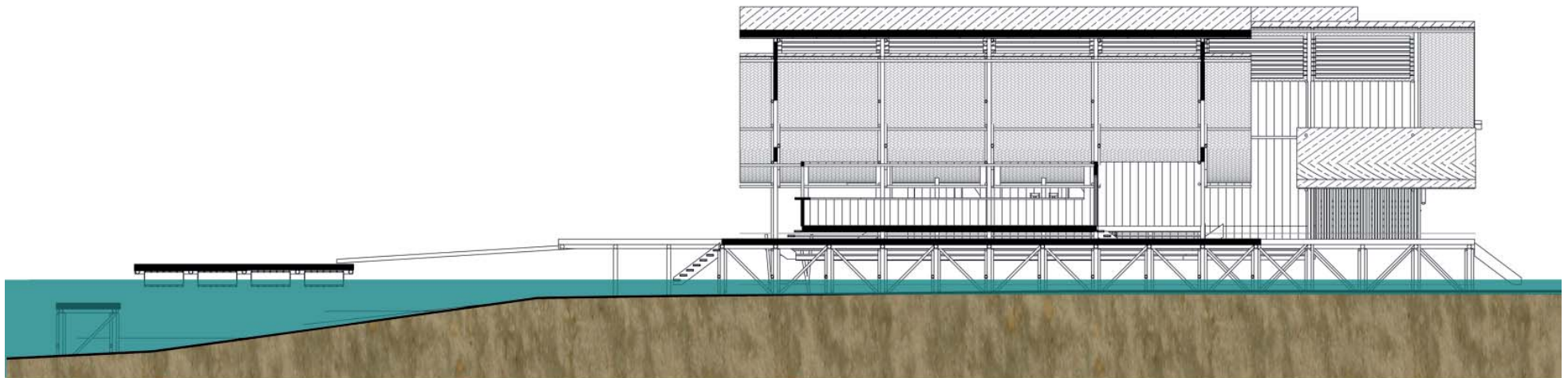
Ground Floor Plan, Dive Centre

1. reception/ dive bookings
2. meeting/study rooms
3. ablutions
4. Netted meeting/learning space
5. Diving instructor's offices
6. Diving instructor's dormitory
7. SCUBA equipment storage & delivery
8. Pump room
9. Dive platform
10. Research dive equipment storage
11. Pump room
12. Research workshop
13. Jetty

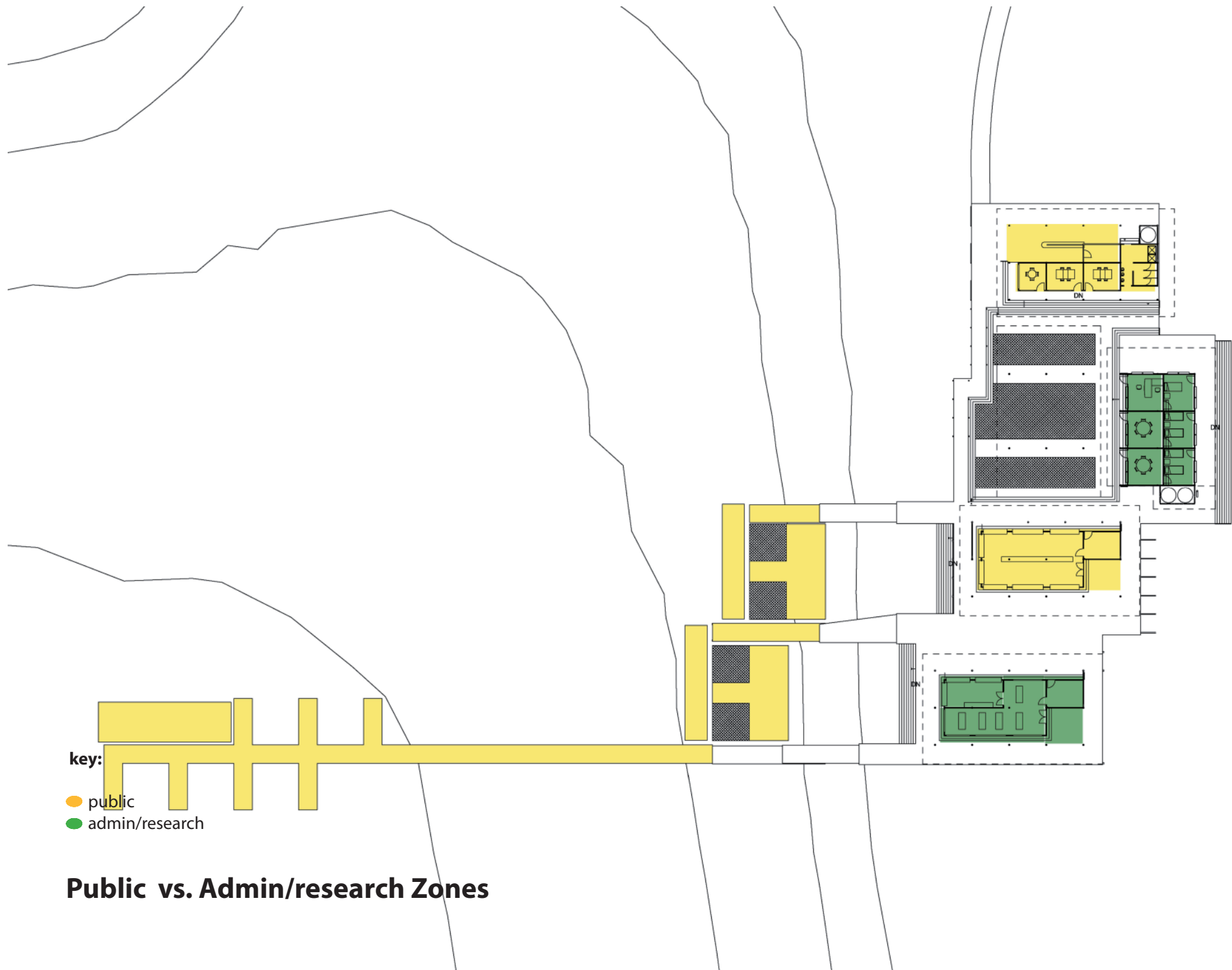




West Elevation



Section D-D



key:

