



Fertile Grain

Agricultural Research &
Educational facility

Gerhard de Kock

fertile grain

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Agricultural Research and Educational facility
The attempt to reconnect the dense urban fabric with the derelict fertile
pocket of land

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Pretoria, South Africa

Project Summary

Agricultural Research and Educational facility

Old telecommunication tower site, Transmitter station
Chumbuni
Urban West Zanzibar
Zanzibar
6° 08'54"S . 39°12'55.3"E

Environmental Potential & Urban Landscapes

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This dissertation forms the Architectural component of a combined proposal and critique on a framework proposed by the Department of Urban Planning and Villages for the Chumbuni area in Zanzibar. (Urban Landscape Laboratory forms the Landscape Architectural component).

a Special thanks to:

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_And to my dear friends and family, I thank you for all your inspiration and support

To my parents Netta and Gerhard.

Abstract

In 2007, incentives for farmers to grow non-food bio fuel crops, increasing transportation costs, climate change, growing consumer demand and population growth caused major food shortages in the world, especially within the high famine-risk sub-Saharan Africa.

The inconsistent food cultivated products in Zanzibar combined with high consumer prices suppresses the economic growth of the agricultural sector on the island.

The large decrease in what once was the primary economical driver (Agriculture) left the Island only to rely on the tourism sector to enhance the economics of Zanzibar.

If a successful strategy is implemented within the agricultural sector of Zanzibar, the country could revert toward becoming, once again, a place of agricultural richness. This dissertation proposes an Agricultural research and educational facility to act as a catalyst for agricultural reintegration.

The agricultural history of Zanzibar and its future potential became the underlining subject of the research and development framework proposed for the Chumbuni area.

The site location and the programme will function as an incubator for local small industries, local farming and micro industries that will directly assist with increasing food security on the island.

The Agricultural research and educational facility is therefore to become a structure that houses a number of beneficial programmes (focused on an educational and symbiotic relationship between industry and public). Public-funding driven cycles of basic education, agricultural education, physical practice and research thus have a platform to influence and be influenced by industry.

Samevatting

In 2007, was aansporings vir boere gemaak om nie-voedsel biobrandstof gewasse te groei, die verhoging van vervoer koste, klimaatsverandering, toenemende verbruikers aanvraag en bevolkingsgroei het groot voedseltekorte in die wêreld veroorsaak, veral in die 'hoë hongersnood risiko' area van sub-Sahara Afrika.

Teenstrydige kos produkte in Zanzibar en hoë verbruikerspryse onderdruk die ekonomiese groei van die landbousektor op die eiland.

Die groot afname in Landbou (vroër bekend as die primêre ekonomiese bestuurder) het veroorsaak dat die eiland staatmaak op die toerisme-sektor vir die groei van hul ekonomie. As 'n suksesvolle strategie is in die landbousektor van Zanzibar geïmplementeer word, kan die land terugkeer na sy status as 'n plek van landbou rykdom. 'n Landbou- navorsing en opvoedkundige fasiliteit wat dien as 'n katalisator vir landbou her-integrasie, word in hierdie skripsie voor gestel.

Die geskiedenis en toekomstige potensiaal van Zanzibar se landbou is die deurlopende onderwerp wat die navorsing en ontwikkelings raamwerk ondersteun (voorgestelde raamwerk in vir die Chumbuni gebied).

Die terein, ligging en die projek program dien as 'n broeikas vir plaaslike klein nywerhede, boerderye en mikro industrieë wat bydrae kan lewer aan die eiland se ekonomie terwyl dit sorg vir voedselsekureiteit.

Die Landbou navorsing en opvoedkundige fasiliteit kan daarom beskryf word as 'n struktuur wat 'n aantal voordelige programme huisves met die fokus om 'n opvoedkundige en simbiotiese verhouding tussen die bedryf en die publiek te koester. Siklusse gedrewe deur openbare befondsing (soos basiese onderwys, opleiding in landbou, boerdery en navorsing), het dus 'n platform om die industrie te beïnvloed en is ook beïnvloedbaar deur die industrie.

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Agricultural research and educational facility

Introduction [01]

01_Introduction

01_01_Problem statement

There exists a void in the fabric of the Chumbuni landscape. Alongside the N'gambo River, the dense, opaque chaos of crowded dwellings, pungent places, cuisine, people and realities, there is a void. The void was once filled with secrets, fabrics, officials and space. Now it exists as a hole in the tapestry of the township surrounding it, and holds the potential to speak affirmative influence into the lives and livelihoods of the communities over which it has been silent since the 1960's (Siravo, 1996:26).

Around the site, urban development continues to spread within the peripheries of the renowned heritage city of Zanzibar, Stone Town. The city has reached a fluid saturation point, and subsequently urban migration has decreased within the capital city of Zanzibar, rapidly increasing in favour of the development of informal settlements and haphazard urban expansion to the east and north of the N'gambo's flood. Poverty, lack of resources and the profusion of urban migration continue to play an integral role in the narrative of this vibrant third world country. In the past, over fifty percent of Zanzibar's economic turnover was generated by agricultural practises and exports (Karume, 2009:2-3); the fertile soil and tropical climate provide abundant opportunity for agricultural activity. In the late 20th century, the diminished clove production in Zanzibar (Sheriff, 1987:251) heralded the beginning of the slow decline of the thriving agricultural industry. In the present day Zanzibar, the major economic driver is tourism – agricultural exports

have faded and dwindled to a subsistence trade. The halt of productive agriculture in the 1990's had a significant impact on the socio-economic structure of Zanzibar, leaving in its wake a trail of economic inertia. 'Industrial' areas toward the north such as Mtoni Palace, mattress industries, textile industries and a number of plastic factories (Siravo, 1996:8) collapsed and labour opportunities became scarce, resulting in rapid informal urban development closer to the economical hub of Stone Town.

There is little discernible architectural typology within the informal settlements to the north and east of Stone Town; here, open public space is something of a myth and an unnecessary luxury to inhabitants attempting to eke out a living in the teeming crush of humanity. N'gambo, Chumbuni and Mtoni sorely lack adequate infrastructure and services, as well as sufficient public space. These are contributing factors to the distinct schizophrenic sense of place, in stark contrast to the rich cultural heritage of Zanzibar. A further schism is evident in the inability of the national infrastructure to provide the basic necessities for its population in areas that are not supported by the tourist industry. The overpopulation of Stone Town and its surrounding districts pressurise the already poor infrastructure of the country's economic flagship; therefore food security, employment rates, waste and water management became some of the most pressing issues within the region (Siravo, 1996:10-11). This thesis seeks

to introduce a blueprint for change, not only to the urban fabric, but to the lives, livelihoods and paradigms of the people of Stone Town, N'gambo, Chumbuni and Toni. The architectural intervention addresses the above-mentioned issues within a framework of built environment development, community initiative, education and environmental industry revitalisation.

01_02_The Question:

How can a dense informal settlement bordering on the void of the project site benefit from a new architectural and landscape architectural typology that attempts to breach the disconnections in space, history, social circumstance, economic systems and human interactions?

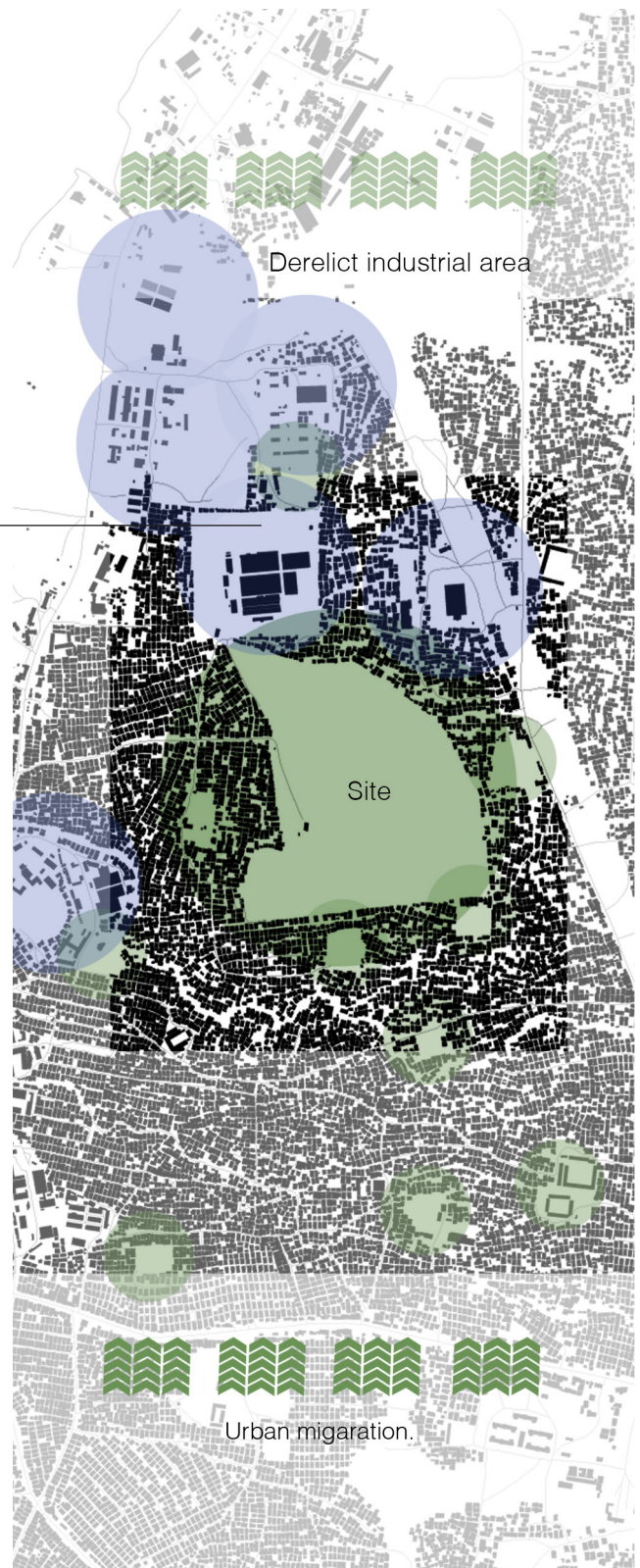


fig. 01.01_Urban migration from rural areas to the economical hub of Zanzibar, Stone Town & industrial Parks to the north with dense urban fabric surrounding the site.

01_03_Hypothesis

Zanzibar's vision for 2020 (Zanzibar. Ministry of Finance and Economic Affairs, United Nations Development Programme, 2002:9) is to shift toward a more sustainable paradigm, to become a country that is capable of supporting their economy on every market level, and address their environmental and spatial challenges with locally viable solutions. Infrastructure design and development is paramount in this endeavour. Pollution and waste management and essential services such as the provision of water and power are key entities which must support the infrastructural amenities, including the industries, on which this thesis focuses – the food and agricultural industry of Zanzibar.

The proposed architectural intervention of this thesis therefore attempts to introduce a system of integrated strategies and facilities to address poverty, food security and resource management, whilst introducing a new typology that facilitates the revival of a cohesive, integrated and self-sustainable culture.

From the infancy of this scheme, the architectural component has been explored in careful synchronisation with the landscape architectural component. This has created a projected situation with a certain resilience in which the systems here proposed are envisioned to operate, facilitate and educate. This collaboration has resulted in a site-wide responsive network that can connect the dense fabric of the urban surroundings with the immediate open spaces, voids and derelict

industrial areas, much like veins bringing life and animation to the proposed architectural interventions of both architect and landscape architect.

The sensitive treatment of the edge conditions become the luminal space that, in reality, will determine the success of the proposed intervention relating to the surrounding social and urban dynamics.



fig. 01.02_Green inspirational urban city farm.



fig. 01.04_Ground fertility.



fig. 01.03_An Analytic Synopsis Industrial Agriculture.



fig. 01.06_Images of urban & natural threshold treatments.

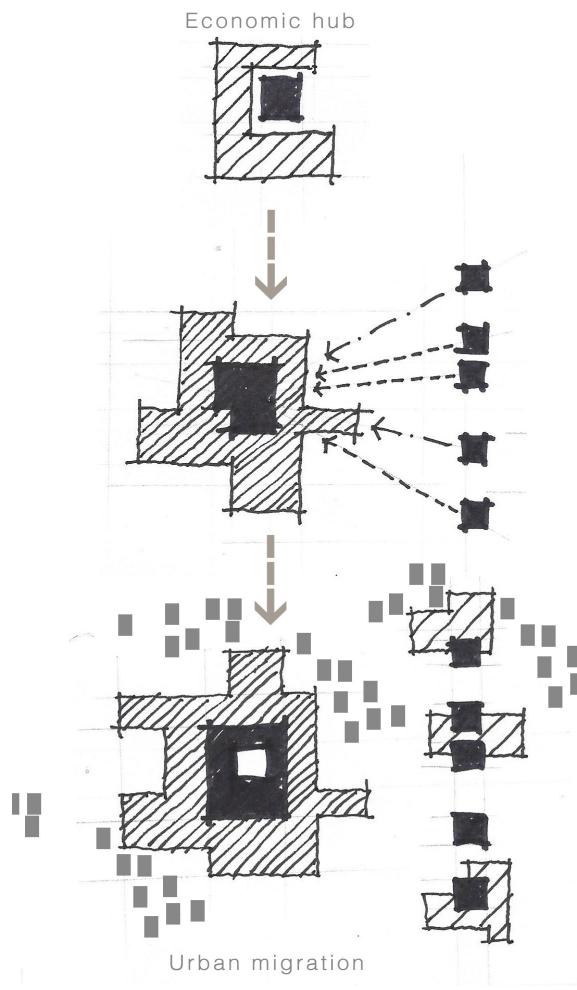


fig. 01.05_Urban analysis and sprawl diagram.

The design is envisioned to re-introduce industrial areas in permutation with productive landscapes on the periphery of Stone Town, this whilst integrating an improved architectural approach to enable an association between the tourist-driven capital and the existing urban reality surrounding it. As this intervention seeks to answer to the larger challenge of reviving the industrial activity of Zanzibar (and utilise the resources that allowed the country to depend on export in the past), the project should be seen as a blueprint for accomplishing the same ideals in other places. As part of this activity, the question must be asked: What are the future possibilities for industries in Zanzibar and how can existing decommissioned industrial sites be reused?

- Is it viable to propose a productive system of this nature within the dense urban fabric of N'gambo, Chumbuni and Toni?

- How will the relationship between the community and the proposed industry manifest?

- How will productive industry on the (now void) fertile pocket influence the local communities and economy?

- How can the architectural intervention integrate the context, allowing the existing spaces and structures to influence the production process?



01_04_Objective

The **primary objective** of this dissertation is to explore and investigate the possible influence of architecture and landscape architecture on urban public spaces within the context of Zanzibar, Chumbuni. These spaces have the potential to create possible spatial resolutions by addressing not only the thresholds and architectural interventions, but also the establishment of a self-sustaining principle that will allow the area in its context to function as a productive machine.

Secondary objectives include the consideration of strategies in which the (now void) fertile land situated within the arms of the dense Chumbuni area will foster the integration of multi-programmes that will consider and respond to the context, economy, traditions, cultures and the community. It is envisioned that an urban park with recreational spaces and a conference centre will be able to sustain itself with both human and resource capital, heretofore unused.

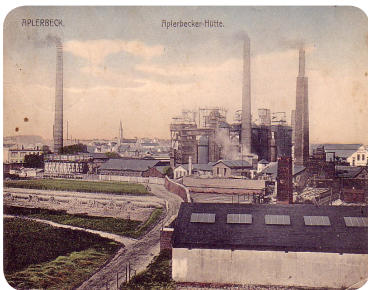


fig. 01.08_Industrial revolution.



fig. 01.09_Industrial & economical growth.



fig. 01.10_Intense Agriculture in Kansas.

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Zanzibar [02]

02_ Zanzibar

02_01_History of Zanzibar.



Historical events in Zanzibar have resulted in a rich palimpsest, first instigated by island trade becoming a means for cultural and commodity transfer. Merchants voyaging across the African great lakes almost 20 000 years ago, fostered trade links between emerging civilisations, a precursor of our current global trade practises (Sheriff, 1987).

The archipelago off the East African coast did not, however, present an excess of valuable products. Unguja (the largest and most populated island associated with the early Zanzibar) offered only a viable port that established a destination for trade activity, the opportunity for development as well as human settlements that could support the import and export of goods. Trade therefore tended toward the mainland, where corridors of safe passage ushered ore, refined cargo and other commodities from landlocked territories, rich in resources. A number of politically distinct periods came and went in the narrative that leads to the chapter of the present-day Zanzibar. These include: the initial domination by the Omans and Yemenis; the involvement in the conquest of German East Africa; the advent of the Maj Maji rebellion; the colonisation by the British regime, and finally the 1970's Independence Revolution (Clayton, 1981:98).

These phases of development are traceable in the eclecticism of the cultural paradigm of contemporary Zanzibar, manifesting in the social fabric in the practise of various religions, to the linguistics of the region, to the symbols and motifs of local architecture.

Zanzibar monopolised three pillars of economy in the early 1700s, namely:

- [1] commodity trade and cash crops;
- [2] trade of ivory from the mainland territory of Tanganyika (Tanzania); and
- [3] slave trade.



fig. 02.01_Panorama of Zanzibar, 1902.



fig. 02.02_Fruit Market in Zanzibar.

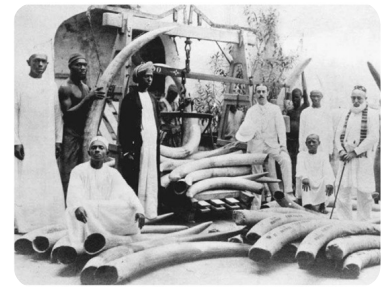


fig. 02.03_Ivory trade in Zanzibar.



fig. 02.04_Clove bags for trade.



fig. 02.05_Drying cloves Zanzibar.

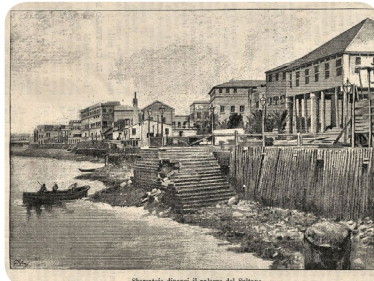


fig. 02.06_Palazzo del Sultano, harbour,
c1885.

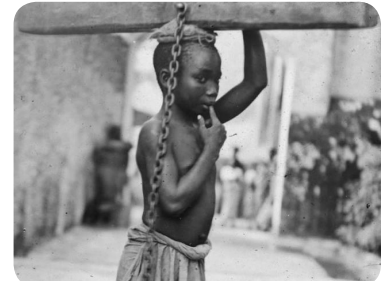


fig. 02.07_Slave boy punished in Zanzibar.

After Zanzibar fell under the sway of the Sultanate of Oman in 1689, environmental resources were managed and developed by an elite caste of Arabs who established the foundation of the cash crop trade in the form of spice-producing plantations. The Bantu population formed the workforce that serviced the plantations, and the benefits of revenue were reserved for the Arab landlords.

Although Zanzibar was well-known for its spice industry, it also drew attention to itself on a global scale for its proliferation of a burgeoning slave trade. Although the region enjoyed the exploits of this lucrative business until the early 1900s, the British banned slaving from 1913, allowing other industries to thrive until independence was granted to Zanzibar in 1963 (Sheriff, 1987:14).

Arab rule established an empire of clove trade through the development of plantations in the mid 1900s, the success of which were greatly assisted by the practise of slavery. By then, the sultans of Oman controlled a large portion of the African Great Lakes district, also known as the Zanj, stretching along the length of the east coast of Africa (Sheriff, 1987:21). Being known for its well established trade routes and bartering connections with other countries, this region fell prey to a series of foreign colonial schemes during the late 1900s, including those of Germany, Britain and Italy (Sheriff, 1987:23-25).

During the short-lived independence period, 1963 – 1964 (Harold, 1967:43-45), the sultans were overthrown after decades of oppression. The birth of nationalism in Zanzibar (after post-independence elections proved ineffectual in defeating Arab rule) created fertile soil in which the Ugandan citizen John Okello, supported by various united African political factions, staged a bloody military coup, thus preparing the way for the birth of the People's Republic of Zanzibar. It is during this period that genocide of 5 000 to 12 000 Arabs and Indian civilians occurred (Harold, 1967:45-46).

It is against the backdrop of this volatile history that the current tourist-driven economy struts its hour upon the stage. The neglect of the production and export industry has been targeted by the present government as a priority issue, this dissertation being a product of the attempt to engage in economic practises which have been lucrative in the past.

02_02_A overview of trade and industry in Zanzibar.



fig. 02.08_European, Arab and South Asian designs blended to form Zanzibar's distinctive architecture. Restored Old dispensary. 12th century mosque in Kizimkazi for Persian traders. Mosque door. Old dispensary balcony shows South asian influences.

In 2004/2005, a household budget survey considered Zanzibar to be one of the poorest countries in the world with 49% of its population of 1 303 500 (2012 Population and housing Census, National Bureau of Statistics Dar es Salaam, 2013:1) living below the basic needs poverty line of 40 000 tsh per 28 days (Omar and Kessy, 2014:5).

New surveys released in 2010, reveal that the situation remains unchanged, with only slight improvement in marginal sectors. The government of Zanzibar aims to improve the welfare of Zanzibaris by implementing strategies to increase annual income figures, by meeting ignorance with education and addressing the issue of disease on a national scale. Through improving the welfare of the people, the government of Zanzibar hopes to foster a sense of belonging and solidarity amongst the population, with the intention to encourage productivity and the expansion of the small business sector. Despite the concentration of government spending on tourist-related development, there has been an alarming decline in this sector of industry between 2005 and 2010 (Omar and Kessy, 2014:7-9).

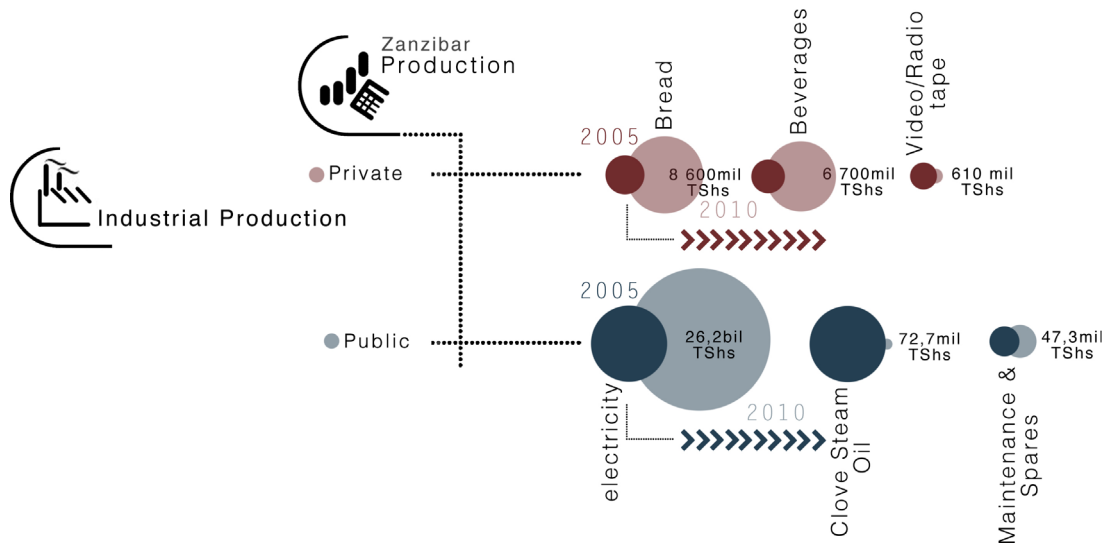


fig. 02.09_Zanzibar's Private and Public Production sector.

The government's secondary strategy is to prioritise the revitalisation of the agricultural industry. The Minister for Agriculture and Natural Resources, Mr. Suleiman Othman Nyanga, holds that agriculture still plays an important role in the development of Zanzibar (Omar and Kessy, 2014:10-14). His statement declares that crop production and husbandry contributes 33% of the total GDP (Gross Domestic Product), promotes food security and provides the country with job creation opportunities.

Zanzibar's government legalised foreign exchange bureaus on the island before Tanzania moved to do so. The aim was to increase the availability of consumer commodities. This allowed the government to establish a free port area which provided a number of benefits to the economy:

- Administration of a regime that imports
- Warehouse general merchandise, exports
- A lift in economic diversification through the free trade system that also allow for better support services
- Well-established storage facilities to improve the trading sector
- Creation of an efficient trading management.

These benefits presented the country with an opportunity to broaden their trading sector. However, most of these industries failed to exist as the manufacturing sector greatly focuses on the tourism sector.

The revolutionary government of Zanzibar closed the doors for local citizens wishing to pursue trading opportunities with the rest of the world. The local citizens of Zanzibar fought against the closure of trading and launched a number of micro industries that produced consumer goods such as shoes, household items, soaps and oils, cigarettes and spirits. None of these micro industries survived the economic downturns. The government was burdened with thousands of Zanzibaris without work (Scholz, 2008).

If a successful strategy is implemented within the agricultural sector of Zanzibar, it is evident that a number of problems can be dealt with and the country could shift toward becoming, once again, a place of agricultural richness, which might foster a symbiotic relationship with the tourism component of Zanzibar's economy.



fig. 02.10_Bwejuu seaweed farming, Zanzibar.



fig. 02.11_Cloves are dried on mats in the sun.



fig. 02.14_Forestry and Agricultural fields in Zanzibar.

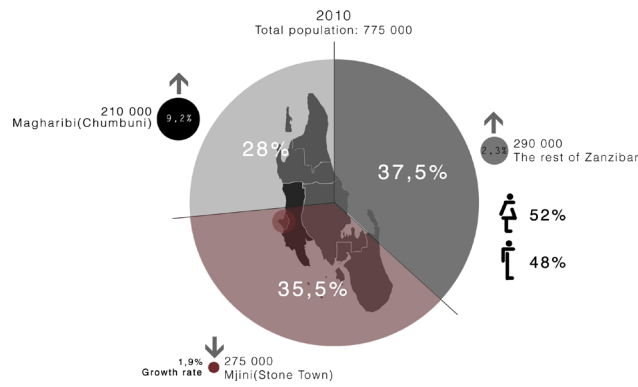


fig. 02.12_Population Growth in Zanzibar.

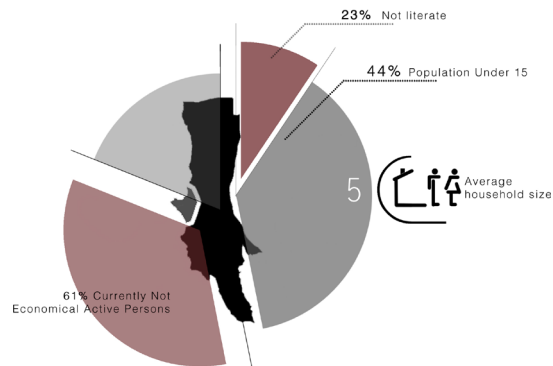


fig. 02.13_Magharibi (Chumbuni).



02_03_Project location.

The informal settlement of Chumbuni that surrounds the site, currently a dilapidated industrial district complete with derelict infrastructure and abandoned telecommunication tower, was reserved (in earlier modern framework development master plans of Zanzibar) only for the development of industrial activity (Department of Urban planning and villages, 2011:4). After the collapse of most export-producing industries in the district, these spaces became un-programmed and offered a place for residential establishment close to the economic capital, Stone Town.

The settlement expanded to the eastern and northern peripheries of the area. The intended 'industrial park', stretching from Mtoni to the N'gambo River, currently houses sprawling informal settlements and derelict structures within vast open spaces bounded by impenetrable concrete walls.

The author believes that the potential of the site lies in the re-use of the derelict warehouses and factories, to realise their potential of forming the skeleton for the revitalisation of the flesh of the remaining spaces on the site to form an integrated hub of activity.

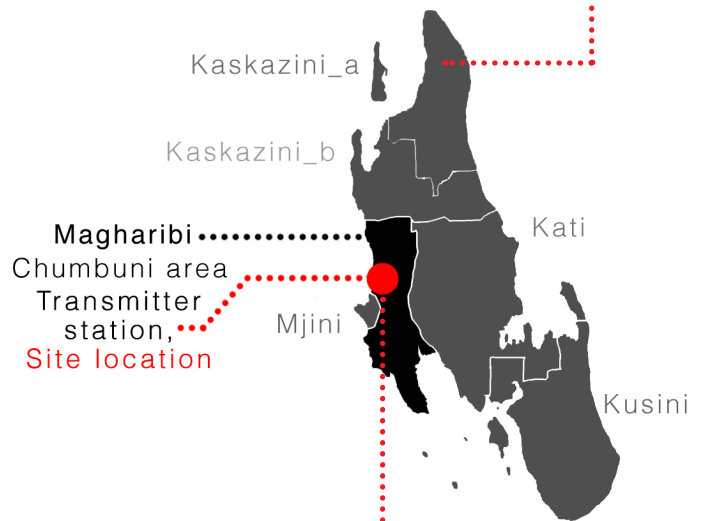


fig. 02.15_Map of Zanzibar by Districts



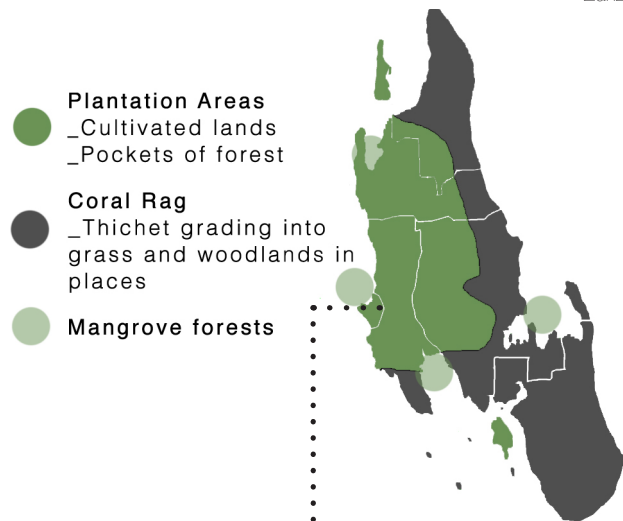


fig. 02.16_Cultivated vegetation on the Island.

02_04_Context of Chumbuni.

Chumbuni is situated 3 km to the north east of Zanzibar's capital, Stone Town. It is an extension of the informal settlement across the Ng'ambo River. The site, once a government-protected telecommunication facility, is surrounded by a large fence that separated the government property from the encroaching informal settlements in Zanzibar and protected the tower (previously used by the government during the revolution to broadcast propaganda (Department of Urban planning and villages, 2011:2-3)). Currently the site is vacant and is only used by small local farmers for the production of fresh produce due to the fertile conditions of the soil.

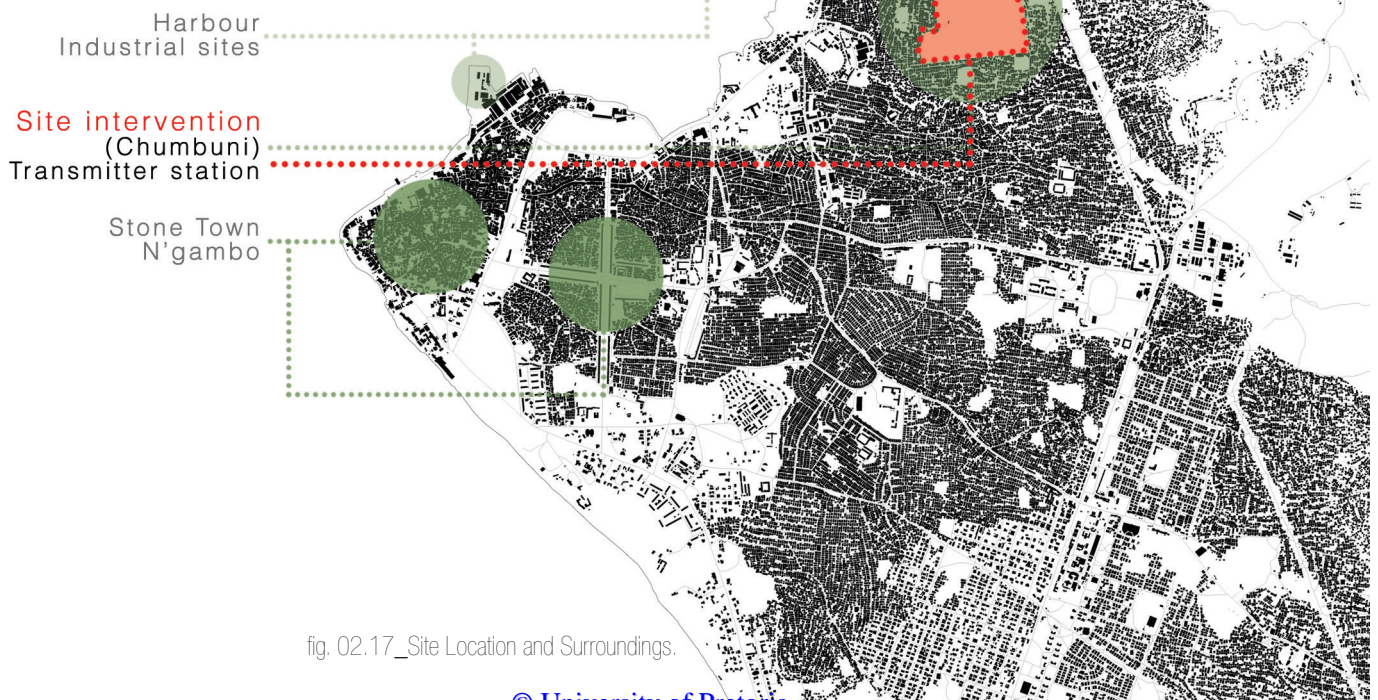


fig. 02.17_Site Location and Surroundings.



EXPORTS_[FOOD SECURITY]

 Urban vision & uplifting of
 the community
 integration & participation


02_05_History of Chumbuni.

In August 2011, the Department of Urban Planning and Village Layout received a directive from the ministry of Lands, Housing, Water and izhar-AMMN (Department of Urban planning and villages, 2011), to propose new development strategies for the area of Chumbuni. For this project funding is procured by the Zanzibari government and the client takes the form of the Department of Urban and Village Planning in partnership with government. The Town and Urban Regional Planner of Zanzibar, Dr. Mohammed Juma Mohammed, proposed that the site be integrated with the surrounding community and context to remedy the arbitrary setting between two new local informal developments: Vanasifa to the west and Vamejegwa to the East (Department of Urban planning and villages, 2011). These settlements bordering the derelict site, are in dire need of public space as well as basic infrastructure and services, due to the initial lack of infrastructural planning and design.

The Urban Planning Department, as part of the planning and inception process, have listed the positive attributes of the site. The most expedient of these is that the Chumbuni site is slowly becoming a recognisable node in the city that boasts the only available open space for the accommodation of recreational space. This is especially important as it is in close proximity of the airport and harbour.

The Department of Urban and Village Planning proposed that the whole area should be developed as a recreational space for public use. The proposal of the Department will be critiqued and comments follow in the next chapter.

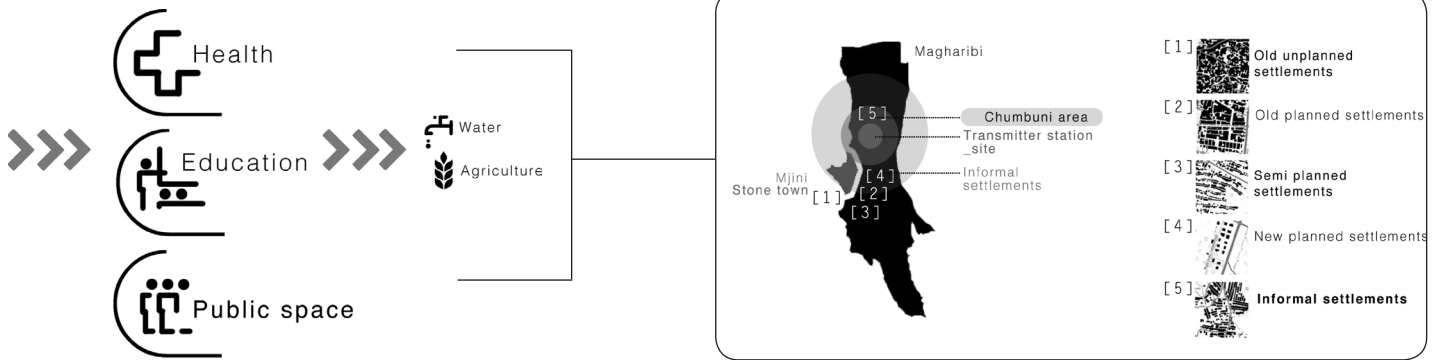


fig. 02.21_Oppurtunities for site Rehabilitation and Reuse diagram in relation with the informal settlement of Chumbuni.

02_01_01_Site specific challenges.

The site in its current state acts as a dividing element between Stone Town and the Chumbuni settlement. Apart from a few local farmers that utilise the fertility of the soil to practise agriculture, the site is also used by the local community to dump waste. For 6 months of the year, locals gain access to the site to dump waste. During the rainy season, the waste conveniently gets washed away to then pollute the southern fresh water rivers and subsequently the ocean.

The main road through the site (orientated north-south) could be beneficial to the integration of site, community, industry and the context. However, access from the west is retarded by poor infrastructure and challenges on- site integration with off-site infrastructure issues. With only two established entrances to the site and poor infrastructure around the site, development opportunities must be carefully weighed against the disruption of residential areas, which could in turn render peaceable public participation difficult.

The Chumbuni site is a prime location to manifest a connection between N'gambo and its neighbouring settlements. However, in its current set of circumstances, the site will remain dormant without an integrated architectural, urban, economic, social and landscape solution.



fig. 02.18_Waste dump on site to the East.



fig. 02.19_Little or none infrastructure for local farmers.



fig. 02.20_Waste disposal site and boundary fence.

02_02_02_Opportunities

The site is already part of an urban development scheme easing the services and basic infrastructure needs (Department of Urban planning and villages, 2011 and Omar and Kessy, 2014). Located alongside the main road connecting the south and the east of the island, it occupies a prime nodal location for development and industrial trade.

The **proposed Architectural Intervention** (an agricultural research, education and industrial facility) will act as a catalyst for immediate and future development. The site location and the programme will function as an incubator for local small industries, local farming and micro industries that will directly assist with

- the resolution of key urban problems in Zanzibar (chapter on urban framework),
- in adding much needed value and vigour to the economic sector, and
- **increasing food security on the island.**

This dissertation will in time introduce a programmatic resolution that, combined with the architectural resolution, aims to provide a resilient precedent (based here within the context of Stone Town, Chumbuni and N'gambo) for architecture to fill the void between diverse conditions, densities and proximities.

Chumbuni is intended to become a production node within the framework of a plethora of events, micro industries and public recreational spaces.

The educational and industrial part of the intervention will assist citizens in the sphere of basic education, as well as the survival skills on how to sustain oneself and one's family through industry. This occurs were the industrial area becomes a supplier of work to the community, and also includes the incorporation of local individuals into the economic management of the initiative. Existing micro industries and small businesses form a mutually sustainable relationship with the public sector that lay the foundation of infrastructure for future development.

Further considerations that the architectural intervention will address:

- The spatial and mental influence that the barrier of the perimeter wall commands, and how this undesirable effect can be reversed;
- The challenge of including the derelict industrial areas to the north in the positive development;
- The potential benefits to the current small time agricultural farmers, and the possibility of including these individuals in establishing a formal system of agriculture;
- The advantages and disadvantages of the development of the Greenfield section of the site;
- The purpose of thresholds between private and public realms.



fig. 02.22_Images of the Fertile soil on the proposed site.

Agricultural research and educational facility

Framework [03]

03__Urban Design

03_01__Chumbuni – A critique

An urban framework for the upliftment and reinvention of the Chumbuni area was submitted to the Ministry of Land Affairs, Housing and Water on the 3rd of September 2011 by the Department of Urban Planning and Villages (represented by Dr Mohammed Mohamed Juma), which also considered the urban spatial redevelopment of the greater Chumbuni district (Anon, 2011:3).

03_01_01__Strategies and results

The spatial development proposal of the Department of Urban Planning and Villages had included research on the basic needs of Zanzibar as a town (general issues) and subsequently focused on the urban issues of the Chumbuni area. The proposal subjected the subject matter to a SWOT analysis, amongst other tools, to determine the nature of the current resource and its potential. An integrated proposal was then presented which sketched a scenario in which Chumbuni is reactivated on many scales, including the utilisation of the derelict piece of land (referred to previously as 'the void') and becomes part of the tourism sector. Programmatic resolutions include:

First Priority_ Infrastructure & Social Services / Socio-cultural facilities:

- Auditorium various activities / Multipurpose hall;
- Community hall or conference hall / Cultural centre or congress centre;
- Garden / Park;
- Parks and Recreation / Playgrounds.

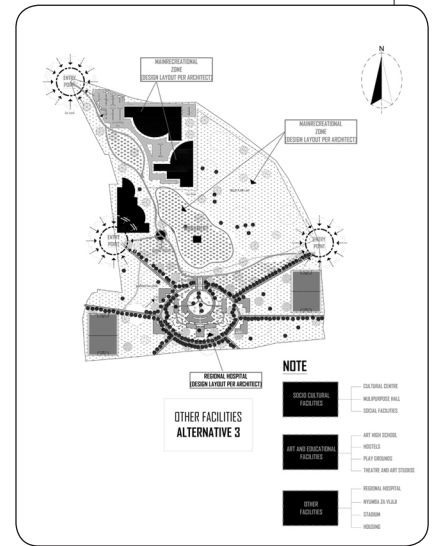
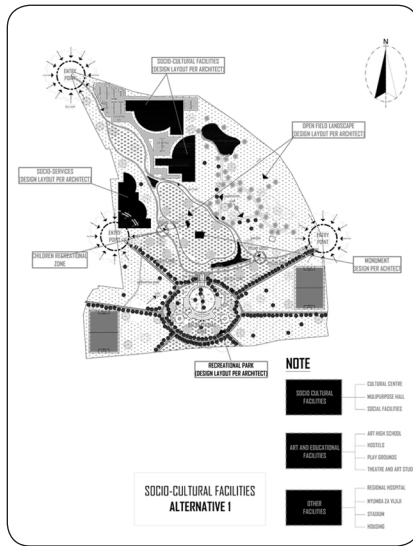
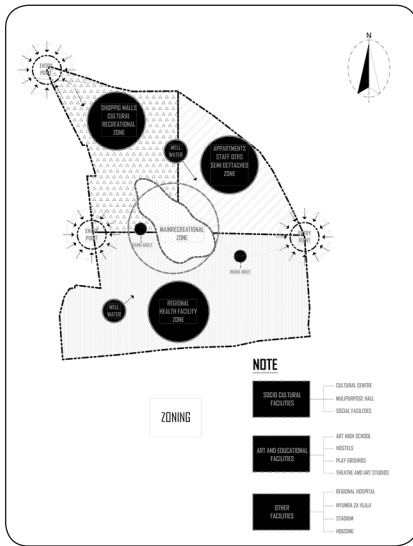
Second Priority_ Ministry of Education, Arts and Drama facilities:

- School of the Art / Art Drama high school;
- Lodging of students / Hostel;
- Gifts Gallery and Library / Art Studio Library.

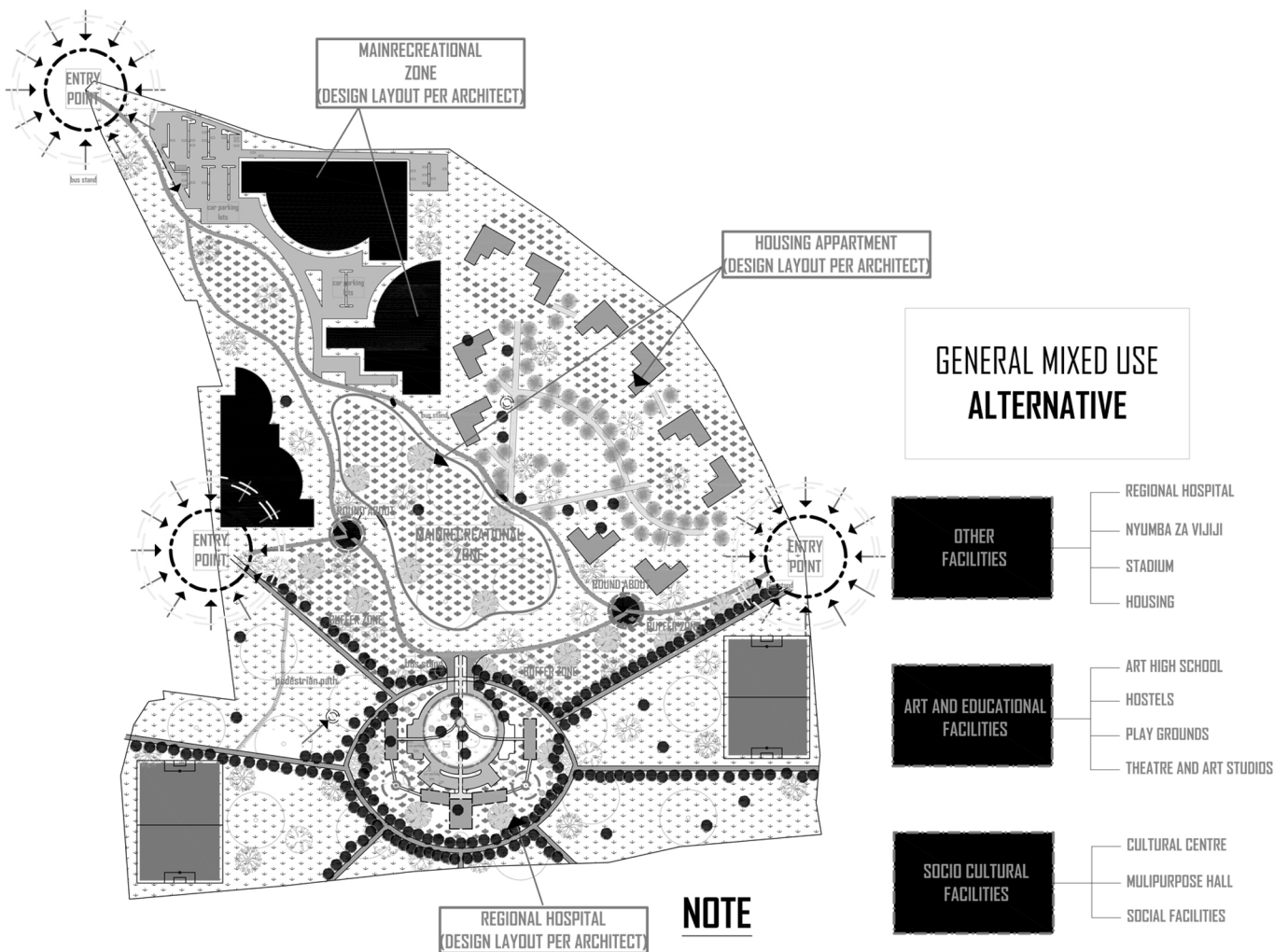
Third Priority_ Ministry of Health facilities:

- Regional Hospital / Regional clinic;
- Houses students of Medicine / Apartment for interns;
- House affairs professionals / Apartment for researchers.

The framework consists of a number of formal nodes surrounding the site as well as those within the site itself. According to the proposal, the existing movement corridors on the western and eastern peripheries of the site need to be re-evaluated along with the spatial relationships between the two. The site will then be able to form a corridor from north to south. The proposal recommends that the use of the majority of the 28 hectares should be recreational.



Proposed Chumbuni re-development - Zonal use



The SWOT analysis conducted on the Chumbuni area revealed the following:

Strengths_

- This is currently the most important, and in fact, the only open piece of land in the city;
- It is easily accessible from the airport, as well as the main port of Zanzibar.

Weaknesses_

- There is a lack of public knowledge of the intervention on the piece of land;
- The area is surrounded by informal settlements which are arbitrary and pose particular and complex socio-economic issues;
- The current infrastructure lacks services that provide fresh water resources; Finances for the use and protection of water are diminutive in this area.

Opportunity_

- To sanction needed services and connect them with existing services in the city;
- To build structures for the use of city dwellers and the country at large, based on the advantageous central locality of the site;
- To establish much-needed play parks and recreational spaces for children and adults;
- To create special infrastructure for the upliftment of civic life such as exhibition and conference halls, art museums, theatres, etc.

Threats_

- The government may opt to use the space internally and the intention to benefit the public might not be achieved;
- Challenges facing the developers are the history of devaluating actions of and disregard for recreational spaces of the local population;
- Non-profitable community investment.

03_01_02_Conclusion.

A number of questions were raised before the Department of Urban Planning and Villages came to a conclusion and proposed a scheme. Some of the questions asked were:

- What are the necessities for Zanzibar Town at present and in the future, for residents and visitors to experience a better quality life?
- What can form a catalyst to the development of the City and its residents for the provision of future prosperity?
- What are the expectations and requirements of a capital city in the 21st century?
- What is needed of Zanzibar to become an internationally recognised and relevant city in East Africa?

Zanzibar Town (Stone Town) and the surrounding towns are in dire need of recreational spaces and public facilities. There is limited space in Stone Town itself (Forodani Gardens is the largest of these and one of very few public parks) (Siravo, 1996:126). According to the SWOT analysis the people of Zanzibar are changing, and thus so are their needs. To render Zanzibar fit for business and tourism it is important to restore its reputation as a place of beauty and order. The town should not only fulfil its role as a tourist destination, but also serve as a focal point for the East African coast through education, art, culture and development of its people. The arts provide one of the most important tools in the tourism-based economy of Zanzibar; The government proposes that art and culture continue to be the catalyst for social and economic development [Cultural Arts Centre Zanzibar, 2013].

The following services were classified as essential:

- Houses of culture
- Games and entertainment facilities
- Lodging of students
- Museum of modern art
- Gardens and parks
- Supermarkets
- Bus stations
- State office buildings
- Residential developments
- Special schools, etc.

The aim of the proposal is thus to increase the economic flow and tourist attraction in the Chumbuni area by cultural and modern art. Dr Juma of the Department of Urban Planning and Villages here suggested that a cultural urban park – a hub for recreation, open spaces, education and activities – should be introduced.

This proposal has been scrutinised, studied and engaged with by both the architectural and the landscape architectural components of this scheme.