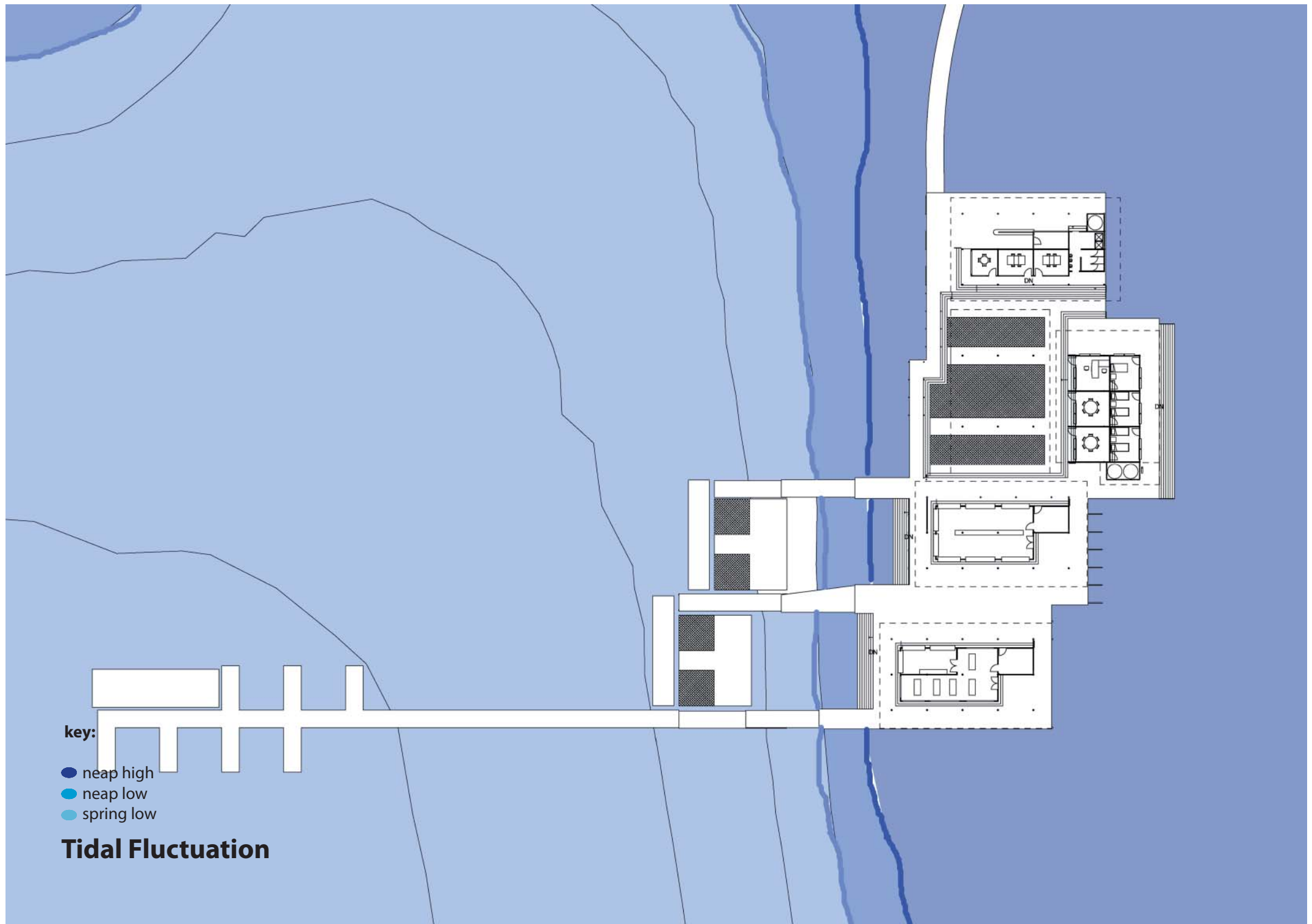
- public
- admin/research

Public vs. Admin/research Zones

key:

- neap high
- neap low
- spring low

Tidal Fluctuation



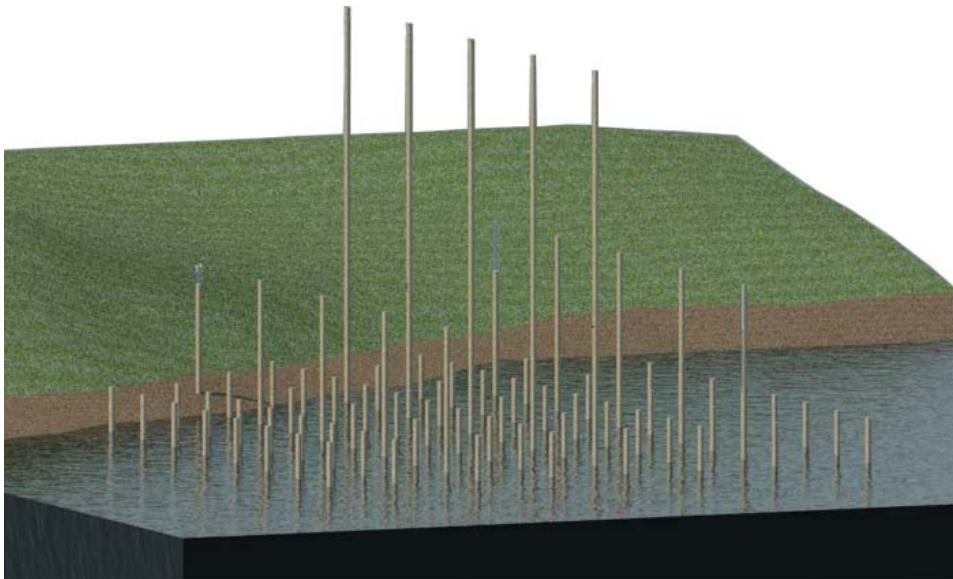


Dive Centre

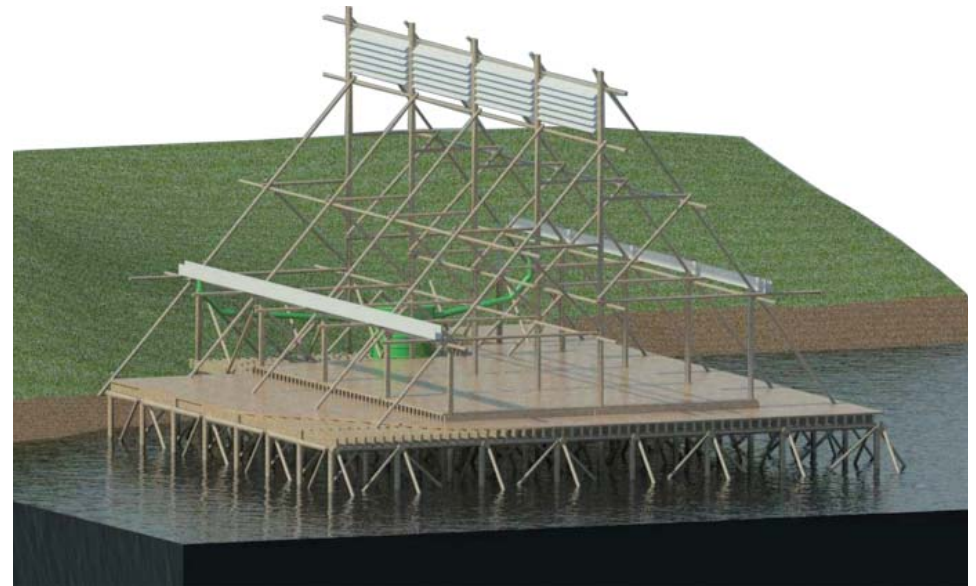


Supporting structure

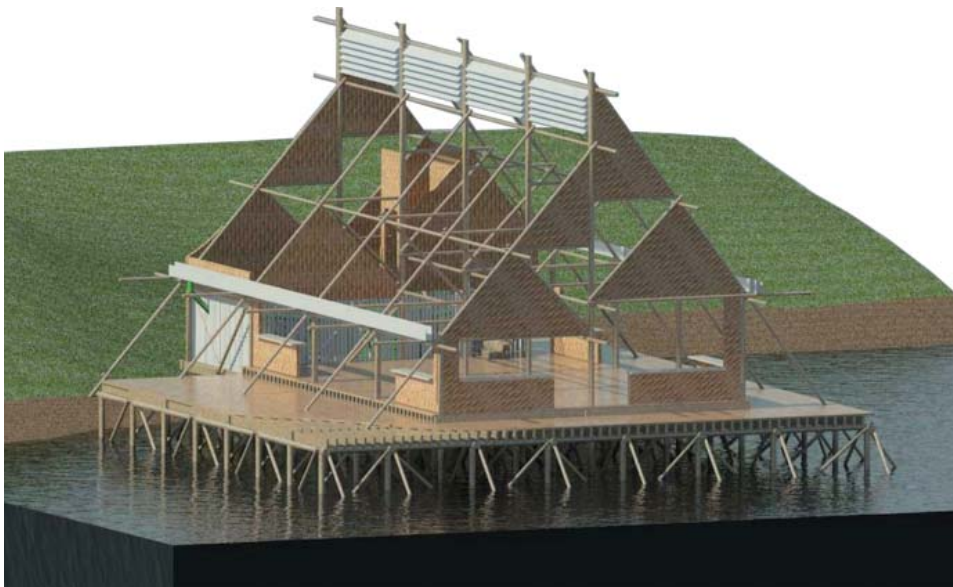
Structural analysis diagram



Piling



Structural frame work and flooring



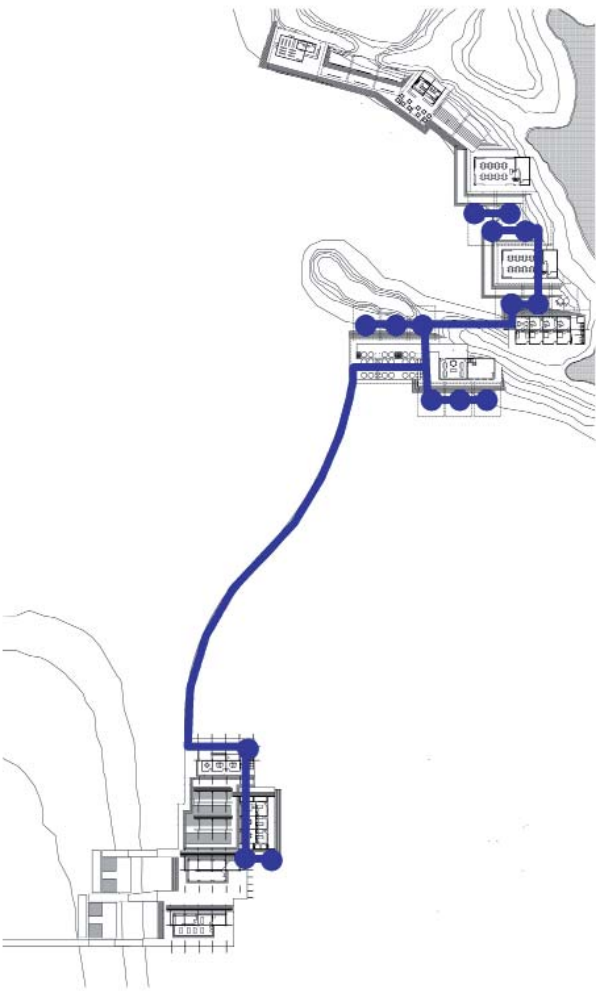
Reed walling