Critique of the Department of Urban Planning and Villages proposal of the study area are noted as follows:

- The proposal lacks a hierarchical road network/system for both human and vehicular movement;
- Retail, commerce and manufacturing have been overlooked as possible drivers of the economic engine within the district;
- The opportunities for the development of residential areas have not been explored;
- Social and communal facilities have been omitted from the scheme where these could provide valuable links to the surrounding communities;

- Public transport and connections to surrounding areas can be further explored;

- The possibilities fostered within an integrated open space network have not been considered sufficiently;

- The spatial arrangement of the current proposal can be redesigned to make more economic use of the land;

- The site does not currently connect the surrounding community with the proposed programmes – this can be remedied with basic urban planning principles;

- Indigenous knowledge of the site, basic mapping of environmental factors and existing recourses should form part of the decision-making process and consequently be incorporated into the proposal;

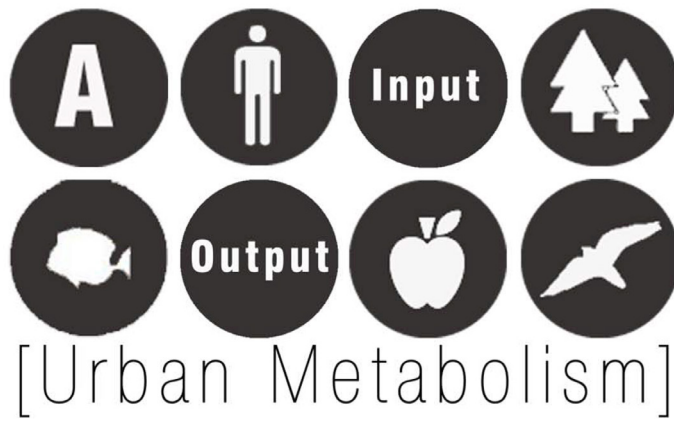
- The proposal does not fully realise and utilise the site's privileged and advantageous position.

The proposal in its entirety tends to disregard the essential connections to the surrounding community. The focus of the research might have presented more accurate results if it were orientated around the needs of the people and not purely on the economic segment of the country. The author feels that a rhetorical question will illustrate the point. The Annual statistics of Zanzibar state that (Zanzibar statistical abstract, 2010, B.3 Education:21-30) 47% of Zanzibaris are illiterate. How will the local people benefit more from a museum for modern art than from an improved basic living environment?

In light of this, the focus should rather be on:

- Creating community centres and economic/ recreational nodes for the upliftment of the local communities;
- Strengthening spatial links and creating a spine between the diverse conditions (so as to integrate the built environment spatially);
- Transform transport interchanges into civic terminals;
- Design public environments that respond to both context and scale of the areas.

This proposal presents a unique opportunity for the Zanzibar government to address some of the pressing issues that confront their population on a daily basis.



'An architectural // landscape architectural mechanism that synchronizes the production of natural variation and man-made regulation.'

03_02_New Proposed Urban Design Strategies;

This dissertation (in close association with the landscape architectural component) proposes an innovative architectural solution for the greater Chumbuni area. This proposal asserts that the development trend will in the near future shift from the sectors on which the Department of Urban Planning and Villages' proposal intends to focus, and will soon be based on a more locally-viable micro-economic and agricultural paradigm in which small businesses become drivers of the economy to match the tourist trade.

The framework for the development will be based on the following interventions:

- Nodes and focal points along a series of spines (adhering to hierarchical layout);
- Programmatic activities along these spines matched carefully to local context and development opportunities through public participation processes;
- Open public spaces in combination with built infrastructure and educational resources.

The aim of the interventions is to:

- Establish clustering, links and consolidation of activities that foster integrated and partnership-based symbiosis;
- Create within the community and its surroundings a significant economical threshold;
- Form a unity of a large district to encourage healthy interpersonal relationships, as well as to aim to heal the relationship between man and the environment;
- Enhance the linkages (horizontal and vertical) through the Chumbuni area, connecting it both north to south (urban to rural) and east to west (harbour to airport).

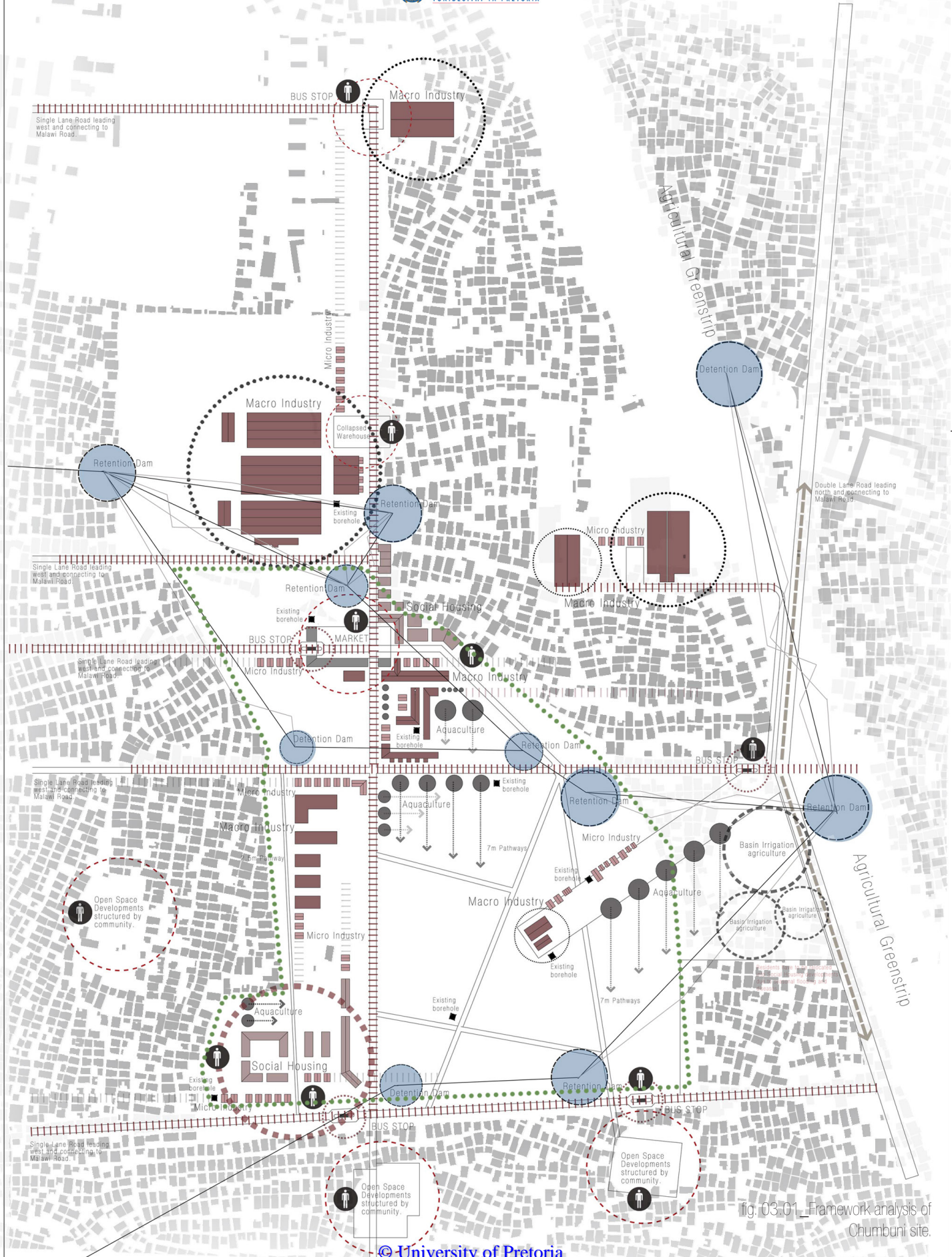


fig. 03.01 Framework analysis of Chumbuni site.

03_03_Framework proposal.

The framework proposal is based on a nodal development system that was established as a result of the research conducted in order to map the site. Special attention was given to main roads and pedestrian linkages, as well as taking careful note of the primary use and other uses of the site at present and in the past. Currently the site is used by a number of local farmers for the propagation of vegetables, namely cassava, mohogo and rice, with smaller quantities of bananas and coconuts (Anon, 2011:5).

The original Chumbuni site is 28 hectares in size and 22 000 mm above sea level (Anon, 2011:2). The new framework proposes to reuse the abandoned industrial area to the north as well as the Greenfield strip to the north east. This will increase the site's size to 75 hectares, allowing for more urban agriculture, aqua- and arboriculture, as discussed later in this proposal.

The proposed framework adds a number of connections to the eastern and western side of the site, linking these east/west roads with the two main roads running from south to north. Established pedestrian routes and desire lines are designated to give access to pedestrians and cyclists only. Permeable boundaries and thresholds are thus established through a once access-restricted site.

As acknowledgement of the heritage value of the site, existing items such as concrete palisades and selected structures will be reused to commemorate that which they once represented. Primary nodes linked by single lane vehicular routes serve as the main activity spines running from the arboriculture area in the north to the southern extremity where agriculture and housing developments are situated.

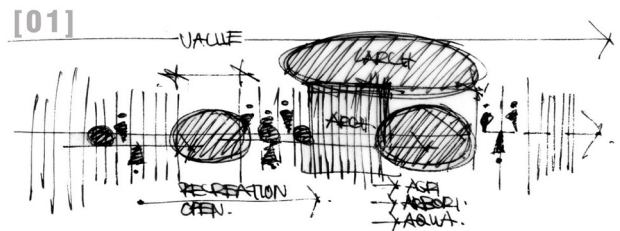


fig. 03.02_Concept development of thresholds and boundaries.

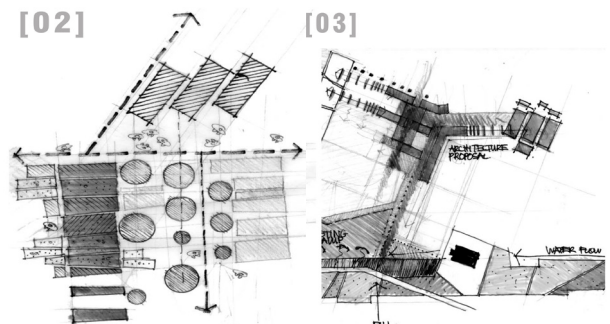
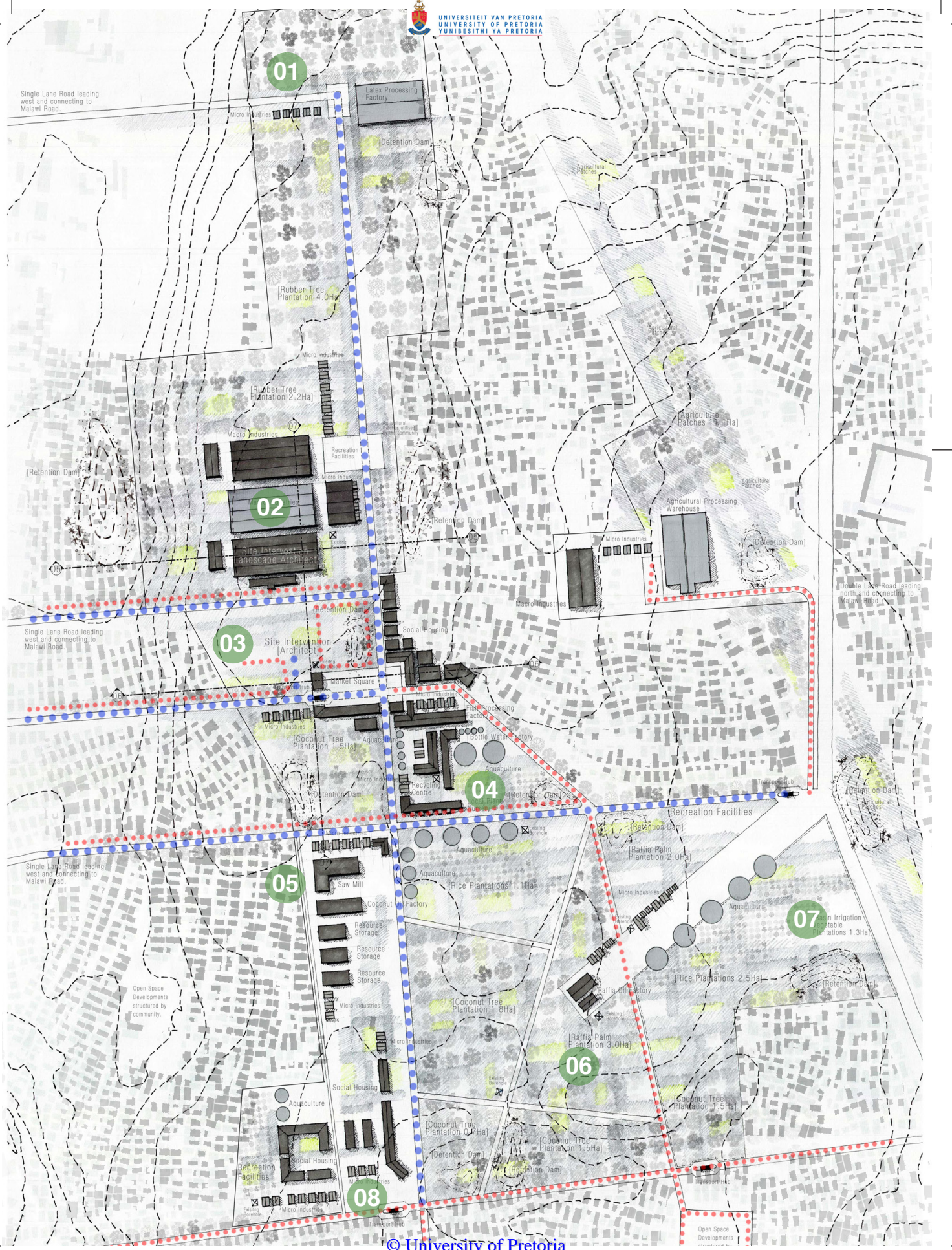


fig. 03.03_Landscape conceptual drawing.

fig. 03.04_Built form conceptual drawing.



Single Lane Road leading west and connecting to Malawi Road

Single Lane Road leading west and connecting to Malawi Road

Single Lane Road leading west and connecting to Malawi Road

Double Lane Road leading north and connecting to Malawi Road

- Primary connections.
- Secondary connections.

Nodes will be discussed from top to bottom, left to right:

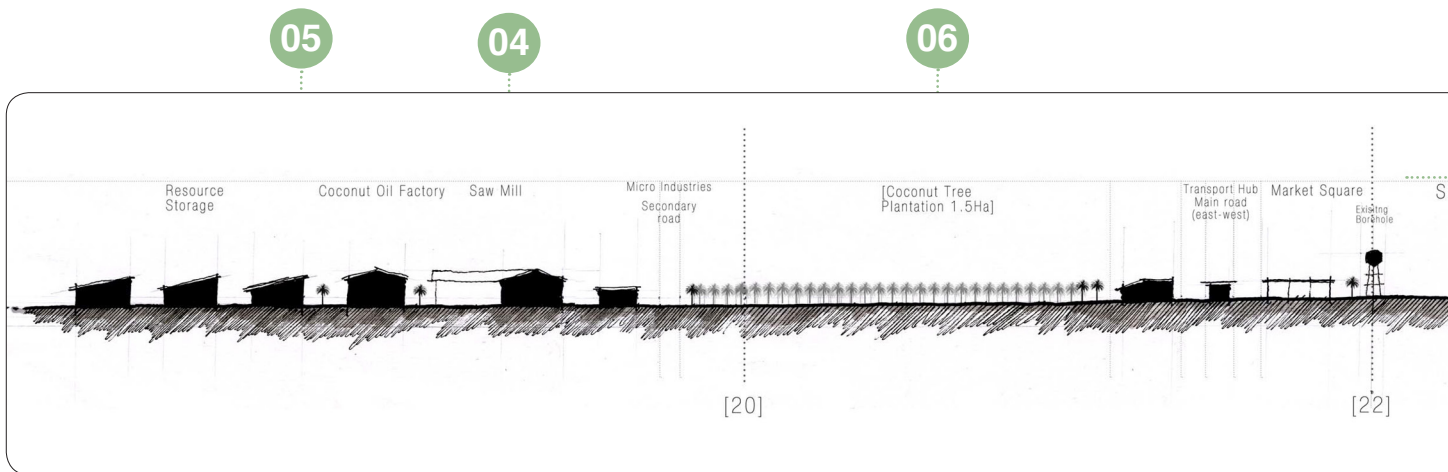
Node [01]_Main service entrance at the north.

- 01** This entrance serves utilitarian routes and facilitates produce/product collection from site and transportation to the main Malawi road. From here, traffic either turns north to the rural areas or south to the harbour and urban areas. This area has a smaller transportation hub for locals and is situated near the micro-industries for the production of arboriculture.

Node [02]_Large scale macro-industries

- 02** This node is a priority of the landscape architect's intervention. The abandoned warehouse forms the skeleton which contains three realms of different landscapes, assisting movement through the landscape by narrating the genesis of the production and recreational spaces. A 6,2 hectare rubber tree (*Hevea brasiliensis*) plantation to the north of the macro-industries area is proposed. This provides the raw materials for but one of the micro-industries that can feed from and augment the production of larger industries to the east (within the fine urban grain) creating a public threshold to the activity of these industries. The site will also house a number of recreational spaces and large retention dams to the east and west to facilitate stormwater management.

fig. 03.05_Final rendered urban framework for Chumbuni.



Node [03]_ Central hub of the framework.

03 This is the site intervention for the Architect. The human movement strategy must first be understood: Two main roads connect the north-south axis by means of single carriageway roads that originate from the main road to Malawi. The road to the north also forms a spatial screen between the landscape intervention and the architectural intervention. The main transport hub of the scheme is located in the south in order to connect the main market square, public space, architectural intervention and landscape intervention legibly to the rest of the site and programmes. A retention dam is situated to the eastern edge of the site. This will later be shown to form a permanent driver in the architectural intervention. To the west, informal settlement is allowed to encroach. The northern horizontal road leads the user to the proposed power supply of the framework (a tri-generation power plant). This road also services the social housing of the scheme in the south.

Node [04]_ Macro-industries and recycling plant

04 Located in the central part of the industrial area are a myriad of activities, including a fish processing factory, recycling centre and local plant nursery. These macro-industries are surrounded by micro industries to the north, south and west. Further west, a 1,5 ha coconut plantation is associated with a retention dam at the south western periphery of the scheme. Large scale aquaculture farms are situated further east and south toward the peripheries. These ponds facilitate the process of rearing the tilapia fish species (*Oreochromis niloticus*) (reintroduced to the fishery industry (Zanzinet Forum, 2004)) that are harvested for processing and consumption. These fish farms feed directly into the rice paddies situated in the south.

Node [05]_ Arboriculture industries.

05 Micro-industries connecting to the larger central market space are introduced to diversify the threshold between residential and public spaces with the smaller grain urban commerce interaction. A saw mill and coconut oil factory (central to this node) are flanked by resource storage.

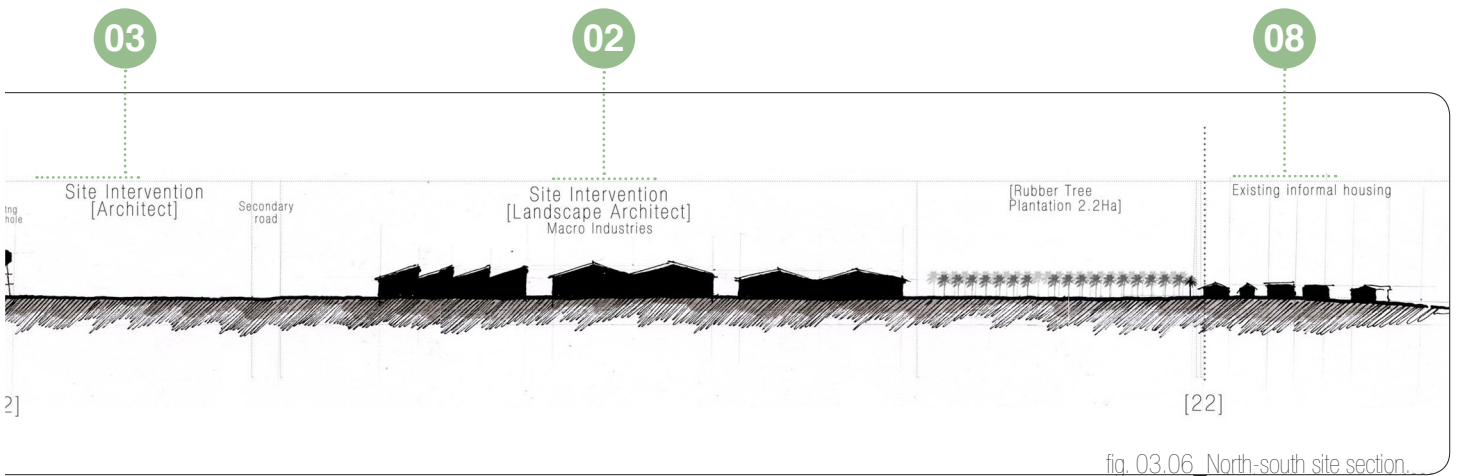


fig. 03.06_North-south site section.

Node [06]_large scale arbori- and permaculture

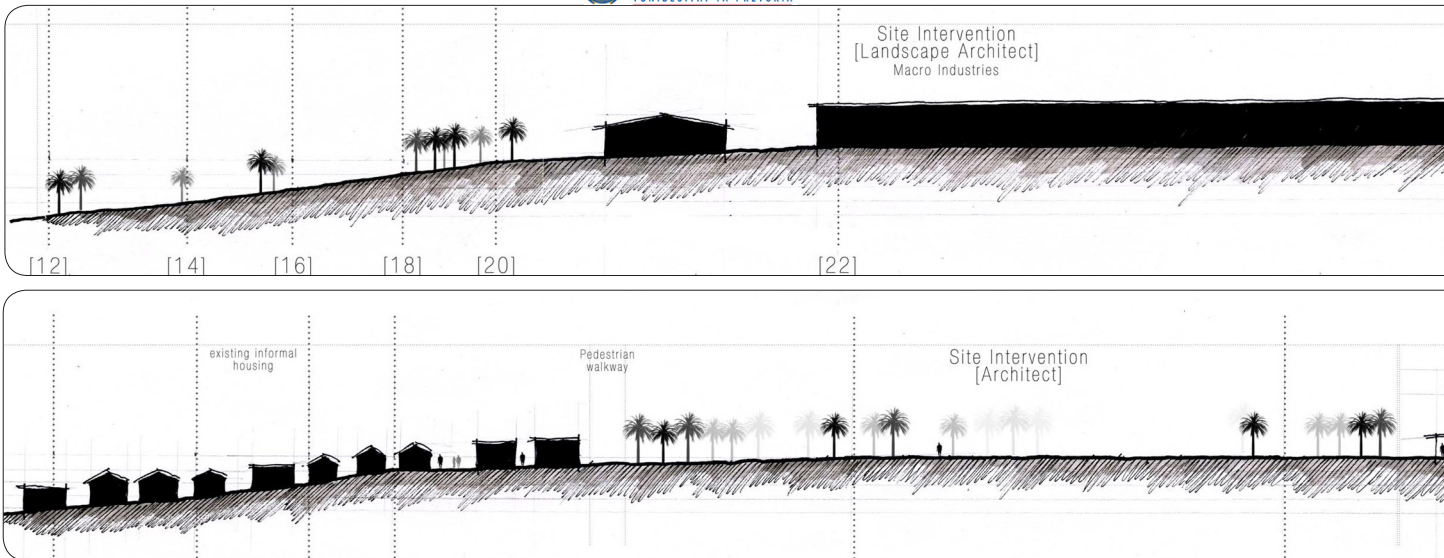
- 06** This node consists of a combination of raffia palm (*Raphia farinifera*) plantations (5,0 ha), coconut palm (*Cocos nucifera*) plantations (5,5 ha) and rice paddies (*Oryza glaberima* & Hybrid *O.glaberima x sativa*) (3,6 ha). A raffia oil factory and aqua ponds are centrally located between the fields.

Node [07]_Basin irrigation plantations.

- 07** An important design imperative was achieved because of the existence of a previously negative natural seasonal occurrence – flooding. The southern parts of the site are under seasonally arising water for 2 to 3 months of the year because of the bimodal rainfall seasons allowing for 400 mm rainfall in the bigger monsoon months of March to May (Kusi, south east monsoon)(Expert Africa, 2014). The existing housing in these areas is relocated as part of the proposal of a social housing zone to protect dwellings from seasonal flooding. Basin irrigation will succeed the ill-advised housing and is designed to control flooding during the rainy season. Yet another retention dam is introduced to achieve effective water management; It will also supply the area with water during the dry months of the year.

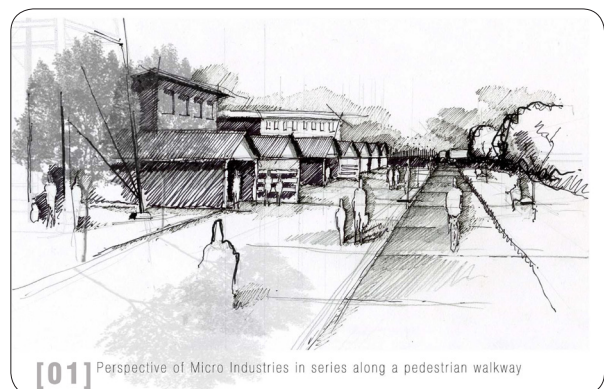
Node [08]_Social housing and micro industries

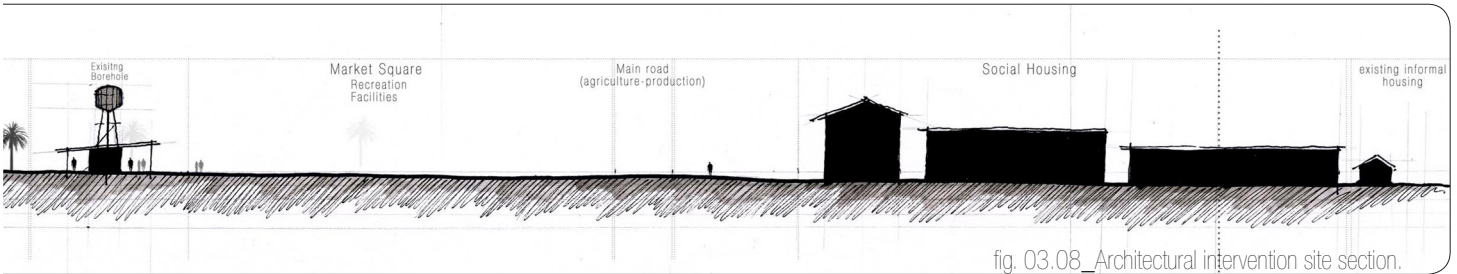
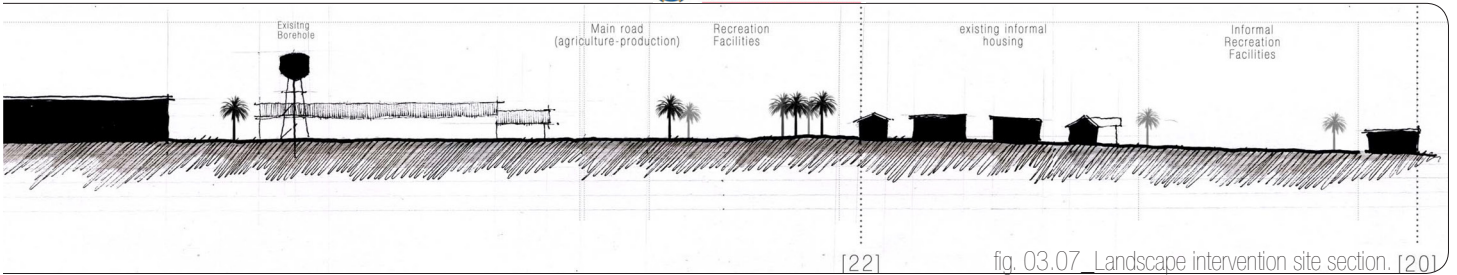
- 08** The housing zone is proposed in association with existing open spaces. The aim within this node is to establish self-sufficient communities that function as part of , yet independent of this framework (The author wishes to add that the housing areas are located between existing residential areas. The intention is, in theory, to allow self-sufficiency values to filter into the larger communities). Two transport hubs are in close proximity to the residential area and open spaces are left to be used as small-scale agricultural holdings.



The most important goal of the new proposed node-orientated framework is to ensure sustainable activity within the nodes so as to keep spines and links active. The architectural component (an agricultural research and educational facility) is therefore to become a structure that houses a number of beneficial programmes (focused on an educational and symbiotic relationship between industry and public) to strengthen the connection with the main market, education for the community, research for the development of agricultural practices, as well as production and utilisation of by-products (micro-industries).

The aim of the agricultural research and educational facility is not only to produce safer, fresher produce, as well as creating better and faster methods, but it also aims to teach the local people skills within the agricultural sector. This includes the use of products and by products. Small business incubators are created within and around the project site. Public-funding driven cycles of basic education, agricultural education, physical practice and research thus have a platform to influence and be influenced by industry.



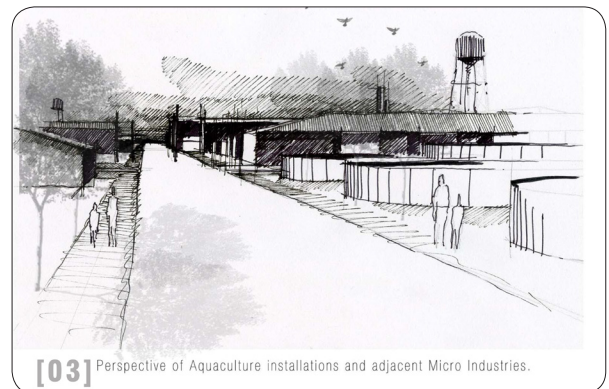


03_04_Development around the nodes.

The framework proposed by the architectural and landscape architectural dissertations focuses on the nodes specifically, and have allowed for further development around the site so as to increase the factors by which success can be measured. Micro-industries and commerce are proposed here to form the plasma between nodes (i.e. along the spines/links). The interventions of the two disciplines discussed further in this document, form part of the initial phase of development and attempt to invigorate the area. The vision is that these phases will lay the groundwork for solutions and begin to address pressing issues on a national scale mentioned earlier in this document.

The proposed framework's ultimate outcome is achieving resilience within its context and become part of the greater urban condition as an integrated commerce, residential, industrial and agricultural hub. This becomes a platform from which resolutions could be tested and used as part of the greater solution to resolve Zanzibar's economic, social and cultural dilemmas. The proposed agricultural research and educational facility can be seen as a living incubator for agricultural processes and production, as well as for practices and industries that will begin to support sustainability in the industry on an increasing scale.

The main nodes (02 and 03) define the public realm where the chief access to the project site is proposed. This leads to the large public square and market, forming an integral part of the agricultural research and educational facility.



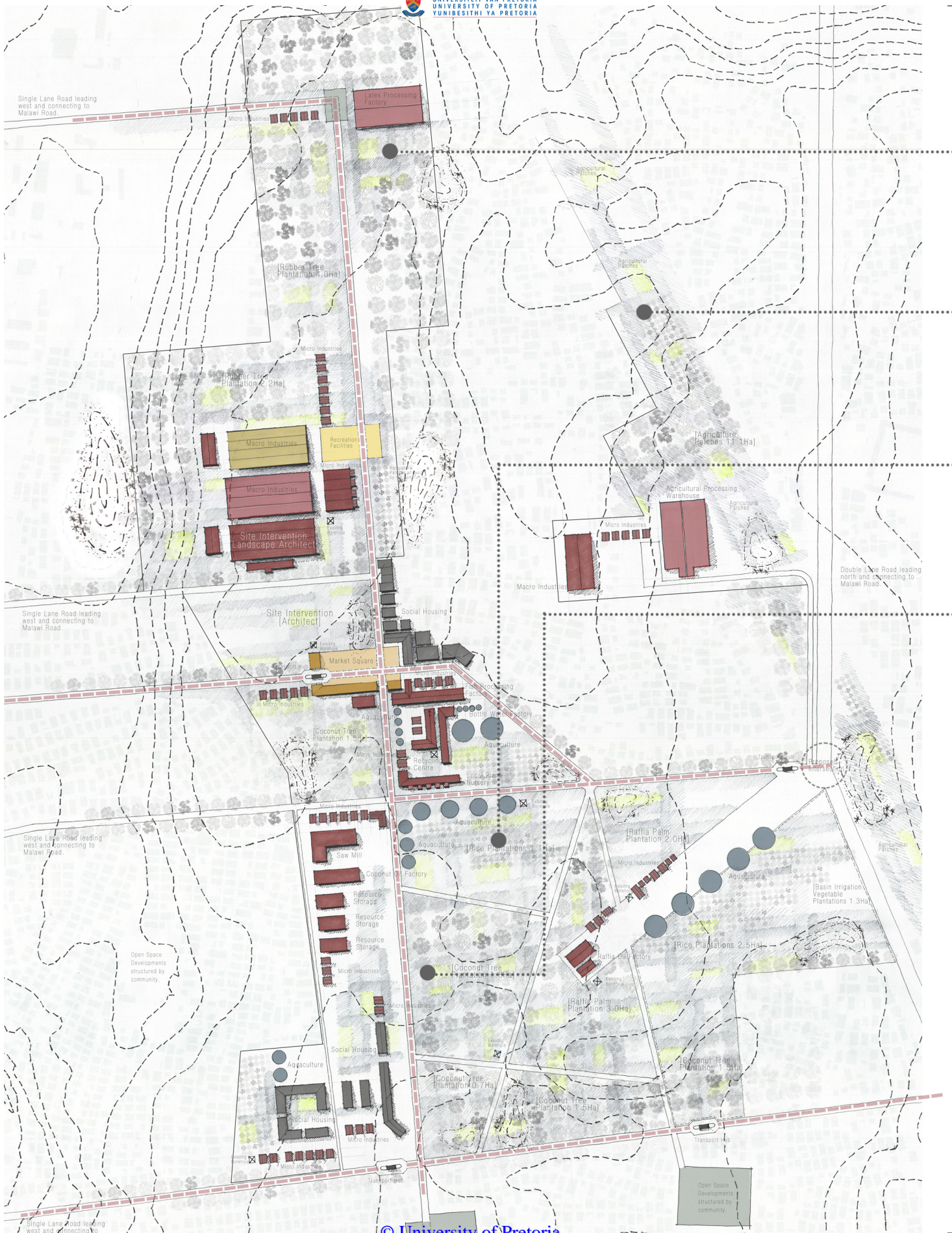




fig. 03.10_Rubber tree.



Rubber tree plantation [6.2 Ha]
[Species: *Hevea brasiliensis*]
Spacing 4.7m x 4.7m = 480plants/Ha
480 plants/Ha x 6.2Ha = 2976plants
Natural Latex: 3024Kg/year/Ha X 6.2Ha = 18748Kg/year
Dried latex material shipped in 20 feet containers from Zanzibar Main Port



[Input] Water / Labour / Natural fertilizers



[Output] Latex / Wood every 30 years



fig. 03.11_Cassava plant.



Agriculture greenstrip plantation [11.1 Ha]
[Species: *Viazi* [yams], *mchele* [rice], *mahogo* [spinach] and *ndizi* [banana], *tungule* [tomato] and cassava [beetroot starch], also *kuku* [chicken] and *n'gombe* [cattle]]

Harvest: Average 40T/Ha x 11.1Ha = 444T/ harvest
Harvested vegetables and meat will be distributed to local fesh produce markets in the framework and close context.



[Input] Polluted Water 7 Soil / Labour / Natural fertilizers



[Output] Large variety of vegetables, pultry and red meat



fig. 03.12_Rice plant.



Aquaculture Constructed [0.7 Ha]
[Species: *Clarias sp.*, *Channa striate*, *Cyprinus carpio*, *Oreochromis niloticus*]

Sex Ratio: Female to male 1:5
3 Fish/sqm = 30000/Ha
30000 Fish/Ha x 0.7Ha = 21000 Fish
Meat harvest: 2.5-3.5kg/sqm = 30000kg/Ha
30000kg/Ha x 0.7Ha = 21000kg = 21tonnes
Fish will be sold to local fish markets and restaurants.



[Input] Water / Labour / Natural fertilizers



[Output] Fish



fig. 03.13_Coconut palm.



Coconut tree plantation [5.7 Ha]
[Species: *Cocos nucifera*]
Spacing 7.0m x 7.0m = 200plants/Ha
200 plants/Ha x 5.7Ha = 1140plants
Nut harvest: 90nuts/tree/year x 1140 = 102600nuts/year
Wood and other bi-products will be used firstly locally and and excess shipped from main port



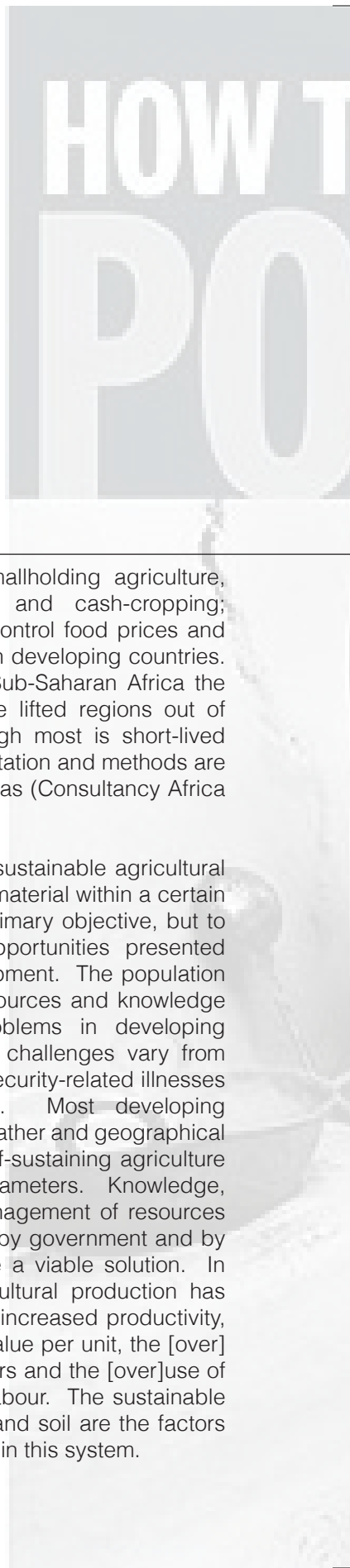
[Input] Water / Labour / Natural fertilizers



[Output] Nuts / Milk / Coir / Wood

Agricultural research and educational facility

Program_1 [04]



04_Program

04_01_[RE]-introducing Agriculture.

Toward the end of the 20th century, the production of agricultural products increased tremendously to facilitate the high population growth rate. According to the Nikhil Ghimmire (Eist10, 2013-2014) List of 10 major problems in the developing countries, five of the issues listed can be directly related to agriculture production and food security (Eist10, 2013-2014):

- | | |
|------------------------|---------------------------|
| [1] Hunger | [6] HIV/AIDS |
| [2] Social exclusion | [7] Agriculture |
| [3] Pollution | [8] No electricity |
| [4] War | [9] Drinking water |
| [5] Health care | [10] Poverty |

Almost a billion people in developing countries have no food to eat or a severely limited food supply. A third of deaths in the sub-Saharan Africa are caused by hunger-related illnesses. Around 2,5 million deaths per year are recorded as attributed to this issue.

In 2007, incentives for farmers to grow non-food biofuel crops, combined with factors of increasing transportation costs, climate change, growing consumer demand and population growth, caused major food shortages in the world, especially within the high famine-risk sub-Saharan African area, as well as rising food prices (Wodon and Zaman, 2008). In 2007, around 37 countries were confronted with a severe food crisis, after which chaos and death followed (Investing in rural people, 2011). The International Fund for Agricultural development proposed

a plan to increase smallholding agriculture, avoiding monoculture and cash-cropping; this was predicted to control food prices and improve food security in developing countries. In some instances in Sub-Saharan Africa the smallholding agriculture lifted regions out of chronic poverty although most is short-lived for no proper implementation and methods are being tough in rural areas (Consultancy Africa Intelligence, 2014).

A guiding principle to sustainable agricultural practice is to utilise all material within a certain crop, not only for its primary objective, but to monopolise on the opportunities presented by by-products development. The population growth and lack of resources and knowledge causes numerous problems in developing world countries; these challenges vary from malnutrition and food security-related illnesses to extreme starvation. Most developing countries have ideal weather and geographical location to maintain self-sustaining agriculture within the right parameters. Knowledge, education and the management of resources need to be addressed by government and by citizens alike to ensure a viable solution. In the modern era, agricultural production has been characterised by increased productivity, decreased nutritional value per unit, the [over] use of synthetic fertilisers and the [over]use of pesticides to replace labour. The sustainable management of water and soil are the factors of utmost important within this system.

TO END POVERTY

EIGHT MILLION
PEOPLE DIE EACH
YEAR BECAUSE THEY
ARE TOO POOR
TO STAY ALIVE.
A PROVOCATIVE
PLAN ON HOW WE
CAN SAVE THEM

BY JEFFREY D. SACHS



fig. 04.14_Images showing 5 major developing country issues.

04_02_The impact of agriculture on society.

More than 50% of the population in developing countries depend upon agriculture or subsistence farming to survive. This figure represents 75% of the world's poorest people, approximately 1, 4 billion people (Eist10, 2013-2014). Farming families make up at least 50% of this tally. The worldwide aim must be not only to provide families with food, but to educate individuals to empower themselves to successfully and sustainably practice farming as a viable income generator. This approach hopes to achieve economic change on a micro and subsequently, macro-scale.

The agricultural sector has undergone a significant change since the publication of *Agriculture at risk* in the late 1980's (Lemieux, 1999). The reference material describes changes that were implemented in larger economical-driven agricultural industries and it had a minor influence in the smallholder and subsistence farmers in developing countries. In some African countries with better managed infrastructure, health and safety have improved, although lack of food security and food-related diseases in the sub-Saharan African region result in a number of deaths each year (Climate emergency institute, 2011).

The consumption of fresh produce is of utmost importance for the human body. One of the main health benefits of plant matter is the high nutrient content per unit. These elements, nutrients and minerals are available in readily absorptive form in raw vegetables, fruits, nuts, legumes and grains. It is precisely this advantage that is kept in mind when encouraging sustainable farming practices on the African continent to counter the vast number of malnutrition deaths each year, not to mention issues such as water body eutrophication, the destruction wreaked by monoculture, and soil fertility depletion with land overuse and mismanagement. Vitamins and antioxidants in fresh vegetables fight infections and promote wound healing, along with forming the foundation of a healthy lifestyle. The amount of vegetables and protein needed to be taken daily differs between different sexes, ages and measures of physical activity.

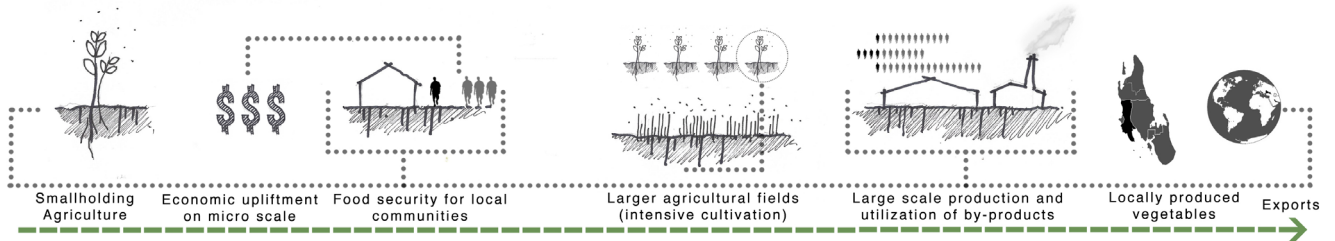


fig. 04.15_Diagram illustrating the impact of agriculture on the society

The standard requirement for a middle aged man is three cups of vegetables a day, and two and a half for a woman of the same demographic (Zanzibar statistical abstract, 2010).

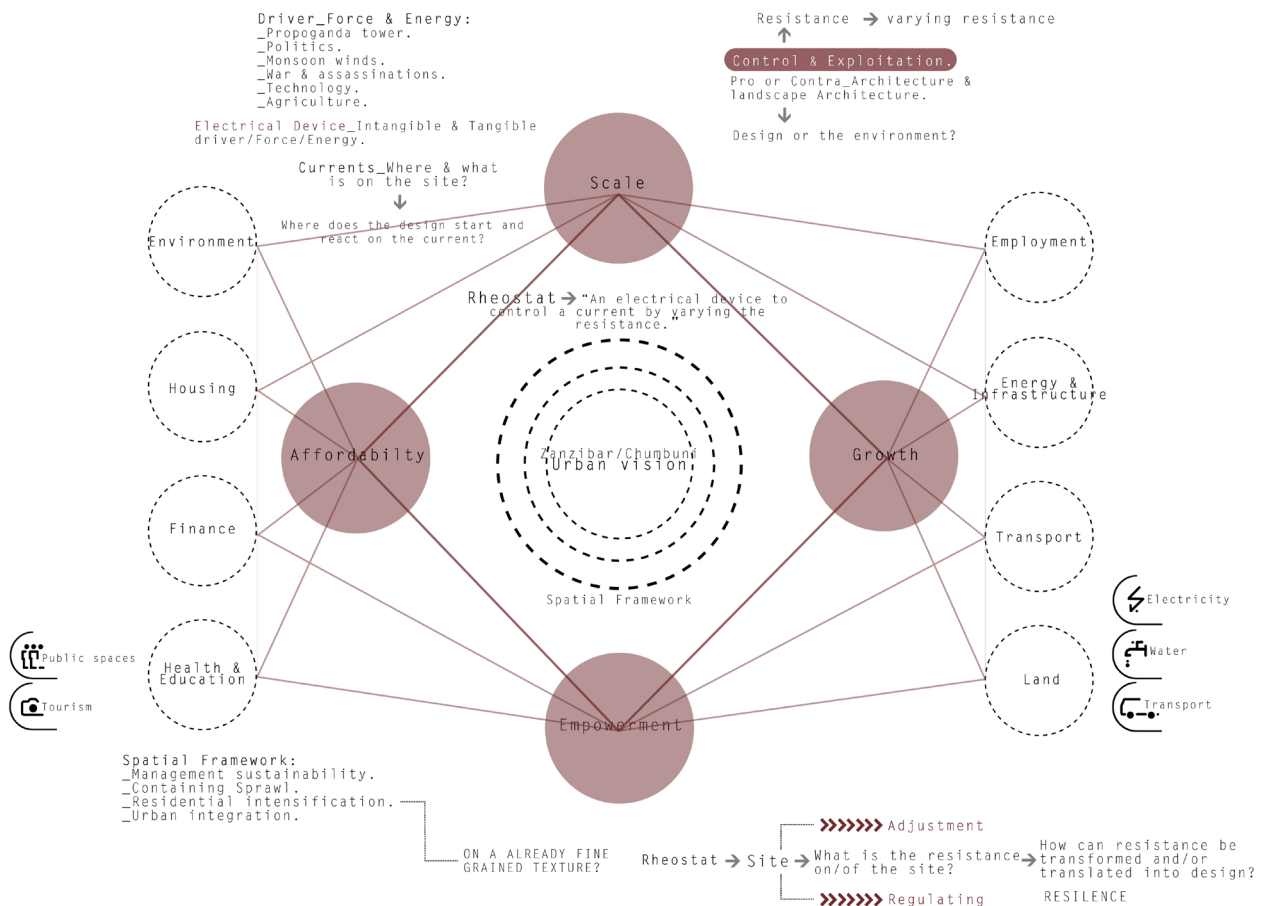


fig. 04.16_Programmatic approach to food security and society.

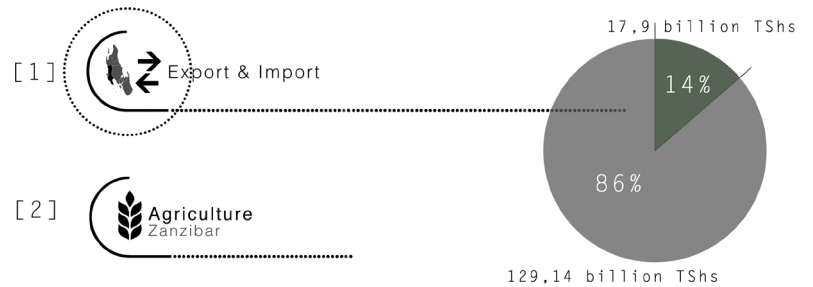


fig. 04.17_Infographic of the exports and imports of Zanzibar.

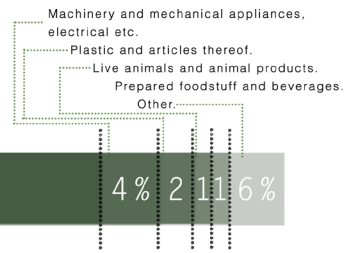
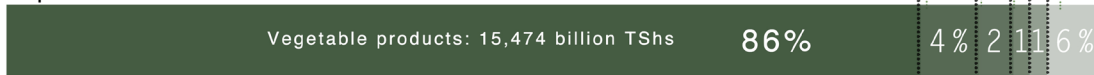
04_03_Agricultural production in Zanzibar.

The production of cash crops and food crops has fluctuated in turnover from 2005 to 2010, and production figures show a decrease of 12% in main cash crops (cloves, seaweed and rubber) from 2008 to 2010.

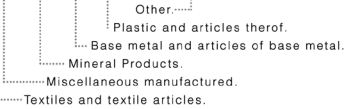
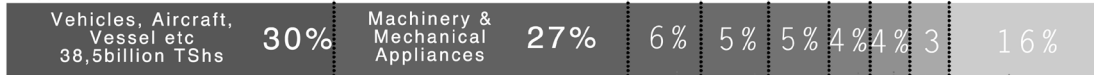
Food crop production and revenue was reported to have decreased in 2009, for example banana, sweet potato, groundnuts, sorghum and cowpeas all decreased by approximately 23%. Although some food crops (cassava, yams, maize and pigeon peas) have shown an increase in production of roughly 28%, the main concern is the constant fluctuation in production from one year to another [Zanzibar statistical abstract, 2010, C.4 agriculture, p.67-71]. Statistics from the Office of the Chief Government Statistician, Zanzibar, June 2010 shows the decrease in more than 90% of all production (cash crops, food crops, fish catches and forest products) in 2008. Furthermore, the annual consumer price index from 2005 to 2010, based on classification of individual consumption movement, rose from 145.4 in 2008 to 158.1 in 2009, while food indices increased drastically from 57.4 in 2006 to 169.3 in 2009. A diagram of the Zanzibar price index and the food related price index both show an increase on the CPI (Zanzibar statistical abstract, 2010, C.1 National accounts, Government accounts and investment:45-56).

The inconsistent cultivated food products in Zanzibar, combined with high consumer prices, suppresses the economic growth of the agricultural sector on the island. These two factors also have an enormous influence on the trade statistics of the country and vice versa. Most of the consumed products in the country are imported from elsewhere in the world (Zanzibar statistical abstract, 2010, C.2 External and internal trade:57-64). According to statistics this is aggravated by small-production of domestic products that cannot satisfy local demand. In 2009, the result in balance of trade (difference between imports and exports) decreased by one million TSh (Tanzanian Shillings) to 91,137.5. Export also decreased from 2006 to 2009 with more than one million TSh 1 000. The large decrease in what once was the primary economical driver (agriculture) left the island to rely solely on the tourism sector to enhance the economics of Zanzibar.