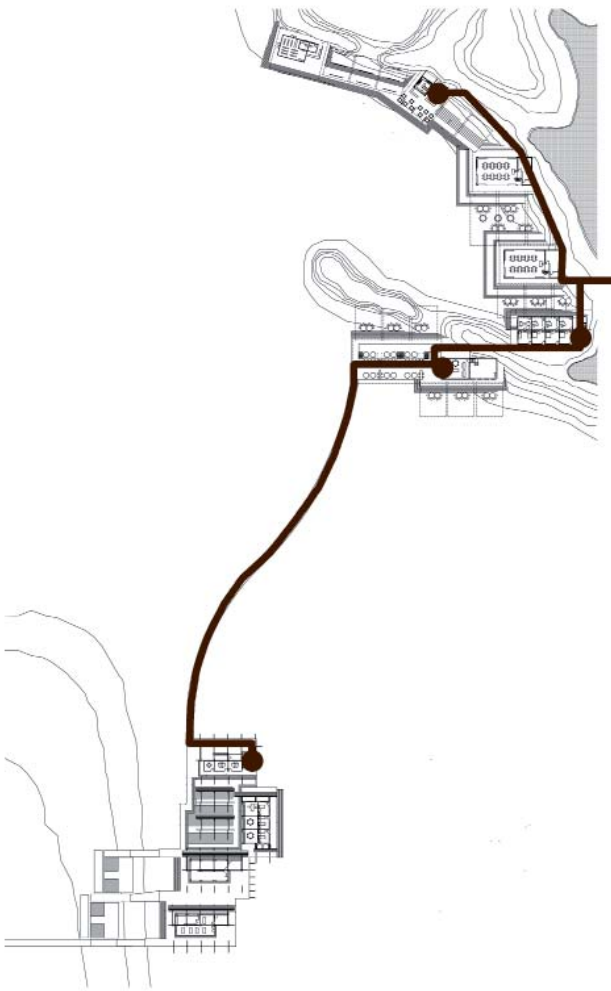
Roofing



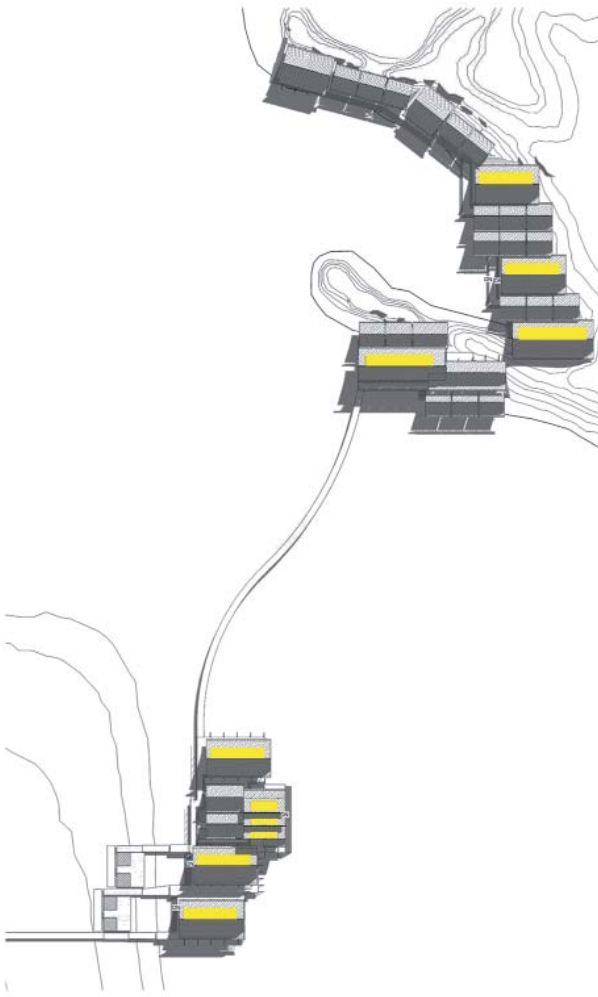
Services



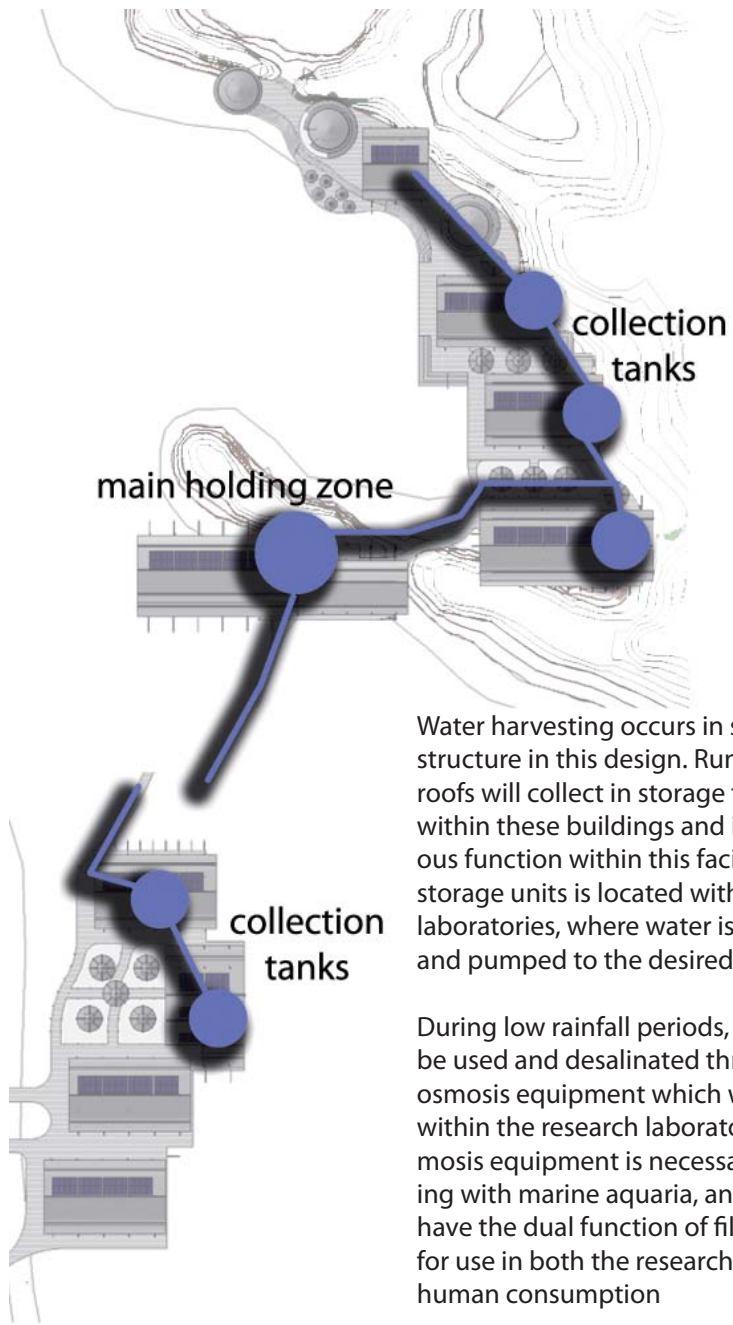
Water harvesting



Sewage treatment



Solar energy



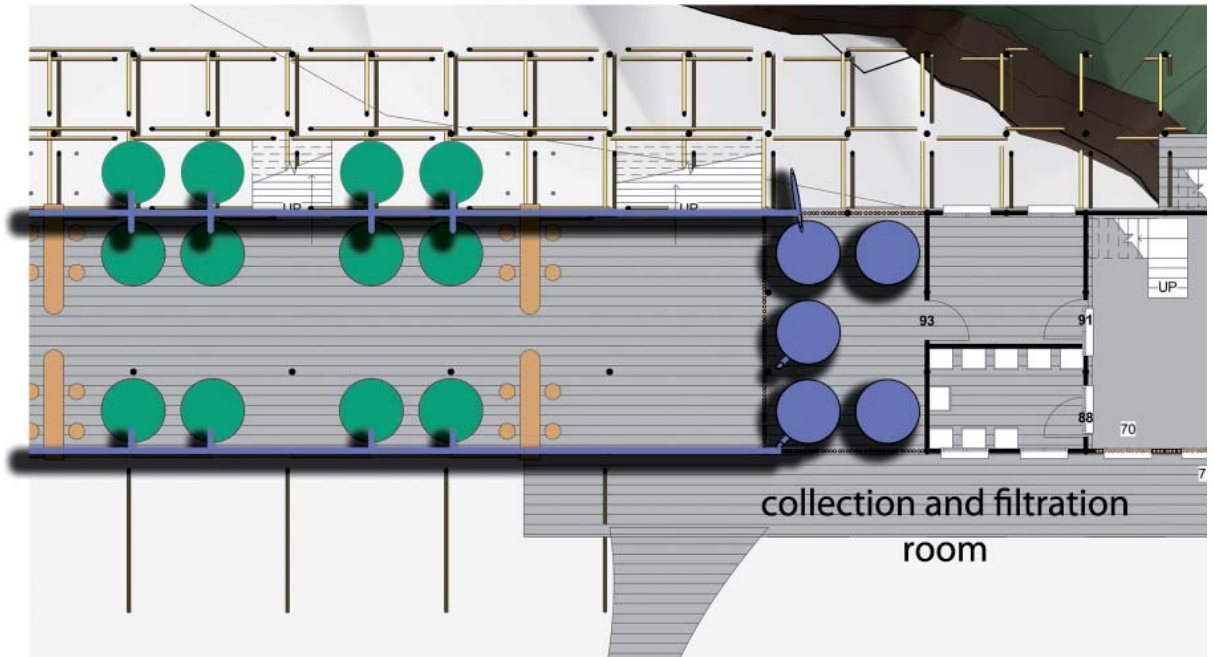
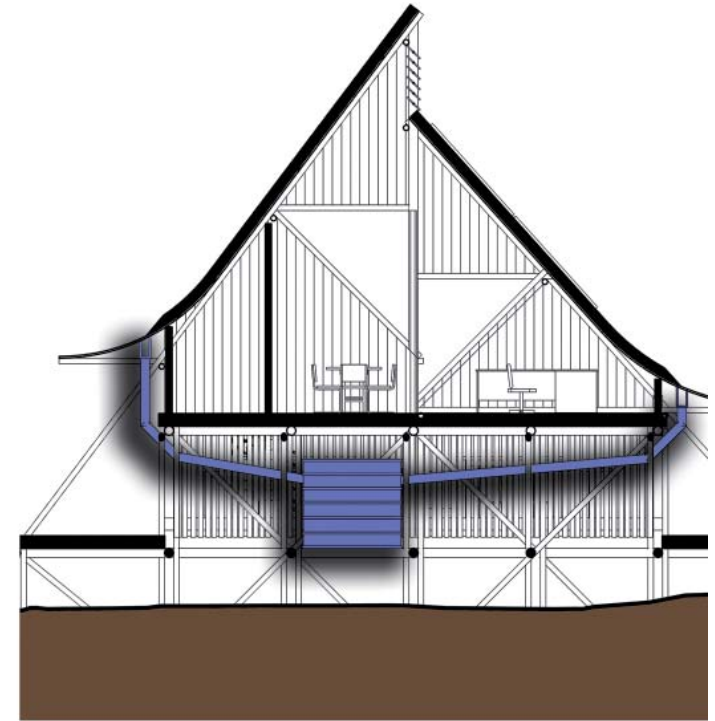
Water harvesting occurs in six of the main structure in this design. Runoff from the roofs will collect in storage tanks located within these buildings and is used for various function within this facility. The main storage units is located within the research laboratories, where water is stored, filtered and pumped to the desired amenities.

During low rainfall periods, salt water can be used and desalinated through reverse osmosis equipment which will be available within the research laboratory. Reverse osmosis equipment is necessary when dealing with marine aquaria, and can therefore have the dual function of filtering sea water for use in both the research aquaria and human consumption

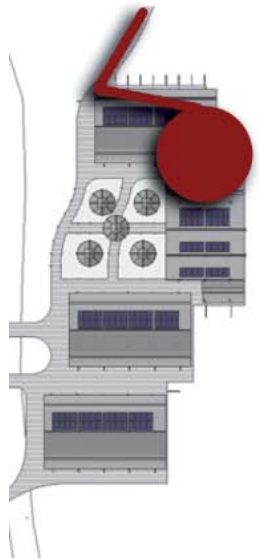
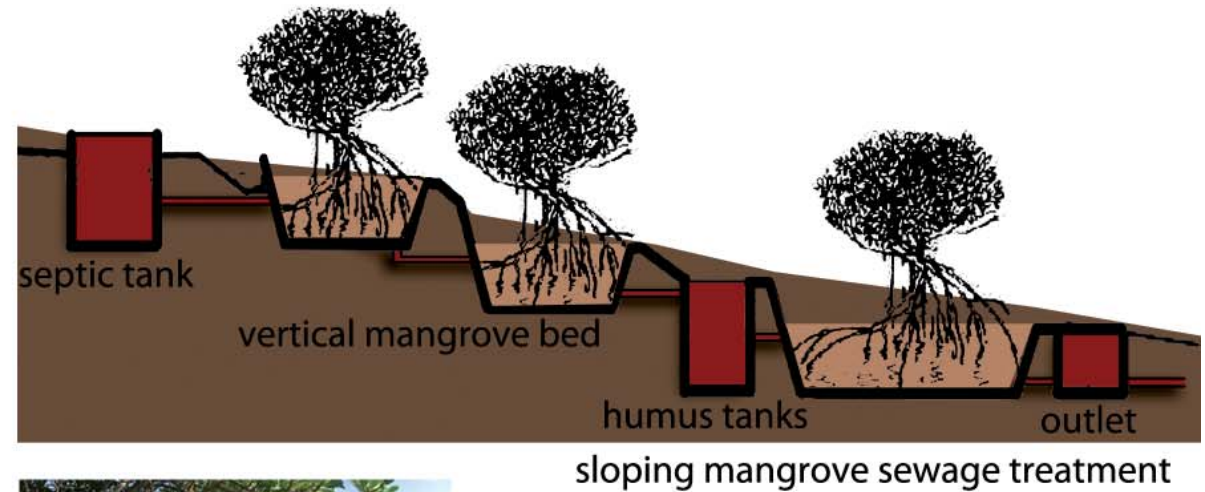
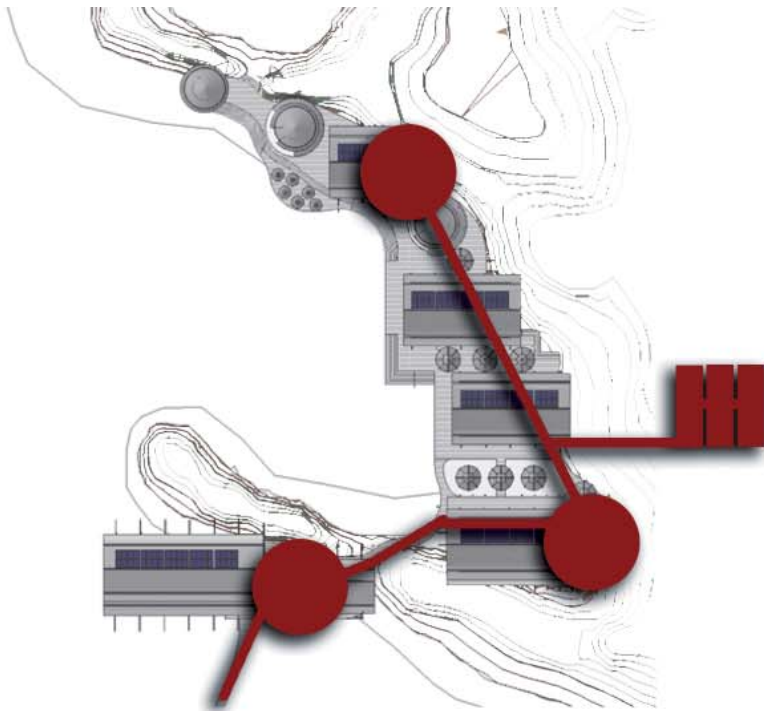
Water harvesting