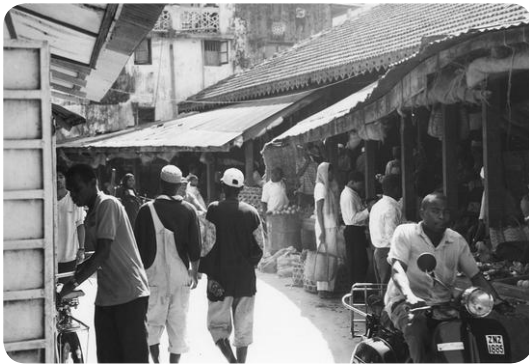
Exports



Imports



04_04_Who will benefit from this agricultural hub?



04_04_01_The local tourism factor.

The programmatic arrangement for the 28 hectare site is agriculturally related. The programme is focused on specific needs and clients at different stages within the life of the scheme. Within the first stage, the activity will attract tourism. The production and processing of fresh food will include an educational tour, combined with opportunities to patronise local restaurants, markets and public recreational spaces. The primary aim of the project is to uplift the community, increase the economic potential of individuals, boost trade, open up regions that lag in infrastructure development and – importantly – increase the value, stability and capacity of the agricultural sector. The basic plan and structure is to facilitate research, learning, development and progress of and within larger industries to smallholder micro-industries. This simplified structure and method will contribute to increase food security of the island, stabilise and manage food prices (fewer imports from the mainland, less risk of disease), and will start to form a norm of income and an economical structure that will diversify revenue opportunities, shifting the imperative on tourism development.

Although the Chumbuni area is located a few kilometres from Stone Town, the projects will rely economically on the large tourism sector in the developing stages as funding must be sourced from the tourism sector (the only sector with financial capacity to fund such a large project).

fig. 04.18_Food markets with fresh produce for locals and tourists.

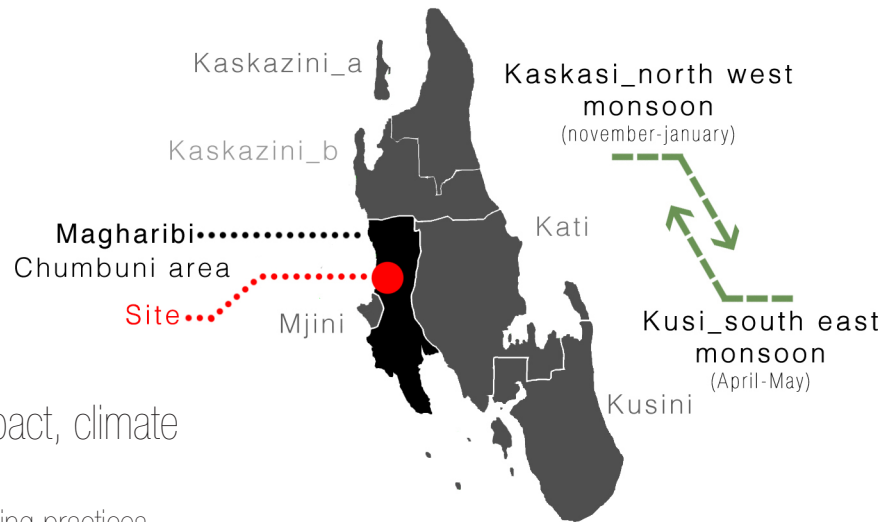


fig. 04.19_Monsoon winds in Zanzibar.

04_05_Environmental impact, climate and water supply.

04_05_01_Unsustainable farming practices.

Unsustainable aquaculture and agricultural practices present the most immediate threat to ecosystems and species around the world. Farming is the largest driver of habitat and biodiversity loss in the world (WWF, 2008). There are multiple negative impacts of contemporary agricultural farming and aquaculture on the environment, a few of these impacts will be discussed in context of the sub-Saharan African part and more exclusively the island of Zanzibar.

Major environmental issues in Zanzibar include deforestation, shifting cultivation (land clearing, seasonal planting of annual crops and agriculture as a whole are the main causes of degradation on the island), loss of freshwater aquatic species, soil erosion, urban desertification, exploitation of marine resources and mining (Zanzinet forum, 2004). A number of these environmental issues will have an effect on the development of agriculture on the project site and the surrounding context. Keeping this in mind allows the designer to consider the impacts of the initial concept; not design in an opposite direction to the issues, but to utilise facts and realities associated with these issues to design a facility which incorporates the issues as motivators, combining this with sustainable principles to create a resilient process of farming. The result will be a system that will improve the existence and future of the community, the country and the environment.

Land conversion and habitat loss have an astoundingly large negative impact around the world, almost 12 million hectares of land are lost each year through desertification (WWF, 2008). Although the piece of land in Chumbuni is being used for local farming, the threat of desertification and gradual soil degradation cannot be ignored. Future stages of expansion will be explored with this in mind.

Water is the world's most precious resource. Most farming practices are woefully wasteful in terms of water use. The mismanagement of water for agricultural practices leaves various water bodies – centralised and decentralised – dry because of the need to support inappropriate crops with natural, non-replenishable water sources. Lakes, rivers and underground water sources are threatened by human activity that gradually lowers the water table and pollutes untold amounts of fresh water (WWF, 2008). Worldwide the agricultural sector consumes almost 70% of the earth's accessible fresh water, where industry only uses 23% and municipalities another 8%. The use of water for agriculture is estimated between 20% and 35%, unsustainable (WWF, 2008). A number of major food producing countries (USA, China, India and Australia) are close to reaching their renewable water resources limits. Some of the main causes of unsustainable water use are (almost hilariously) leaky irrigation systems and cultivation of thirsty naturalised crops not suited to the growing environment.

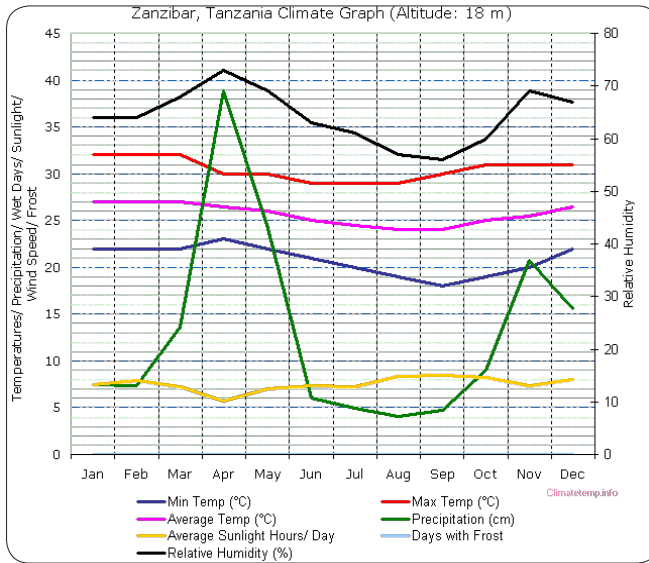


fig. 04.20_Climate data of Zanzibar.



fig. 04.21_Zanzibar Airport flooded in May 2002.

Zanzibar has a shortage of accessible fresh potable water, although the climate of the island is more than viable for producing a number of crops and has a strong, consistent precipitation each year. Reasons for this situation could be attributed to water and waste mismanagement. The proposed scheme therefore needs to include water catchment areas for irrigation, detention and retention. Dams have been introduced to collect, store and release water that is directed from the eastern part of the island. Systems have also been proposed that purify water of varying quality for a range of uses (trash traps, silt traps, bio-swales, constructed wetland systems and UV filters). This water is then re-introduced into the system at various points to ensure minimum water loss, i.e. a resilient system (to be discussed in detailed programme chapter and technical chapter). Water on the site must be managed to restrict excessive water use that could negatively affect the chemical and mineral profile of the soil or wash sediment and pollutants into rivers.

04_05_02_Soil degraded and loss

When natural pieces of land are cleared and ploughed, the process exposes the topsoil that is often blown away by wind or washed away by rain water. The loss of topsoil can lead to reduced soil fertility, degraded land and severe erosion. Major crops that cause soil erosion include corn, coffee, palm oil, tea, rice, tobacco and cassava (Zanzinet forum, 2004).

Other important impacts also need to be taken in consideration when designing systems that manage land use, for example pollution, genetic erosion and climate change control.

Farming is the world's largest industry; it employs over one billion people worldwide. In a world where agriculture represents such a large segment of human activity, it must follow that farming and agriculture are to be implemented and managed in a sustainable way and with utmost care to preserve the environment that allows us to enjoy domination over the plant and animal kingdom. Sound agricultural practices can help to preserve and restore critical habitats, improve soil health and water quality, protect watersheds and benefit both communities and countries economically. The revitalisation of the agricultural sector will be beneficial to both the economic growth of the country and the health, safety, education and communities of Zanzibar.



Fertile Grain

Agricultural Research &
Educational facility

Raising food, caring for the land – in their blood. Outstanding in their fields, doing what they love. Farmers are true to one thing, and one thing only. Growing it better, one eye to the sky and one to ground. Raising hopes, raising dreamers – in their hearts. Outstanding in their fields, eyes to those they love. Farm wives washed in blood, sweat and tears. Growing it at home, in the field and in their souls. Raising it generation after generation – in their DNA. Outstanding and insane, outstanding and obscure. Farmers are a special breed, and so it should be.

Shanyny silinsky, December 4, 2012

04_06_Fertile Grain.

04_06_01_Introduction.

The production of vegetables, fruits and fish rarely enters the mind of the consumer with the question of where it comes from, how it was cultivated and the processes followed from the seed to the vegetable, the nut to the tree, and the ovum to the fish. The process of producing edible crops is not as easy as buying seeds from a market, sowing these in the topsoil, adding water and waiting for fresh produce to appear. Food production through farming is a complex and non-linear process of knowledge transfer, education, environmental acknowledgement, preparations, consideration and conditioning of soils, careful procurement and application of fertilisers and pesticides, procurement of machinery (equipment) and water supplies, the response to climate and weather patterns, and the adherence to processes for efficient production. Under each of these categories there is another list of principles that needs to be followed to ensure a positive, productive agricultural landscape.

This dissertation sees fit to divide the agricultural process into five categories for discussion;

- [1] Education
- [2] Agriculture / aquaculture / arboriculture implementation
- [3] Research
- [4] Industry
- [5] Micro-industry / smallholder agriculture

Research within the agricultural sector is a relatively new concept to the globe [International livestock research institute, 2008]. The aim of an agricultural research and educational facility is to extend the country's scientific knowledge and agricultural problem solving.

One of the earliest agricultural research centres in the world was the ARS (Agricultural Research Service) situated in the United States of America. The company was established in 1953 by the federal government of the United States. The purpose of the facility was to solve problems in their chief national programme areas: nutrition, food safety and quality; animal production and protection, sustainable agricultural systems and natural resources; production of crops and protection of natural resources (United States Department of Agriculture – Agricultural Research Service, 2013).

An agricultural research and educational facility in the heart of Zanzibar's informal settlement will present the country with a solution that combines the basics of education, knowledge of agriculture, low and high-tech systems and integration of the synergy (public sector, private sector and the community) to form a facility that can host a novice farmer and a specialist alike in large-scale industrial agriculture.



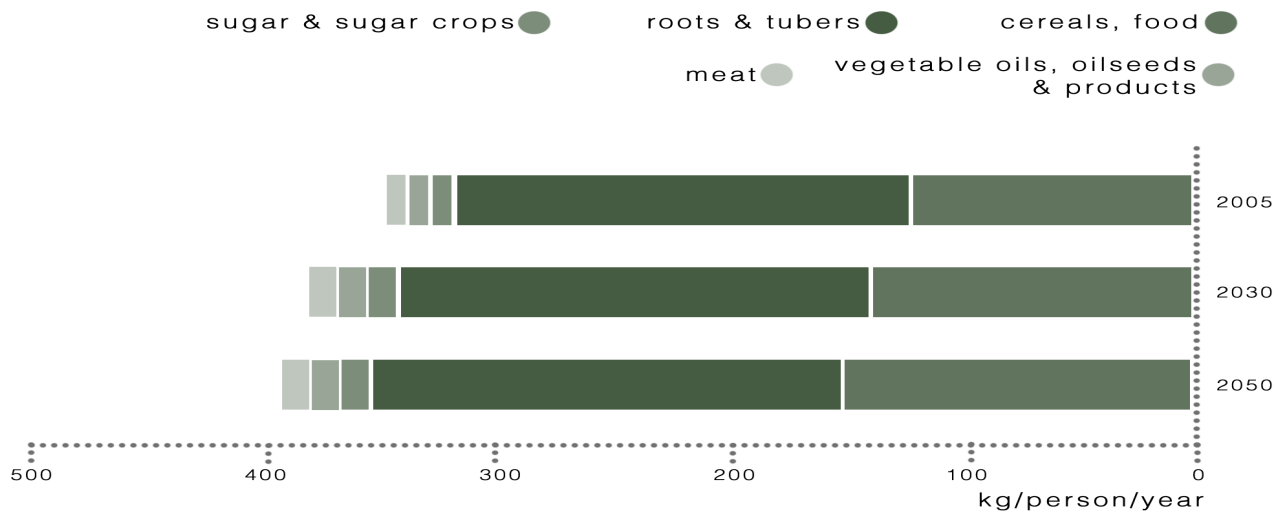


fig. 04.23_Consumption of food products in Sub Saharan Africa.

The aim of the research educational facility is to gather and provide information with the scope of this directive: To address and solve complex and simple issues within the agricultural sector to support sustainable practice, community upliftment and holistic financial and environmental practice. The programme will be an asset to individuals, communities and regions as it aims to:

- Ensure high quality, safe agricultural products and foods;
- Assess the nutritional needs of Zanzibaris;
- Build a competitive sustainable agricultural economy;
- Enhance the environmental and natural resource base, and
- Provide financial opportunities to rural/urban citizens, communities and society.

The research and educational facility will work in cooperation with surrounding colleges, universities and secondary education institutions to build a hierarchy of knowledge within the field of agricultural practice.

The agricultural research and educational facility will further cater for a large number of research fields that will educate farmers in the school of sustainable aquaculture. The facility will cover topics and research directions on most of the cash and food crops particular to Zanzibar. Minor food crops include amaranths (*Amaranthus hybridus* L.), okra (*Abelmoschus esculentus*), cucumber

(*Cucumis sativus*), pumpkins (*Cucurbita maxima*), eggplant (*Solanum melongena*), cow peas (*Vigna unguiculata*) and coco yams (*Colocasia esculenta*). These will be planted in small quantities for the purpose of study, experimentation, research and observation. The most productive crops, those most consumed and most-demanded (Zanzibar statistical abstract, 2010) i.e. rice, sweet potato, cassava, yams and tomatoes, will be researched, planted on site in larger quantities and processed. By-products will be experimented upon and studied in equal measure to allow for maximum usage of the crop. Most of the processing of the main food crops will be directly related to the aquaculture on site (aquaponics and hydroponics system) the aqua farming will re-introduce freshwater fish to the island.

A pressing issue in Zanzibar is the loss of freshwater fish species (Zanzinet forum, 2004). The dominance of marine species over generations of aquaculture and fishing during developmental years undermined the significance of freshwater species in favour of ocean species. It should be noted that Zanzibar once had a goodly collection of freshwater species; the populations have however shrunk drastically from the 1970s and 1980s. Freshwater species were undermined by herbicides, pesticides and natural processes. In the 1980s, rice farmers from Pemba and Ungula used dangerous pesticides such as Malathion and DDT that caused a significant

04_06_02_The informal industry and the sensitivity of the fertile grain.

loss in numbers of fresh water species. This issue has not been of great concern to neither the industry, nor the government, nor even the environmentalists as of yet (Zanzinet forum, loss of fresh water species, 2004).

The introduction of tilapia fish into specialised dams and sustainable systems will grow in importance alongside the main crops forming aquaponic systems. The proposal hopes to establish a resilient, sustainable and zero-waste generating system for the growing of fish and food crops.

In the development of this agricultural research facility the clients, users and observers need to follow integrated paths to ensure a uniform understanding of what happens within the building and surrounding the building. The surrounding context, rich in heritage, utility and resources, allows a number of local residents to move through the site and gain access to the building. However, it is important to note that the users must understand what the building is meant for before they enter. This will be addressed in the design chapter of this dissertation.

The architecture and the integrated agriculture therefore also need to allow residents and local communities to broker a personal relation with the architecture (through spatial identity, programme and interaction) and foster the perception and assumption of personal belonging, either physically, emotionally or intellectually. The architecture, then, is required to allow for a typology that could foster such perceptions whilst this results in an ownership for the public. The author sees this aspect as a contributing factor to the success of the proposed facility.



fig. 04.24_Conceptual image of the integrate grain beneath the surface

Agricultural research and educational facility

Program_2[05]

05_Program.

05_01_The facility and informants / design considerations.

05_01_01_Agricultural research and
educational facility: Public interface vs. industrial
privacy.

“Program_A planned series of future events, items, or performance; a set of related measures, events, or activities with a particular long-term aim.”

Program is a tool which helps the evaluator to understand the special demands of each situation and develop the appropriate evaluation methods for a particular program (Chen, 2005).

The research facility has a number of determinate sets of processes and occurrences that need to be in order to enable the facility to achieve the long-term goals it is tasked with. The facility does not rely solely on set processes and their subsequent goals, but rather on the actual impact of public interfaces and events combined with the set occurrences. The influences it has on the socio and economic relations of the Chumbuni area, Zanzibar, are of paramount importance. The public/community interaction forms the spine of the facility Their involvement can reveal a number of potential and appropriate spatial configurations that will allow the designer to better anticipate unforeseen events and respond in formalised processes.

The research and educational facility will challenge the resiliency of thresholds in the dense urban fabric of Chumbuni. The public context in this scheme will allow for the interaction of local communities, establish successful precedents, and form an incubator for the rest of the east coast of Africa to follow suit.

The production processes will create nodes, linear and decentralised movement patterns that will guide visitors through the building, to engage their senses by use of visual, participatory and knowledge-based connections. The observance of and education processes involved in the systems at work, aim to enlighten the users in subjects concerning the fundamental principles of agriculture, sustainability and the importance of food security in developing countries. It is hoped that his process will be extrapolated to the larger context and generate similar nationwide benefits from the observance of the development of a new socio-economical sector in Zanzibar.

05_02_RE[introduction].

The dissertation proposes the reintroduction of an industrial facility that facilitates production in the dense urban fabric of Chumbuni. The facility is proposed to interact and integrate with the public realm to assure that the proposed agricultural research, education and industrial facility can function to its full potential (forming a beneficial social and economical hub). The processes involved should move away from the historical approach to industrialise the factory and agricultural sector and rather allow the public to interact with the learning processes, production and cultivation of fresh produce. A number of legislative guidelines need to be followed during the realisation of such a facility (Zanzibar Investment policy (ZIP), 1986 – 2000:11); public and private thresholds need to be addressed to allow the community to feel the unity of the production plant in the centre of the informal settlement. The general layout of fresh produce industries need to be considered to allow for the public to really interact through a cyclical process.

The agricultural sector policy (1986 – 2000) of Zanzibar has the primary overall goal to promote sustainable development of the agricultural sector for economic, social and environmental benefits for the local people. The public department recognises the environmental degradation as a major issue and concern to agricultural development; lack of public awareness on the preservation and conservation of environment and natural resources is an attribute to that problem. A

number of other attributed factors include rate of population growth and density (Zanzibar Statistical Abstract, 2010, Population:10-14).

Another major sector that will determine the positive affect on the agricultural hub and the community surrounding it, is the water policy (1986 – 2000) which also recognises that the development of water resources and sanitation management is imperative. The policy states that the development of water programmes should be done in a way that is not harmful to the environment. The policy pays special attention to the implementation of Basic Assessments (BA) and various levels of Environmental Impact Assessment (EIA) facility (Zanzibar Investment policy (ZIP), 1986 – 2000). Environmental control and monitoring, water pollution, soil degradation, water scarcity, depletion of water resources, waste disposal hygiene and drinking water quality are requisite issues that must be addressed towards the supply of potable water.

The final policy that has bearing on the success of the agricultural research and educational facility is the educational policy (2006). This national policy recognises the necessity of incorporating environmental education into school curriculums and other educational institutes.

Enshrined within the majority of policies governing various sectors, it is recognised that the importance of environmental impacts, sustainability and education concerning these must be part of every stage of activity nationwide (Zanzibar Investment policy (ZIP), 1986 – 2000:7) Although according to the national land use plan (1995) Zanzibar's largest land-consuming sector is agriculture and it comprises 60% of total land area. The agriculture sector is, however, regressing because of a lack of basic training, implementation and knowledge (little or no skills development) (Sustainable management of Land and Environment, 2010 – 2013:8-12).

The agricultural research and educational facility of Chumbuni addresses the most fundamental aspects of the major industry governing policies (regional financial and business service, tourism, manufacturing, agricultural, trade, energy and social services policies) in Zanzibar (Zanzibar Investment policy (ZIP), 1986 – 2000:9-12). These aspects include bettering knowledge, waste management, sustainable design and productive land use combined with learning and recreational facilities.

The facility houses a medium to large-scale production line. The main vegetables are used in the larger scale production and will also be exploited for their by-products (number of processes, for example: drying, reusing rice husk for insulation, using cassava for composite

flour, fermented products and cassava starch) which include cassava, tomato and rice.

The three main vegetable groups work parallel with the aquaculture and use each other to form a closed sustainable loop system (feeding from each other). The research facility and the aim of the processes and methods tested in the research facility will be discussed at the end of the chapter.

The agricultural hub in its totality (master framework) takes part in the nationwide tradition of 'using as little as possible for as much as possible'. A number of waste management plants are situated on the site and smaller specific waste, water and energy management systems are situated in the building itself. The waste products (organic and inorganic) will go through a number of different processes. The organic waste with low protein will be used as compost in the production of cash crops; the organic waste with high protein (fish) will be fed to a bio-digester for energy. The inorganic waste will come from around the country to be processed to create biogas/syngas (Science for Environment Policy, 2000) for domestic use. A large number of water processes are incorporated into the building, using water from the retention dam, adding nutrients for the minion wind covers [fertilisers will be produced to enhance growth ability of vegetable in harsh conditions, making the plant more durable and resistant], filtering water to reach the quality level suited for industrial use [water with Alkalinity 0-120mg CaCO₂/- to enhance waste

management, no or negligible interference with processes, little damages to equipment and a better quality product]: and further using bio-swales for the use of irrigation, until the water management scheme produces potable water for human consumption (processes will be discussed in the technical chapter).

The industrial, research and educational facilities will harmonise working conditions by allowing as much possible natural light into the proposed buildings. The concept of using traditional courtyard spaces is utilised. This structure will allow for the ingress of more natural light; courtyards also form nodes through the building, acting as platforms for vistas to and around the architecture leading to productive landscapes and recreational spaces.

The public interface of the building allows for passive surveillance and the active interactions of users with the architecture. Visitors to this space will observe, learn and interact with the processes and systems discussed previously in terms of sustainability and agriculture, through semi-public space-making exercises on the part of the architect. The micro industries on the periphery will allow the people to interact, purchase and also sell products within the agricultural incubator.

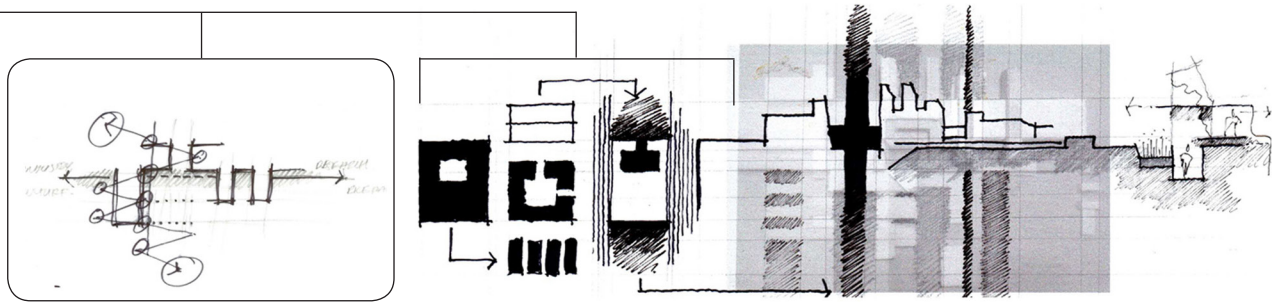


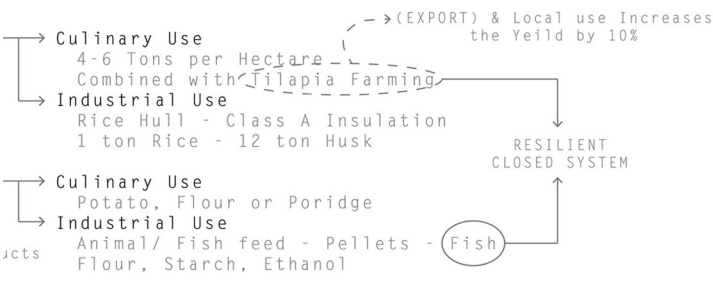
fig. 05.25_Conceptual analysis.

- Artificial Ponds (1400m³)
- Hydroponic/ Aquaponic Systems
 - Cash Crops (Cassava & Tomatoes)
 - Testing of Spices (Exclusive)
- Food Security
 - Production System & Growth Efficiency
- Mosquito Control
 - Fish eats Larvae
- Fish & Rice Paddy
 - Fish increases Rice production with 5-10% & control Pests



- Industries (Lilapia Leather Culture Possibilities)

- Construction
 - Coir of the husk.
 - Charcoal of the Shell
 - Oil of the Kernell
- Export
 - Latex
 - Rubber

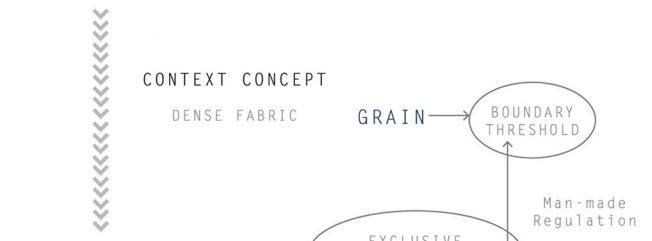


[3] AGRICULTURAL RESEARCH AND EDUCATIONAL FACILITY/ CENTRE
Productive Landscape - Fresh Produce Market

- Food Security
- [1] By Product Utilisation
 - [2] Production System
 - [3] Growth Efficiency

Micro Industries
Community Involvement/ Educational & Economic Upliftment

COMMUNITY INVOLVEMENT



[4] GRAIN AS A MONOPOLY OF ARCHITECTURE/ LANDSCAPE_ [2]+[4]

[5] ARCHITECTURE AS THE COURTYARD

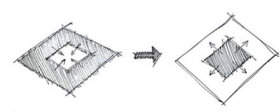


fig. 05.26_Architectural intent.

05_03_General guidelines to research, industry and education facilities.

05_03_01_Guidelines for industrial Production processes

The facility is designed, constructed and equipped to allow for everyday intended use, and is locally connected to existing and surrounding nodes from the main transport hub to the south (complete with activity spine) to the landscape recreational spine to the north. The facility should not have a negative spatial impact on the environment and the surrounding context, communities should in fact benefit in a sustainable manner from the agricultural research and educational facility.

The facility building has been designed to allow for maximum natural light; a light weight[translucent material] system covers the larger part of the design, while heavy construction spaces (concrete design) forms landmarks in the landscape and are kept to the minimum. Local materials and building methods are incorporated.

The production system will follow a linear arrangement with several different production stages for the three main vegetable groups. The rice and cassava production line will function with medium machinery (15-40m²) and tomatoes with small machinery (10-15m²). The production process generally follows as: preparation and storage of raw material after harvesting, processing, intermediate storage, assembly-checking, testing, finished and packaged product, and store allocation, then export or deliver. The location of the industry is advantageous as it is near to large storage facilities, near to local formal and informal markets, near to an abundance of micro industries that can purchase and utilise the by-products. A considerable advantage is that the facility will be near to the main harbour and airport.

Climate control becomes a fundamental design informant as the building needs a lot of natural light for comfortable working conditions but still needs to accommodate for the high temperatures of Zanzibar and its high humidity. In some instances (e.g. harvesting processes for Cassava) the storage facilities need a relatively high humidity but low temperatures. The work place (education facility and research facility) needs cool dry places for students, lectures and researchers. Using the wind and the water bodies surrounding the building, passive cooling systems will be introduced but will largely rely on cooler dry air for cross ventilation of spaces that require lower humidity (offices and laboratories).

05_03_02_Cassava_Harvest Maturity indices and production.

Cassava propagation is one of the most labour intensive vegetable mass-production activities in the world. It takes an average of about 721 man hours to plant 1 hectare (10 tons of Cassava roots). 212 hours are required for harvesting, 156 for handling and 353 for processing.

The most common method of harvesting cassava is by hand, the difficulty of harvesting is dependent on the moisture of the soil. The main stem of the plant is cut back to 300-500mm above ground to be used as a handle to pull roots from the ground. During dry season the soils are heavier and the ground is compacted, requiring the roots to be dug up by hand and simple instrument, in most cases. The lifting process cannot be performed by machinery as breakage of roots or scratched skins offer easy entry points for decay. Another point to consider is that in the dry season the upper plant of the Cassava need to be removed several weeks prior to harvest to allow for curing whilst still in the soil. This in itself is a time consuming and labour intensive task.

Additional considerations during cassava harvest include the following: the Cassava roots need to be graded in the field and any damaged, diseased or unmarketable roots need to be discarded; Cassava should be placed after harvesting into well ventilated field containers for transport (wooden crates or strong plastic containers).

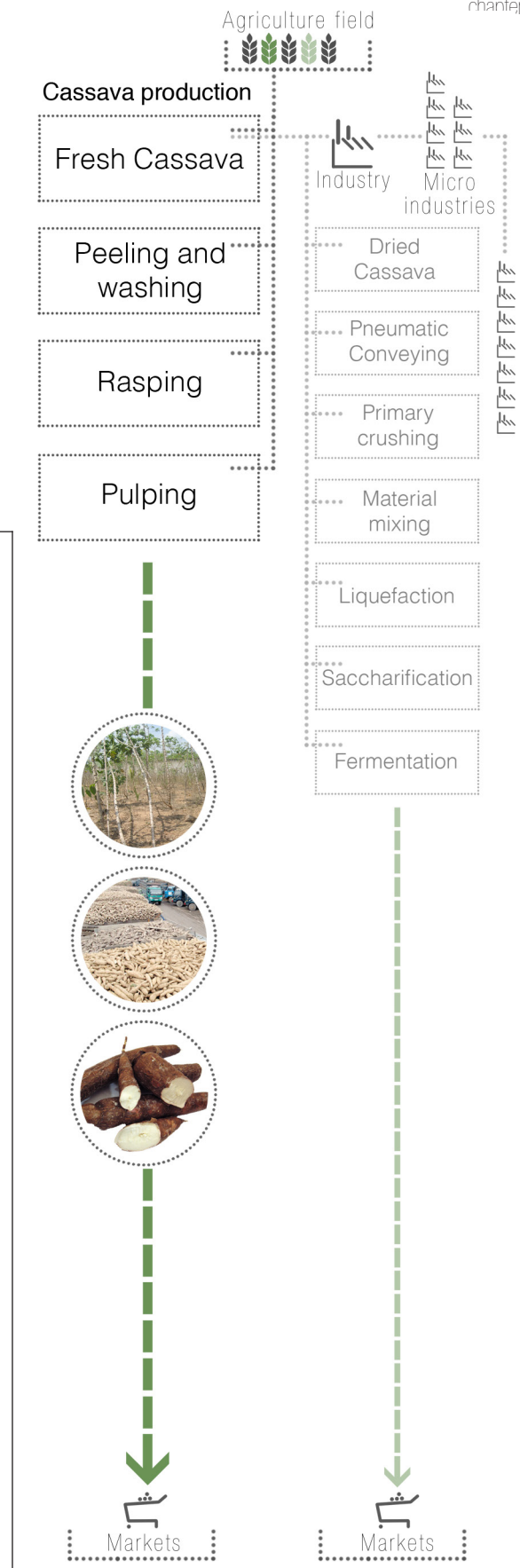


fig. 05.27_Cassava production and processing.

Curing process for Cassava storage:

_Roots need to be cured immediately after harvest;

_Curing improves potential market life by reducing lowering incidence of decay and water loss during storage;

_The curing process thickens the skin and forms new tissue on injured surfaces (curing is not possible if the root has suffered a significant amount of damage).

_Cassava is not washed prior the curing process.

_Optimal curing conditions are 26.5 °C to 29.3 °C and 90% to 95% relative humidity (RH) for 4 days immediately following harvesting.

_Cassava can be cured indoors or outdoors it only needs to comply with the ambient temperature [Department of Agriculture, Cassava production guideline Forestry and Fisheries, 2010].

Temperature control

Fresh Cassava (*Manihot esculenta*) roots are highly perishable in normal temperatures, and even become wholly unmarketable within a few days. If the correct curing process is followed the fresh roots can be stored for several months. The recommended temperature for maximum Cassava storage life is 2 °C (stored for 4-5 months). In the absence of temperature control there are a number of other low-input storage methods and structures. One such mechanism is the above clamp storage silo. Here, roots are piled up between 300kg-500kg (storage life in

this scenario is 4 weeks). Cassava roots need to be stored at a high RH to minimise water and mass loss, and root shrivelling ([Department of Agriculture, Cassava production guideline Forestry and Fisheries, 2010]).

Preparation for market and micro industries. Cleaning/washing.

The surface quality of the Cassava root needs to meet market regulations and expectations. Excess soil should be removed from the root by means of a soft brush or cotton gloves. Cassava that needs to be exported should be cleaned by carefully submerging the roots in a tank of cleaned water sanitised with 150 ppm hypochlorous acid and maintained at a pH of 6.5 (this may be achieved by combining 3 litres of bleach per 100 litres of water) (Department of Agriculture, Cassava production guideline Forestry and Fisheries, 2010:9-12). Grading, sorting and packaging according to further industry standards follows.

Waxing involves dipping Cassava roots in melted paraffin wax at 51.5 °C to 52.5 °C for the measure of one second. The wax adds a smooth thick surface coating to the root that helps reducing root moisture loss and extends market life by at least 2 months (National Agricultural Research Institute (NARI)).

The Cassava can then be transported to micro industries around site for the utilisation of the raw material (products include starches, flour, bread, ethanol and medical products).

05_03_03_Rice_harvesting methods and production line.

Rice production in Africa cannot keep up with the increasing national demand, only 54% of Sub-Saharan African rice supplied is locally because of the consistent droughts. If the water supply is reliable the average African yield 2, 32 tons per hectare (2006) can be raised to 5 tons per hectare (standard global rice yield).

Paddy crops should be harvested when the grains become hard and contains 20-22% moisture. Harvesting before maturity results in a low milling recovery and the rice will produce a higher amount of immature seeds. The crop harvesting should be done within the required timeframe; late harvesting results in shattering and cracking of rice in the husk, thus exposing the grain to rodents, birds, insects and pests. Harvesting is to be avoided during the wet season. Methods need to be implemented to avoid missing the secondary tiller panicles (increasing harvest yield significantly). The paddies need to be dried up a week to 10days before harvesting as this promotes easy harvesting and employing mechanical harvesters. Harvests need to be protected from rain and excessive water exposure. The yield should avoid direct sunlight drying for it increases breakage of grains during milling.

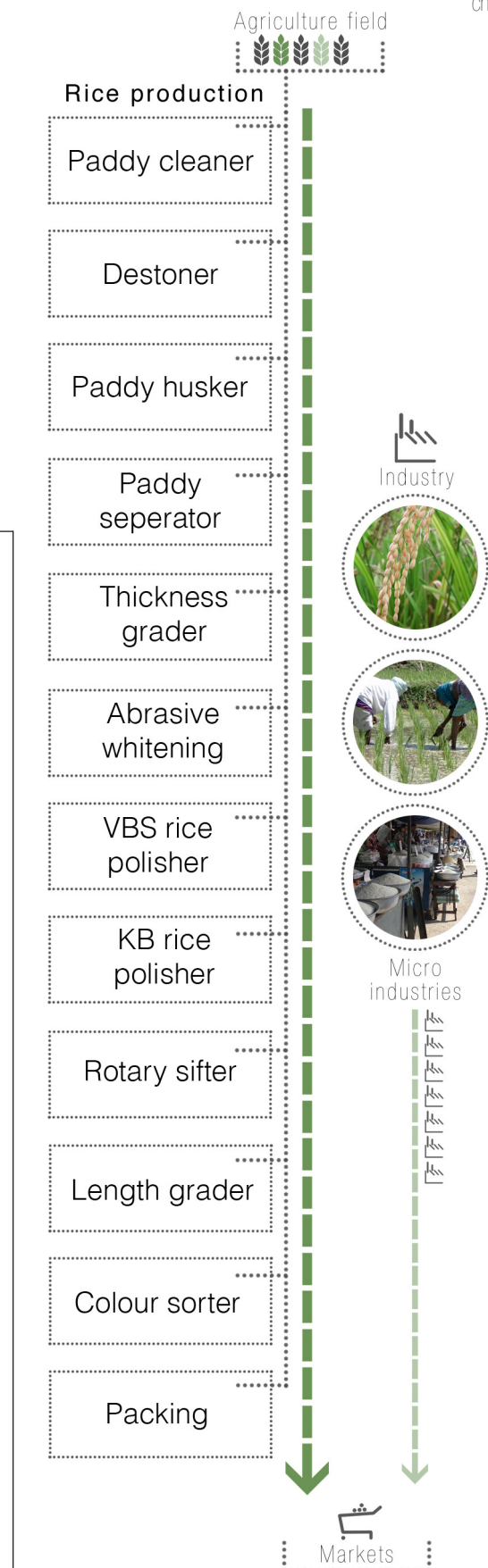


fig. 05.28_Rice production and processing.

Post-harvest equipment includes (Pandey, Principles of Post-Harvest Technology, 1998) all;

- Larger paddies will make use of combine harvesters; in small paddies the local work force will be used;

- Power operated paddy threshers (portable rice thresher);

These threshers are operated by 5-10hp (Horse power) electric motor or by tractors (semi-axial and axial flows will be used in the Agricultural hub). The work capacity of these threshers varies from 500-1300 kg per hour;

- Power operating winnowing fan;
These fans clean the manual and electrically operated paddy threshers.

- Hullers/rice mills;
This machinery processes the crop yield with an average of 72% successful rice recovery, 22% husk and 6% bran recovery. Traditional methods of hand and foot pounding (Dhenki [Pingale, 1976] can be used for small local paddies but for the commercial Agricultural hub, rice hullers, Sheller's and rice mills will be used. Hullers achieve an average total 65% yield but do not give completely clean rice. The single pass modern ice mills only have 10% breakage and have a 70% yield recovery (Pingale, Handling and Storage of food grains, 1976).

Grading and packaging.

Grading is a process that determines the sort of rice, lengths and yield. The grading will comply with the marketable regulations and expectations within the proposed facility. Packaging is convenient for handling, transportation and storage. Rice, if no properly stored, can have a negative impact on the quality.

- Graded rice will be packed into new clean, sound and dry jute bags, cloth bags and poly woven bags, depending on the product;

- The packaging shall be free from insect infestation, deleterious substances and fungus contamination;

- Packaging shall be securely sealed;

- Packaging shall contain one grade of grain only;

- Packaging will comply with the Standards of Weight and measurement (Packaged Commodities) Rules, 1997.

Storage

The storage structure needs to be located on a raised well-drained site. Easy access is preferable and it should be protected from excessive heat, moisture and pests. Sufficient space need to be provided between stacks for proper aeration. The storage facility needs to be clean and well isolated. Before the storage of rice commences, it should be properly dried to avoid quality deterioration and rotting. The facility needs a number of storage bays to store old and new stock separately. In the storage facility the rice bags need to be kept on wooden crates with a cover of polythene sheet to avoid excessive moisture from floor level. The facility/structure need proper aeration in clear weather conditions but need to avoid aeration in rainy seasons. A few traditional storage structures will be present in the design of the Agricultural hub. These will allow locals to see the different methods of storage from low-technical and low cost to more complex technical and industrial systems as storage methods. Some of these include the Mud-bin, Bamboo reed bin, Thekka, metal drums, brick-build godowns and silos (Pingale, Handling and Storage of food grains, 1976).

05_04_Aquaponics, aquaculture, rice and tomatoes.

Combination of fish and rice farming

As previously discussed, rice is economically a very important crop. Combining it with fish farming will be beneficial to the farmer as a provider of supplemental income and protein, the system is also beneficial for the systems managing the fish and the rice. This specific combination of propagation practice has a rice crop yield increase of minimum 10% and the Tilapia fish have been observed to thrive in the rice paddies (International Center for Aquaculture and Aquatic Environments, 2005).

Advantages of rice-fish culture.

- _Additional income and food;
- _Control of insects and mollusc which is harmful to rice;
- _Reduced risk of crop failure because of the move away from monoculture;
- _Fish also stir up soil nutrient and defecate in the water, thus increasing the nutrient intake of the rice resulting in an increased rice yield.

Fish management

Management for the fish and rice farming include stocking, fertilisation, feeding, and water quality control, harvesting and restocking. The Tilapia fish will be introduced to fish farming as the main fish species.

Paddy preparation for the Nile Tilapia (*Oreochromis niloticus*) as the principle species (Arce and de la cruz 1977) is as follows:

- If water is safe and clean, 5000 tilapia fingerlings per hectare are stocked into trenches to aid survival chances
- Fish growing season is 70 - 100 days and expected yield of fish is 300kg per hectare.

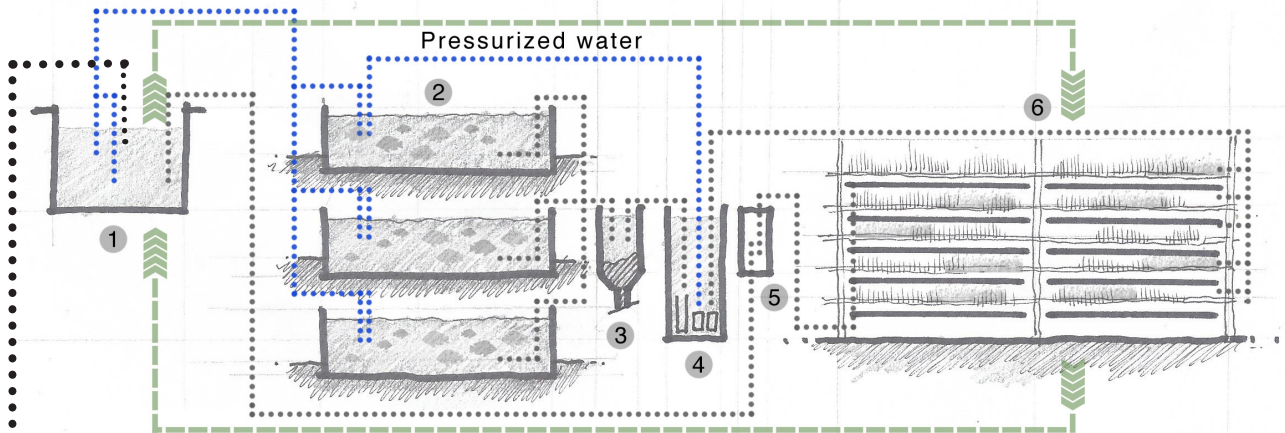
Aquaponics and fish.

Affirmative actions and guidelines for efficient Aquaponic systems (Nelson & Pade, 2007):

- _The feeding rate ratio should be used for design calculations;
- _The feed input must be relatively constant;
- _Add supplementary calcium, iron and potassium;
- _Ensure good aeration;
- _Remove solids;
- _Be cautious with aggregates that can clog pipes;
- _Use oversized pipes to reduce the effects of bio-fouling.
- _Use biological control to manage population;
- _Ensure adequate bio-filtration;
- _Control the pH.

Aquaculture system.

Fish waste and uneaten food turns into ammonia. Bacteria turns ammonia into nitrite. Bacteria turns nitrite into nitrate. Nitrate is absorbed by vegetables along with other nutrients. Excess water is cleaned through a bell siphon. The water is returned with ammonia removed to the fish tank/pond.



- | | |
|--|---|
| 1 Sump with pump and aerator. | 4 Backup pump, rock filter and sand filter. |
| 2 Aquaculture ponds, with aerator pipes and backup pump. | 5 Bell Siphon. |
| 3 Swirl filter with fish emulsion drain. | 6 Grow bed with vegetables. |

fig. 05.29_Aquacultural system (Aqauponic).

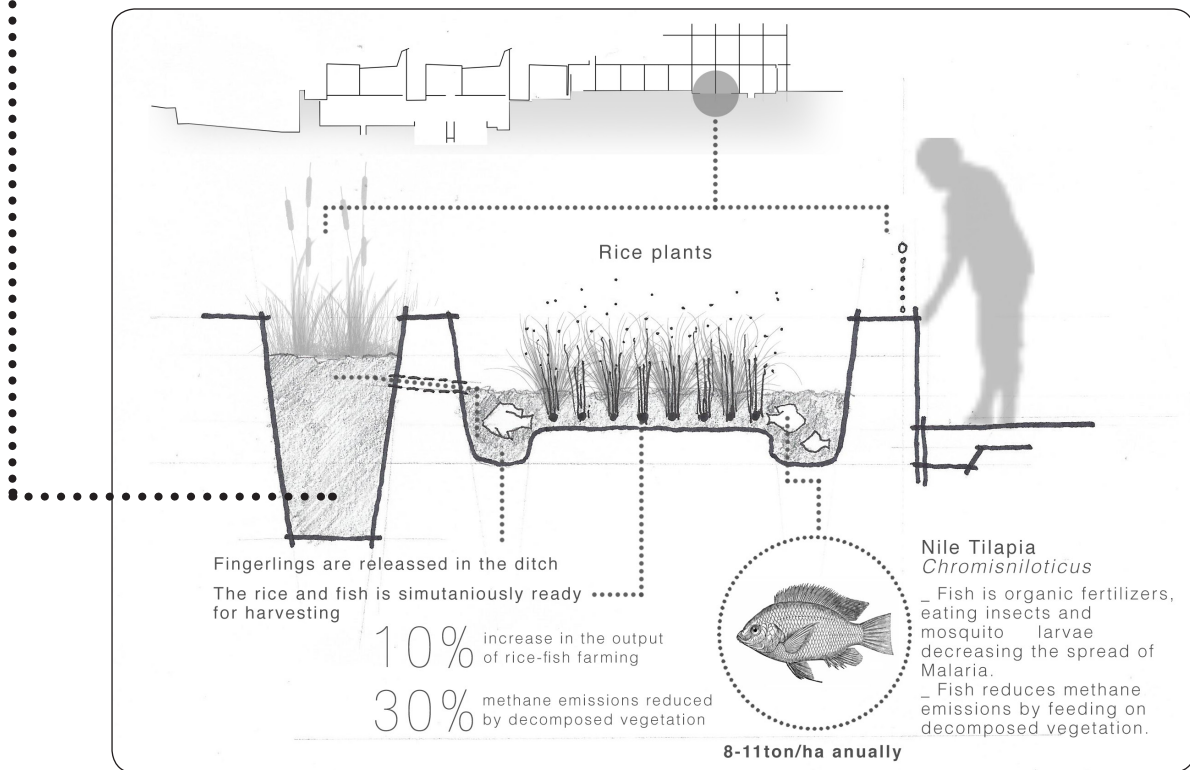


fig. 05.30_Combination of Tilapia and rice.

05_05_The Research facility (Technical investigation).

The research facility will deal with, as subject matter, a number of research processes and methods. The facility focuses on the utilisation of by-products, the increase of production of selected crops and their growth period. The Research facility will focus on a large variety of plants and vegetables. The facility will consider the affect that seasonal monsoon winds have on the agriculture and will use amplified nutrient water conditioning programme (resilient system that takes nutrient filled water from the retention dam and through technical processes after irrigation puts it back into the system) to challenge the use of direct sunlight for the growth of agricultural products (basement cultivation). This will allow locals to understand which vegetables can be planted in small courtyards for small households with limited direct and indirect sunlight.

A number of plant and vegetable species will be cultivated in the basement, from vegetables that need no sunlight to vegetables that need 4-5hours indirect sunlight. The production method for leafy vegetables will result in thinner leaves; however these will still have the same nutritional value (Growveg, Dore, 2010).

Leafy vegetables that can be planted in deep shade:

- [1] Lettuce,
- [2] Kale (wild cabbage) and
- [3] Spinach.



Cruciferous that can be planted in deep shade:

- [1] Cabbage and
- [2] Cauliflower.



Root vegetables requiring 4-5hours indirect sunlight:

- [1] Carrots,
- [2] Potatoes and
- [3] Beetroot.



The main energy source of growing vegetables and fruits is limited in these circumstances, so it is of utmost importance for the cultivation of fresh produce in the basement to allow for proper drainage, ventilation, soil preparation and good fertilisers (organic).

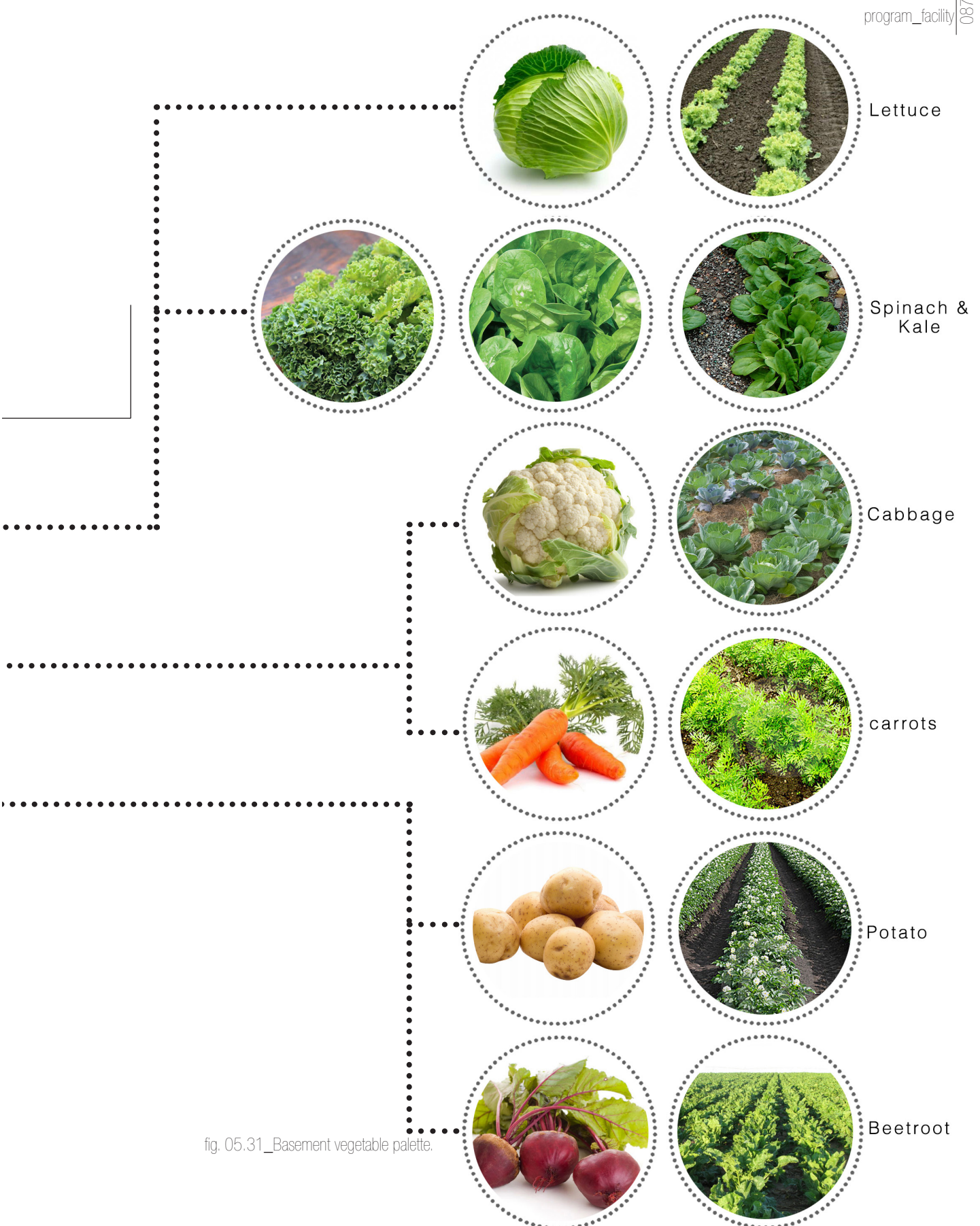


fig. 05.31_Basement vegetable palette.