reverse osmosis system

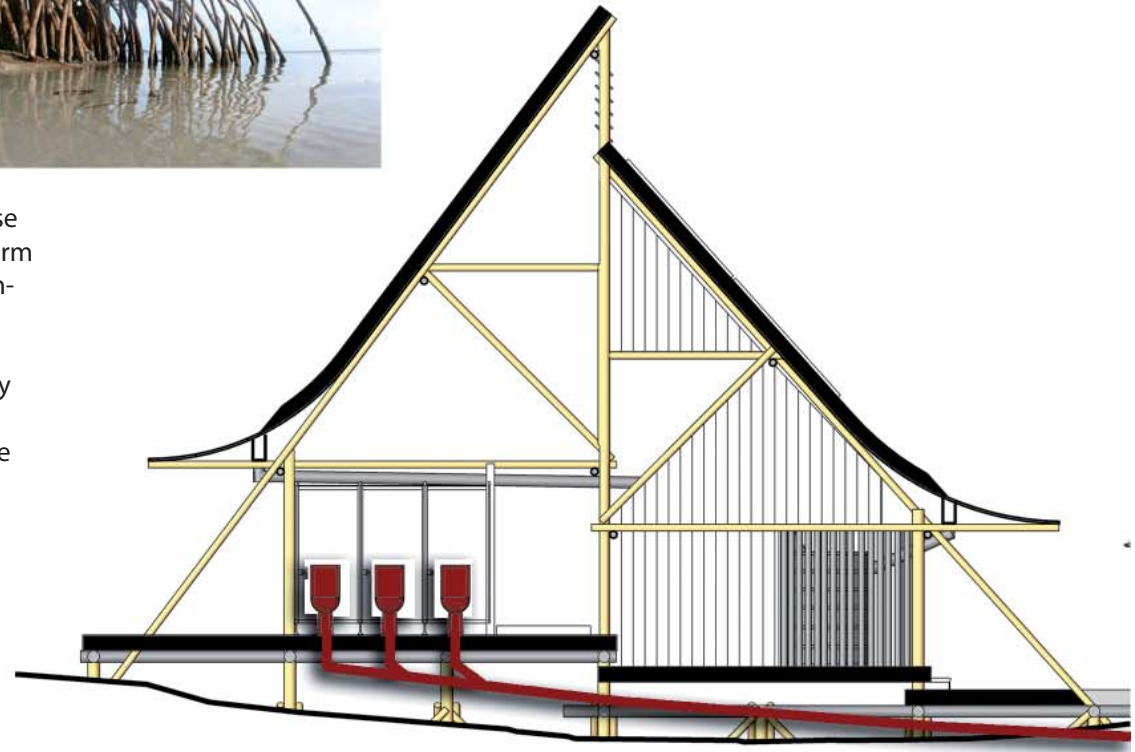


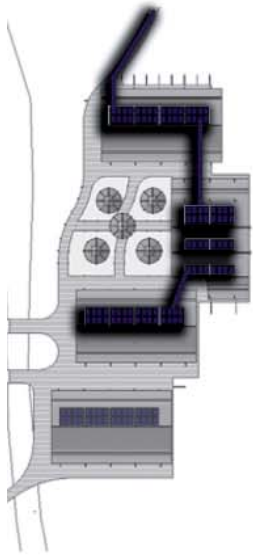
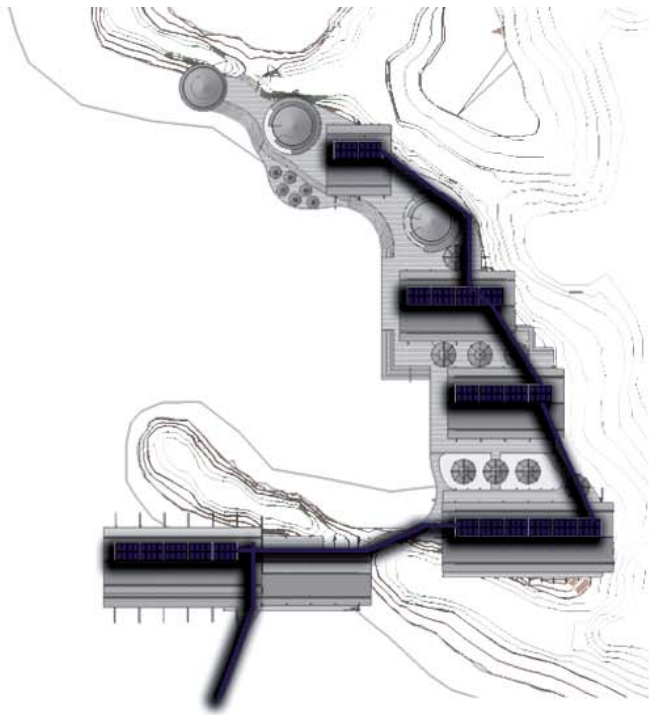
collection and filtration room