Agricultural research and educational facility

Theory [06]

06_Theory.

06_01_Connecting the Fertile grain with public Industry.

History of the industrial typology that influenced the neighbouring World heritage site (Stone Town) and the dynamic informal settlements surrounding the town.

The history of early industrial design in the study area dates back centuries, however, it can be gathered that the designs done in the early 1800's were based purely on pragmatics. The pragmatic approach addressed issues involving financial constraints and its proponents hoped that future industrial designs would contribute to the humanization of space (Jones, 1985:12-13). Although early industrial designs and structure were designed by architects, industrial typology architecture has had a marginal impact on the history of architecture. This is likely because industrial architecture is focussed on achieving two main goals: efficiency (mass production) and safety.

On site, the origin of the industrial aesthetic can be seen in the simple mill building built in the 1700's; this structure displays very simple masonry work and additional wooden buildings with rhythmic openings and repetitive forms. This kind of utilitarian approach can be seen as the precursors of the modern factory. The modern mill designs responded poorly, if at all, to the surroundings and landscape; material and scale in the architecture were also not an idea explored within this typology. The conglomeration of the mill structures blocked the rivers and canals that fed the millwheels to generate power for their machines. The

mills reflected the technology available to respond to crises and realities in the modern factory workplace - problems of fire, flooding and natural light were addressed. Buildings were designed to be long and narrow with unobstructed interior spaces for the maximum use of floor space. The early industrial buildings were aesthetically basic facilities because their utilitarian nature placed them very low on the aesthetic and social hierarchy. The built environment reflected social importance from the earliest times, and the 19th Century Zanzibar is no exception. Buildings in better public opinion and with higher reputation such as churches and royal structures displayed elaborate decoration and frivolity; Service buildings enjoyed no such luxury.

Many designers of industrial structures were not famous, sometimes unknown due to the small impact it had on the traditional architecture (Nelson, 1939), one of the earliest contribution in the development of industrial architecture before the monumental industrial buildings of the twentieth century was Albert Kahn, An era where the answers would come from the material (enhancement of concrete and iron), a more flexible and adaptable layouts (Clinton, 1978).

It is ever since the modern movement had sprung to life and industrial practices grew in complexity and importance, that architectural theory needed to respond to the industrial challenges that the development posed. New forms need to define ever changing

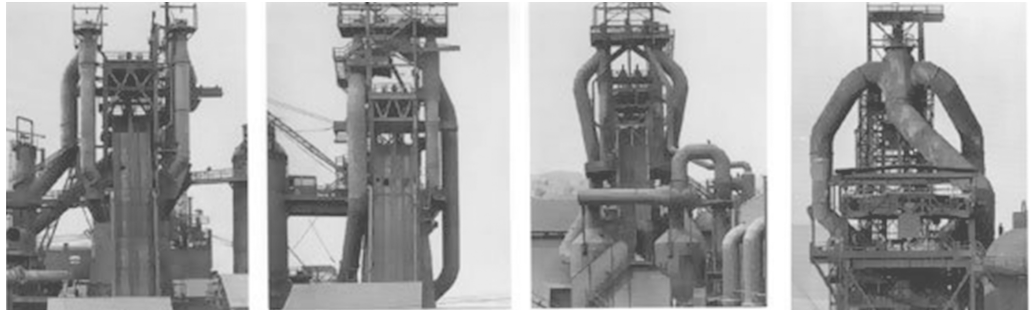
technologies, factories and facilities. The production of quantity, quality, efficiency and safety would dignify the workplace. Deutscher Werkbund (Schwartz, 1996) is worth mentioning in this context, founded to improve the quality and design of German manufactured goods. Considered two of the most influential industrial buildings in the twentieth century were the work of Peter Behrens's AEG factory, and Walter Gropius & Adolf Meyer's Fagus Shoe Last Factory. The AEG factory was regarded as a "temple to industrial power" had a monumentality based upon neoclassical principles. Inspiration was drawn from the industrial typology as it was an aesthetically and materially honest movement and one of the few that enhanced the modern movement. The typology relied on little to no decorative elements and focussed on technology and functional program. This movement inspired innovative building design and uplifted the development of technology (Sen, 2004:5-6). This monumental approach resulted in purely static objects and artefacts within the landscape which were mono-functional and struggled to adapt to the ever changing industry and technology.

A group of German Architects saw in the failings of the monumental industrial typology a pragmatic solution; new programs need to be added to the mono-functional spaces of the industry to humanize it as a whole. The industrial typology quickly shifted from a design philosophy to an architecturally applicable

technique – one of modular expression that allowed space to become adaptable, keeping up with the ever changing typology.

Although theoretical, the changing of typologies incubated solutions to the lack of humanization and multi-functional spaces in industrial architecture. In reality the "industrial culture" also morphed to some extent in first world countries (America, Europe and China) leaving behind derelict industrial parks, especially in the developing countries where the diversity of the economy was not of such a nature that it could infill activities to replace the original programme. Separation from context, landscape and urban framework has left these industrial spaces deserted.

Contemporary industrial architecture is often combined with the paradigm of sustainability, an industrial culture of reuse, minimum waste programmes, low energy inputs and re-adaptation. The reuse of derelict sites and structures so as to keep the industrial heritage intact and remember the cultural attributes of a once modern or culturally significant factory is a fast growing trend and a solution to the ever growing burden of brown-field sites, and the irreverent and irresponsible use of Greenfield sites. The re-interpretation of the architectural form becomes the main focus of this paradigm as the building infrastructure is already in place and the most of the existing structure is not demolished but reframed and redesigned for new programmes. These principles of reuse

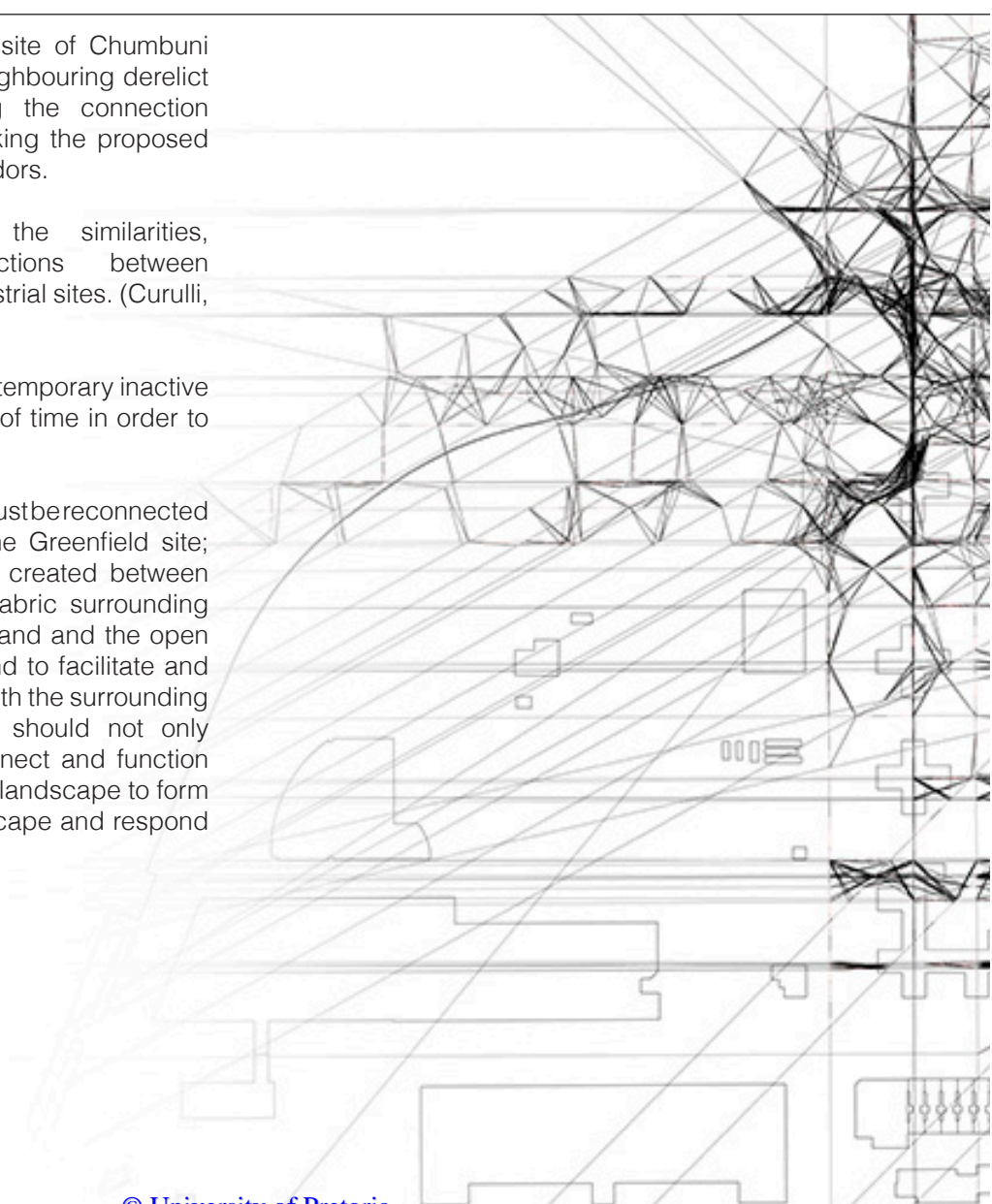


can benefit the Greenfield site of Chumbuni as it can start to use the neighbouring derelict Brownfield site, enhancing the connection made between them by linking the proposed nodes creating activity corridors.

Irene Curulli discusses the similarities, deviances and connections between agriculture and derelict industrial sites. (Curulli, 2006:33)

“...industrial wastelands are temporary inactive lands, left bare for a period of time in order to recover natural fertility.”

The existing Brownfield site must be reconnected and reused in relation to the Greenfield site; a public threshold must be created between the dense physical urban fabric surrounding the derelict industrial wasteland and the open piece of fertile pocket of land to facilitate and connect the new built form with the surrounding context. The architecture should not only house the program but connect and function freely within the context and landscape to form an integral part of the landscape and respond appropriately to the context.



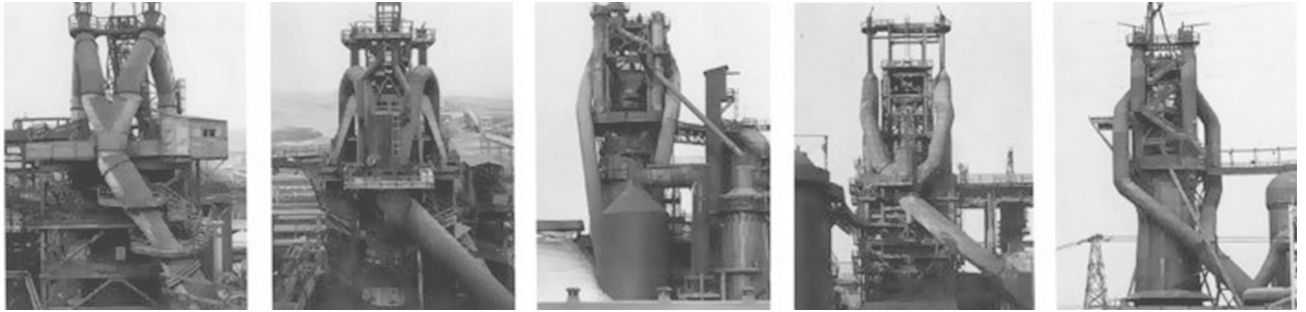


fig. 06.01_Bernd and Hilla Becher, industrial architecture of western europe, families of motifs, 1959

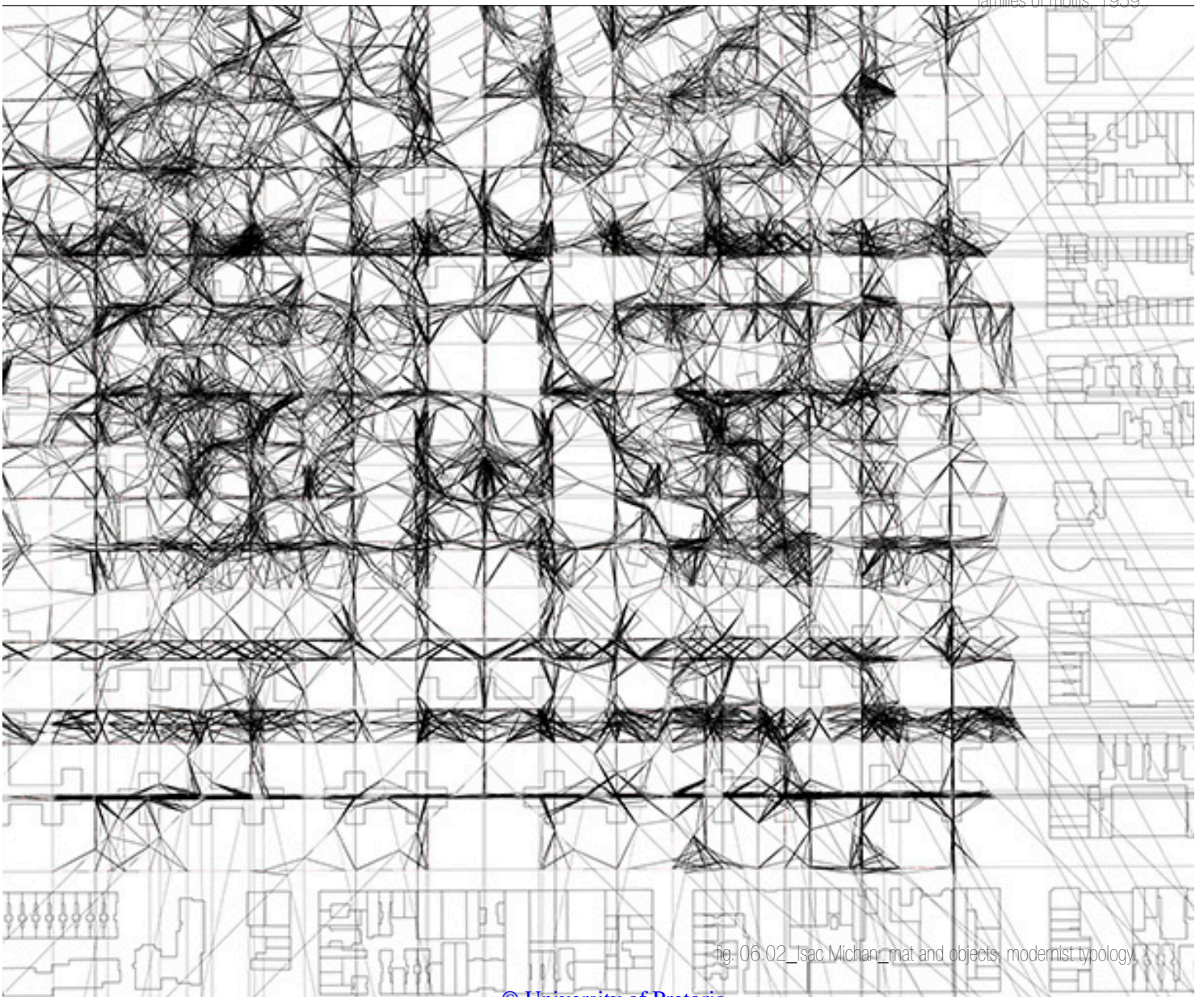


fig. 06.02_Isac Michan_mat and objects, modernist typology

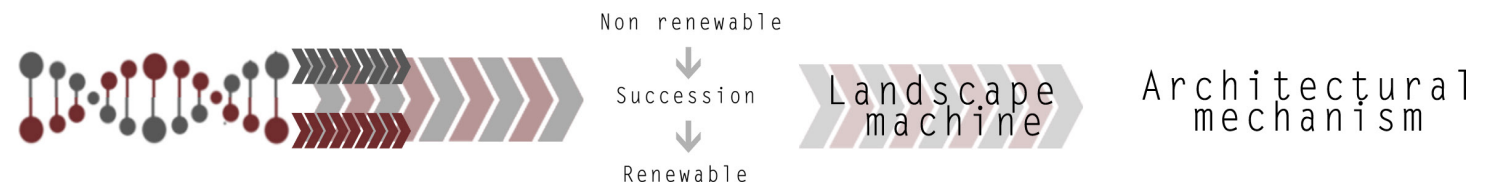


fig. 06.03_Diagram of Architecture and Landscape architecture combined to form architectural mechanism.

Landscape urbanism is a relatively new phenomenon compared to Urbanism, a discipline that moves away from the traditional constructs of urbanization and urban design. The urban condition in the Chumbuni area presents a number of issues (as previously discussed) for resolution in the site development.

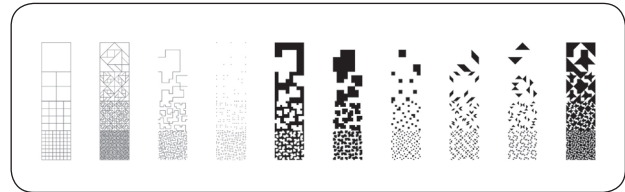
Landscape urbanism with its relative complex structures (addressing conditions of infrastructure, water management, biodiversity and human activity) act as a guide; influencing the design process when with regard to the community and its interaction/ close engagement with the urban condition (examining the implications of the city in the landscape and landscape in the city)(Corner, 2006:25)

Landscape urbanism has the ability to contribute to its immediate context in such a way that the communities can interpret and understand the conditions in which they are located, enabling them to engage with the landscapes and the architecture, as well as with the transitions between conditions. The end result is projected to be that the communities influenced start to understand the importance of resilience, resilient systems that can benefit the infrastructure, the economy of Zanzibar, the urban community and private individual families. The design of the facility in this dissertation will include a combination of infrastructural urbanism and Mat urbanism. Mat

urbanism suggests abstract architecture that creates a “thick” surface and hybrid building designs that can both accommodate and reinterpret the architecture and the landscape architecture.

Infrastructural urbanism controls the future activities by promoting the design and the use of artificial ecologies rather than solely exploiting the existing environmental conditions, integration as a single system is thus achieved.

The integration of the urban context, landscape architecture and architecture will form a mechanism that synchronises the linear production systems of man within the “natural urban landscape” of Chumbuni.



06_03_Architecture to become the courtyard.

The nature of a courtyard structure has been used in the organising of space for millennia, manifesting in a number of cultures – the first records of courtyard design dates as early as 10,000B.P.(Neolithic Yarmukian site) The courtyard system is one of Zanzibar’s foremost architectural features, allowing for climatic considerations to be included in the design, thresholds to be incorporated between private and public spaces and has an influence on the cultural means of living (Garfinkel, 1993:115-134).

The distinction between form and shape proves useful to the proposed scheme, where form refers to the fundamental organization of space and shape. For example, changes in shape or material are less fundamental than the relationship between spheres of spatial influence. A second theme that manifests in the form/shape relationship is one that involves an important attribute of courtyard spaces: the distant privacy mechanism. The mechanism mainly emphasizes privacy of a space where the outside physical elements are within visual range, yet not physically intrusive.

The courtyard could therefore be seen as illustration of a relationship between the private and a public domain. The courtyard also establishes a basis for important subsystem of setting/contextualising factors to be incorporated (meeting place, place of public and private interaction and place of cultural/religious events).

Within these systems, creating a hierarchy between spatial arrangements (the idea of a courtyard within a courtyard furthers the concept of a system within a system where each influences the other). Within these spaces, specific activities occur as part of a larger system of activities, which function within a larger set of activities. In this way the physical courtyard structure in perpetuity mirrors the interconnectivity of programs within the scheme.

The third important feature of the courtyard system is that the courtyard space itself allows for access from the central space to the outer spaces (the shape of the conventional courtyard space was determined throughout the ages with various connections to religion, tribes, culture, region and modernization of living) (Siravo, 1996:52-66). The three contributions to spatial arrangement allowed by courtyard design (namely privacy, setting and access) can be categorized accordingly. The dominant attribute is the privacy mechanism (allowing the private and public to be separated using the courtyard as a threshold from public to private), secondly the courtyard as the setting/contextualising factor (activity node) and finally the courtyard as a means of access (connecting the different realms, private, semi-private, semi-public and public).

There are various building methods that make the construction of courtyards possible.

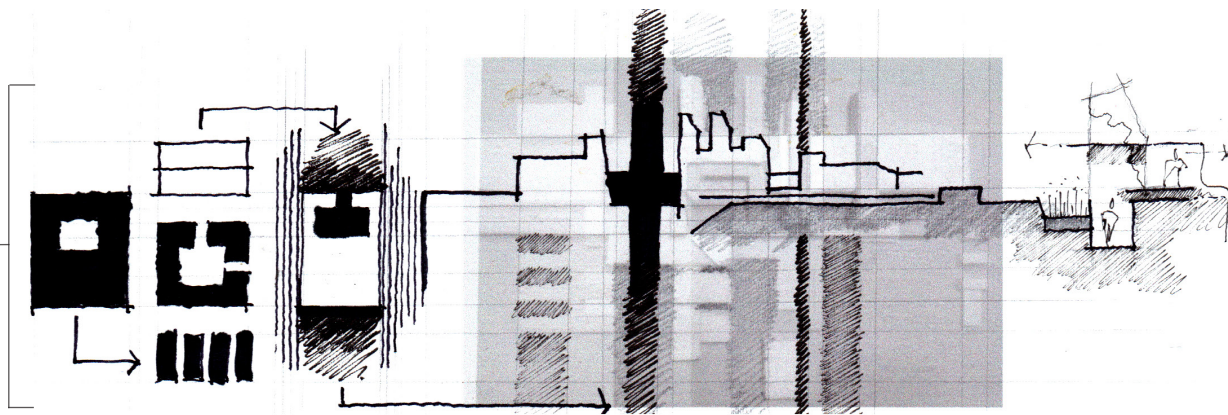


fig. 06.04_Conceptual courtyard exploration.

In Zanzibar, the traditional Swahili houses, the Omani courtyard systems and the modern Swahili systems are a few. [Describe each one, perhaps?] When observing the different architectural expressions, the courtyard is often situated relatively close to the middle front parts of the buildings. These courtyard spaces group private spaces with more semi-public spaces toward the entrance of the houses. The entrances are fitted with Baraza's that form part of an important architectural feature in the design of Zanzibar buildings. The Baraza's (seating area in front of the building before entering, a place for public interaction and recreation) are elements positioned on the façade of the building which contribute to the detailed streetscapes (more common within the City of Stone town rather than the Chumbuni area). Many courtyards in Zanzibar are used for the practice of religion and the housing of small farm animals (Siravo, 1996:52-66)

As the courtyard forms an integral part of the Swahili culture, prevalent in Zanzibar (Siravo, New planning framework, 1996:116-137) thresholds are carefully articulated to ensure that spaces are experienced according to the purpose of each individuals' visit, as part of a journey through space – a dynamic exercise rather than a static one. A journey from the market to the central courtyard and beyond is intended to gradually change one's perception of scale within spaces (from the dense urban condition to the vast open space) to integrate the landscape whilst providing a platform where each activity, person, space and program have learned to coexist.

The Agricultural Research and Educational Facility will rely on thresholds and building grains to incorporate the diverse aspects of the site, the program, the site inhabitants and the environment at hand. Similar to the functionality of courtyards, thresholds can communicate the spatial language that not only forms a connection between industry and architecture (similarly to the distant privacy principle), but allows for the architecture to become the courtyard within this vast open land that is currently isolated.

Agricultural research and educational facility

Precedents [07]



07__Precedent studies.

07_01_Unilever Indonsa plant.

The precedent studies that follow were chosen based on how each study can inform the design process. The information extracted from the studies focuses on the fundamentals of the dissertation, namely programme, climate, form, materials, context and technology.

Riverhorse Valley, Durban, completed September 2011, Elphick Proome Architects.

This precedent study had a number of architectural features that gave inspiration to the design process of the proposed facility dealt with in this dissertation. The Unilever building explores industrial art, form and energy-efficient principles.

The Unilever building can be described as an “industrial art piece” and a landmark for the food industry in South Africa. The building is divided into research facilities, offices extending into the facilities, and savoury dry food plant. A concordant architectural language was the key design principle and is displayed at a variety of scales. The concept for the Unilever building is a formal metaphor in abstract reference to the conveyor production lines. The offices are laid out to form an interlocking conveyor belt that is iconic to the concept of production. The major focal aspects of the Unilever design were the embodied sustainable principles that were integral to the large scale design. Maximized use of natural light, management of thermal loss and gain, water usage, air treatment and deployment of materials were key elements in the design.



fig. 07.01 _Image of offices of the Unilever Indonsa plant.



fig. 07.02 Perspective of glass and structural work at the offices



fig. 07.03 Aerial photo of the Unilever building, office block (left) and industry (right).



fig. 07.04_Perspective of the offices

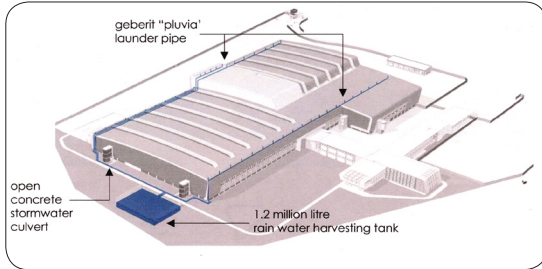


fig. 07.05_Water strategy.

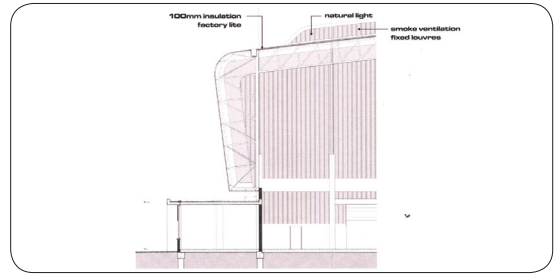


fig. 07.06_Warehouse storage enclosure system.

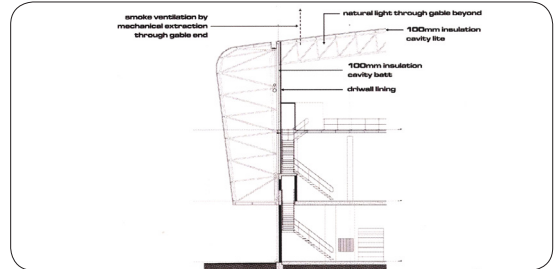


fig. 07.07_Production area enclosure system.

07_01_01_Sustainable water principles.

The main aim of the Unilever project was to increase supply whilst reducing the carbon footprint. One of the most fundamental features of the building is that it is the first plant worldwide to be completely water neutral. This is achieved by a number of sustainable macro-systems; the Unilever building boasts a 22 000 m² roof for rain water harvesting, and the abundant amount of water is stored in a million litre storage tank under the ground in subterranean water tanks. The water resources and technology allows for the building to reuse 70% of the water at the production facility. Grey water is recycled and treated to obtain drinking quality by means of biological systems and reverse osmosis. All the water systems are installed and operate separately to ensure that there is a continuous supply of water for production.

07_01_02_Heat and light principles.

A large number of embodied energy reductions were made to the Unilever building: steel was replaced with sunscreens to reduce the use of aluminium roof sheeting. The enormous spans in the factory were justified with a deep vertical truss system to ensure less use of steel and greater spans. Connected to the truss system, fixed louvres and polycarbonate sheeting were used to optimise diffused natural light and ventilation through the factory. The offices are fitted with performance glass and fixed sunscreen louvres that respond to the façade's orientation, allowing for as much natural light as possible but eliminating the ingress of direct sunlight.



fig. 07.08_Air control level 0.

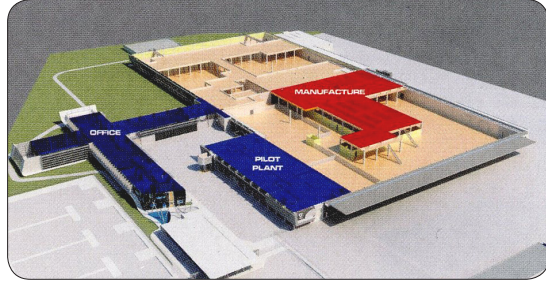


fig. 07.09_Air control level 1.

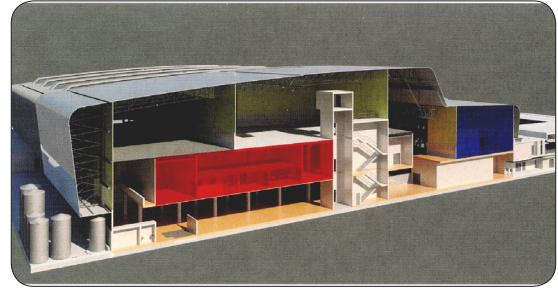


fig. 07.10_Air-treatment zone strategy.

07_01_03_Air principles.

The Unilever building has no geyser and relies on one of the HVAC system chillers for a heat-recovery action imitating that of a geyser. Heat that is extracted from the factory and warehouses by means of the airconditioning system is transferred to the water in the hot water plant by a heat exchanger. The high-efficiency and sustainably designed HVAC system and air-cooled water plant selected (over water-cooled chillers) drastically reduce water usage in the building. A selected portion of the building requires humidity control: This requires overcooling and then reheating the air to remove moisture. This additional heating is also provided by the heat-recovery chillers. Most of the external air is introduced by the use of energy-recovery wheels, which provide consistent cooling of the generally hot and humid ambient air.

07_01_04_Waste management.

Waste is sorted on site and the solid waste is sent for recycling. The organic waste is sent to nearby needy communities that take advantage of the benefits of compost heaps and gardens in their neighbourhoods.

“The broad concept for the building and its main spatial features were developed out of an intention to represent something of the factory process it housed”

[Elphick Proome Architects].

The building in its totality carefully fulfils the goals of high level water neutrality and substantially reduced embodied energy levels through the use of low-maintenance low carbon footprint materials.

07_02_Materiality in four climatic zones. Gorongosa Biodiversity Scientific Service centre in Mozambique

Crafford and Crafford Architects' projects are situated in a variety of social and natural environments. Most of their projects are mainly focussed on the sub-Saharan Africa region. Although observing their past projects in different climatic regions (arid, mountainous, bushveld and coastal biomes) there is a well-defined thread that runs through each individual project: each of the specific designs is exceptionally responsive to the specific local context and environment. The designs are also mainly influenced and driven by the manipulation of local materials and methods/skills that they see as commonsense architecture.

Site analysis at the beginning of each project forms an integral part of their design methodology. This analysis include ecological analysis, climatic data, vernacular architecture and analysis of local cultures, assessment of local skills and methods, and a detailed researched analysis of local materials.

The way materials are used within the design process is evaluated on their availability, distribution, transportability, reusability, renewability, local uses and contraction methods. This firm is especially conscious of the impact materials can have on experience and comfort.

Gorongosa Biodiversity Scientific Service centre in Mozambique, Crafford and Crafford Architects.

The need for durable construction materials and availability is a major challenge in more remote tropical areas. Most often buildings in tropical areas built with local materials need to be augmented by lightweight construction materials shipped in from elsewhere. At the Gorongosa Biodiversity Scientific Service centre a termite proof lightweight steel construction is combined with local palm tree planks. The palm tree planks also give the building a handmade personality.

In Gorongosa, the temperature seldom drops below 20 degrees Celsius in summer night time and can rise above 40 degrees Celsius in the height of daytime. The major design challenge was to keep scientists cool whilst they conduct their research. The only natural way of cooling down buildings/structures in hot humid climates is through wind movement. Buildings in the Gorongosa Biodiversity Scientific Service centre were all designed to allow for optimal airflow by using cross ventilation. Roof structures were designed to form and act as a chimney allowing rising hot air to escape the building faster. The building is raised 500 mm from the natural ground line to prevent flooding whilst this also allows for cooler air to enter from below the building, mimicking the ventilation system of a termite mound.



fig. 07.11 _Section through offices resized.

In all of their projects, materiality and the use of materials form the basis of the end product. They strive to introduce a variety of systems for each project as each project has to blend in with the environment and mimic the geological features and vernacular architecture according to the project's locality in order to be considered a success. In all of these circumstances the natural materials and crafts/vernacular building traditions become the most apparent features.

Crafford and Crafford Architects see nature as an asset, with which a building can conduct a dialogue and become a contributing entity within its surroundings.

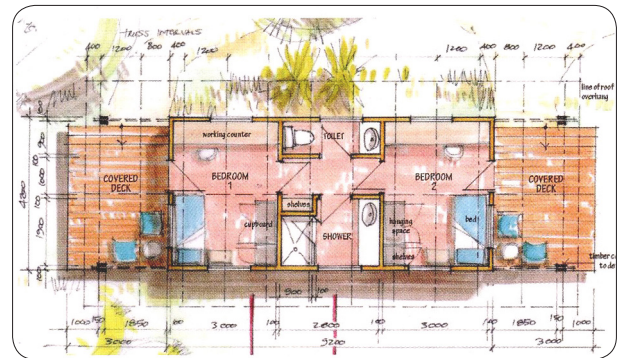


fig. 07.12 _Gorongosa floor plans.

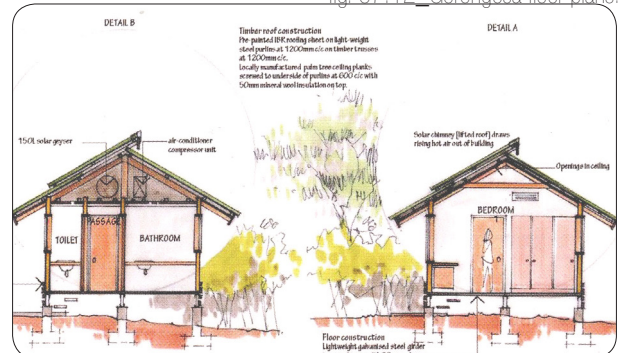


fig. 07.13 _Gorongosa sections showing materials.

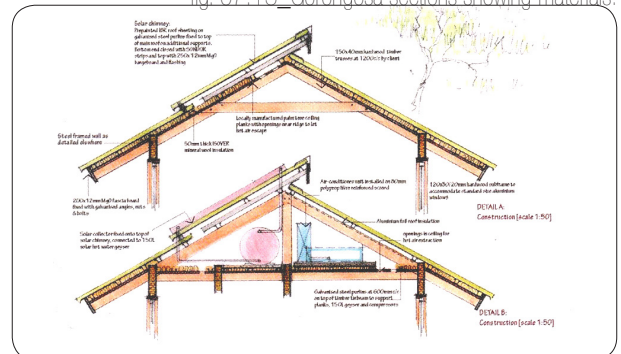
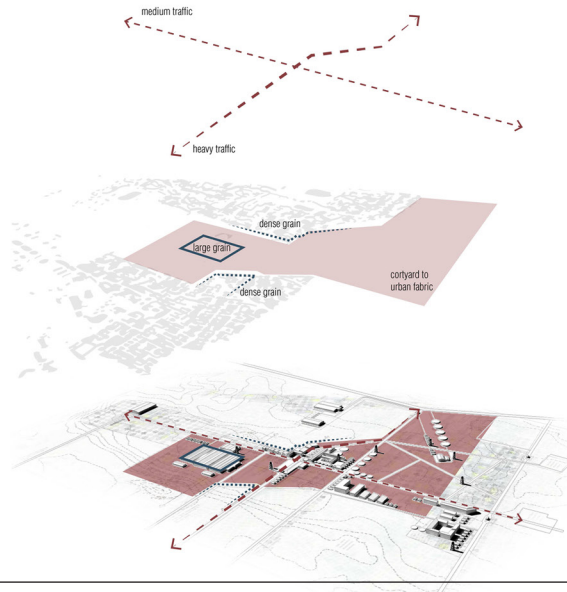


fig. 07.14 _Gorongosa roof construction.

Agricultural research and educational facility

Design [08]



08__Design development.

08_01__Design drivers.

The main design informants of the agricultural research and educational facility can be divided into two main categories: firstly, the impact of the context, site and history of agriculture in Zanzibar and secondly the concept of connecting public, industrial and private interfaces. Before the two main design drivers can be discussed, some practical and legislative elements need to be addressed. The general layout of research facilities, formal educational and industrial areas must be understood to allow spaces to integrate coherently – publicly and privately. Equilibrium is to be established between the public interface of markets, education and the semi-private research, industrial spaces.

Early design drivers to be addressed.

[01] The agricultural research and educational facility has to comply with the legislation and standards of the Department of Agriculture and the Department of Urban and Town planning of Zanzibar [Zanzibar Investment policy (ZIP), 1986 – 2000].

[02] The building should be orientated to allow for maximum environmental performance, allowing the living component to efficiently utilise direct sunlight and indirect sunlight, as well as ventilation for the research of crops that can survive without sunlight, and ultimately to become familiar with how to utilise these spaces. The building is orientated to the north to take advantage of northern solar exposure

for natural day lighting. The northern façade is designed to allow for passive extraction of hot humid air whilst the southern winds are utilised to drive passive cooling systems.

[03] The production process of cassava, rice and other vegetables, combined with the major water process envisioned to animate the building, are conceived of in terms of production lines. Detailed orientated processes have aided in the design layout of the production and research facility. The water processes, for instance, form a linear system that runs along the main central axis/channel from the east to the west of the site.

[04] The conceptual connection and integration of the landscape, recreational spaces and production activities to the north interact most obviously where the main streets connect these activities (north to south) with the public interface of the architecture (with an east-west orientation). These links form activity nodes within the site, were main links cross larger nodes and public interfaces are formulated. These nodes have been considered and analysed for their potential to become courtyard spaces.

[05] The design should be manipulated to incorporate and interact with surrounding communities to reuse the derelict industrial area to the north. The reuse of the concrete fence as a public threshold rather than

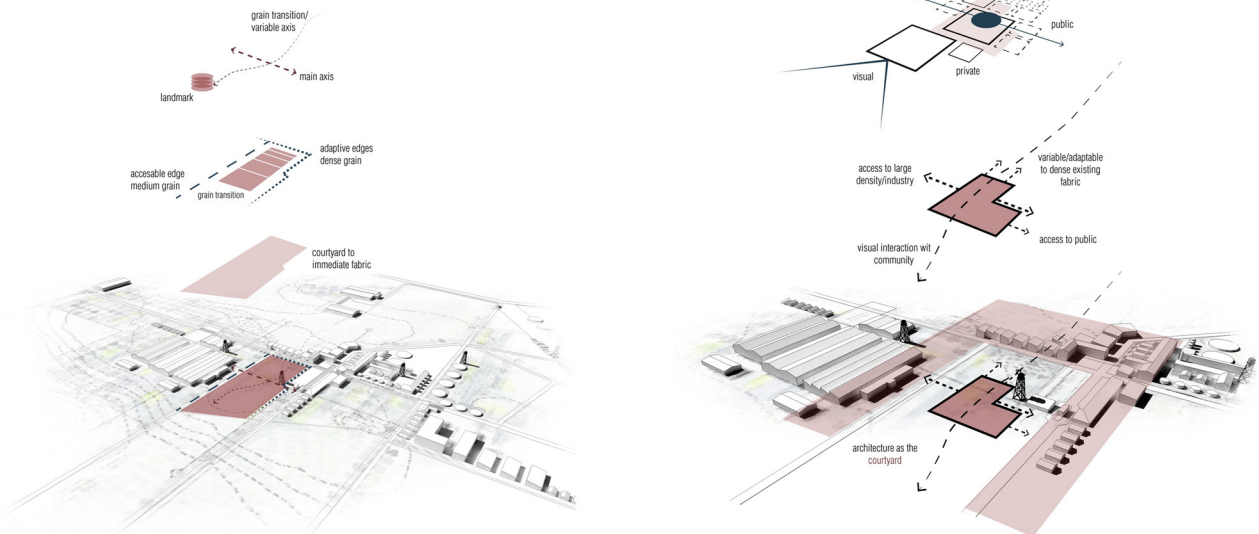


fig. 08.15 Diagrams illustrating the connections on site, context and how the concept development can function within the site.

a boundary separating the site from the context, is another design aspect that this scheme explores.

[06] As discussed in the detailed programmatic chapter, the agricultural research and educational facility has an intensive water demand and subsequently, a considerable treatment system. Water storage, reuse and catchment areas guide the design decisions from the beginning of the process. The retention dam to the east of the site functions as a storage facility where water is fed to the building and moves through a number of processes to return to its natural state. The resilient and environmentally sound principles employed in the design's physical expression will allow for locals to observe the importance of self-sustaining values/practices and the influence of food security and potable water. The site will in reality be using the facility as an interactive incubator for the betterment of the surrounding community.

08_02_The context as a design informant.

The proposed urban framework led the author to a rectangular site of almost 30 000 square metres, situated toward the northern part of the site. It is surrounded by main roads at the north, west and south and connected to existing informal settlements to the east.

The main transport hub forms an axis from here through the public square, the agricultural research and educational facility, landscape interventions and production, and ends at the large scale production facility to the north. The site consists of a retention dam on the eastern edge of the site (approx. 2 000 m²; 6 000 000 litres) and one municipal bore hole.

Alongside the main transport hub, micro-industries populate the southern boundary and on the eastern boundary, markets form an interactive edge. The road connecting the architectural intervention and the landscape architectural intervention will be punctuated by a small public square connecting the agricultural hub with the landscape intervention. The western edge is a threshold leading to private and commercial agricultural fields connecting the existing communities with the agricultural hub. To the eastern side of the site across the main south-northern road, the site's tri-generator power plant is situated in combination with biodigesters and parabolic heat collectors, forming a link from the northern road through to the architecture and landscape sites.

To allow for maximum exposure to traffic (vehicular and pedestrian), the site is centrally located to the access routes from the northern and southern roads.

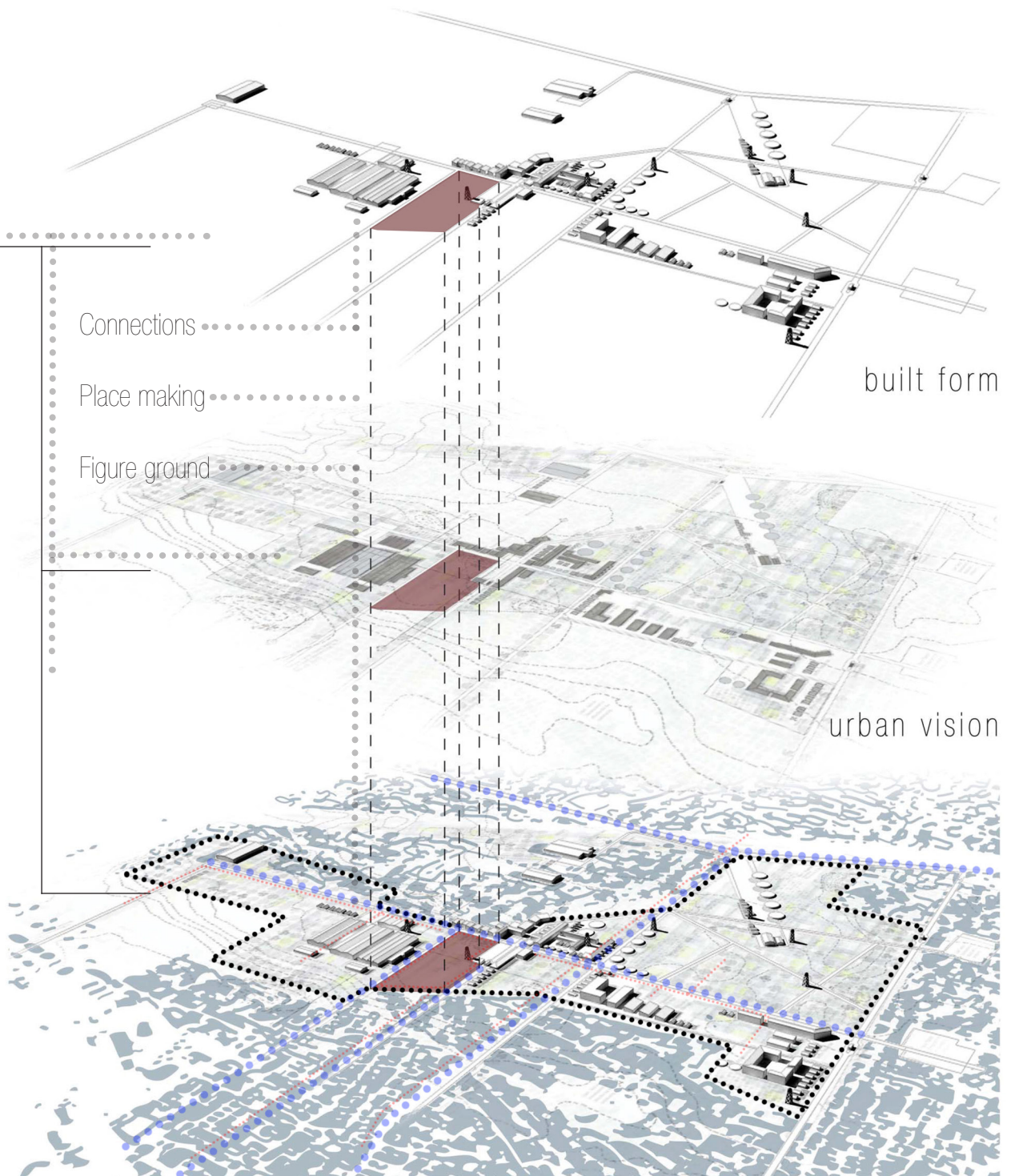


fig. 08.16_Existing fabric with new proposed framework and architectural site.

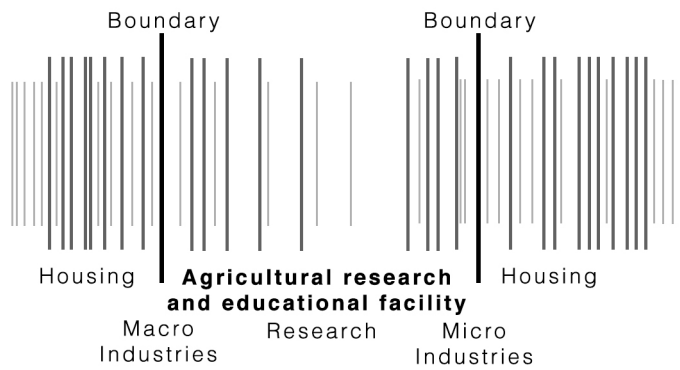
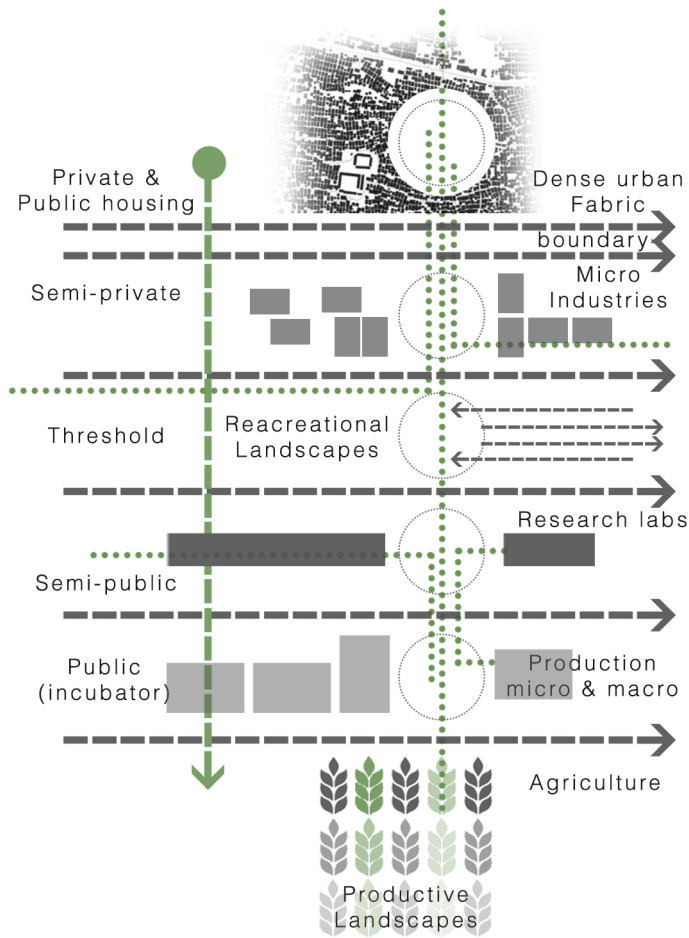


fig. 08.17_Concept development and threshold diagrams.

08_03_Conceptual exploration and planning.

The first conceptual exploration revolves around urban design issues, to reconnect the abandoned site with the existing dense urban context. The aim is to invigorate the site by sensitively removing and reusing parts of the concrete fence boundary. This will allow for a permeable threshold: although some parts of the site will be used for private activities, the open thresholds are resolved with care toward the programme as well as the users. The threshold needs to allow the interaction of the local communities but also ensure that informal housing developments do not expand onto the site.

These explorations established a number of connections that are important from within the site to the nodes surrounding the site. It is preferred to make connections with the main activity nodes and movement axis using architecture as the connecting element, although the function of the building is not only to connect conceptually and spatially, but to form an active courtyard space within the large-scale site. The building in its totality should form a main node, integrated with the surrounding landscape, recreational spaces and productive landscapes. A linear design approach along the two main north-south axes (connecting the main transport hub with the large scale production and recreational spaces) and the east west axis (connecting the urban context to and from the airport, harbour, Stone Town and the inland) forms part of the initial approach.

The east-west axis will also be associated with the retention dam at the eastern edge of the site where the dam will be channelled along both axes to provide water to the site (processed water, enriched with extra nutrients, potable water and water for irrigation to the sites surrounding the specific architectural site).

These strong axes essentially divide the site into four discernible smaller sites, each allocated with a certain programme and with its own minor courtyard spaces surrounding the main courtyard in the middle of the building. The resolution of the courtyards became a main design informant. The courtyards form a large part of the East African architectural typology and more specifically part of the Swahili architecture (courtyards are used excessively in Zanzibar and facilitates their lifestyle, creating space for socialisation, contemplation and rituals). The aim was to identify courtyard spaces within these individual quarters, determine their programmes that connect these spaces to the main central courtyard where it forms part of and interlinks with the remainder of the site. The courtyards will also address the hierarchy of the surrounding context from small private courtyards (informal housing) to larger public courtyards (industrial areas). The four programmed sections still read as a single large linear building with smaller, lighter substructures to the edges (it is however the architecture that becomes the courtyard). These smaller substructures toward the edges bridge the disconnection of

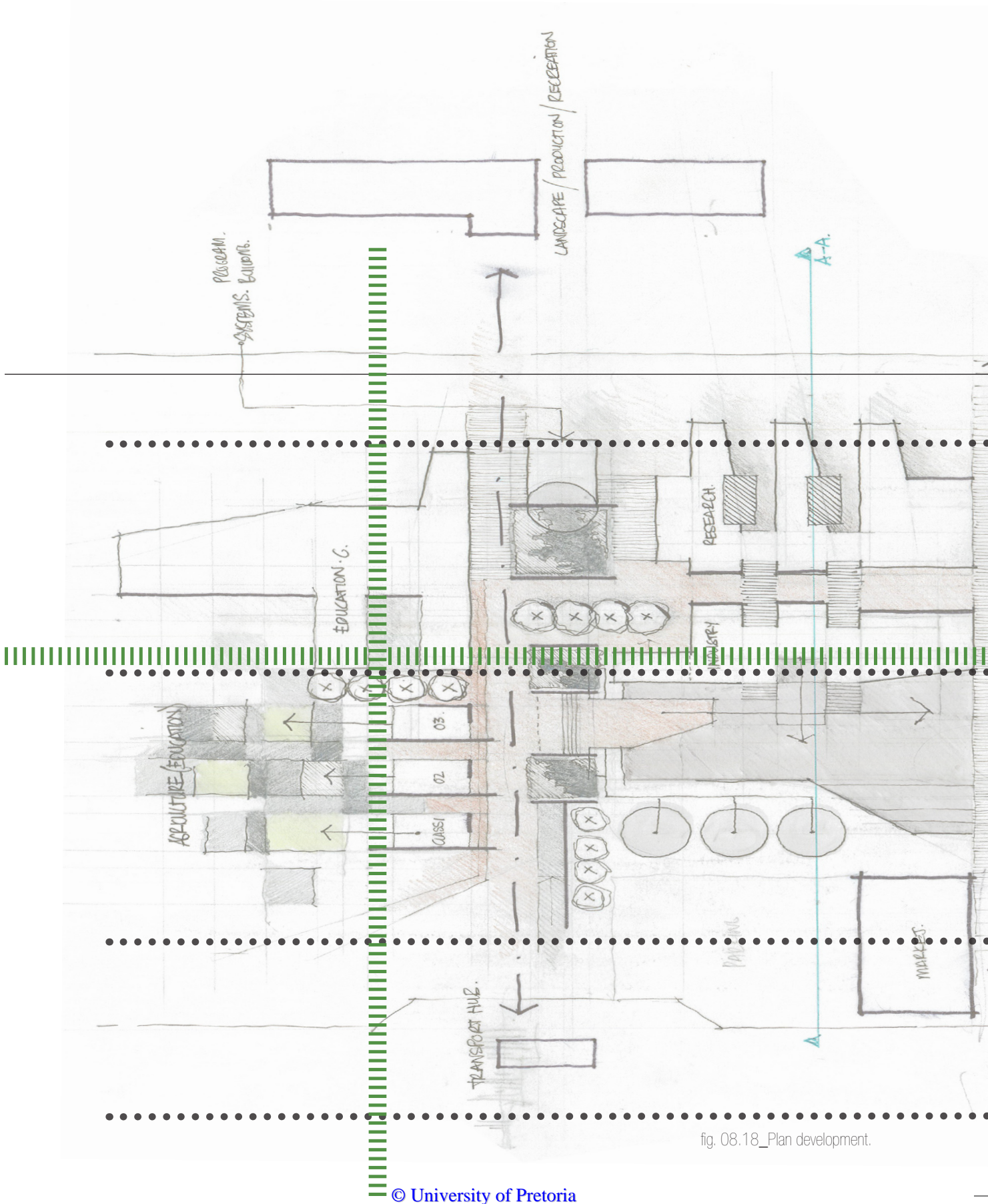
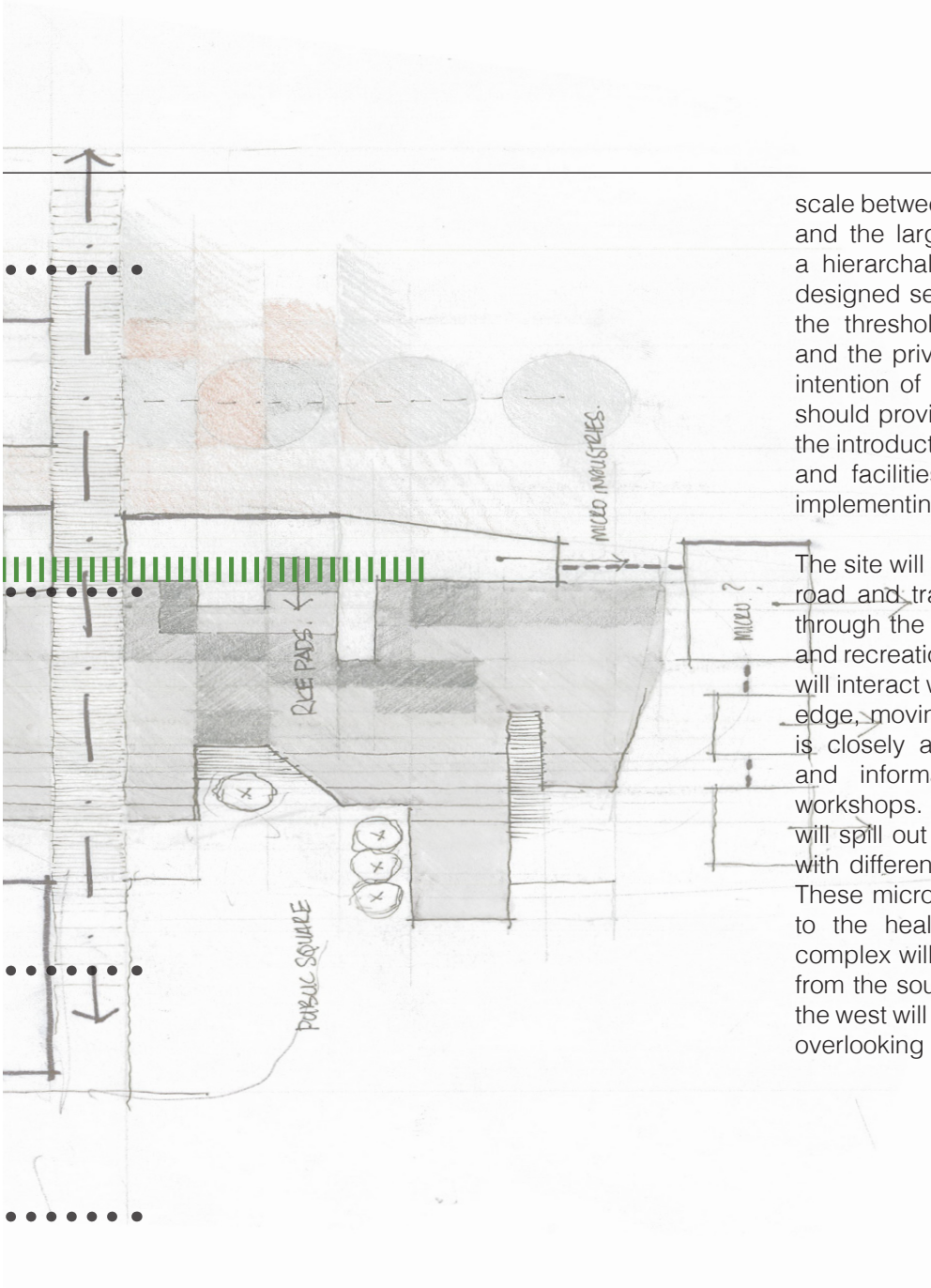


fig. 08.18_Plan development.



scale between the local housing units (existing) and the large industrial warehouses, forming a hierarchal spatial system. This system is designed sensitively as the architecture forms the threshold between the public, industrial and the private housing settlements. It is the intention of the designer that the architecture should provide a new public interface through the introduction of everyday spatial necessities and facilities to create a space of learning, implementing, recreation and providing.

The site will mostly be accessed from the main road and transport hub in the south, moving through the different spaces to the landscape and recreational spaces to the north. The users will interact with a public street market from the edge, moving to a semi-public courtyard that is closely associated with the street market and informal educational classrooms and workshops. The semi-public courtyard space will spill out into the main axis and will be fed with different micro-industries (from the west). These micro-industries are directly connected to the health of the larger industry. This complex will be accessible to service vehicles from the southern main road. The industry on the west will look out on to the agricultural fields overlooking the existing urban fabric.

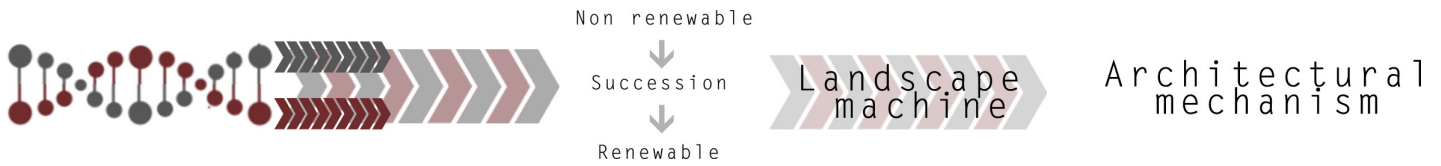
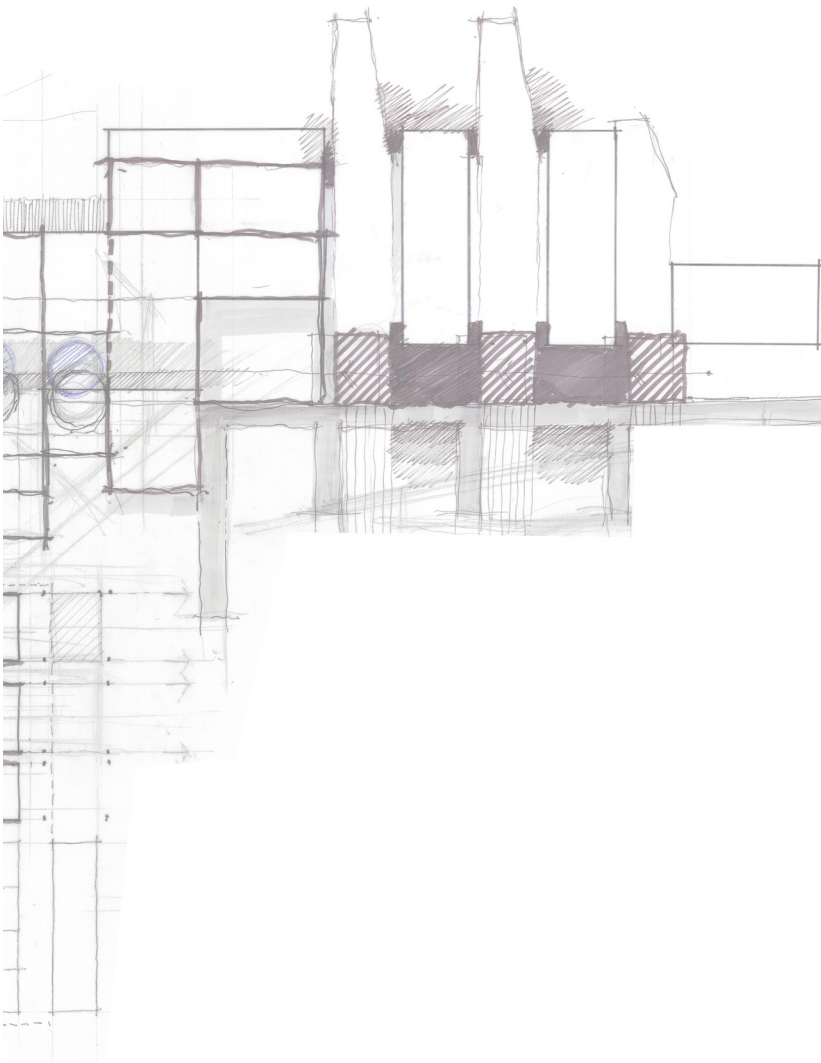


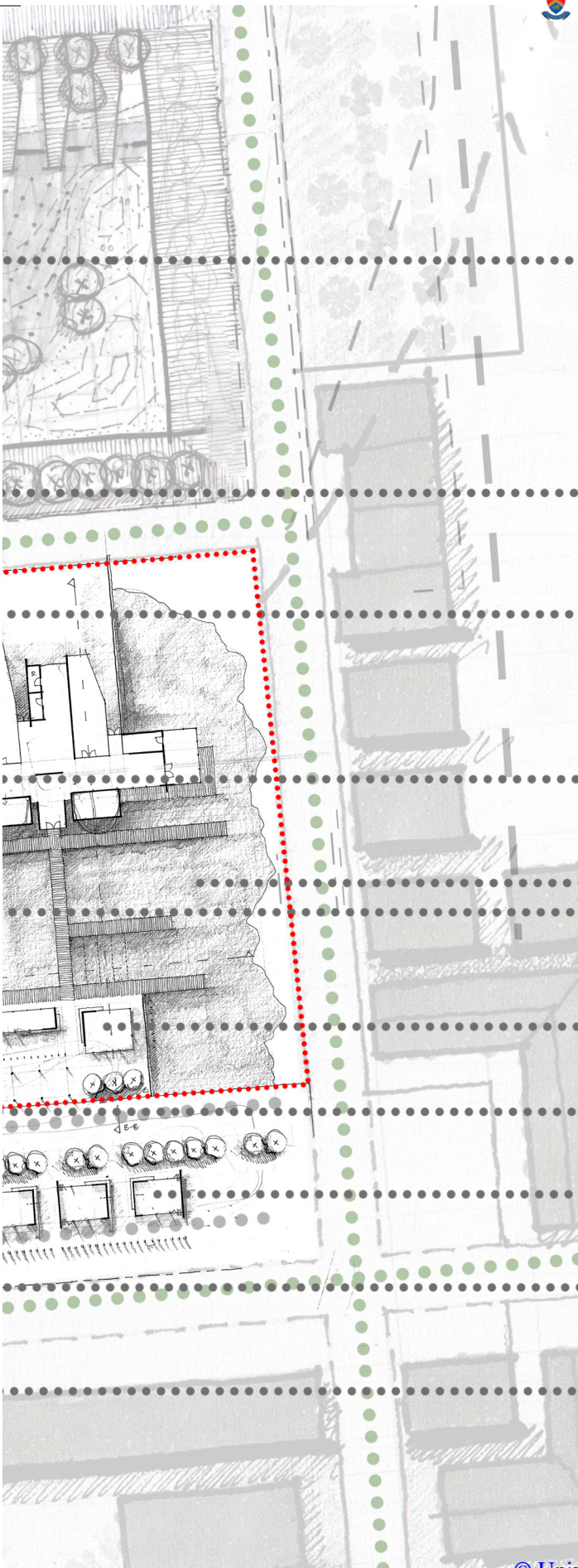
fig. 08.20_Conceptual diagram of integration between Architecture and Landscape architecture.



The cassava fields will be integrated with the linear building toward the northern edge of the site. The design consists of a formal educational facility (associated with the cassava fields) divided by the main courtyard and the research facility to the north-eastern edge of the site. The research facility and the informal educational area are separated by a retention dam (water courtyard) which forms part of the research facility. A local first floor restaurant will connect the individuals within the research facility with those of the formal educational facility. This social space will extend out on to different roof gardens, and as a result will connect the building with the landscape physically and visually (with the agricultural fields on the horizon in the background).

Using a static grid (900 x 900 mm), the design here begins to explore the spatial possibilities on site and begin moving toward a technical understanding of what the intended architecture could become.





Landscape intervention
Urban landscape laboratory

Architectural intervention
Fertile Grain

Covered cultivation pods

Research facility

Retention dam
Main central courtyard

Informal
education/workshops

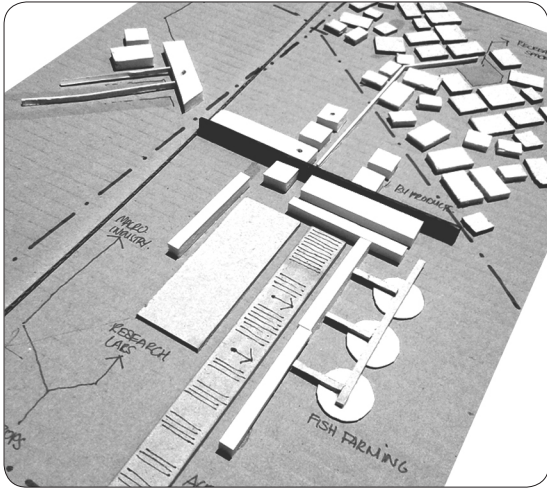
Micro industries

Market

Industry

Formal education

fig. 08.21_Context diagram and Architectural intervention within the context.



08_04_Spatial analysis

Connections.

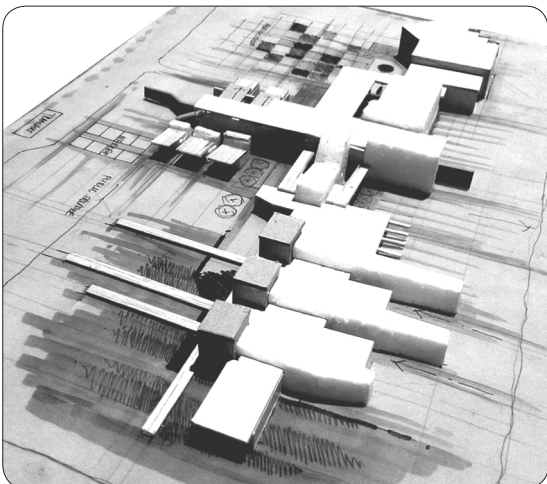
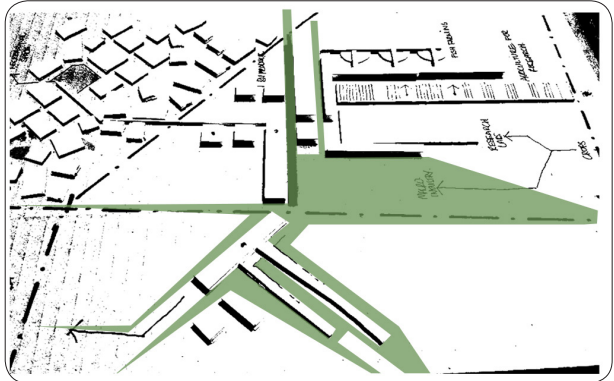
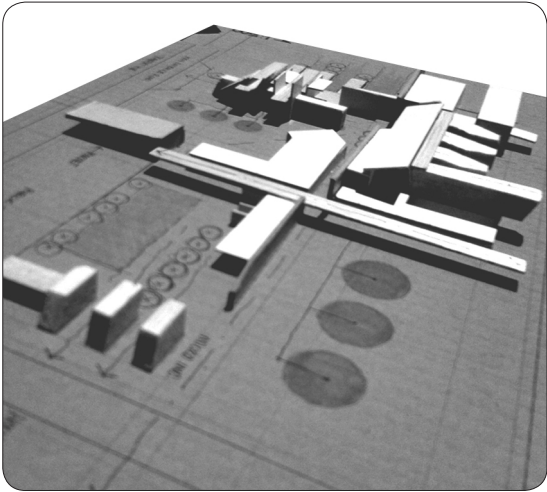
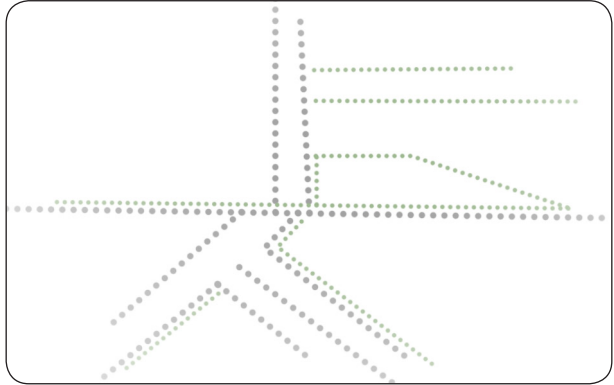
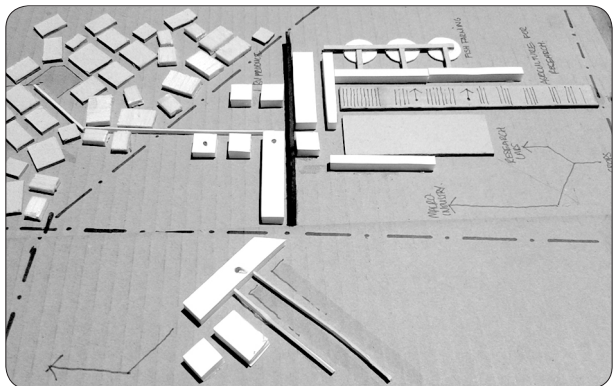
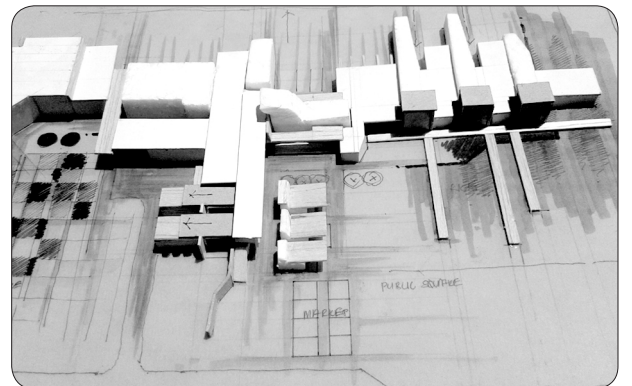
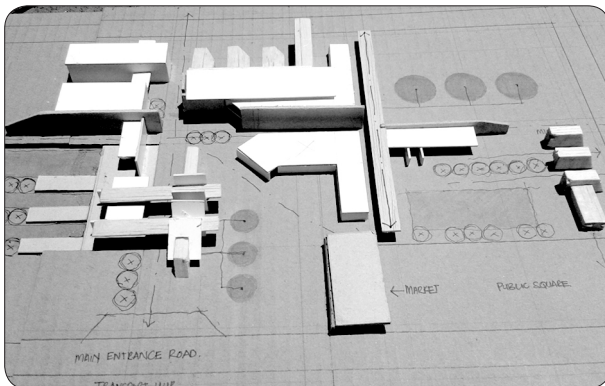
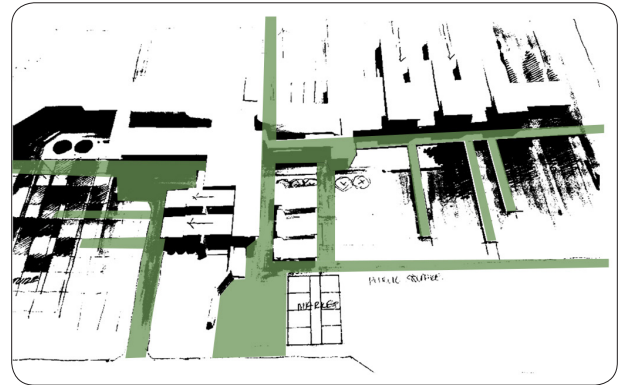
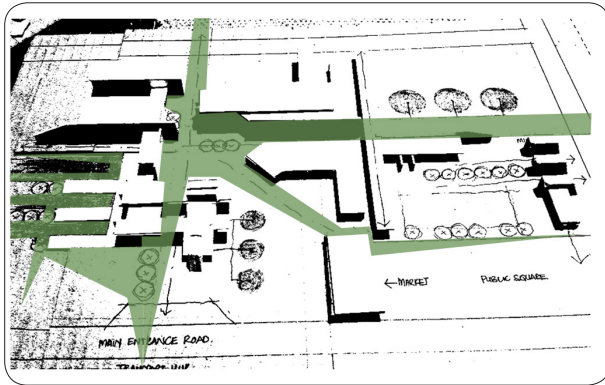
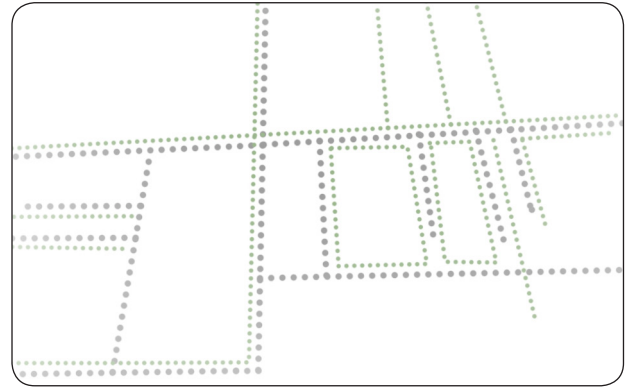
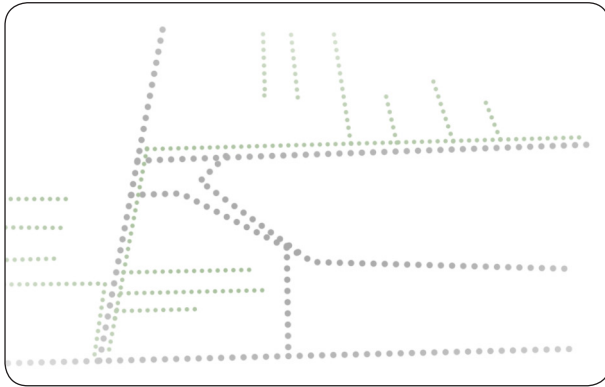


fig. 08.22_Conceptual space exploration.



01_Intention.

fig. 08.23_Intention for space and connection analysis.

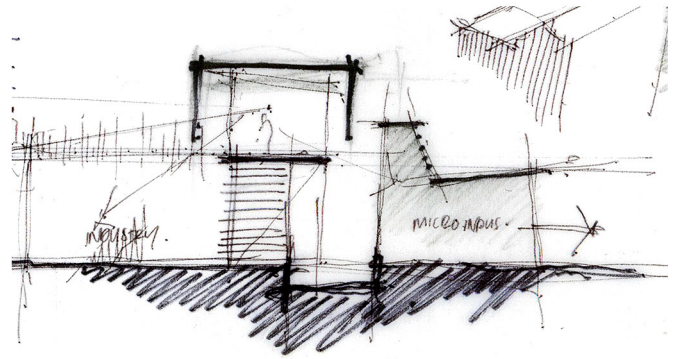
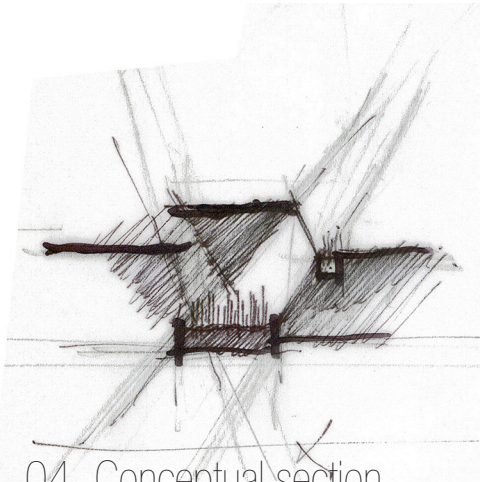


02_first response.

03_second response.

fig. 08.24_First response to space and connections.

fig. 08.25_Second response to space and connection.



08_04_Conceptual section exploration.

The conceptual exploration of the building from the initial concept needed to address the public interface realm and the private industrial realm. The relatively flat terrain of Chumbuni posed a challenge in creating different public and private planes while retaining its ability to create haptic spaces for the user and spectator. As important as the user is in the design of the facility, the architecture needs to allow for sustainable practices. Thus, the design should allow not only for comfortable spaces for the users but also for agriculture to thrive in certain conditions and the requirements of the programme to be fully met.

The response to this consideration manifests in part in the proposal of a large retention dam that will create a level change allowing for basements, cold storage spaces underground and suitable environments for research, methods of testing, etc. that the research facility requires. The building is expressed in three levels: basement, ground and first level. Walkways divide the levels, giving spectators and students visual access to processes, research, and methods of experimentation and production of agricultural produce. The different planes within the conceptual design will allow the user to directly interact with the surrounding agricultural procedures within the architecture. Higher structures will be used to house bird towers for pest control, re-introduction and fostering of bird life, and finally water storage and processing tanks that will later feed purified water to lower systems

in dryer months, using gravity. These tall structural frames will also form visual landmarks within the landscape, combining the landscape and architecture not only horizontally but also vertically.

The design of the section was influenced by environmental considerations, especially those concerning climate control due to the harsh climatic conditions of Zanzibar. The height of the structure and the depth below the ground level enhances the efficiency of the passive design systems introduced in this scheme. Natural lighting, cooling and ventilation are drivers from an environmental point of view; these have resulted in further exploration from a technical approach. A balance is created between the production and processing activities, and the passive systems. It is envisioned that these systems will sustain each other.



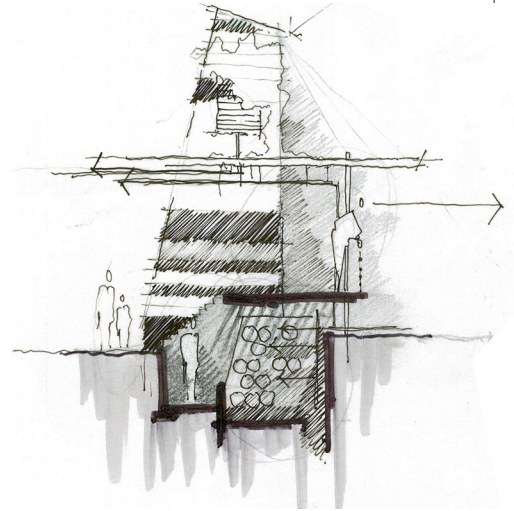
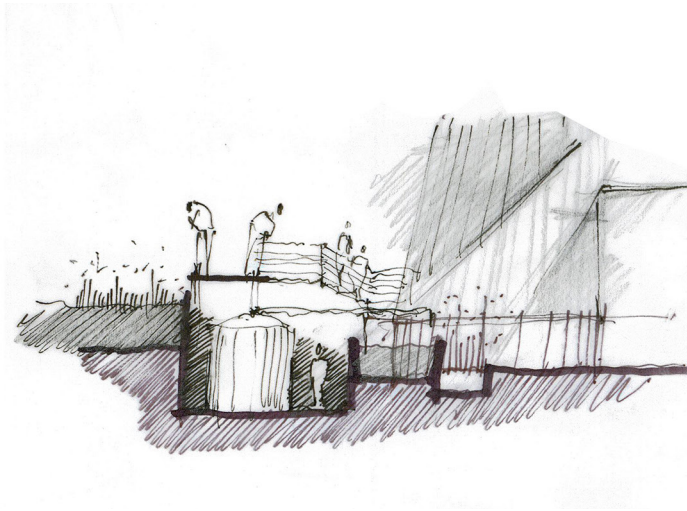


fig. 08.26_Sectional exploration.

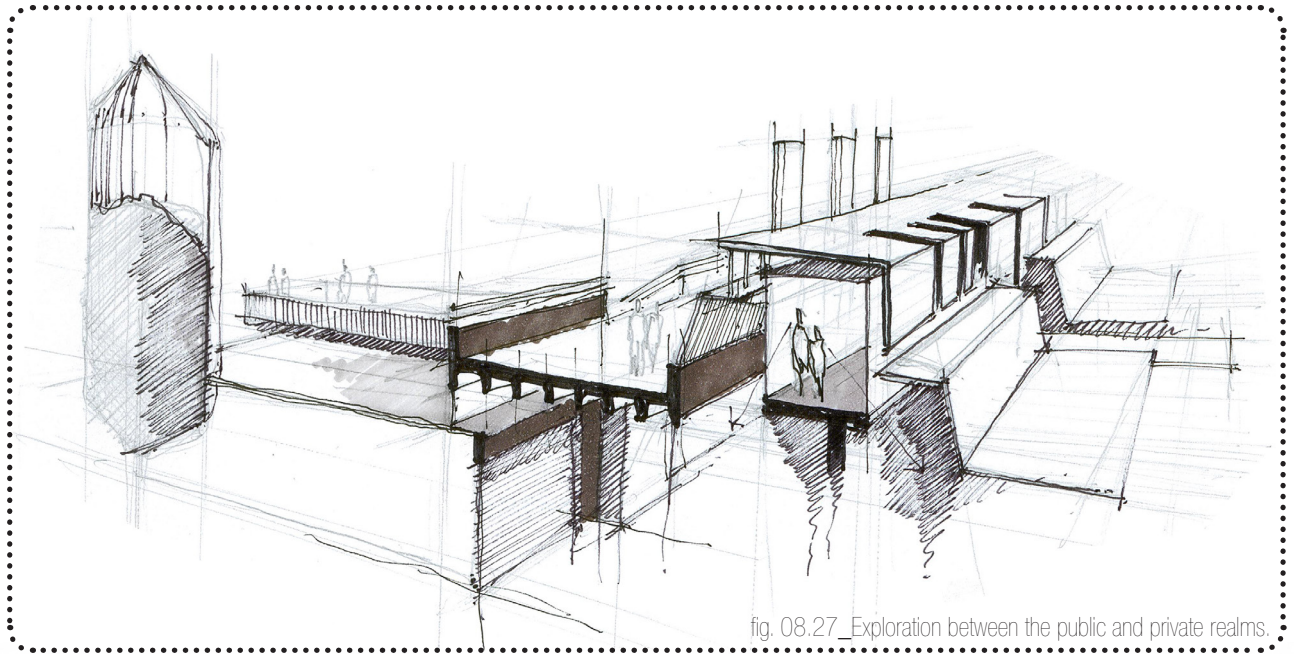


fig. 08.27_Exploration between the public and private realms.

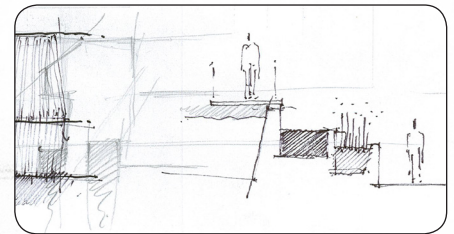
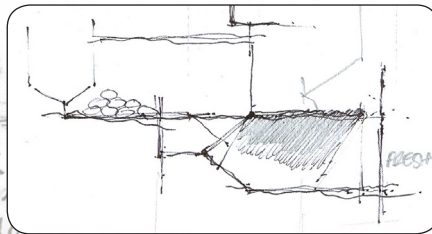
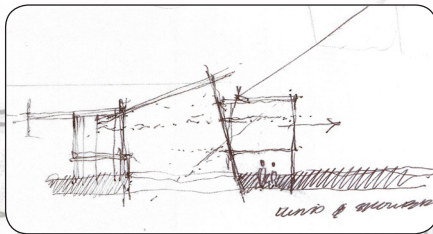
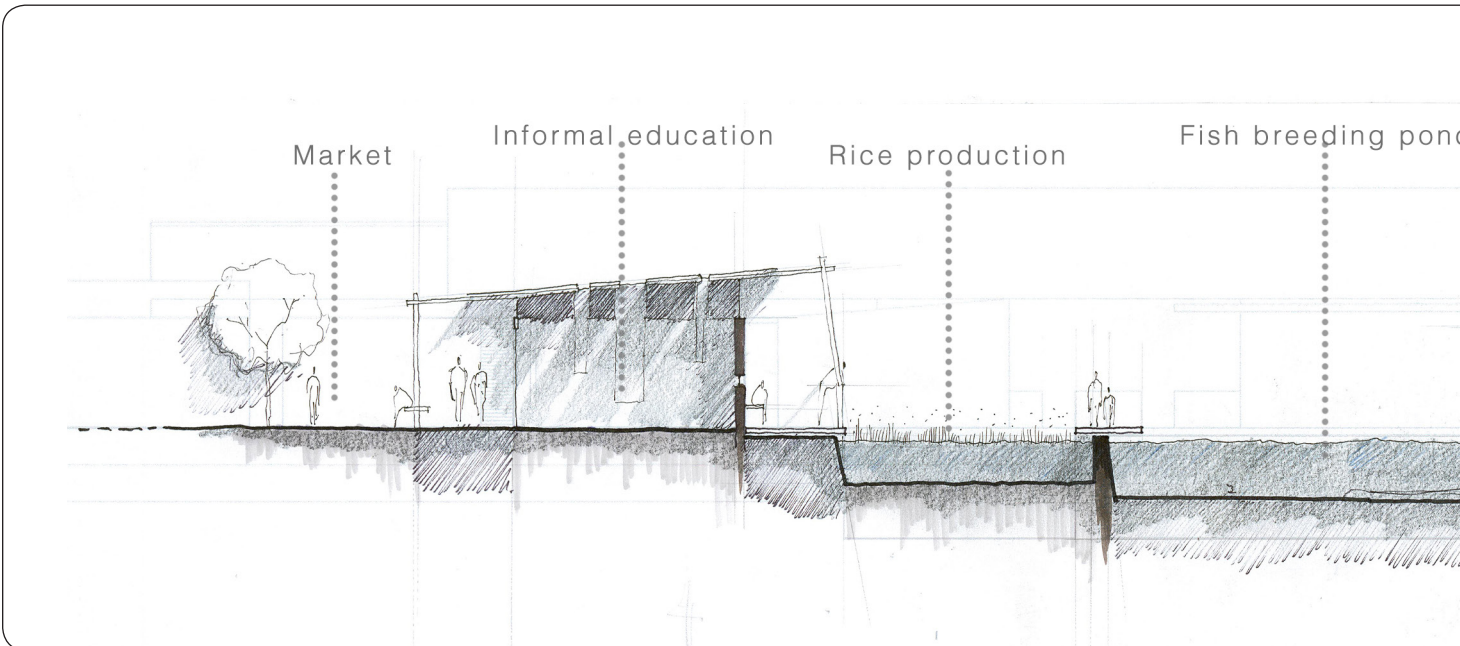
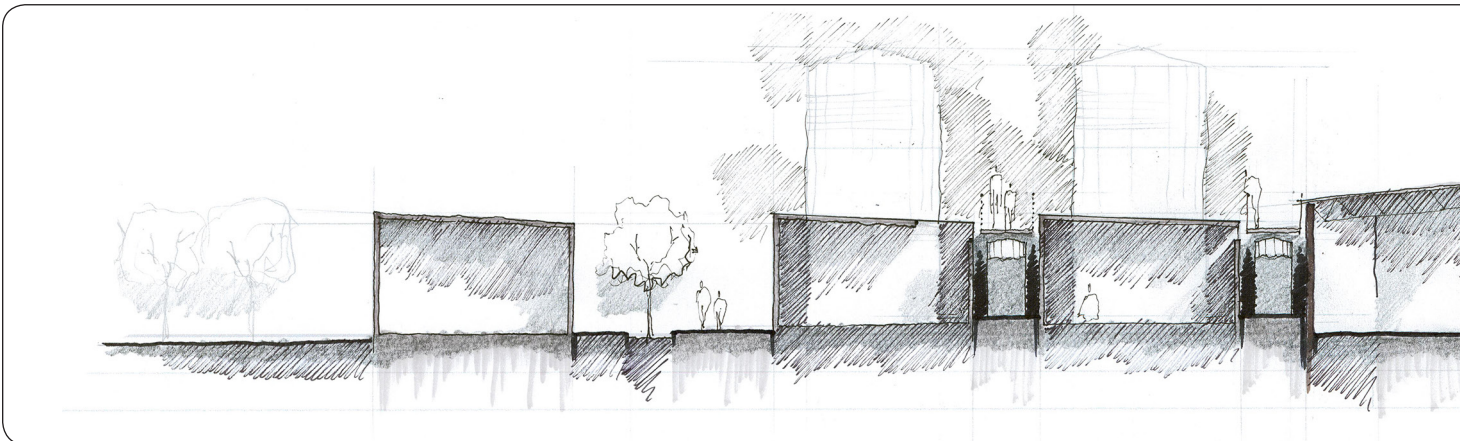
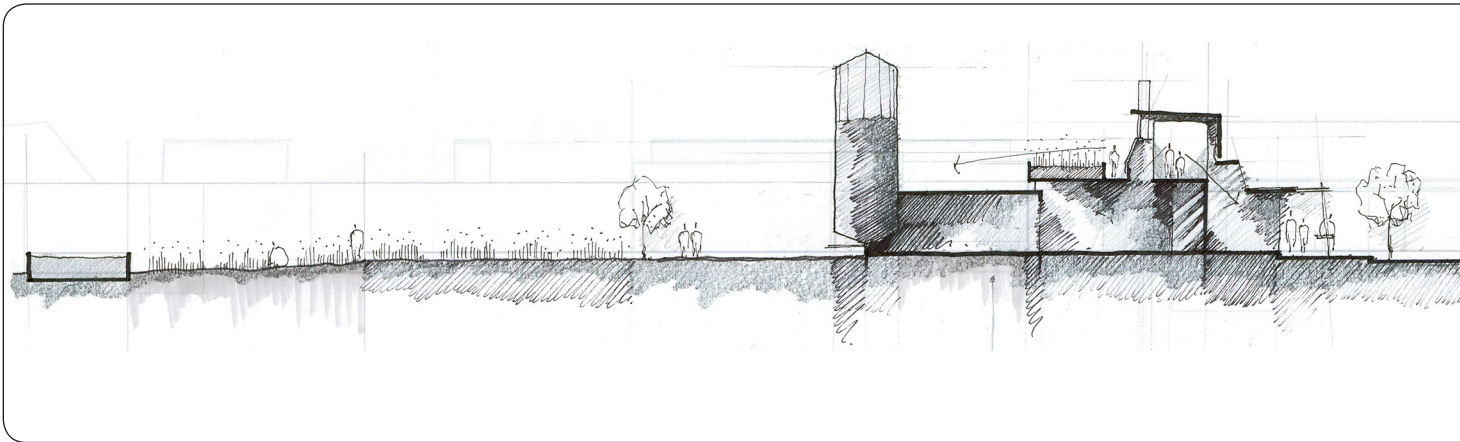
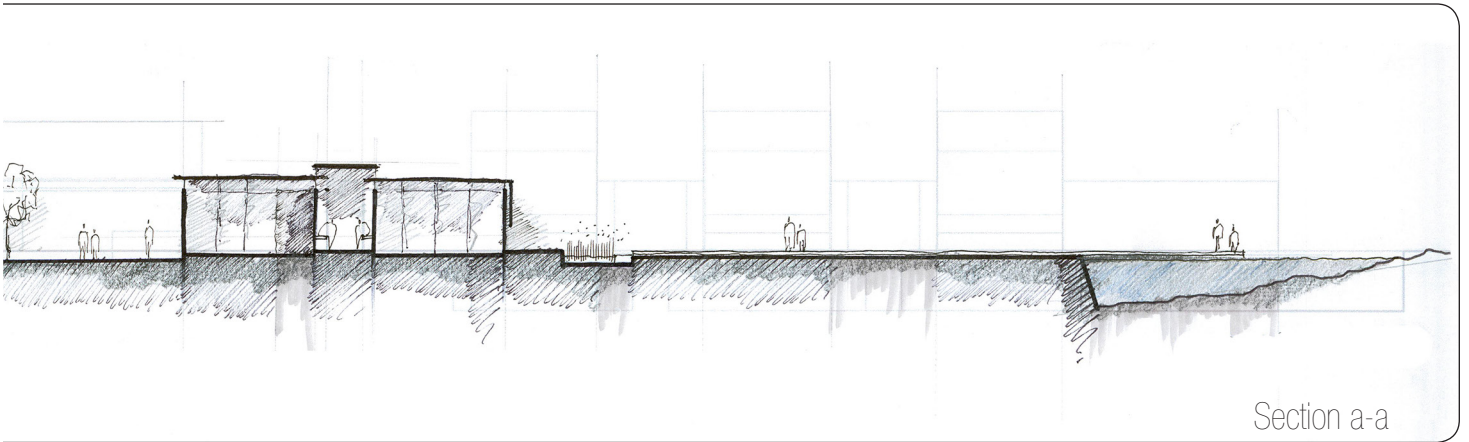


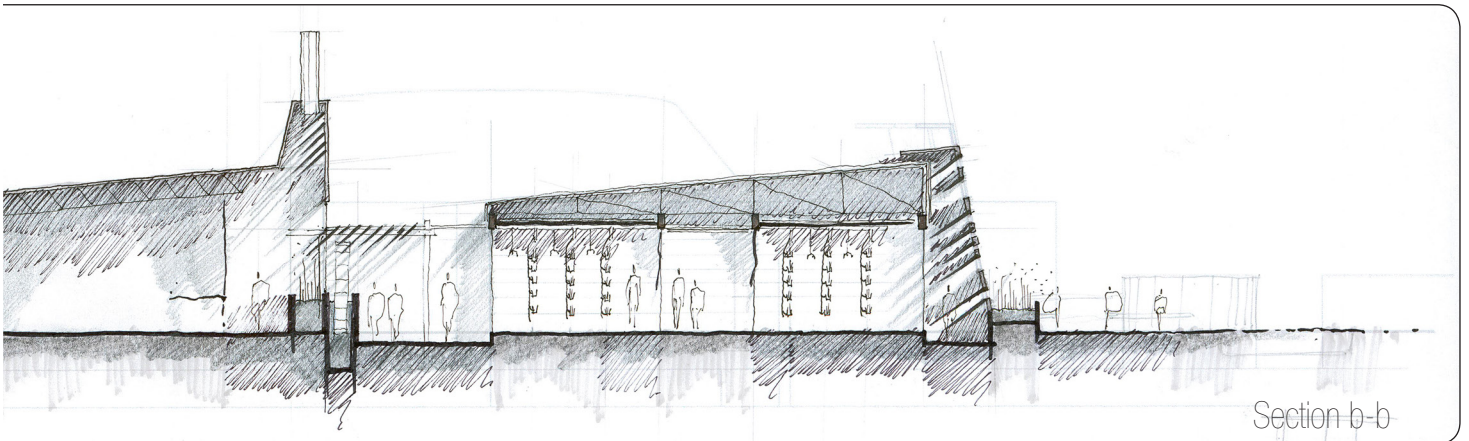
fig. 08.28_Conceptual section diagrams.





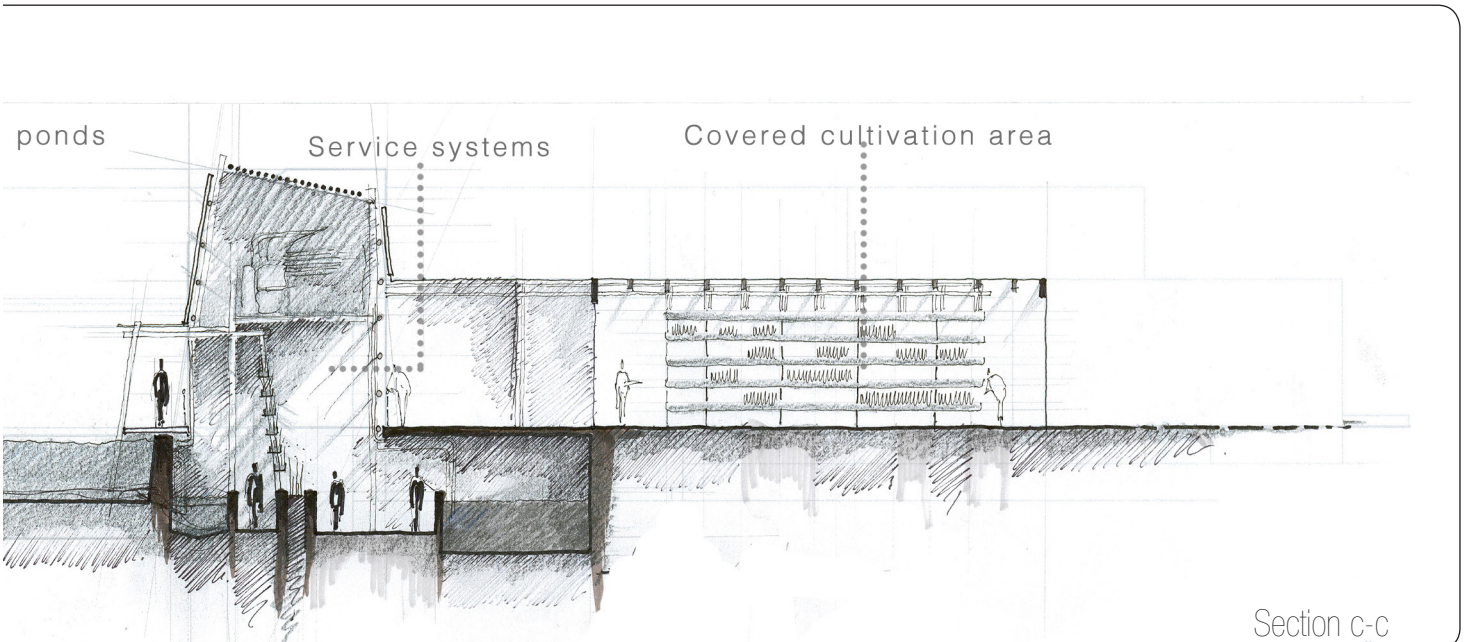
Section a-a

fig. 08.29_Conceptual spatial sections of the structure and connections to surroundings



Section b-b

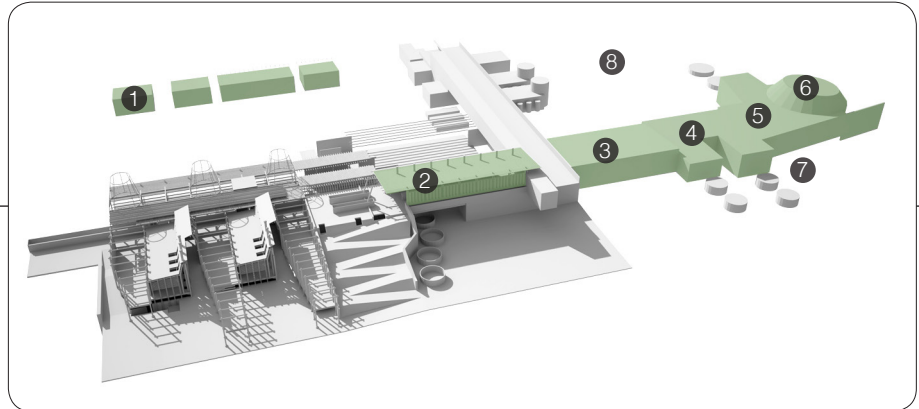
fig. 08.30_Conceptual spatial sections of the structure and connections to surroundings



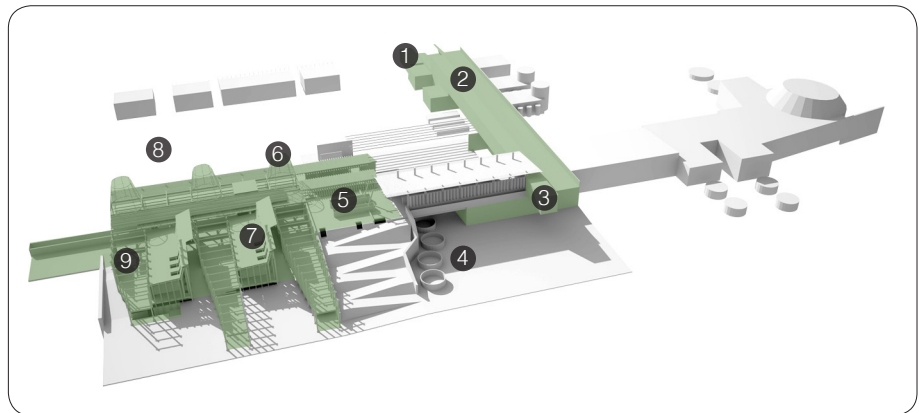
Section c-c

fig. 08.31_Conceptual spatial sections of the structure and connections to surroundings

- ① Informal education.
- ② Restaurant.
- ③ Formal education.
- ④ Lecture halls.
- ⑤ Auditorium.
- ⑥ Library.
- ⑦ Fish ponds.
- ⑧ Service entrance.