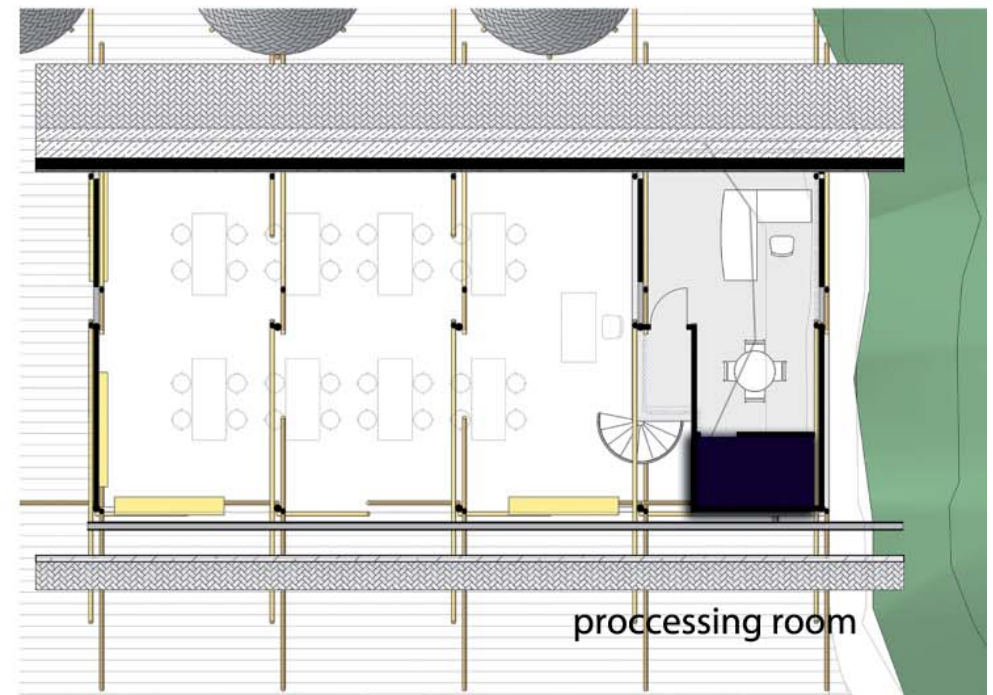
The issue of sewage can be addressed through the use of 'Mangrove sewage treatment' technologies. This form of sewage treatment is beginning to be used throughout this region because of the unique accessibility to vegetation like mangrove and reed plantation. This method is both a sustainable and ecologically friendly method, and forms a functional symbiotic system benefiting both the architectural intervention and the surrounding environment.

Sewage treatment





Because of the intense climatic conditions of the site, solar energy is an ideal solution to the issue of electricity and power. As the main structure of this facility all face north, solar panels will be fitted on all north facing roofs. Storage and dissolution plants will be located within each structure and will provide the energy needed to sustain such a facility.



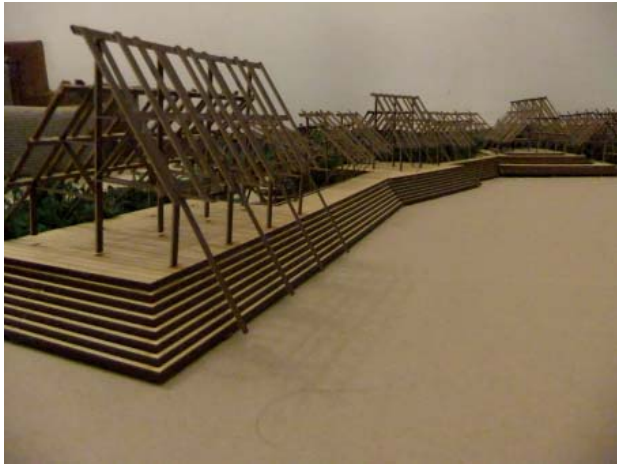
Solar energy



model











An aerial photograph of a river delta, showing a complex network of channels and distributaries. The image has a green tint, possibly representing vegetation or water quality. The word "Bibliography" is overlaid in white text.

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Interviews

Dr. Andrea Marshall (director of The Manta Ray & Whale Shark Research Centre)

Dr. Simon Pierce (researcher at The Manta Ray & Whale Shark Research Centre)

Alex (local villager, Ponto da Barra)

Maxwell (head master of Scola Primaria Completa de Conguiana, Ponto da Barra)

Liezel Te Blanche (diving instructor, Palm grove lodge)