- ① Micro industries.
- ② Industry.
- ③ incubator.
- ④ Wetland system.
- ⑤ Recreational space.
- ⑥ Treatment towers.
- ⑦ Research labs.
- ⑧ Retention dam.
- ⑨ Covered cultivation area.



- ① Western entrance.
- ② Agricultural fields.
- ③ Northern connection.
- ④ Main courtyard.
- ⑤ Transport hub.
- ⑥ Water courtyard
- ⑦ Eastern entrance.

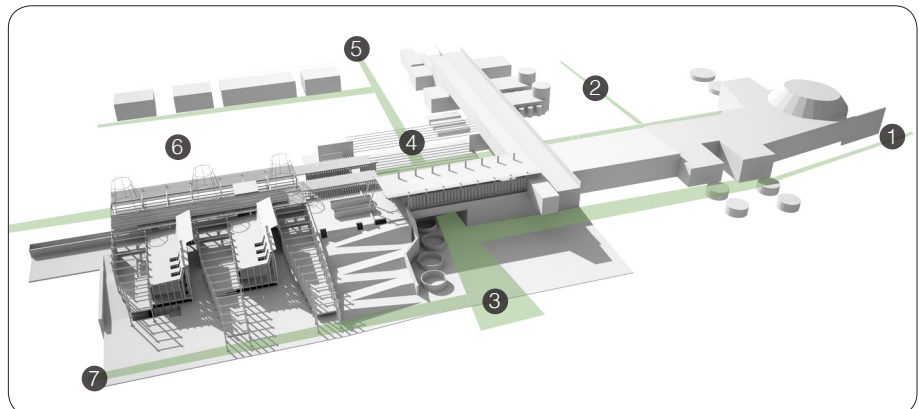
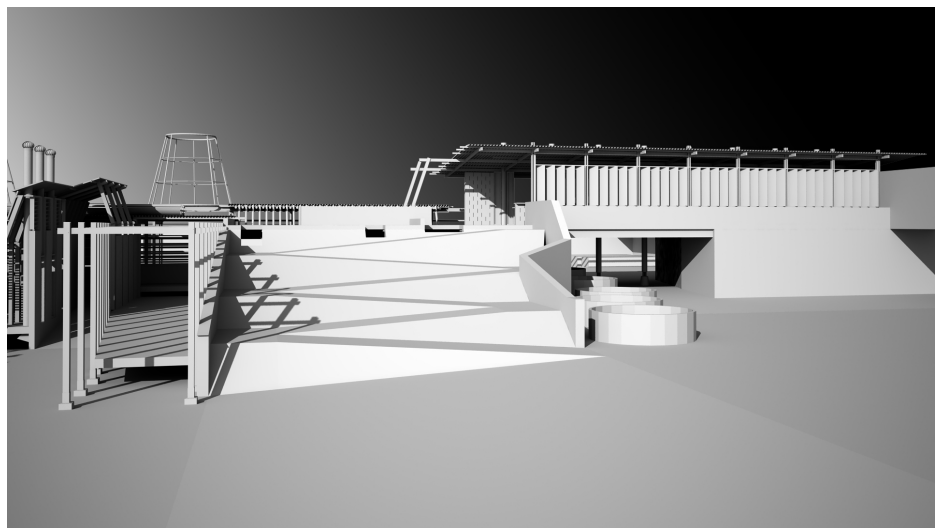
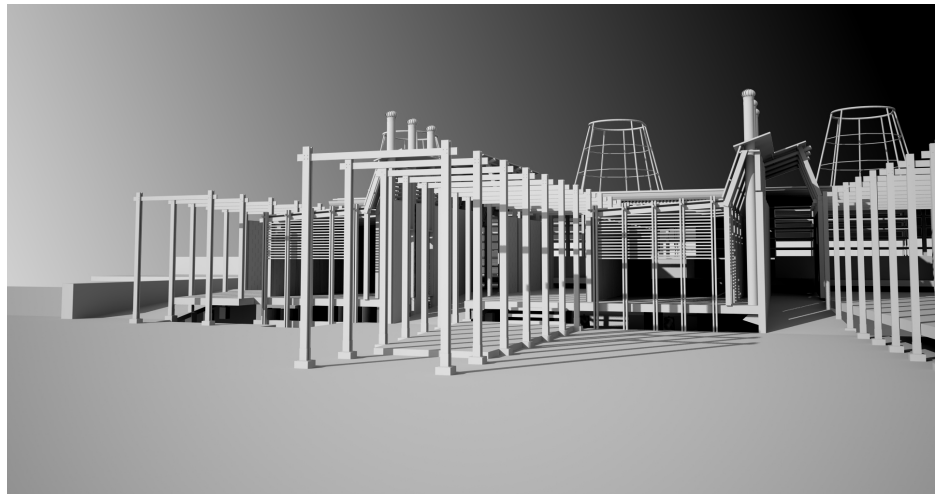
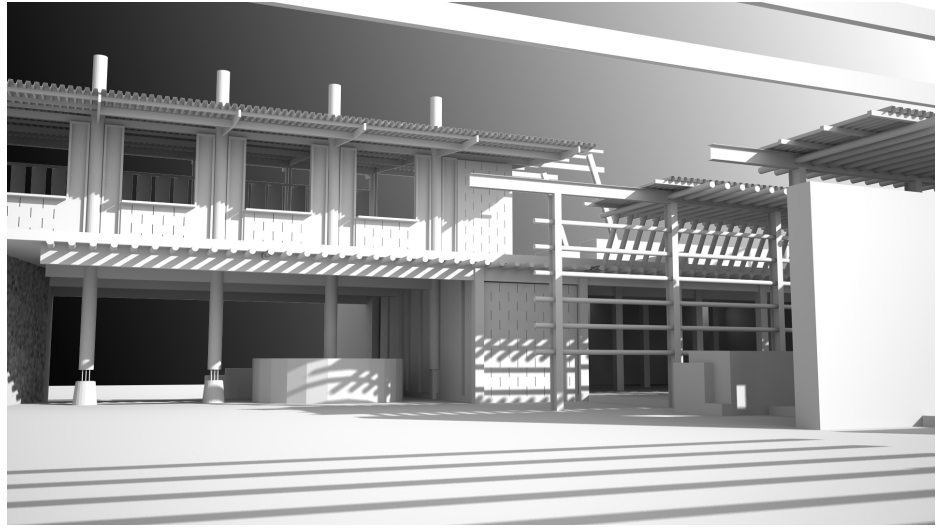


fig. 08.32_Programmatic illustration of the Agricultural hub.



Agricultural research and educational facility

Technical [09]

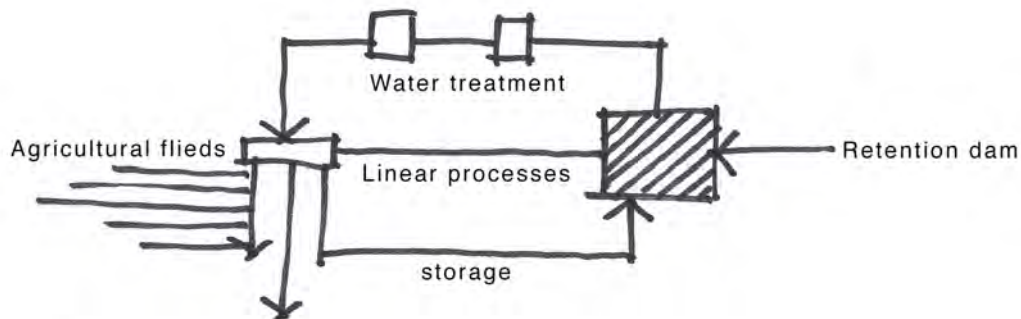
09_Technical investigation.

09_01_Agricultural Research and Educational Facility.

09_01_01_Research facility.

Water channels and processing plants.

The main processing plants and water channels, as discussed in the design development chapter, are recessed into the ground to form a number of different planes, connecting the public and private realms. The recessed floors also create an insulated condition under which the research and testing facilities can stay cool without the use of mechanical cooling systems. The processing plant is mainly constructed using in situ concrete, connected with the retention dam surrounding it, similarly. The concrete retaining walls are moulded to form channels and working platforms. The basement will function as a typical basement construction with parts of it allowing for water to filter through for testing and the maintenance of some working platforms; it also decreases the hydro tension from the shallow water table below. The open structure and the introduction of water resulted in a number of technical resolutions that needed to be explored.



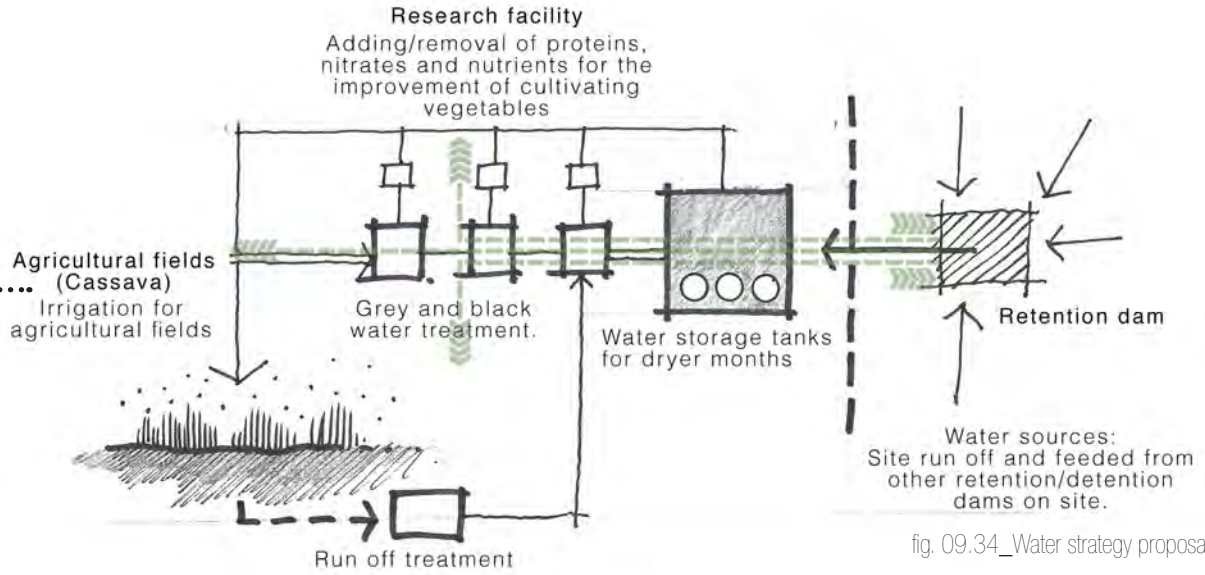
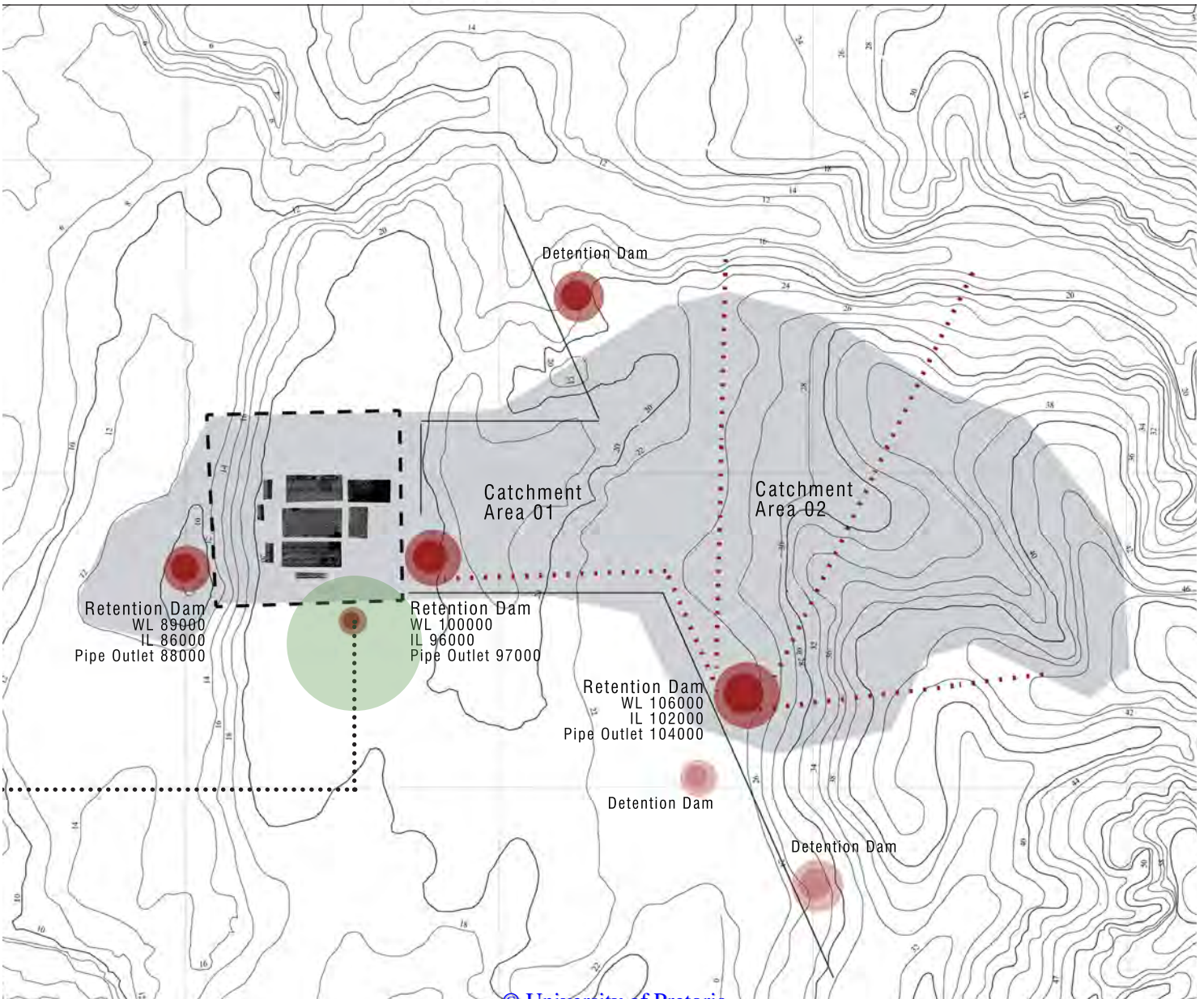


fig. 09.34_Water strategy proposal.



A sustainable water strategy must be demonstrated in the design of the landscape. On a larger scale, the sites catchment area could be identified. Storm water run-off from the eastern escarpment will be harvested in an integrated hydrology system, which consists of various bio-swales, retention and detention dams as well as constructed infrastructure.

The topography of the site is sloping from east to west with an increase in gradient existing at the western end of the site. The natural flow of run-off water also follows the gradient of slope. The water strategy is formalised to harvest and control the storm water run-off from the catchment areas and the site. The water strategy demonstrates various sustainable design principles and techniques to control and manipulate water on site for different programmes, such as irrigation, water storage and retention for aquaculture.

[01] Water Budget NEW

Total Catchment Area: 487275sqm

Month	Precipitation	Catchment Area	Run off Coefficient	Yield
January	0.089	487275	0.45	19515.36375
February	0.056	487275	0.45	12279.33
March	0.153	487275	0.45	33548.88375
April	0.401	487275	0.45	87928.77375
May	0.255	487275	0.45	55914.80625
June	0.068	487275	0.45	14910.615
July	0.048	487275	0.45	10525.14
August	0.047	487275	0.45	10305.86625
September	0.051	487275	0.45	11182.96125
October	0.097	487275	0.45	21269.55375
November	0.226	487275	0.45	49555.8675
December	0.194	487275	0.45	42539.1075
Total				369476.2688

Total Roof Catchment: 5670sqm

Month	Precipitation	Catchment Area	Run-Off Coefficient	Yield
January	0.089	5670	0.9	454.167
February	0.056	5670	0.9	285.768
March	0.153	5670	0.9	780.759
April	0.401	5670	0.9	2046.303
May	0.255	5670	0.9	1301.265
June	0.068	5670	0.9	347.004
July	0.048	5670	0.9	244.944
August	0.047	5670	0.9	239.841
September	0.051	5670	0.9	260.253
October	0.097	5670	0.9	494.991
November	0.226	5670	0.9	1153.278
December	0.194	5670	0.9	989.982
Total				8598.555

Water Budget on Catchment Area

Month	Yield	Intensive m2	Extensive m2	Intensive m3	Extensive m3	Total Demand m3	Yield
January	19515	6760	1750	2704	350	3054	16461
February	12279	6760	1750	2704	350	3054	9225
March	33548	6760	1750	2704	350	3054	30494
April	87928	6760	1750	2704	350	3054	84874
May	55914	6760	1750	2704	350	3054	52860
June	14910	6760	1750	2704	350	3054	11856
July	10525	6760	1750	2704	350	3054	7471
August	10305	6760	1750	2704	350	3054	7251
September	11182	6760	1750	2704	350	3054	8128
October	21269	6760	1750	2704	350	3054	18242
November	49555	6760	1750	2704	350	3054	46501
December	42539	6760	1750	2704	350	3054	39485
Total							332848

An excess of water exists. This allows for the tributary water course to have a constant base flow of water. During harsh and long periods of drought water can be pumped from the bottom detention dam to the top retention dam. Water from the water wells can also be used to irrigate important agricultural fields.



200 TREES

[Coconut Palm] // *Cocos nucifera*

Plant spacing 7.0m x 7.0m = 200 plants/ha // 80-100 nuts/tree/year // 30-45l/day irrigation // uses include wood, leaves, fruit and coir.



140 TREES

[Raffia Palm] // *Raphia farinifera*

Plant spacing 9.0m x 9.0m = 140 plants/ha // 25-30 tonnes of fruits/ha/year // 100-150l/day irrigation // uses include leaves, fruit and oil.



480 TREES

[Rubber Tree] // *Hevea brasiliensis*

Plant Spacing 4.6m x 4.6m = 480 plants/ha // 30-35g latex per tapping per tree = 3024kg/year/ha // uses include wood and latex.



21T/HA

[Rice] // *Oryza glaberima x sativa*

The cultivation of rice is well established in sub-Saharan Africa. Rice can be harvested every 4 months // 21 tonnes of produce/ha/year // 20% husk as by-product.



25T/HA

[Fish]

Breeder colony male to female ratio 1:5 // 2-4 fish/sqm // dykes max 1 meter deep // catfish *Clarias sp.* & mudfish *Channa striate* = 5-10% (species composition) // carp *Cyprinus carpio* = 10-15% // tilapia *Oreochromis niloticus* = 75-85% // harvest 2.5-3.5 kg of meat/sqm.



35T/HA

[Cash Crops]

The cultivation of beetroot, cassava and spinach is widely practiced on the island and can be considered a staple food. Most crops can be harvested every 3-4 months = estimate 140T/HA/Year.



25T/HA

[Spices]

Spice such as Ginger, cloves, cinnamon, nutmeg and vanilla are cultivated. Most spice species can be harvested every 5-6 months and produce an estimate of 25T/HA.

09_01_02_Retaining walls and construction.

The southern concrete retaining wall divides a 6 000 000 litre retention dam and the interior of the basement. A typical tank basement method was used for the retaining walls to prevent water entering the spaces that need to remain dry.

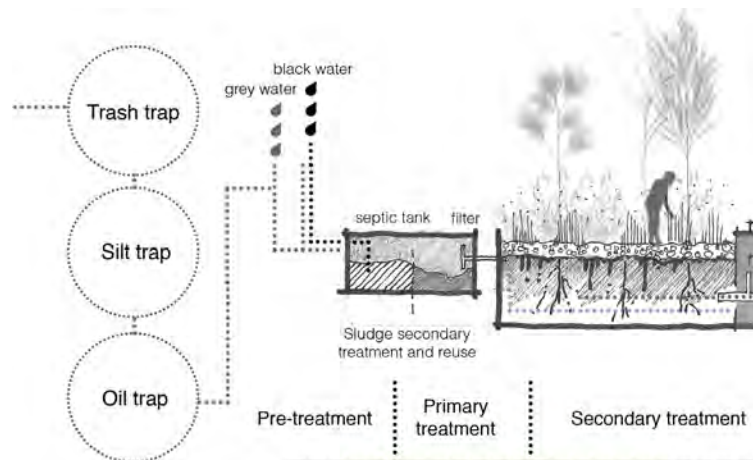
09_01_03_Drainage.

The drainage system plays an integral role in both the design of the recessed water channel construction and the basement. The open structures between the basement and the dam wall will allow water to enter by moving underneath the floor into the drainage system. The sump and drainage system needed to be large enough to cater for the monsoon months on the island. These sumps also need filters to allow water to filter through but prevent debris (ground, sand, leaves, roots and waste) from passing through. From these main sumps the water will be pumped to the treatment plants situated parallel to the main water channel. There will be different ducts for contaminated water, waste water and run-off water. The main southern retaining wall will house valves along the bottom to allow water from the retention dam with high nutrients (fish manure that is collected at the bottom) to enter the channel, along which it will flow to the aquaculture centre where it will be processed and reused.

09_01_04_Concept recycling diagram. Recycling diagram.

The roof covering the main research facility is informed by previously discussed environmental considerations so as to allow for passive, natural ventilation and to harness maximum natural day lighting. The roof is also formed around the central services courtyard, covering the treatment and processing facilities. Traditional architectural methods were considered in the design of the roof coverings. The general aim of the construction of the facility is to create an open ventilated haptic structure.

This resulted in the decision to use timber and



Recycling processes.

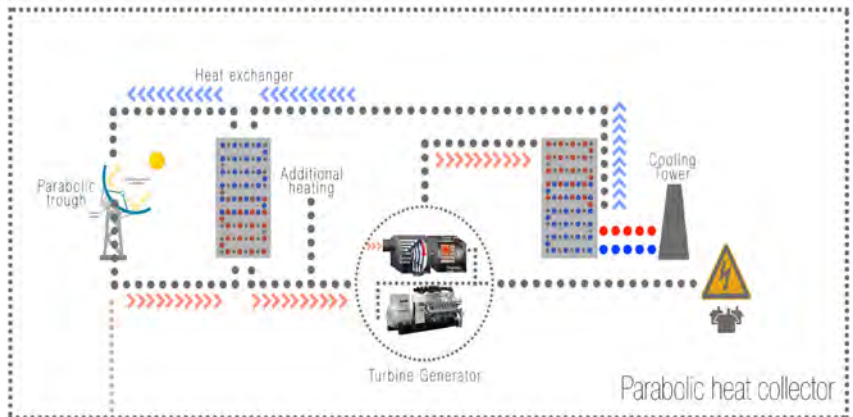
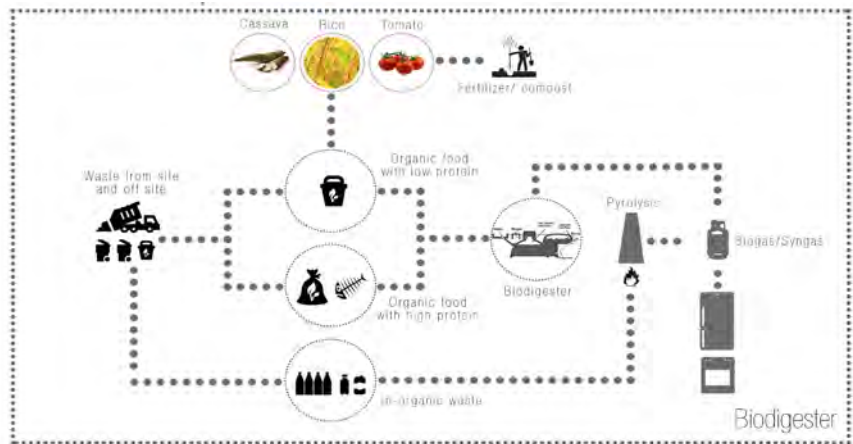


fig. 09.36_Water treatment.

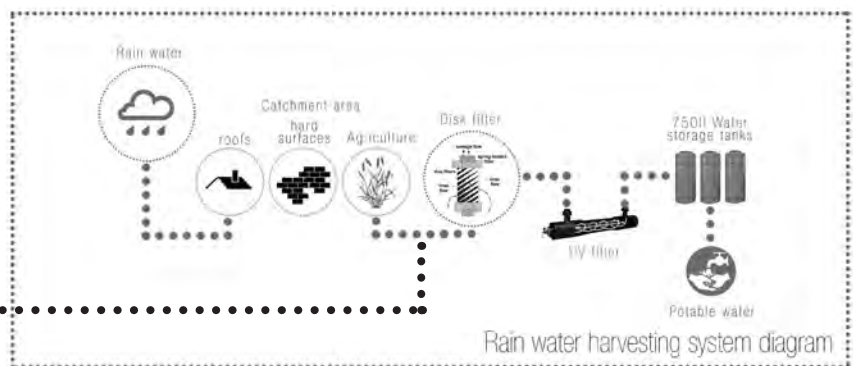
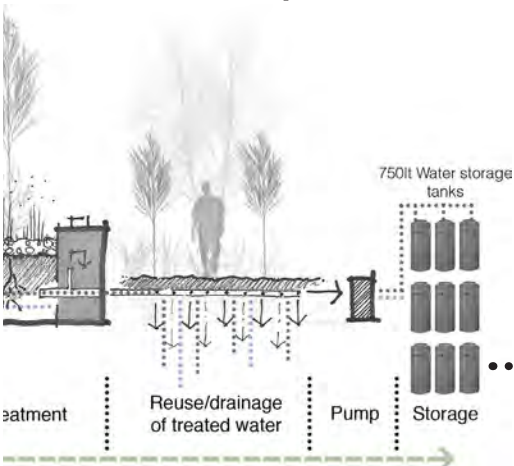
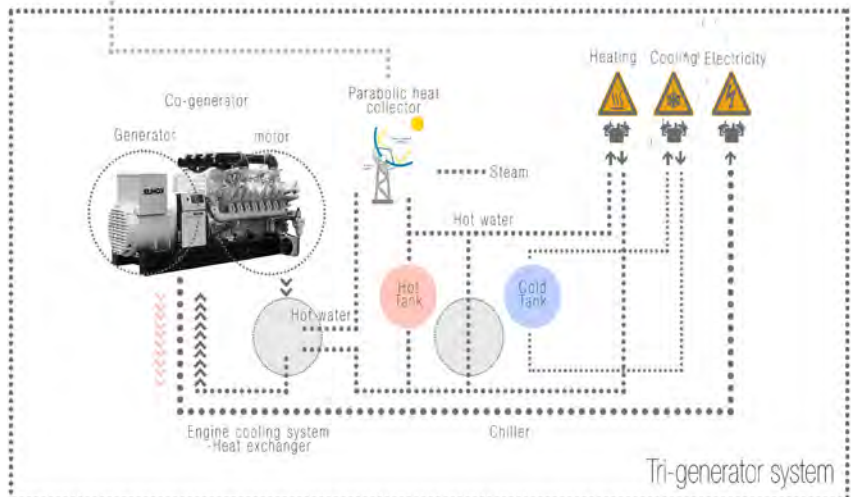


fig. 09.37_Sustainable treatment and harvesting systems.

09_01_05_Temperature control and ventilation.

steel portal frames. The main steel portal frame was designed to allow for the architectural environmental considerations and to house larger water treatment systems, hydroponic systems, storage and larger spans. Smaller and lighter timber structures extend from the main steel frame toward the south and north. The frame allows for openings at the northern facade and the southern facade for maximum cross ventilation and natural lighting. The frame also allows maximum possibility for the northern and southern sun to enter the recessed basement, semi-covered and covered systems spaces.

The roof creates semi covered spaces and internal spaces where the channel and services can run concurrently and create different public and private planes of circulation.

Solar energy assisted chimney stacks are used within larger production areas where maximum northern solar gain can be harvested to enhance the performance of the stacks. This system is combined with a passive cooling system that introduces fresh cool air into the southern bottom part of buildings. The cooling system gathers hot, arid fresh air (air is partly cooled by the southern wind blowing over the agricultural fields) from the southern edge of the site with 300 mm air duct pipes running 3 000 mm beneath the surface in the cool soil. When soil temperature reaches a constant of 18°C, the ducts release cool air into the building. The air inlet also contains a solar generated fan which forces the air across the space. Within the piping system, an air scrubbing system is introduced (removes bad smells before entering the building). Processes, haptic behaviour and machinery heat the air; the hot air rises to the highest point of the building where the solar chimneys extract it.

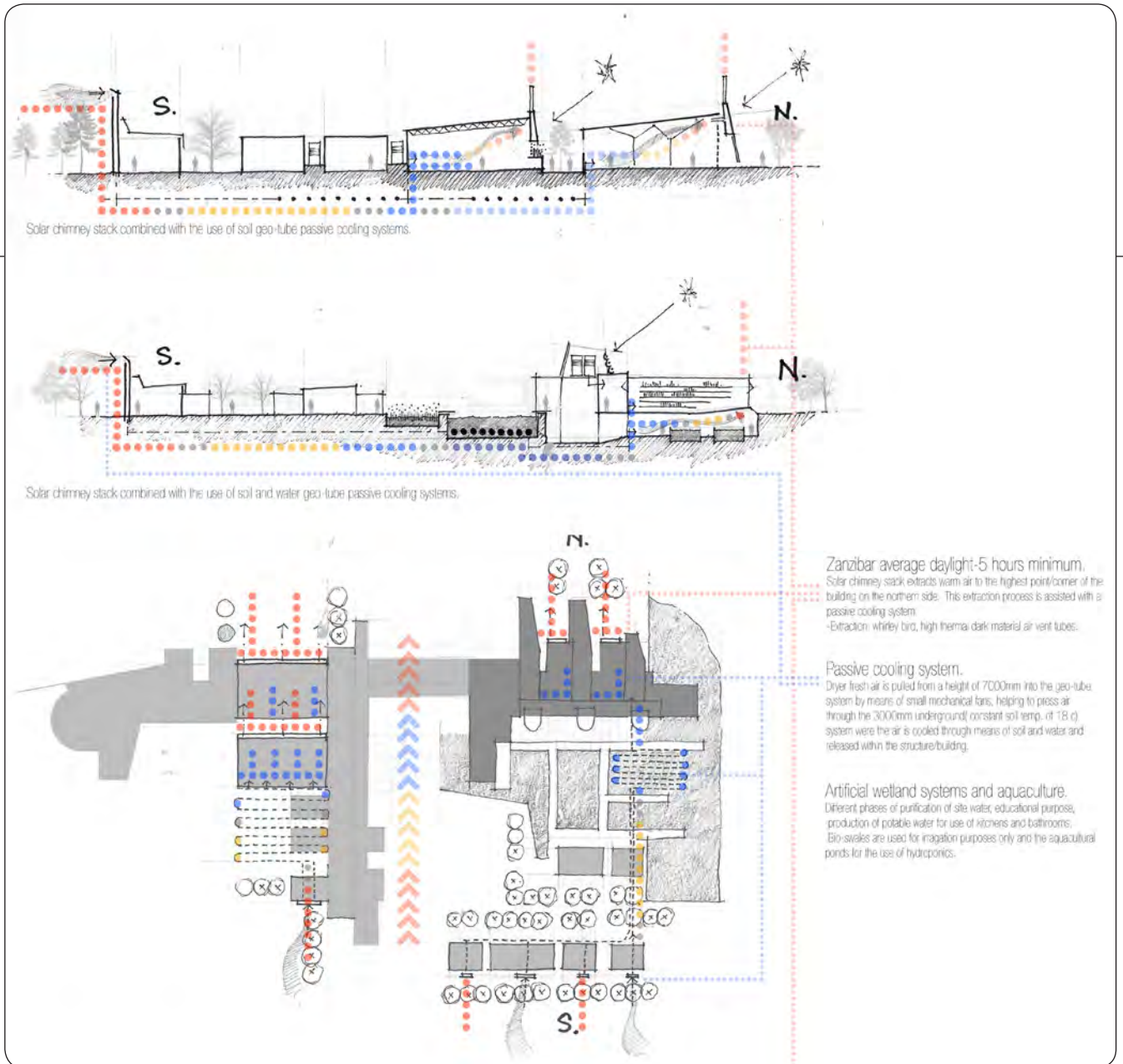
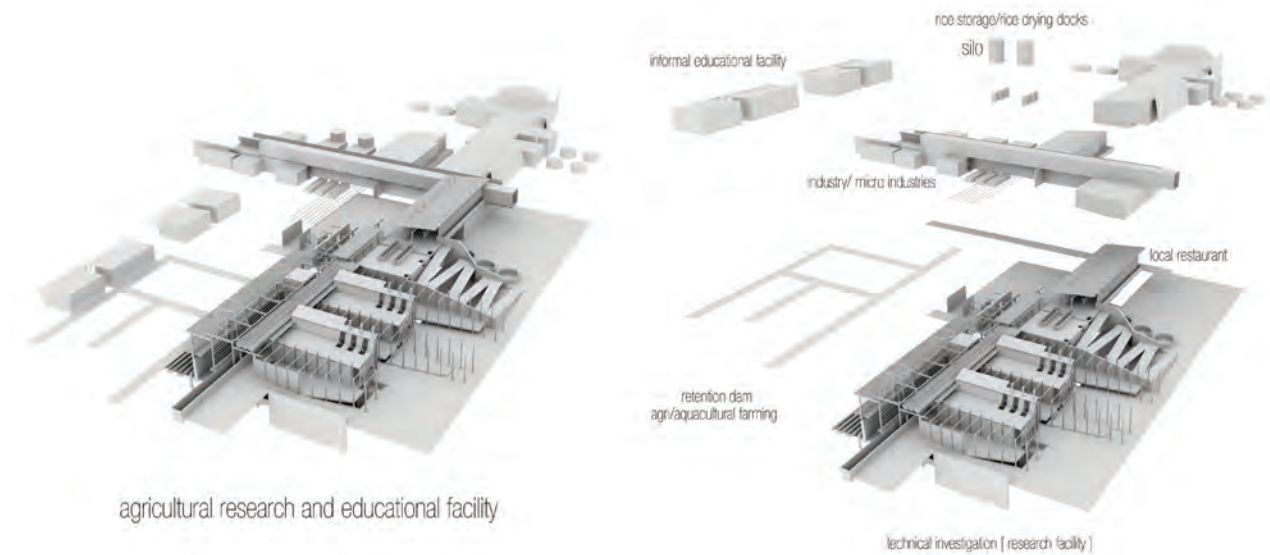


fig. 09.38_Evaporative cooling method, Geo-pipe system.it



09_01_06_Tectonic investigation.

The research facility uses the same passive cooling principles for cooling, although the piping of the cooling system runs on the bottom of the retention dam, cooling the air more quickly and more efficiently than its subsoil counterpart. The hot air is extracted by means of 300 mm tubes that are laid from the basement to the top of the roof structure: these pipes are used as extraction pipes and as light wells. The pipes are fitted with whirly birds that are driven by the southern wind and heat generated inside the building.

A number of skylights on the ground floor and on the first floor will allow for natural light to enter the basement level. These skylights are designed to extract pockets of hot air that accumulates in designated areas to ensure sufficient natural lighting for some leafy vegetables in the basement whilst extracting the stale air.

09_01_07_The skin.

The skin of the building is designed using a number of different materials, each chosen to enhance the space architecturally and to ensure a comfortable environment within the space by use of sustainable principles for both the user and the cultivation of vegetables.

IBR roof sheeting will be used for the roof coverings for the most part. A product from Macsteel Africa, Novotexi 440, Zinalume ultra steel wide span members will be used to accommodate the wide truss/portal frame spans. The Novotexi is used for buildings that are situated in regions with dramatic weather conditions and an abundance of wind activity. The Zinalume cover is chosen as it is low maintenance and guarantees a longer lasting product life than other materials. Metal roof sheeting is used as roof coverings combined with timber pergola structures and roof gardens on slab. The different use of the roofs connects the landscape with the architecture and the surrounding industrial/housing context.

Locally produced hollow core concrete blocks are chosen for wall construction. These blocks can be reinforced and the hollow core can be used for services, the units are spaced so as to allow for air access and extraction. (Diagram) The walls are built in 1 600 mm sections to allow 200 mm for the timber construction for the research and cultivation spaces between the concrete block walls.

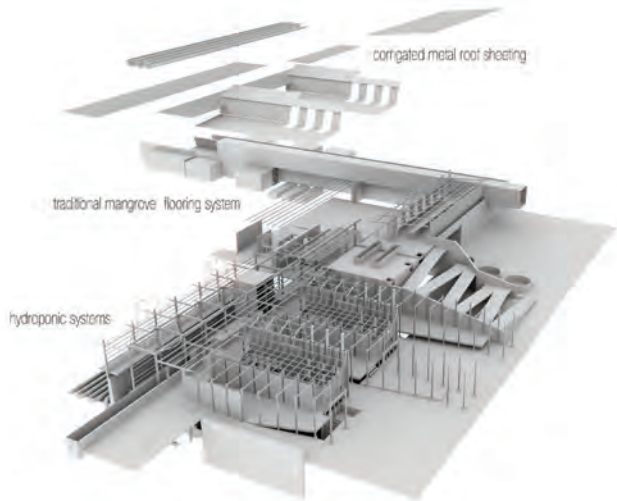


fig. 09.41_Skin and frame of the Research facility.

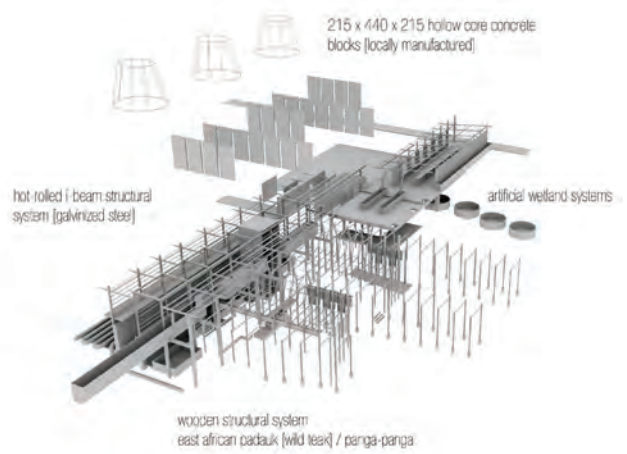


fig. 09.40_Structural system and materials.

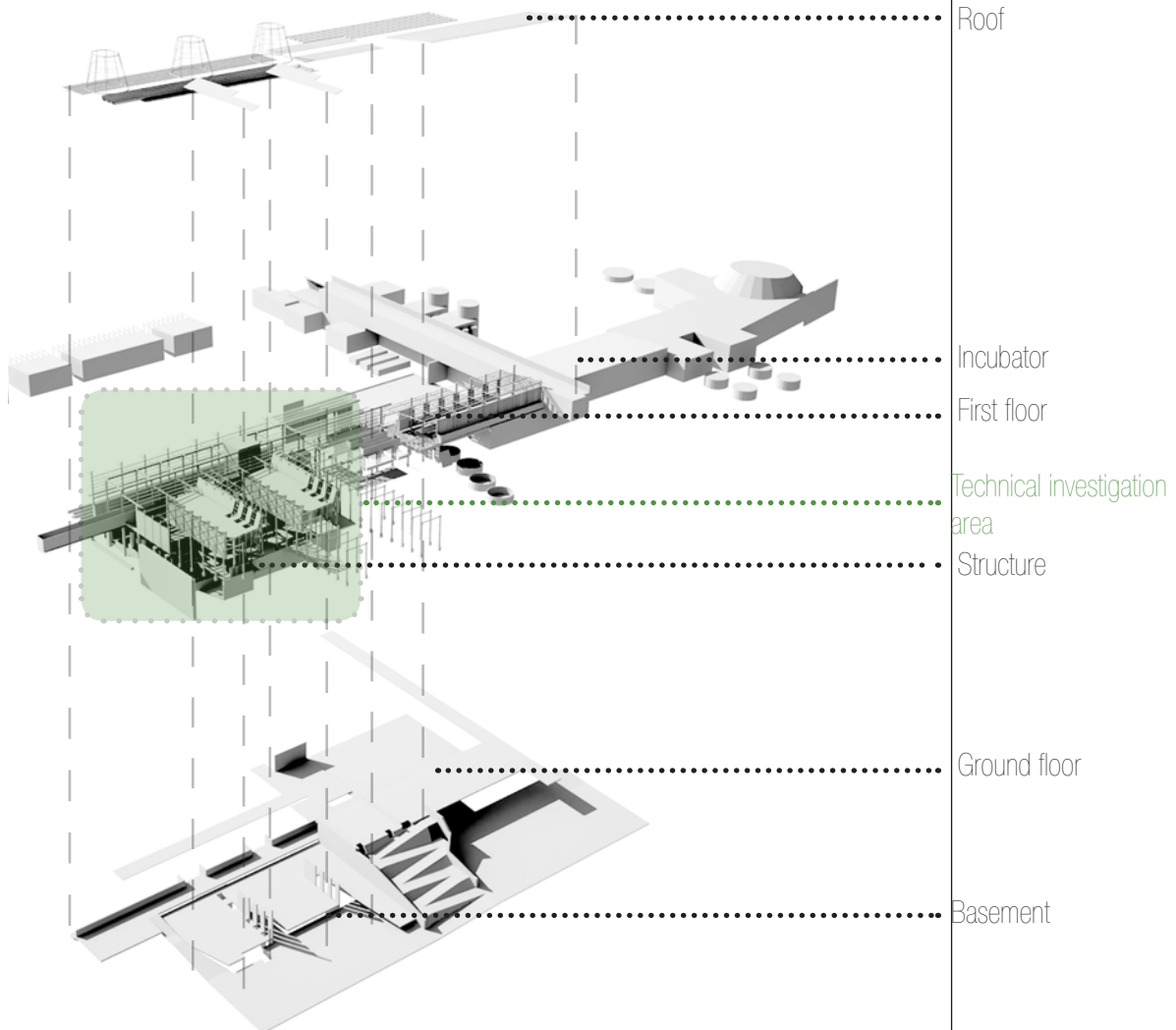
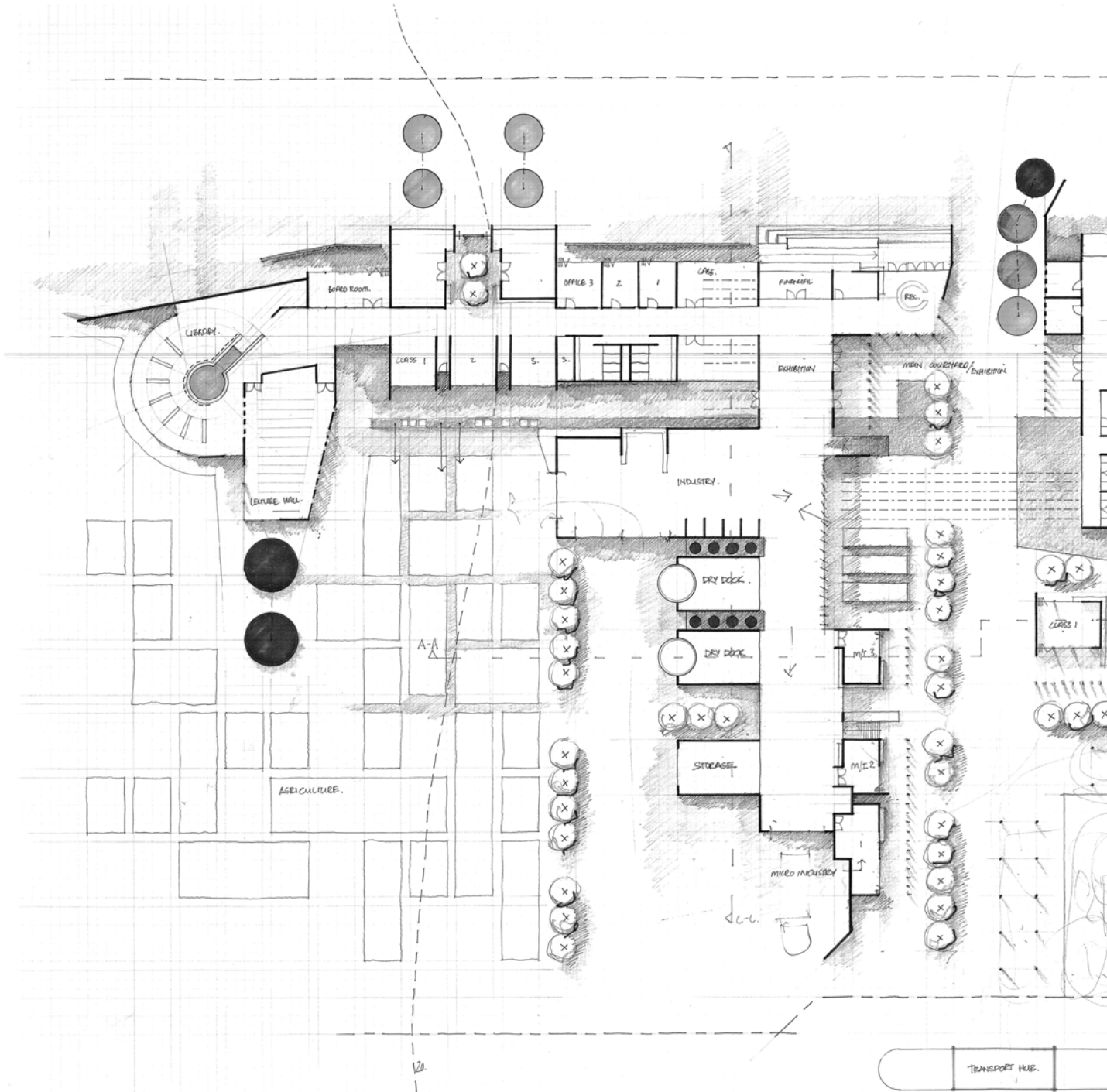


fig. 09.42_Technical investigation area, exploded levels.



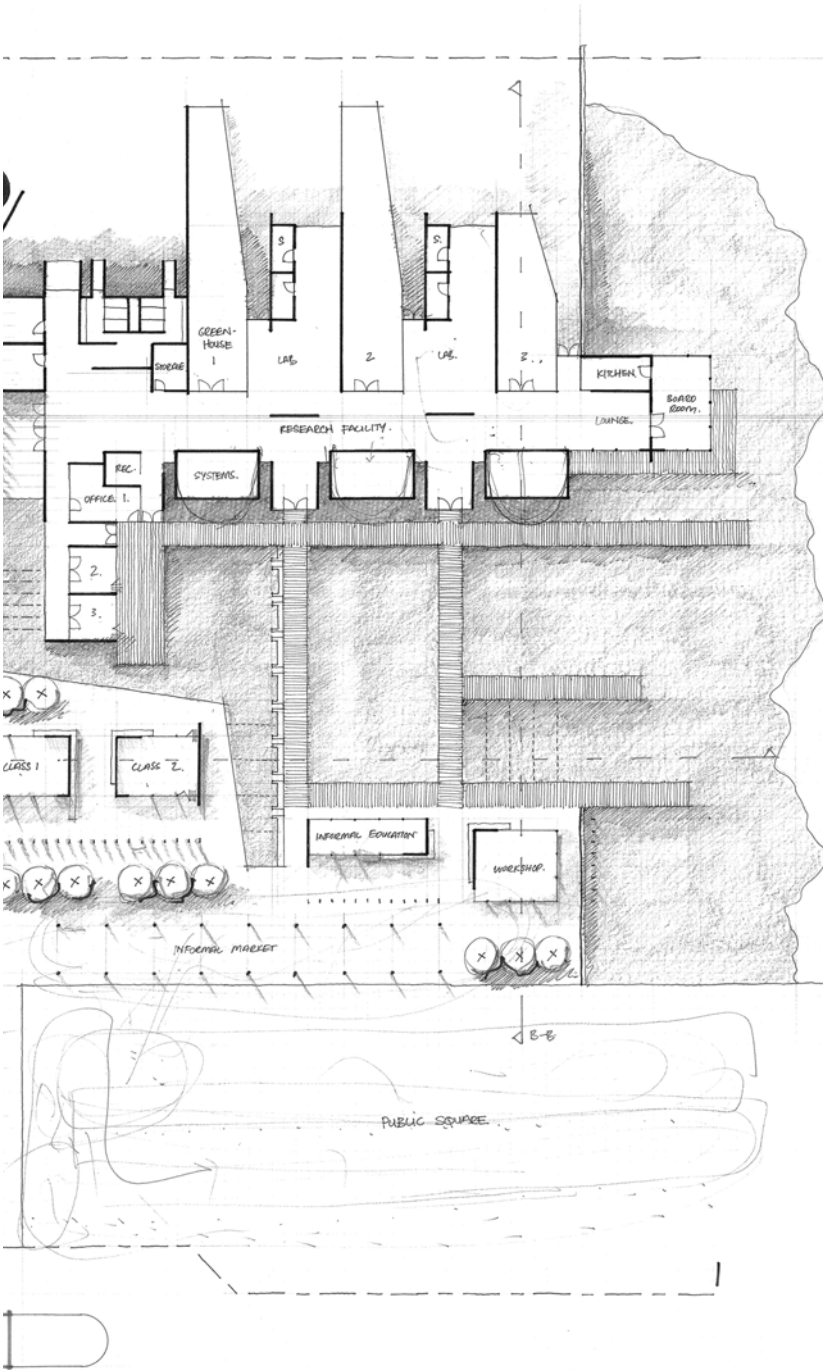


fig. 09.43_Ground floor plan of the Agricultural research and educational facility.

This 1 800 mm system slots neatly into the 900 mm x 900 mm grid system used in the design of the facility as a whole. The timber construction between the concrete walls is mounted to these, creating a 50mm gap. This gap is used for cross ventilation and allows water services to be accessible for the irrigation purposes of the cultivation area.

The skin encasing the cultivation area (or “greenhouses”) between the research laboratories is covered with Marix 20307WTD (polyester spunbond non-woven fabric) to protect seedlings from the annual monsoon winds, the harsh climate conditions and pests (birds, rodents, etc.). This agricultural fabric has 87% water permeability and 40% shading capability.

Adjustable louvre systems are introduced on the northern and southern façade whereas fixed louvre systems are designed for the northern edge of the research facility to allow sufficient indirect natural day lighting without the direct penetration of the harsh African sun. The design calls for a number of skylights and roof gardens. The roof gardens maximise the cultivation area of vegetables for research and testing on the premises, connect the haptic landscape space with the interior research and testing spaces, and takes advantage of the earth as an insulation material. The skylights have a maximum opening area of 0,8 m and an install width of 1 000 mm. They are designed to withstand water penetration and weather impacts of 10J (Joules), as well as to resist ultraviolet radiation degradation for a period of at least 15 years. Skylights became an integral part of the scheme, as life is directly connected to the sun and the facility is intended to sustain just that.

09_02_Technical design and material selection.

The agriculture research and educational facility focuses on the combination of industrial design methods, traditional building methods, material selection and environmental design principles. The building materials therefore reflect the surrounding context while exploring and challenging methods of construction with local materials. The scheme aims to embody the innovation of industrial and environmental design. An extensive material selection will be used in the building of the facility, allowing for innovative new methods of using traditional materials; these are further explored in the technical chapter. The use of a variety of materials also affects the public interface of the agricultural hub, managing the different interfaces of private and public spaces.

Timber construction forms a large part of the design of the agricultural hub. Traditional mangrove poles will be used for light construction and for reinforcing for the concrete floor systems. Locally manufactured 440 x 215 x 215 mm hollow concrete blocks will be used for external walls and 140 x 215 x 215 mm blocks will be used for internal walls. These blocks will not be used as load carrying members due to the uncertainty concerning the strength of the locally produced concrete blocks. These sections will rather test the integrity thereof as a potential structural material. A concrete column system, combined with a small number of steel frame portals will be used to control the larger spans. The main steel frame portal will be used within the research facility.

These steel members will be imported from off-shore companies with better steel grades than local companies can offer. The steel members will all be galvanised and assembled on site with bolts and nuts (no welding to allow for easier reuse and adaptation of the facility if the future development needs to change). Timber and concrete of higher strength must be imported from the mainland Tanzania. Panga-Panga (*Miletia stuhlmannii*) and East African Paduak (*Pterocarpus angolensis*) (wild teak) timber members will be used for construction on site.

Building waste:

preference 1	separate all types
preference 2	as preference 3 + wood and synthetics
preference 3	clean rubble, low grade chemical waste, metal and remainder
not recommended	unseparated waste

The separation of by-products and building waste opens up possibilities for further reuse. Reuse reduces dumping and saves material. The agricultural hub has a number of waste treatment plants for organic and inorganic materials. These waste materials are incinerated to create biogas and heat for the tri-generator on site.

Hard paving:

preference 1	recycled concrete slabs
preference 2	concrete slabs, turf
preference 3	clay tiles, concrete blocks
not recommended	asphalt

Recycled concrete slabs are chosen for their lower energy content over clay tiles. This hard smooth surface also creates a larger rain water harvesting platform.

Semi-hard paving:

preference 1	wood chippings
preference 2	sand
preference 3	shells
not recommended	gravel

Wood chippings are collected from shredded branches (locally available). The use of wood chippings for footpaths, need to be changed every 5 years. The arboriculture proposed will allow for new wood chippings every 5 years. Wood chippings is easily available and cost efficient.

Foundations:

preference 1	wood with top
preference 2	concrete with reclaimed aggregate
preference 3	
not recommended	concrete without reclaimed aggregate

Reinforced concrete with reclaimed aggregate is used in the design of the Agricultural facility not for its environmental preference but for its durability and stability.

Ground floor construction:

preference 1	hollow ceramic elements
preference 2	hollow concrete elements with reclaimed aggregate or limestone
preference 3	solid concrete with reclaimed aggregate or limestone
not recommended	solid concrete without replacement for gravel

Solid concrete floor slabs are being used for hollow core prefabricated elements will be costly and need to be brought in from the mainland.

First floor construction:

preference 1	wooden elements
preference 2	hollow ceramic and concrete elements with reclaimed aggregate
preference 3	concrete with reclaimed aggregate
not recommended	concrete without reclaimed aggregate

A combination of concrete with reclaimed aggregate and timber is used. Traditional methods of reinforcing the floor slabs with mangrove timber poles are being used.

Internal wall construction:

preference 1	loam construction
preference 2	flue-gas gypsum blocks, sand-lime blocks
preference 3	cellular concrete blocks, natural gypsum blocks, masonry
not recommended	prefabricated concrete

Hollow core concrete blocks are used for it is locally manufactured. The blocks are durable and can store electrical and piping within the hollow cores. Loam construction is not used for it is labour-intensive and will need an abundant of maintenance and special mortars to with stand the harsh climate conditions of Zanzibar.

External wall construction:

preference 1	sustainable durable wood, loam construction
preference 2	masonry
preference 3	cellular concrete blocks, natural gypsum blocks
not recommended	concrete

Roof shape:

preference 1	pitched
preference 2	arched
preference 3	flat
not recommended	

Advantages of a pitched roof is that rainwater flows off easily, reduces the need for waterproofing. Allows more northern natural lighting and is directly integrated with the extraction of hot air in the use of passive sustainable systems.

Pitched roof construction:

preference 1	sustainable wood
preference 2	box panels, sustainable plywood, chipboard
preference 3	steel structure
not recommended	plywood made from tropical wood

Wood is used for it will be more cost effective to import it from Tanzania as steel. Steel will need to be preformed, galvinised and bolted together. Timber will integrate the landscape and the traditional essence of Swahili architecture.

Roof insulation:

preference 1	cork, cellulose, natural product
preference 2	mineral wool
preference 3	EPS
not recommended	PUR: extruded polystyrene

Rice husk will be used for the insulation of roofs and wall panels. Rice husk as insulating material is environmentally safe, has low thermal conductivity and high thermal resistance making it a perfect construction material for tropical areas. Phenolic resin adhesive added enhances the material to be water and humidity resistant.

Roof covering:

preference 1	Timber shingles, reed
preference 2	clay or concrete roof tiles
preference 3	fibre-cement slates, corrugated sheeting, bituminous slates
not recommended	zinc, copper

IBR Novotexi 440 Zinzalume ultra steel wide span sheeting will be used. The sheeting is durable and can withstand the aggressive monsoon winds.

External windows:

preference 1	sustainable durable wood, untreated softwood
preference 2	softwood with solid borate implant
preference 3	aluminium, preserved softwood, recycled PVC
not recommended	tropical wood, PVC

Timber is derived from a renewable source and has low embodied energy. Timber also has sound thermal properties and is durable.

External doors:

preference 1	sustainable durable wood, untreated softwood
preference 2	softwood with solid borate implant, sustainable plywood
preference 3	aluminium, preserved softwood, recycled PVC
not recommended	tropical wood, PVC

Wooden framed LE-glazing is used for the entrance doors and folding doors.

Stairs:

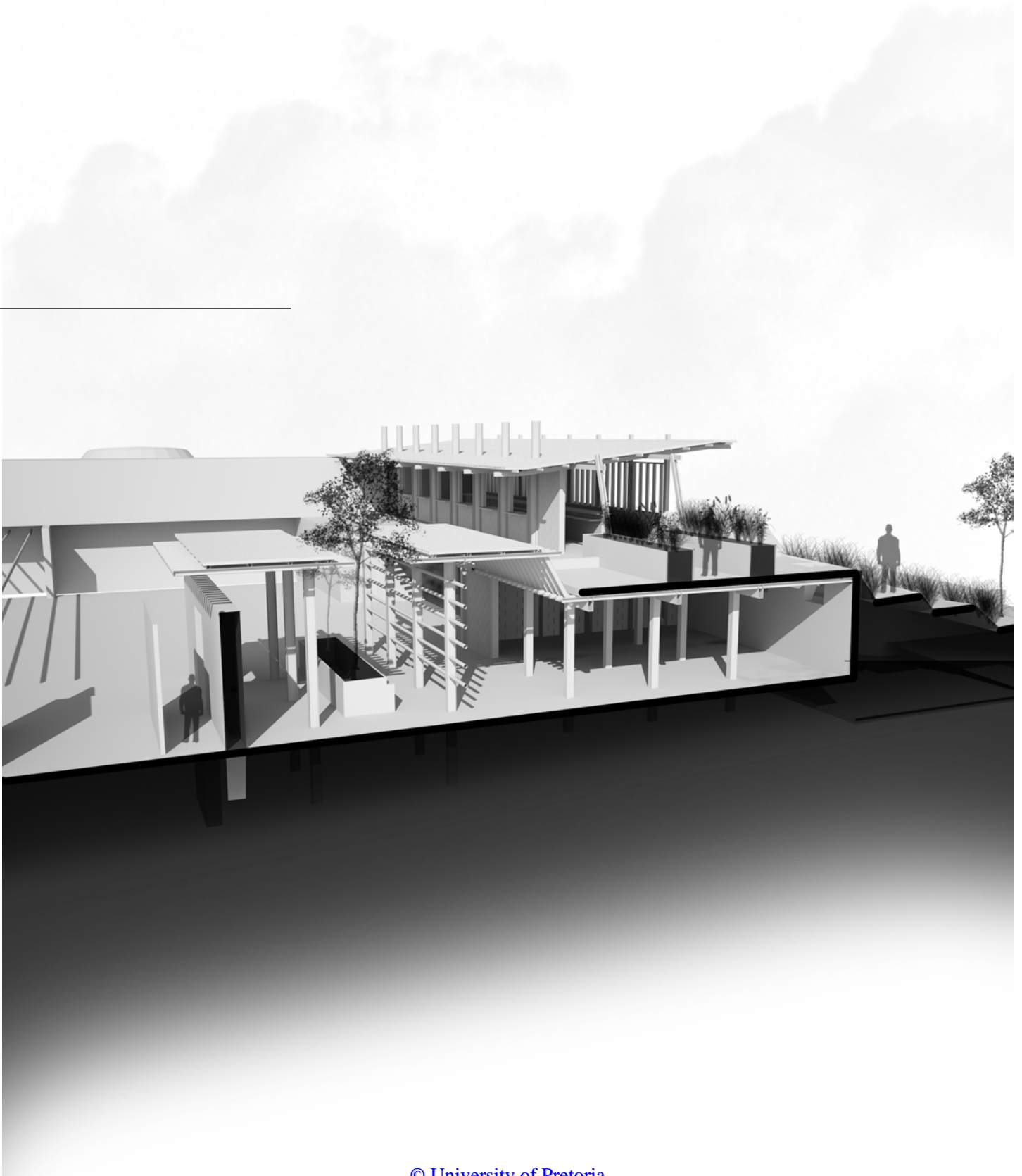
preference 1	timber
preference 2	steel
preference 3	concrete with reclaimed aggregate
not recommended	tropical wood

Concrete stair is the alternative for multi-storey building and has the structural element that can resist fire for maximum fire rating.

Glazing:

preference 1	argon-filled LE-glazing
preference 2	air-filled LE-glazing
preference 3	double glazing
not recommended	single glazing

The use of low emissivity glazing has a lower U-value than double glazing and single glazing. LE-glazing should be used to achieve significant energy savings, the building also benefits from the LE-glazing thermally. LE-glazing is 25% dearer than double glazing but the additional costs are repaid by the energy saving within its life-time.



Material selection:



Panga Panga
Millettia stuhlmannii



Wood post-milling

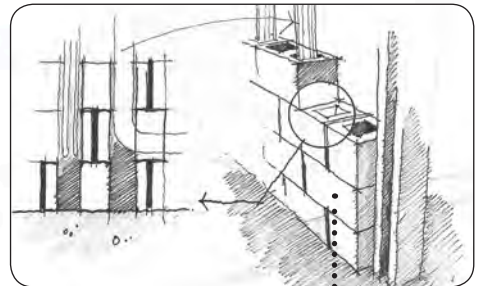
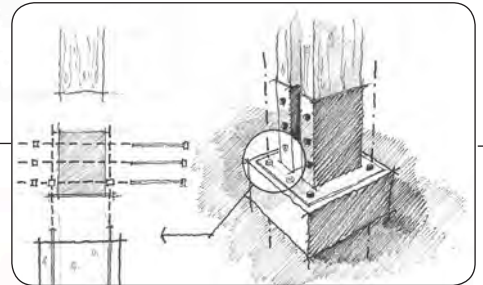
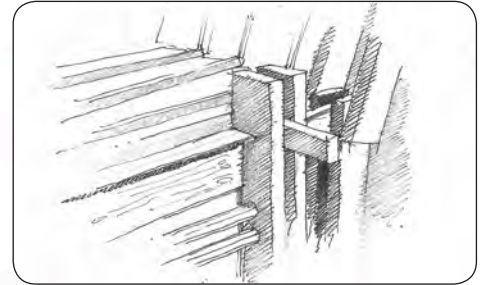


Wood post-sanding



Wood finished

Density (Kg/m ³)	881	Hardness (Kgf)	739	Bending strength (Kg/cm ²)	1,033	Durability	Medium	Stability	High	Workability	Medium
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East African padauk
Pterocarpus angolensis



Wood post-milling



Wood post-sanding



Wood finished

Density (Kg/m ³)	624	Hardness (Kgf)	671	Bending strength (Kg/cm ²)	1,144	Durability	Very	Stability	Medium	Workability	Good
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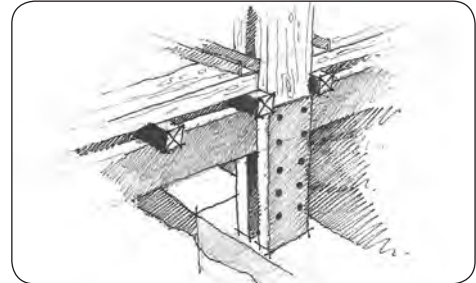


Locally produced
hollow core concrete blocks

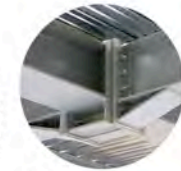




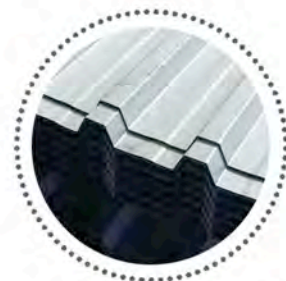
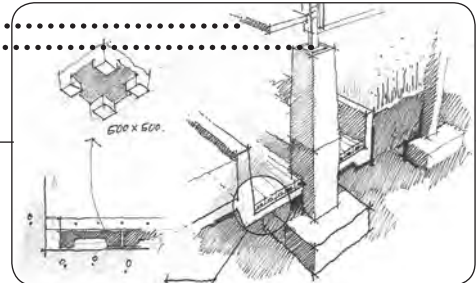
Reinforced concrete footings and columns



Galvinised hot rolled Ibeam profiles



Steel profiles bolted together



Novotexi 440, Zinalume ultra steel wide span members



Marix 20307WTD, Polyester Spunbond non-woven fabric

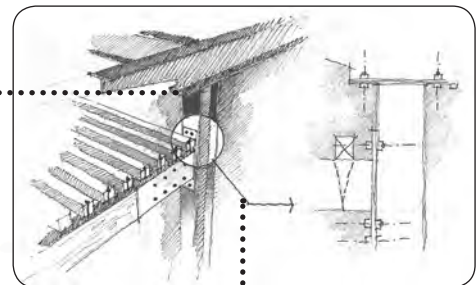
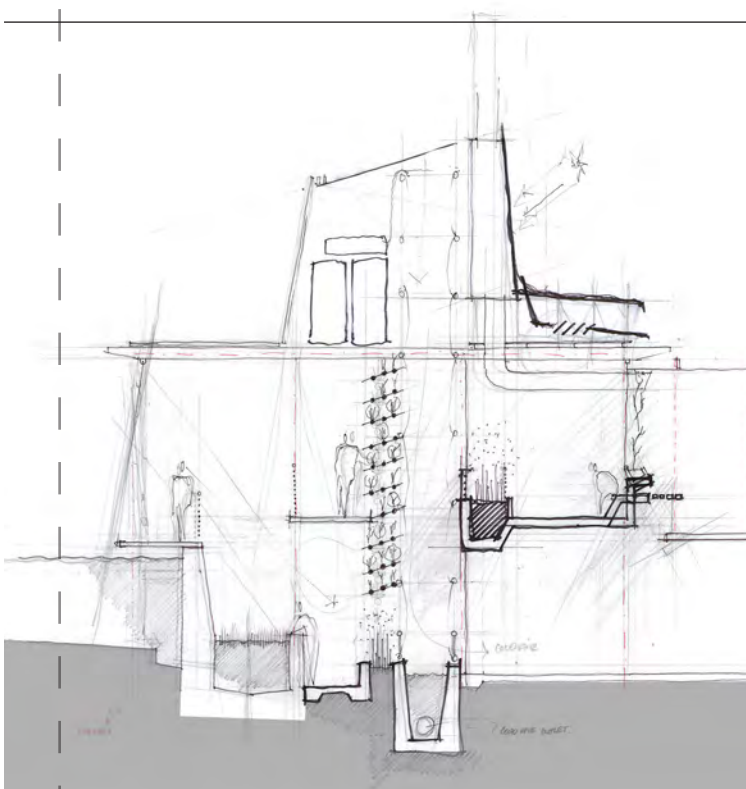
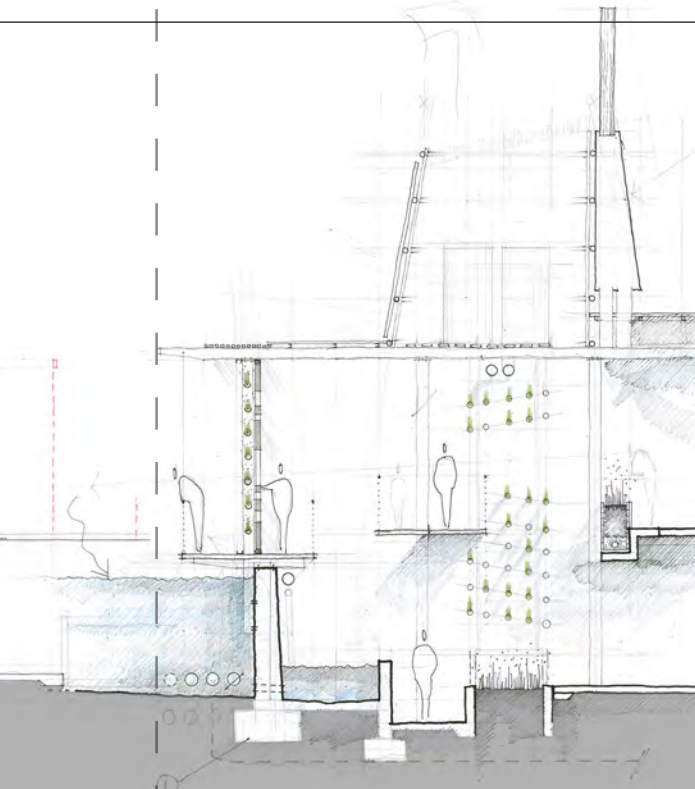


fig. 09.44_Material selection and connections of materials.

Section exploration:
1_Intention.



2_first response.



3_Second response.

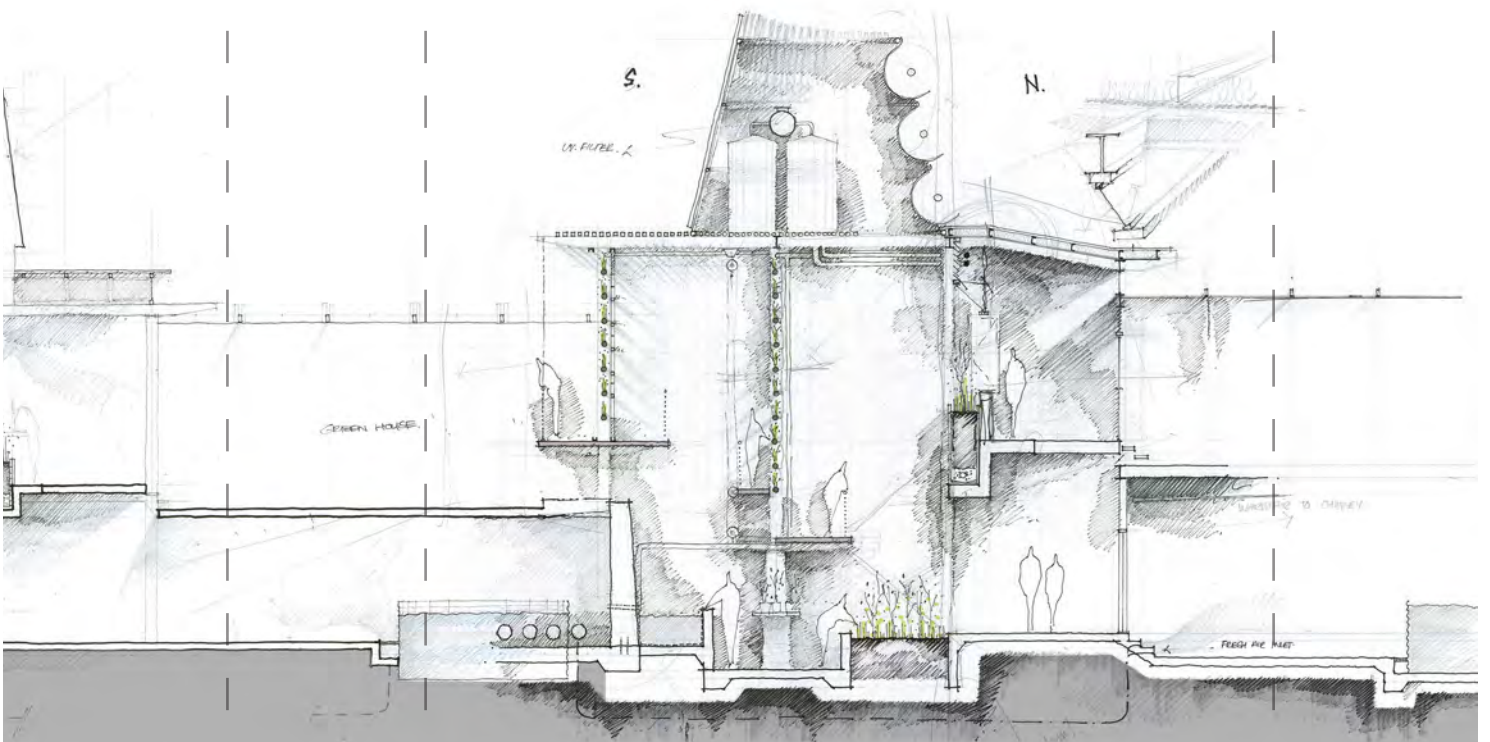
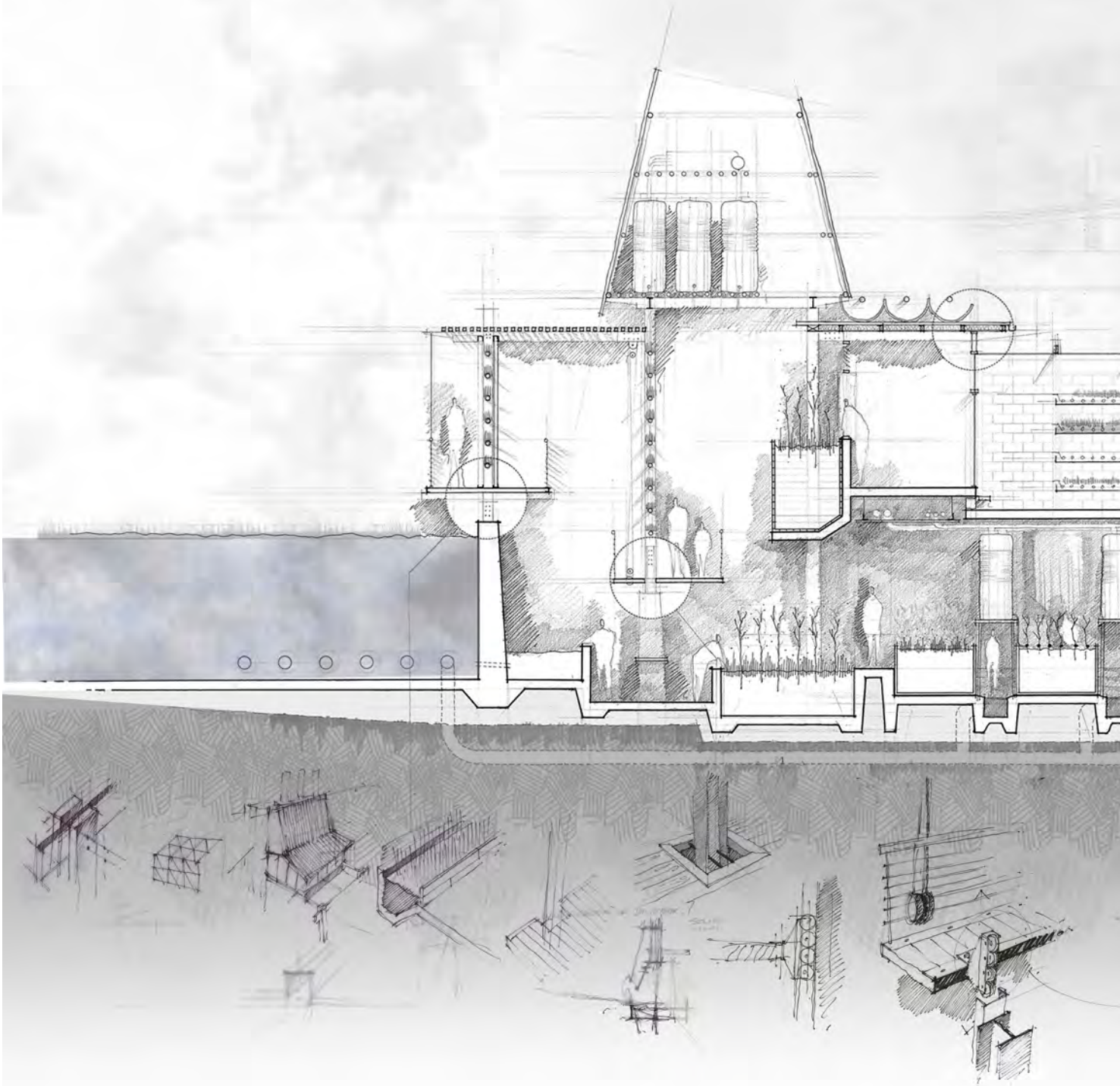


fig. 09.45_Technical section exploration.



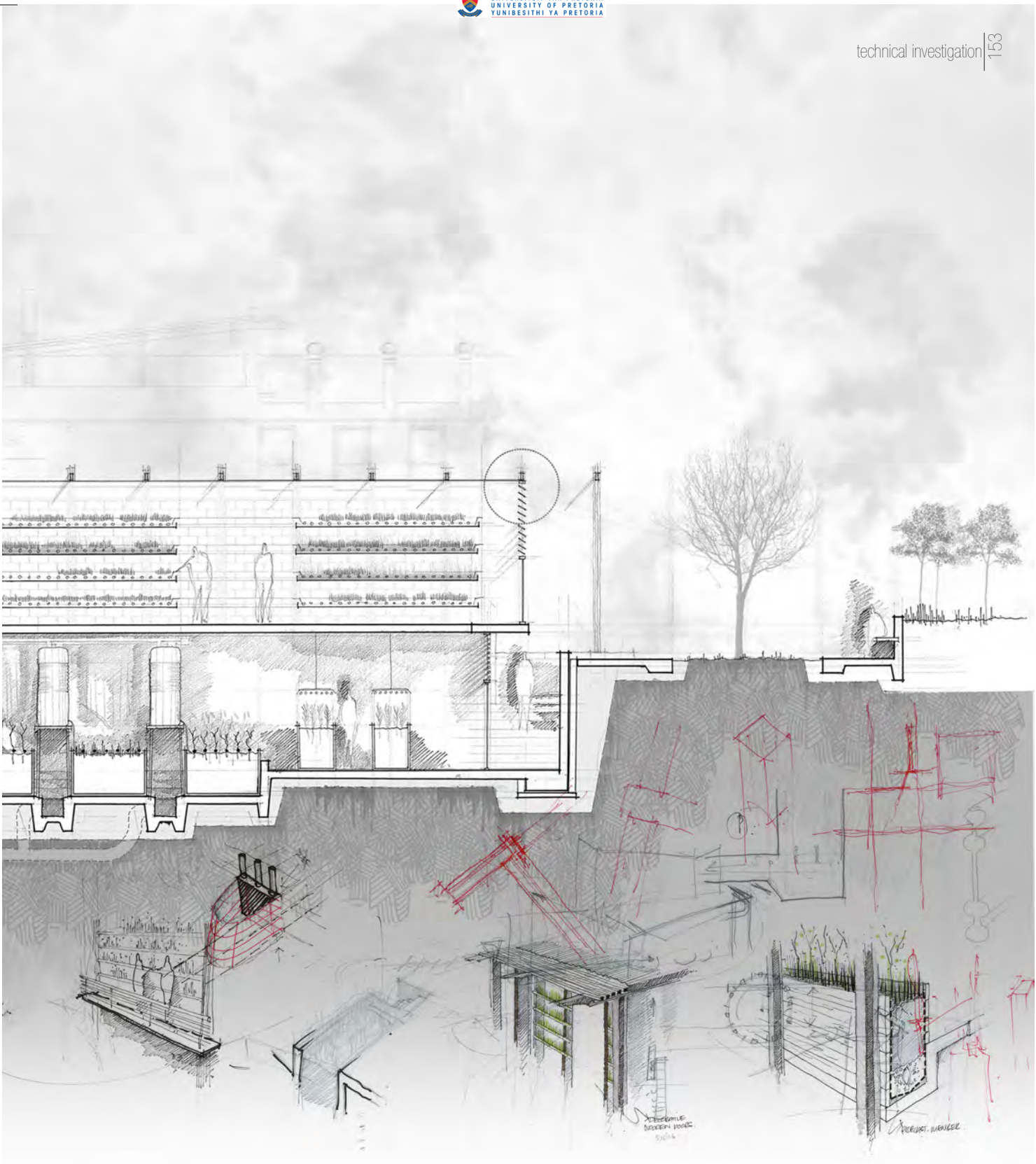
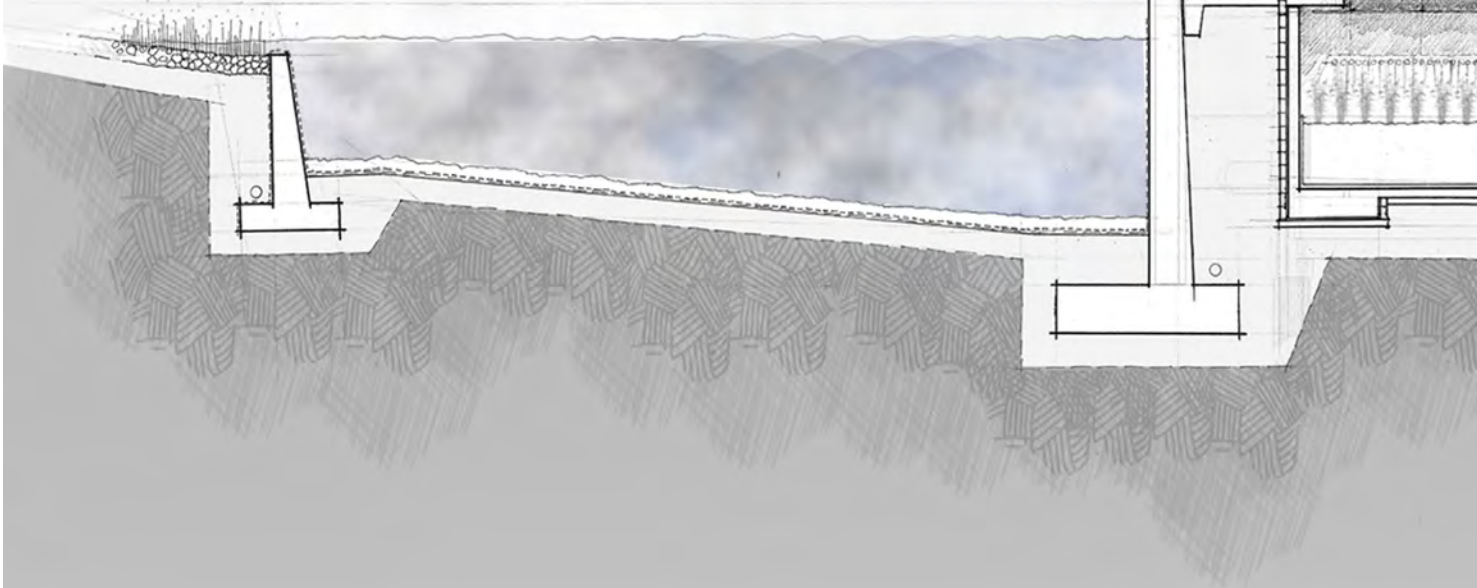
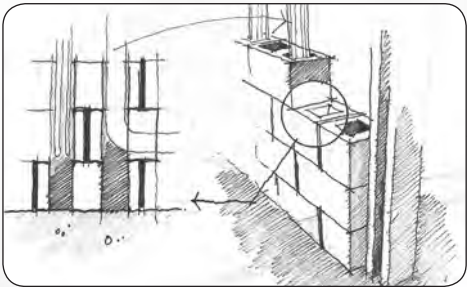
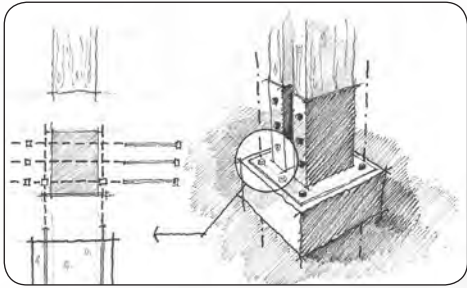
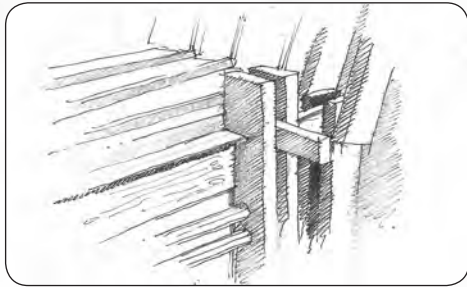


fig. 09.46_Section A-A through the retention dam and water treatment plant.



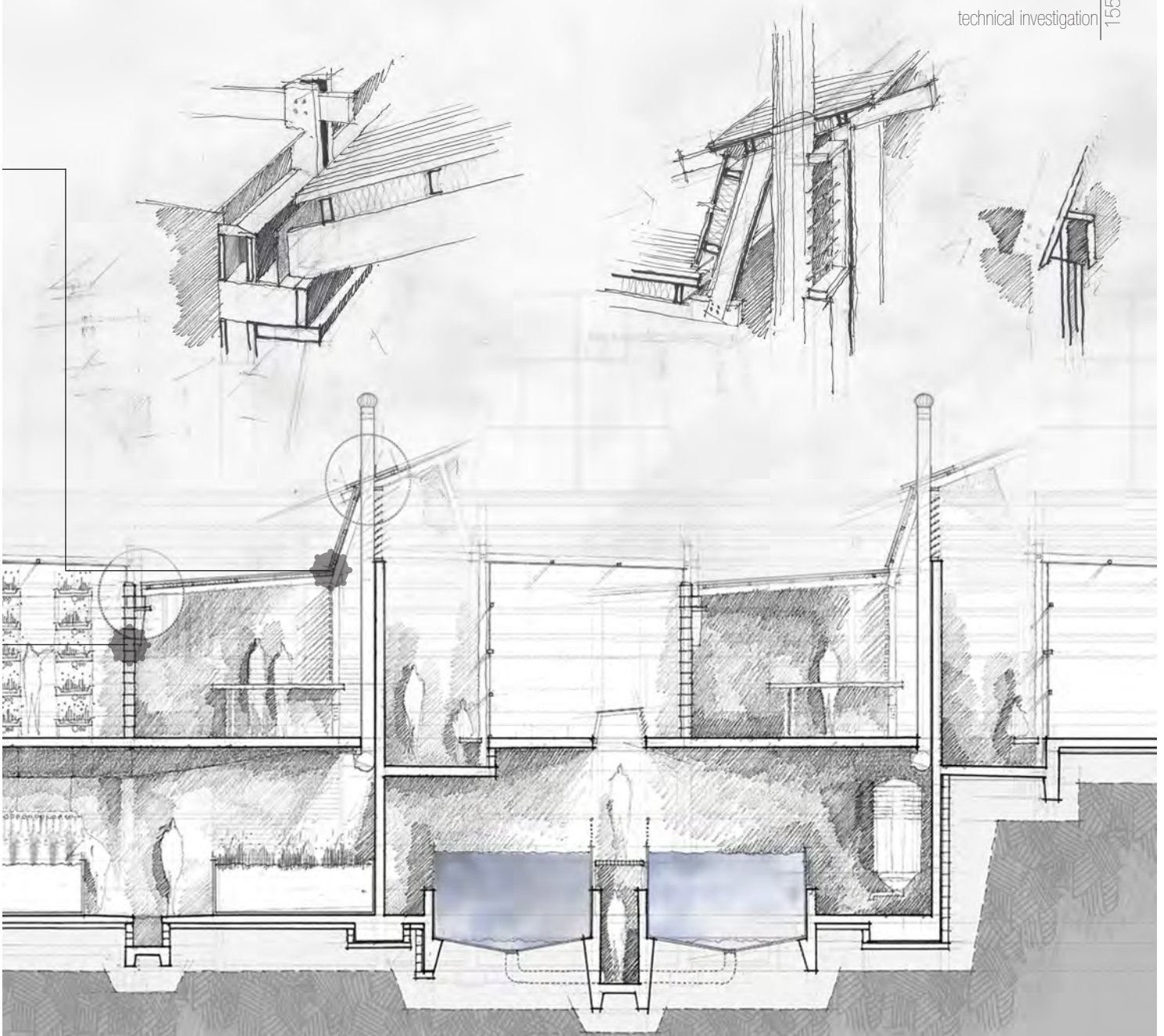
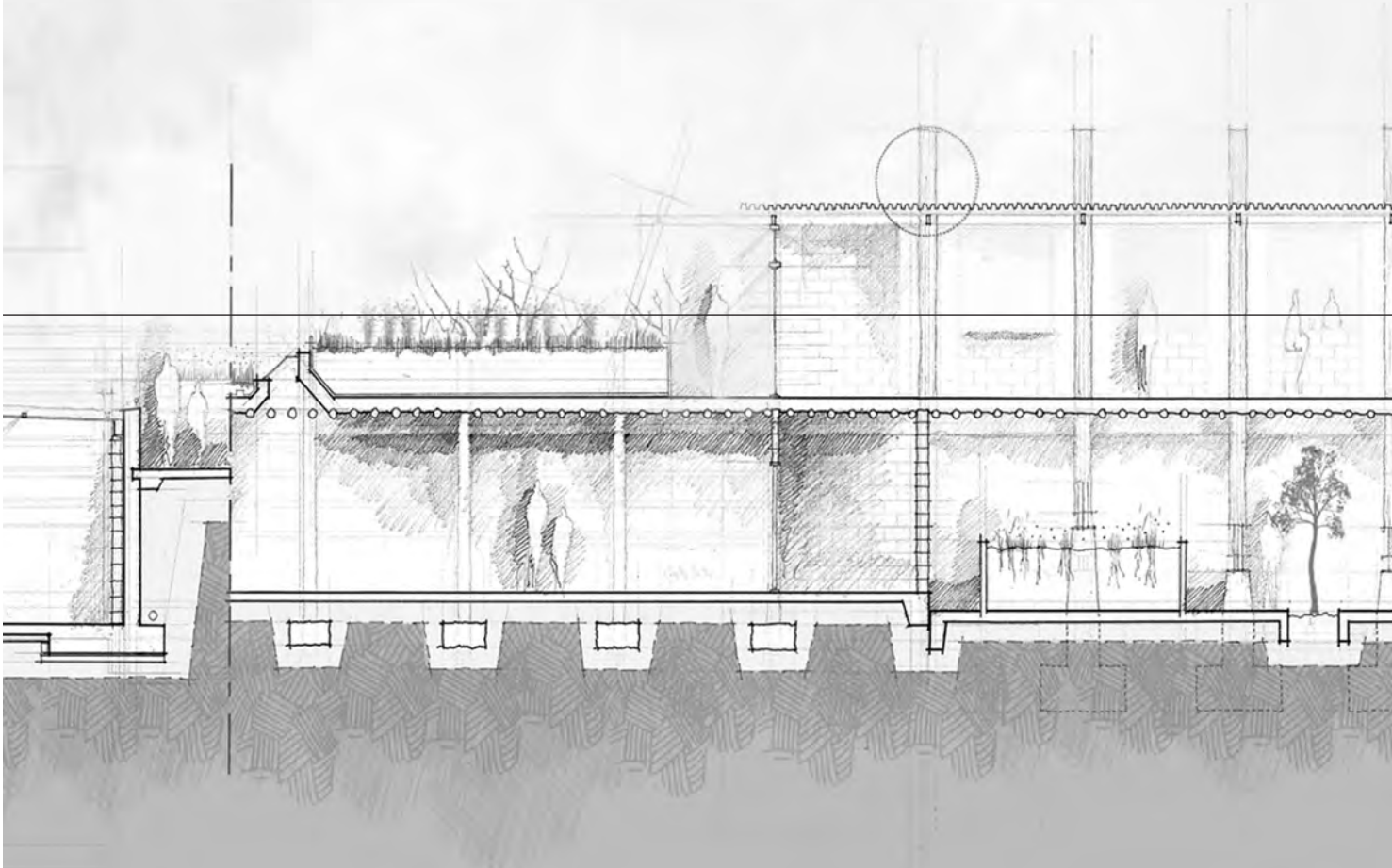
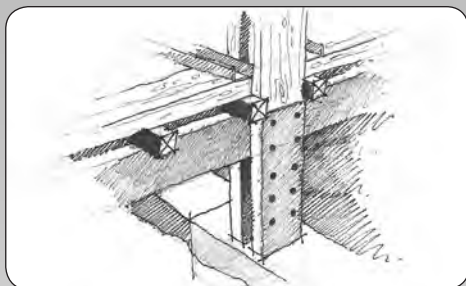
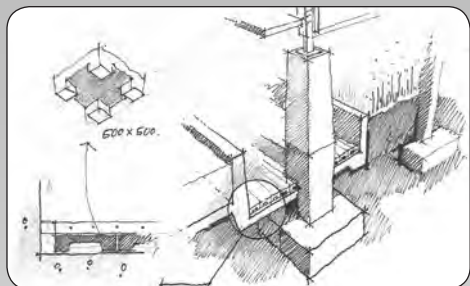
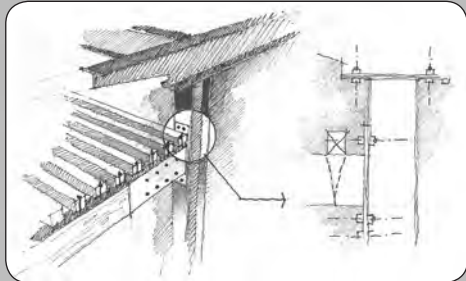
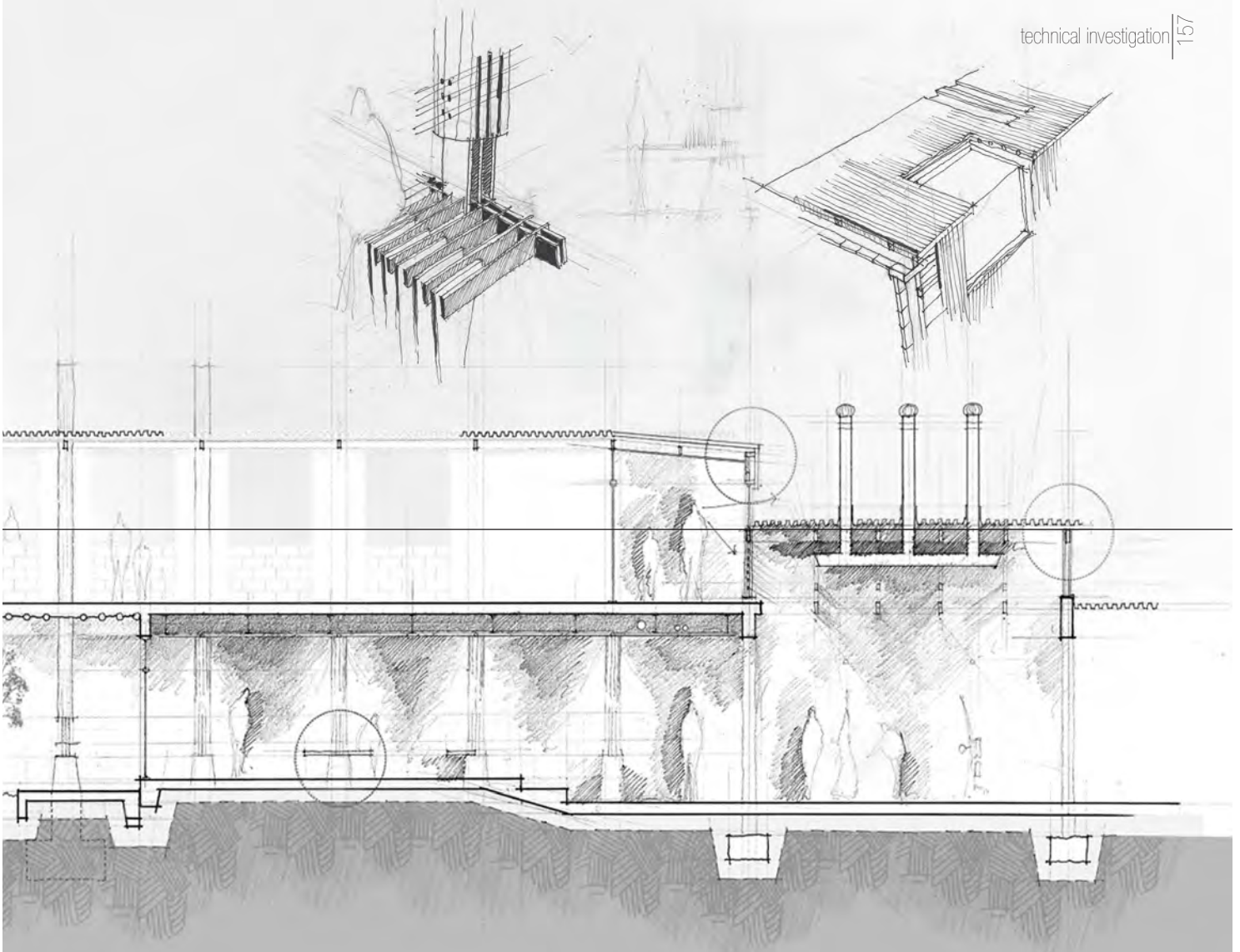
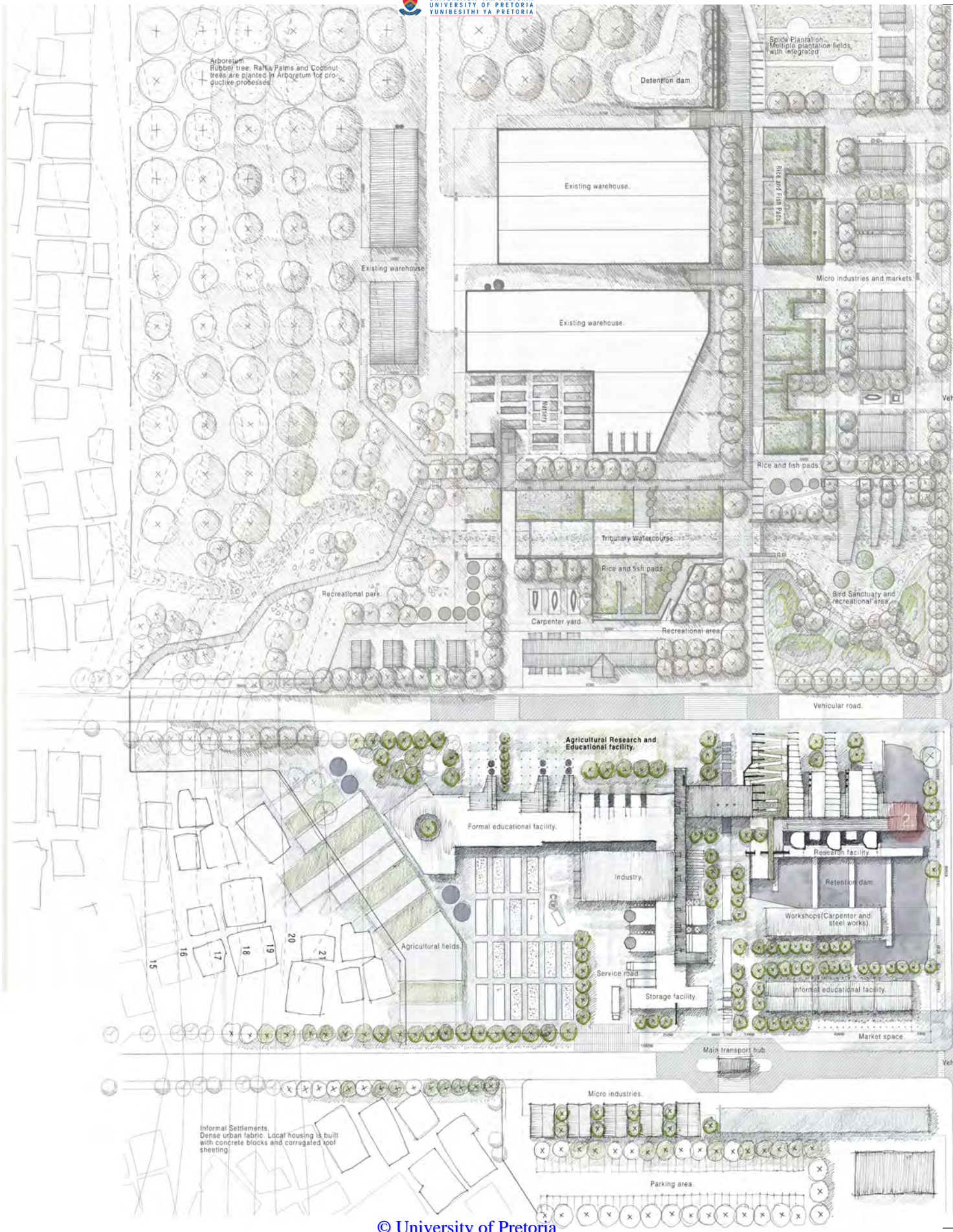


fig. 09.47_Section B-B trough research facility, restaurant and "greenhouses"







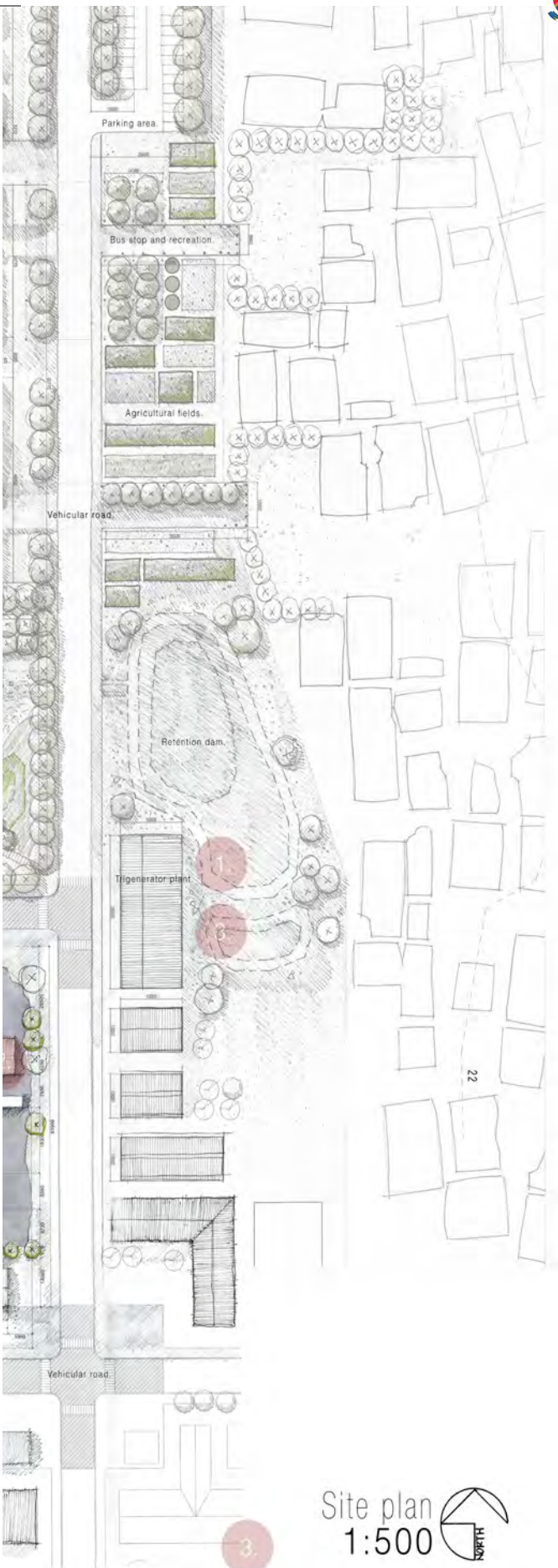
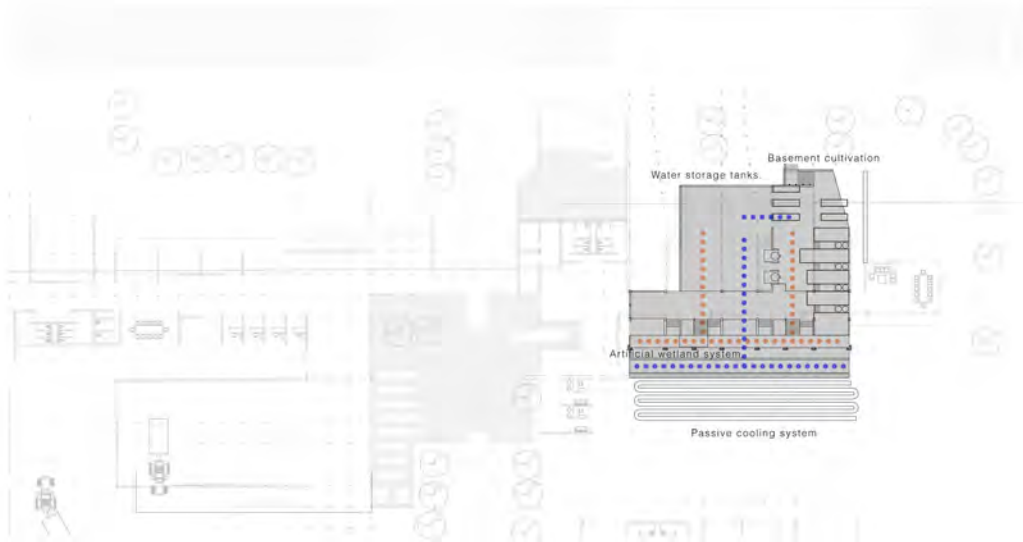
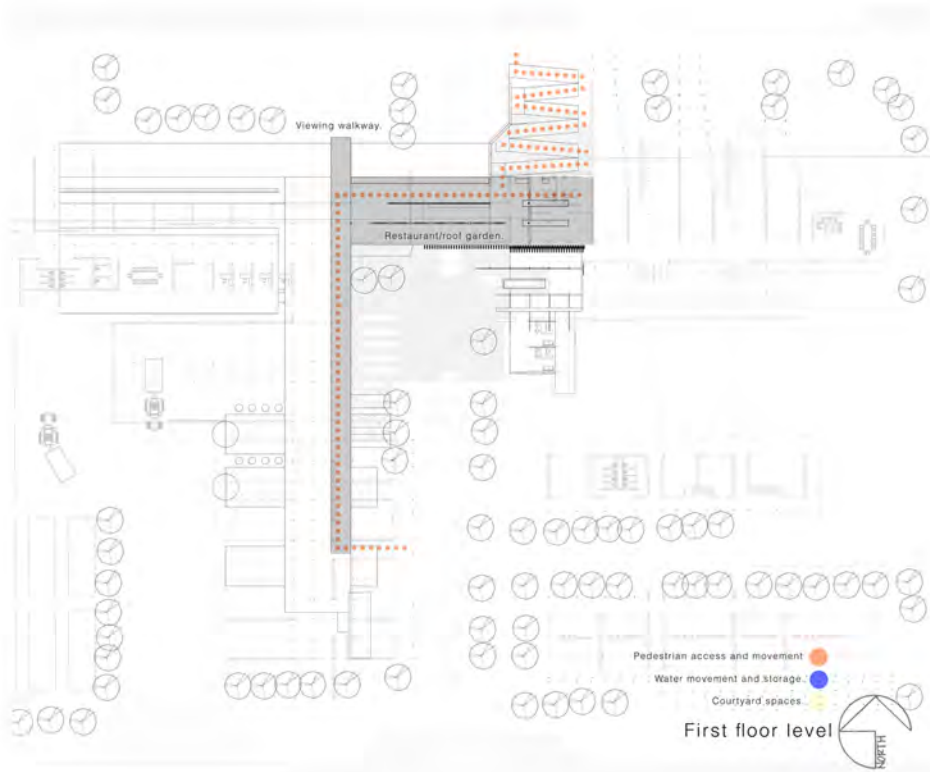



fig. 09.48_final site plan.



Basement level 



First floor level 

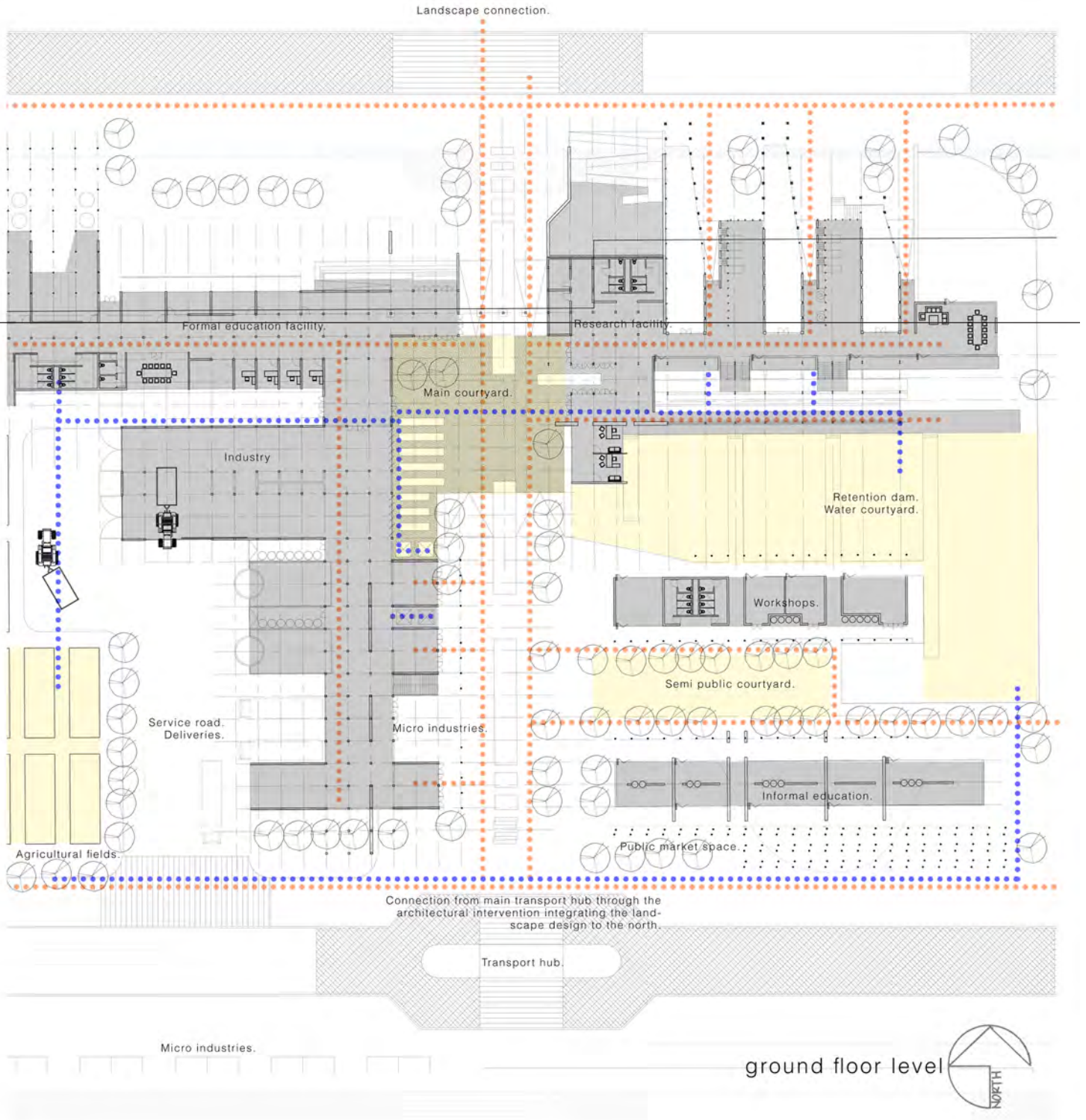
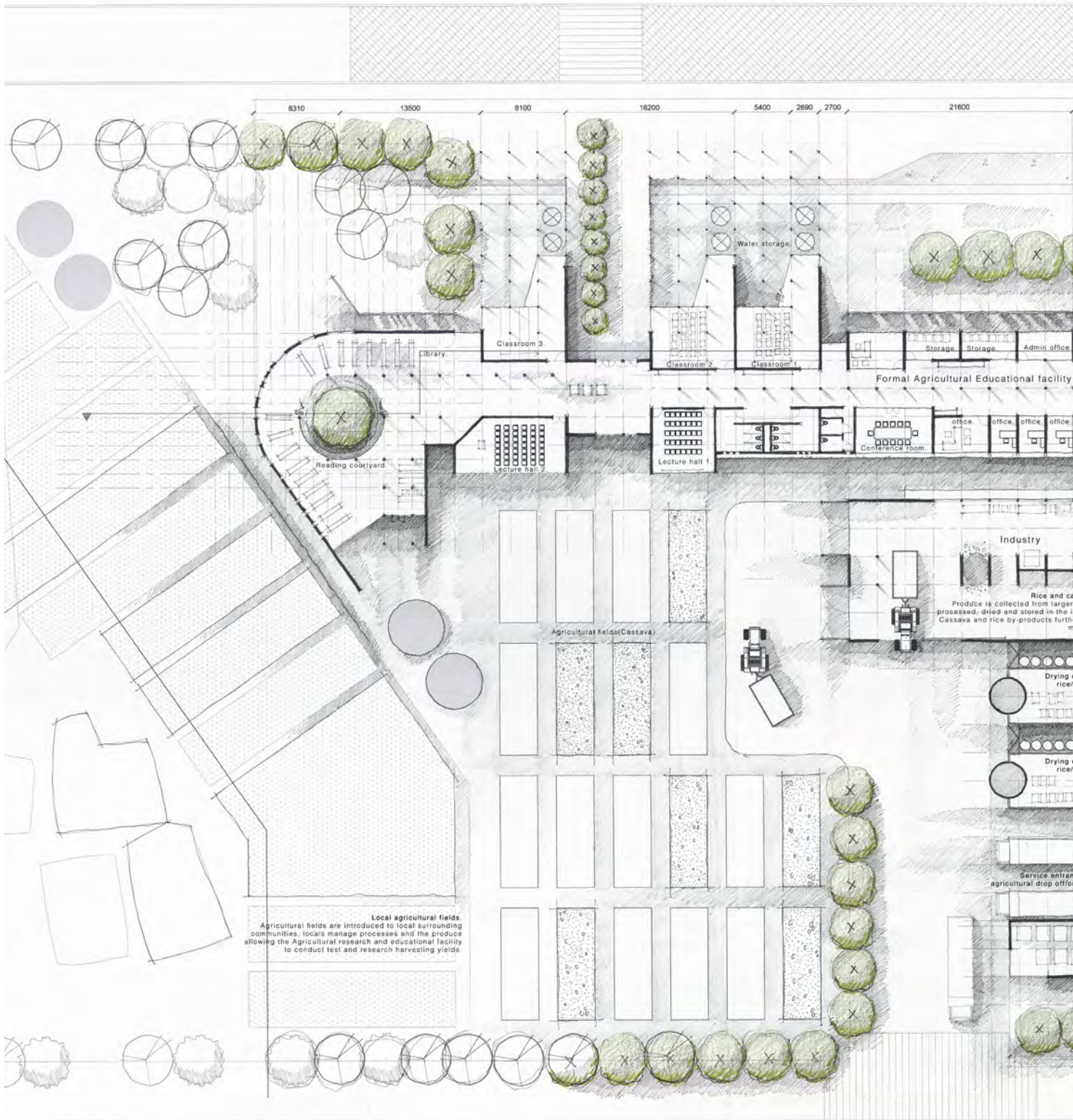


fig. 09.49_Diagrams illustrating water and pedestrian movement on basement, ground and first level.



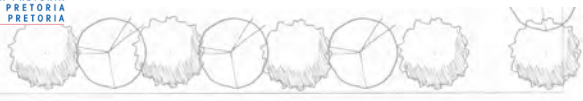
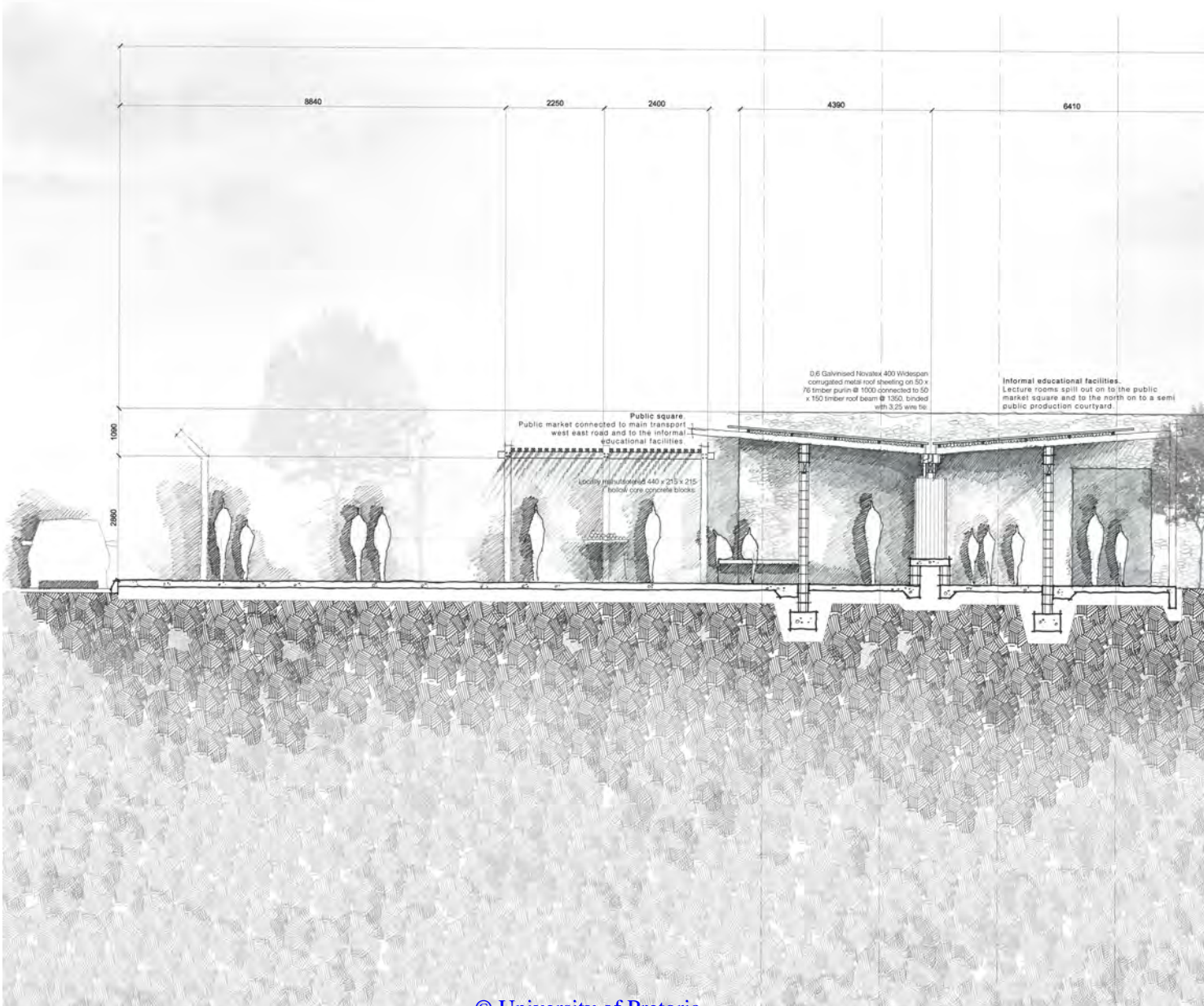


fig. 09.50_Final ground floor plan, 1:200.



1100 6650 1120 2620 7320

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o a semi

Rice and fish pads.

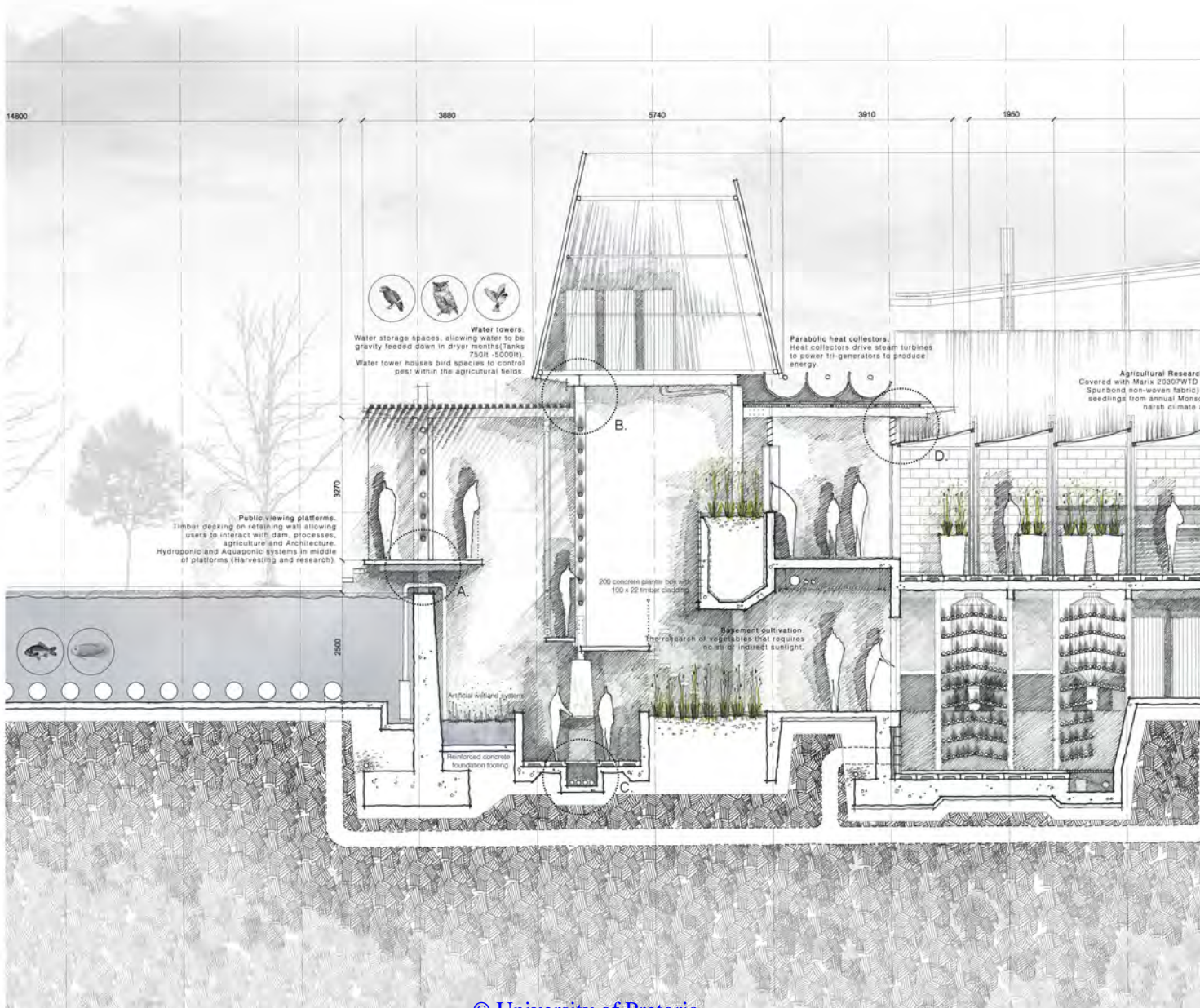


Passive cooling strategy.
Dry hot air is pulled in with vertically driven fans, air cleaner pads are cooled through earth pads 3000mm below ground to cool air and is released within the building.

Workshops.
Artisan and craftsmanship (Timber and steel workshops) opening on to semi public courtyard integrating the informal eggshells, facilities and market space.

Water courtyard.
Retention dam on the eastern boundary. Fish breeding (Tilapia, Carp and catfish) and rice fields for research connecting with the research facility.

fig. 09.51_Final Section a-a.

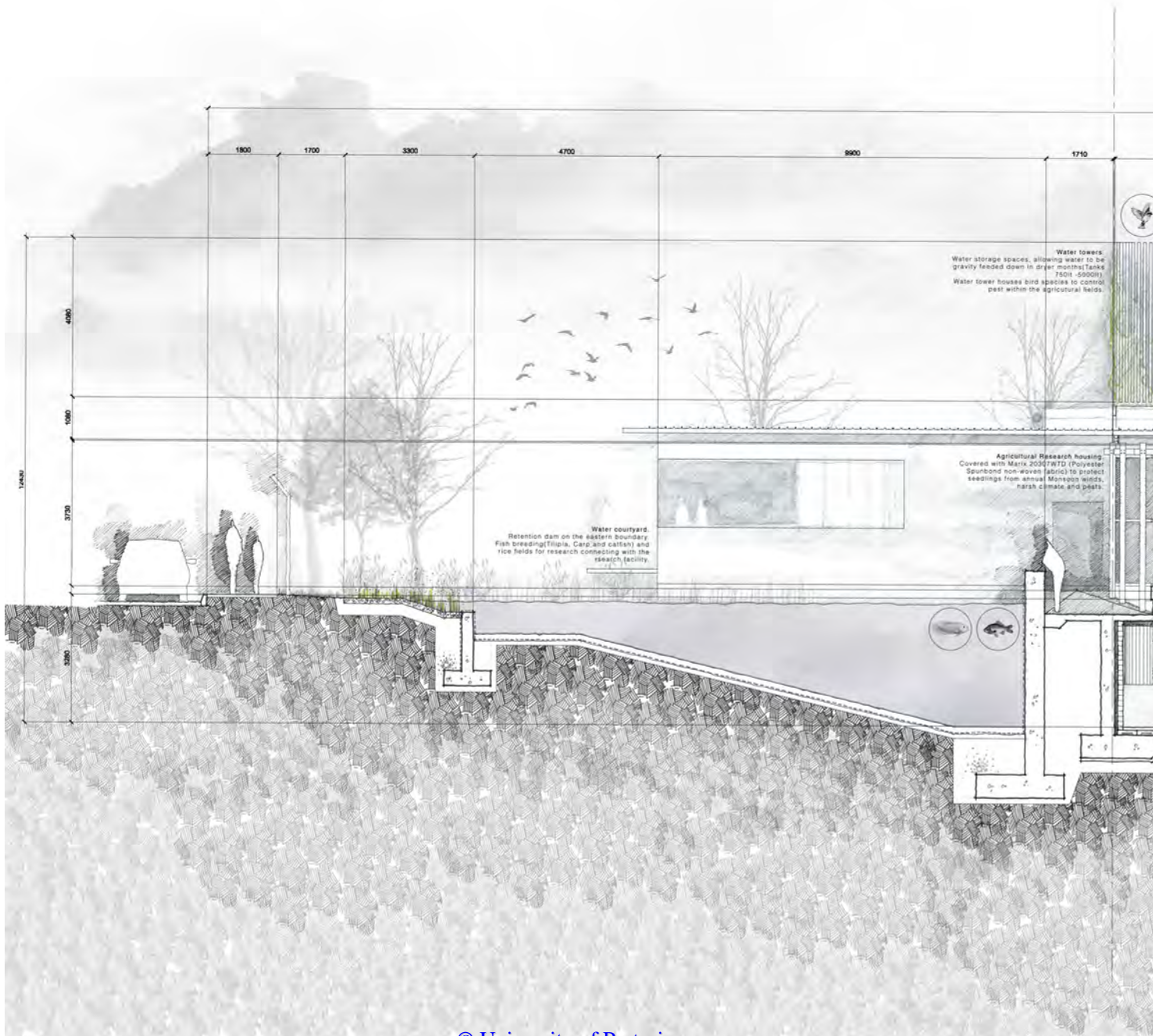


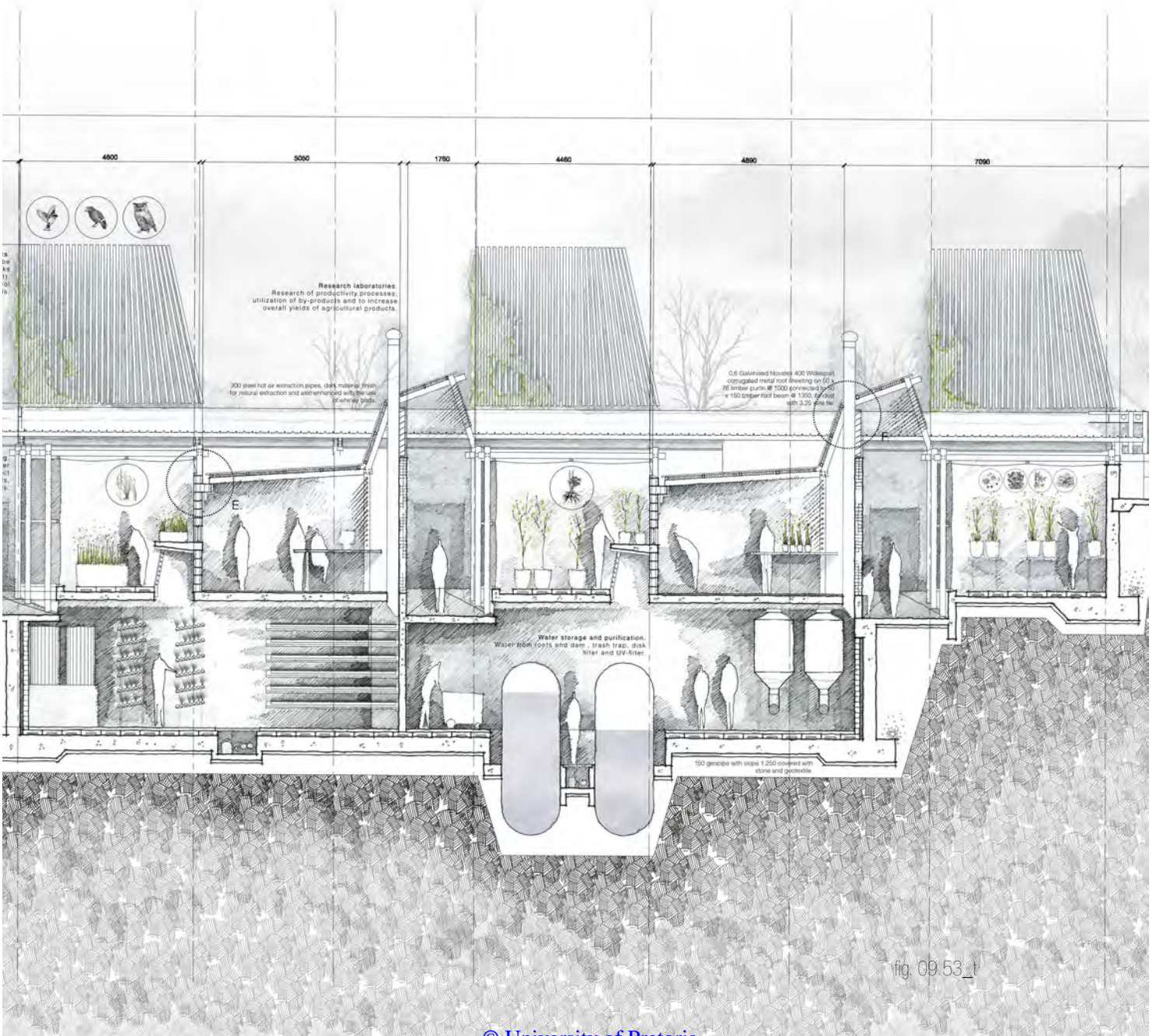


ultural Research housing,
via 2037WTD (Polyester
-woven fabric) to protect
n annual Monsoon winds,
harsh climate and peels.

Connection to the Landscape
Connecting the Architecture and the lan
Architecture to the North.

fig. 09.52_Final Section a-a.





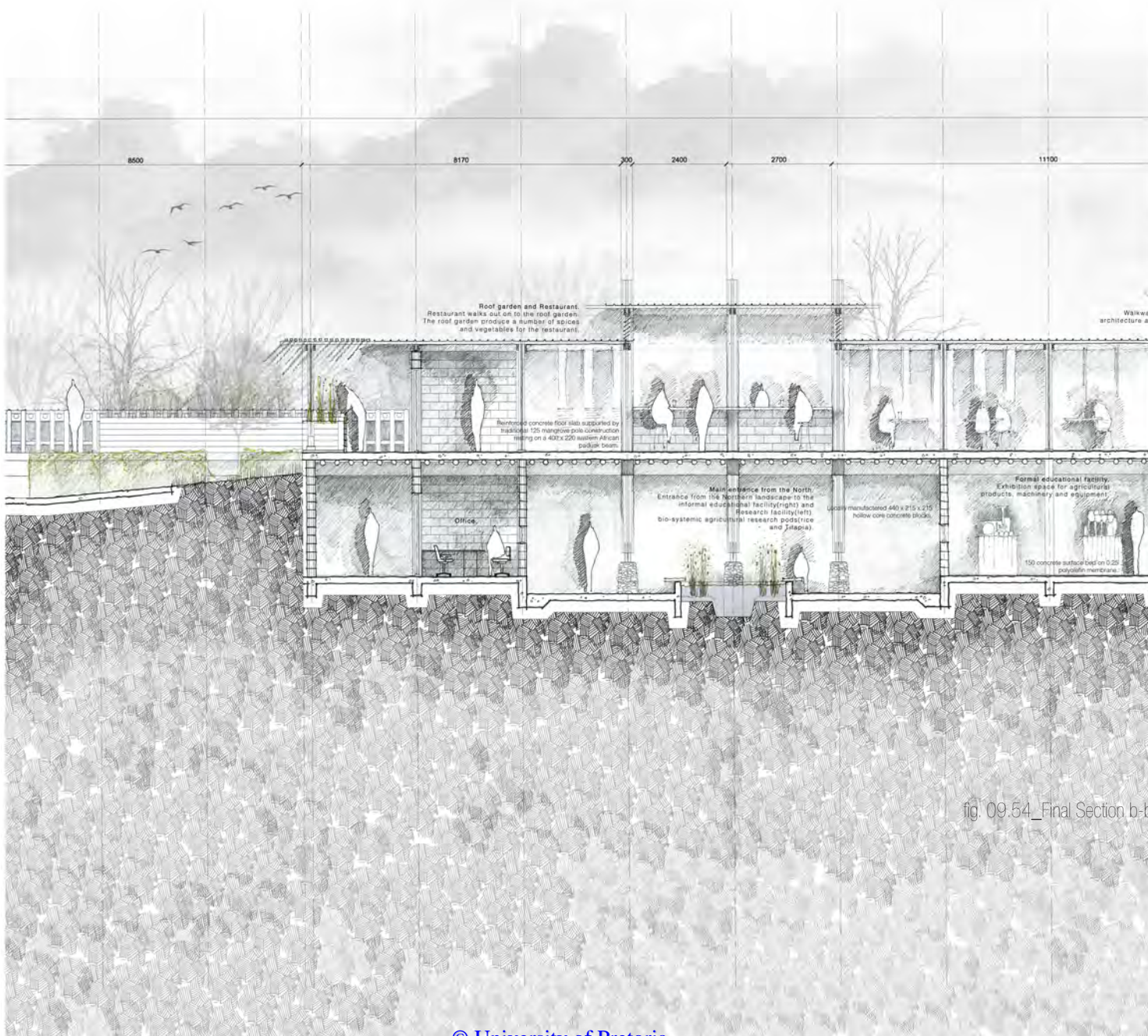
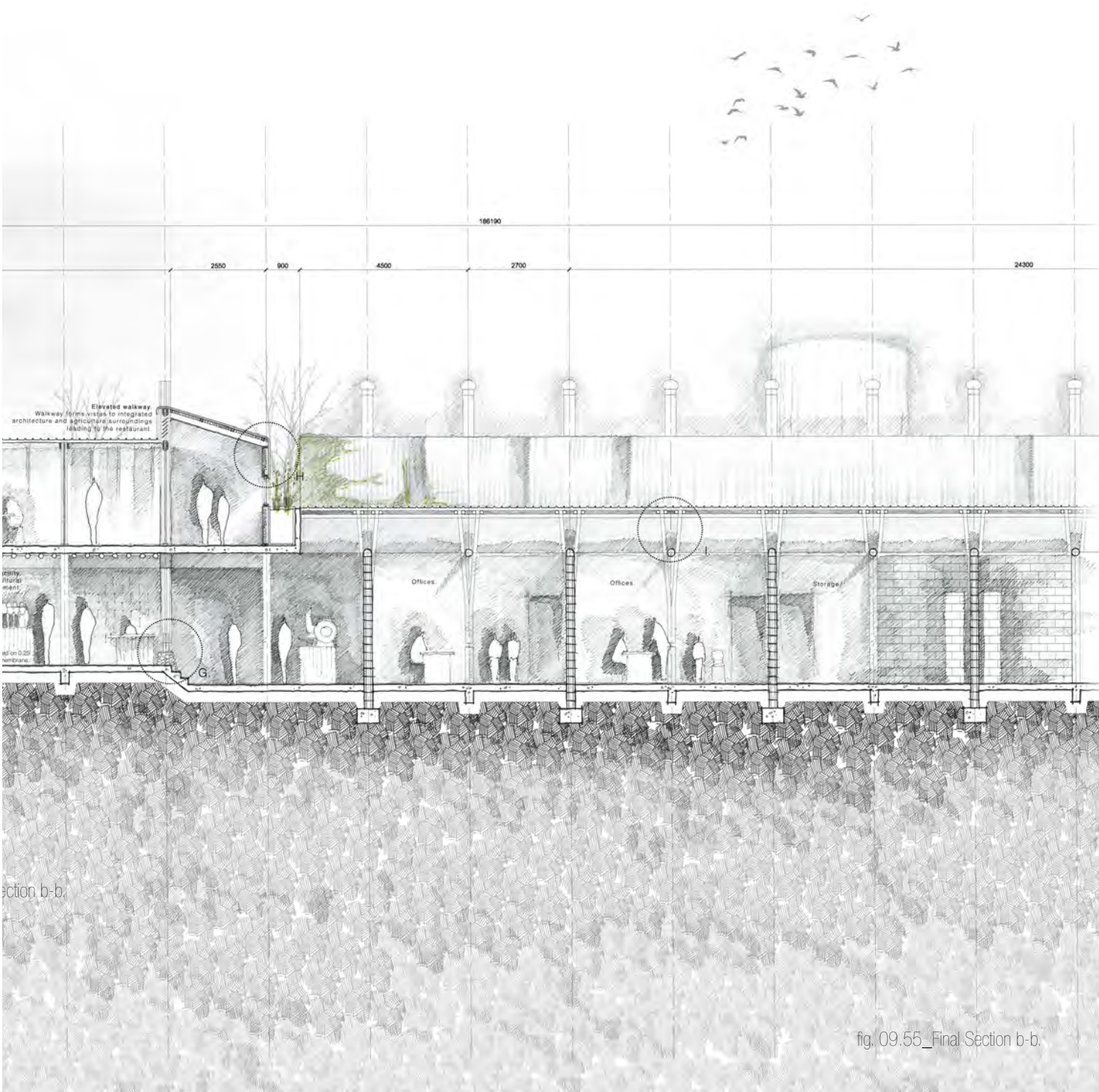
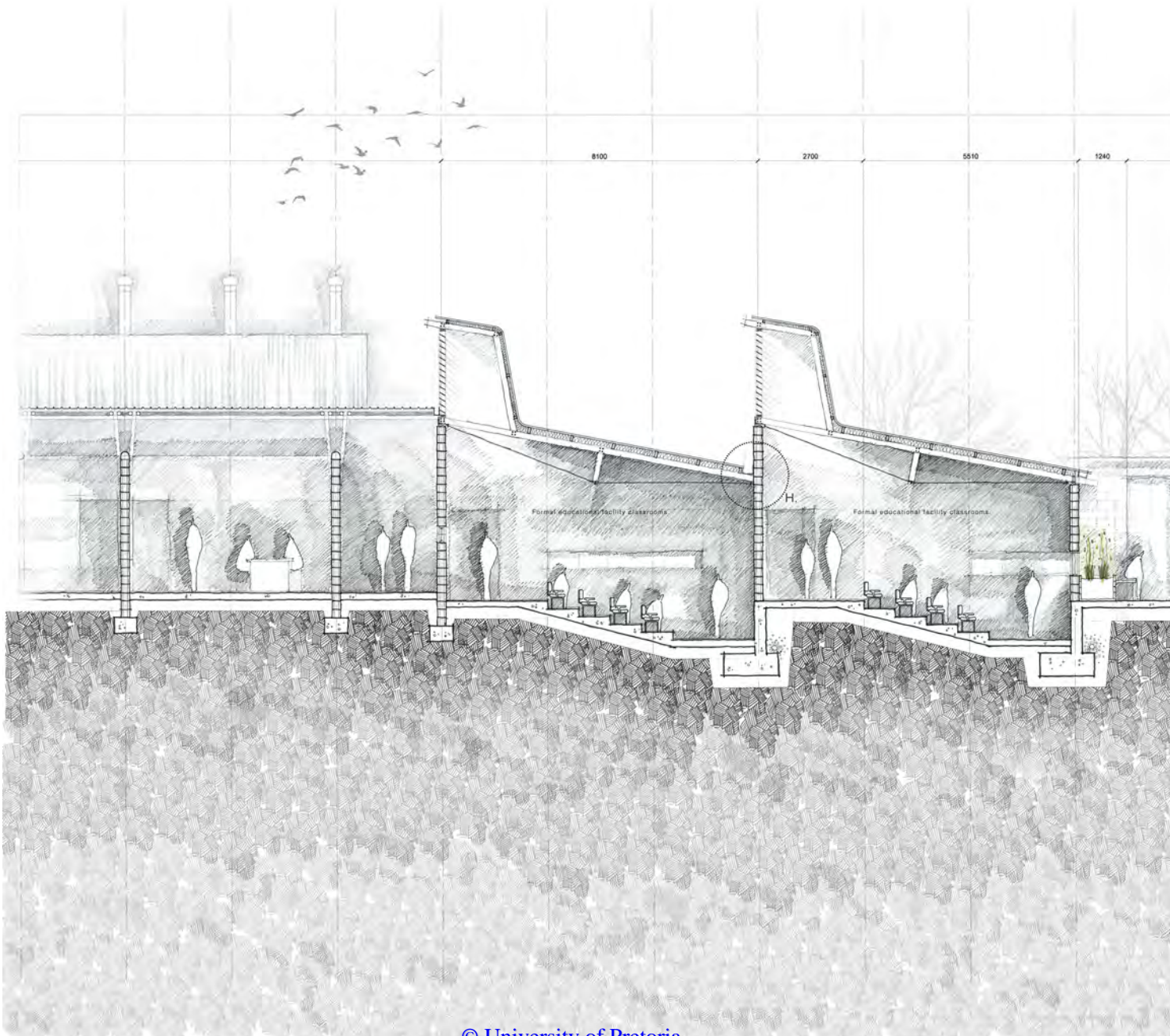


fig. 09.54_Final Section b-f



Section b-b.

fig. 09.55_Final Section b-b.



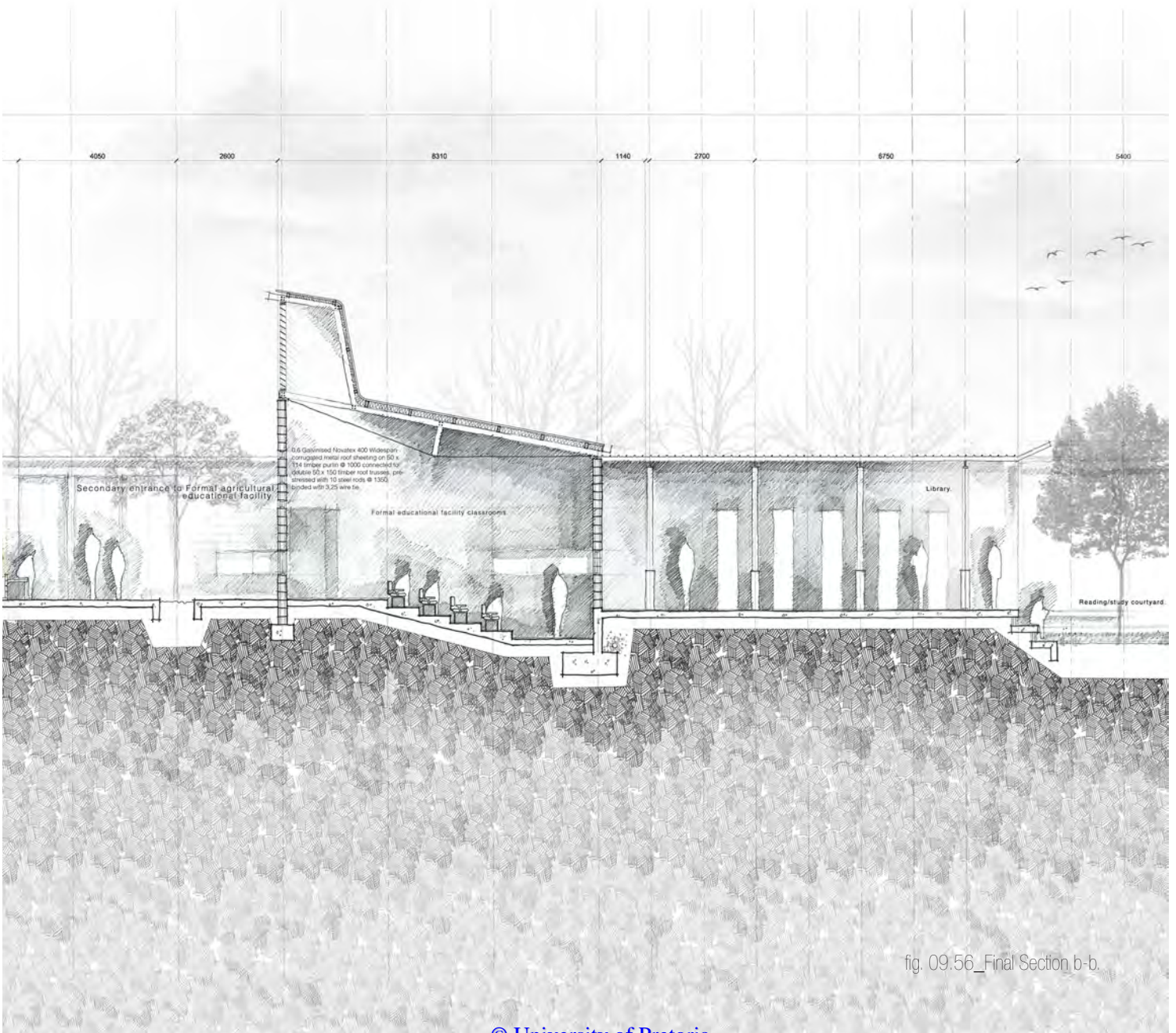
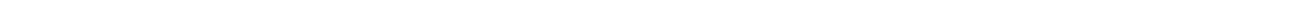


fig. 09.56_Final Section b-b



fig. 09.57_Final Section b-b.



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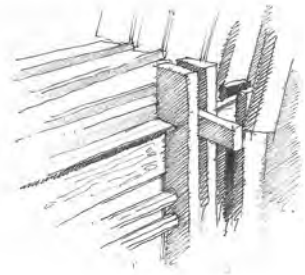
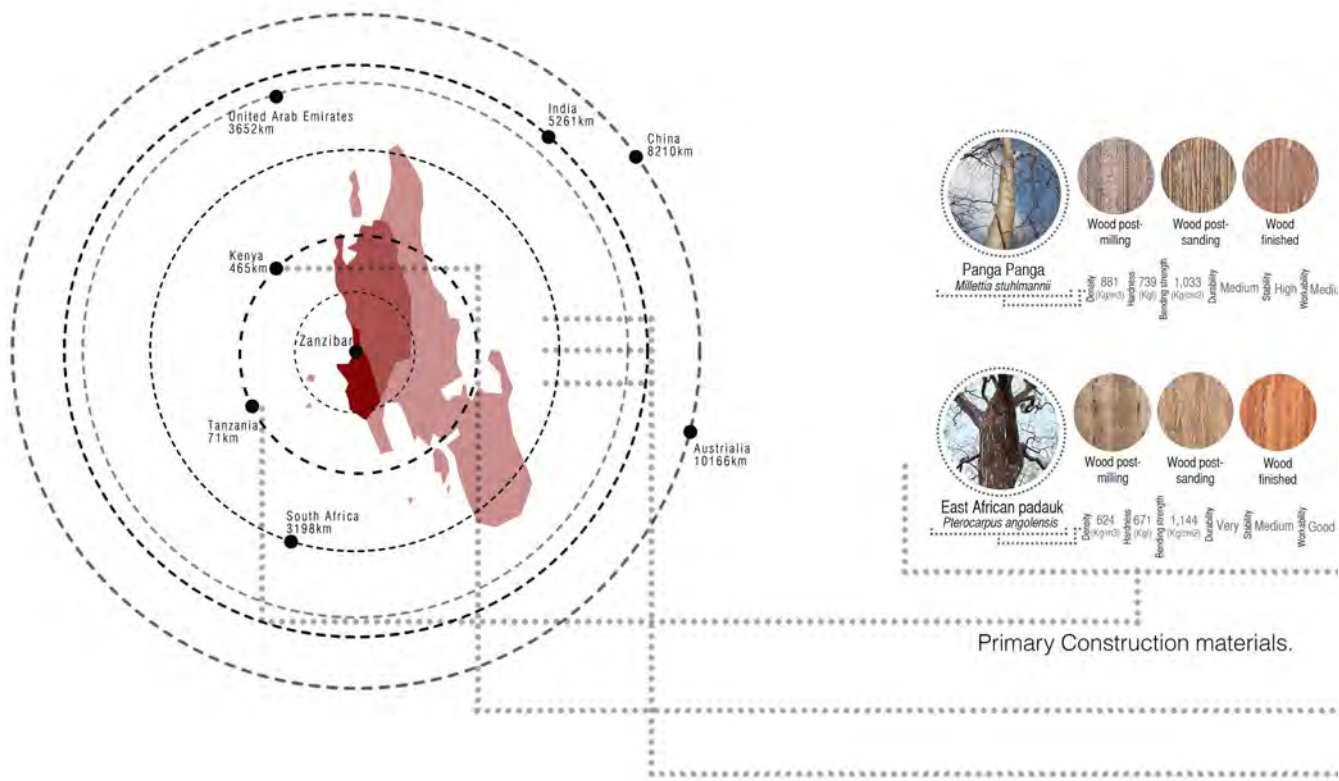
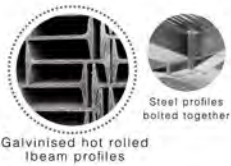
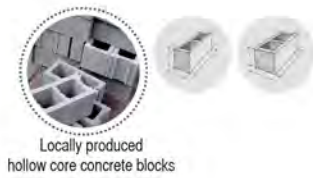
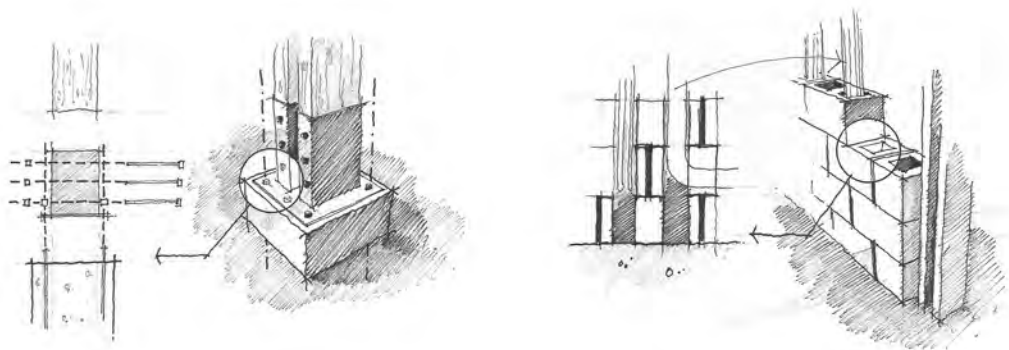


fig. 09.58_Material selection and locality.



Secondary Construction materials.

Wood finished
High Workability Medium
Wood finished
Medium Workability Good
als.



A.

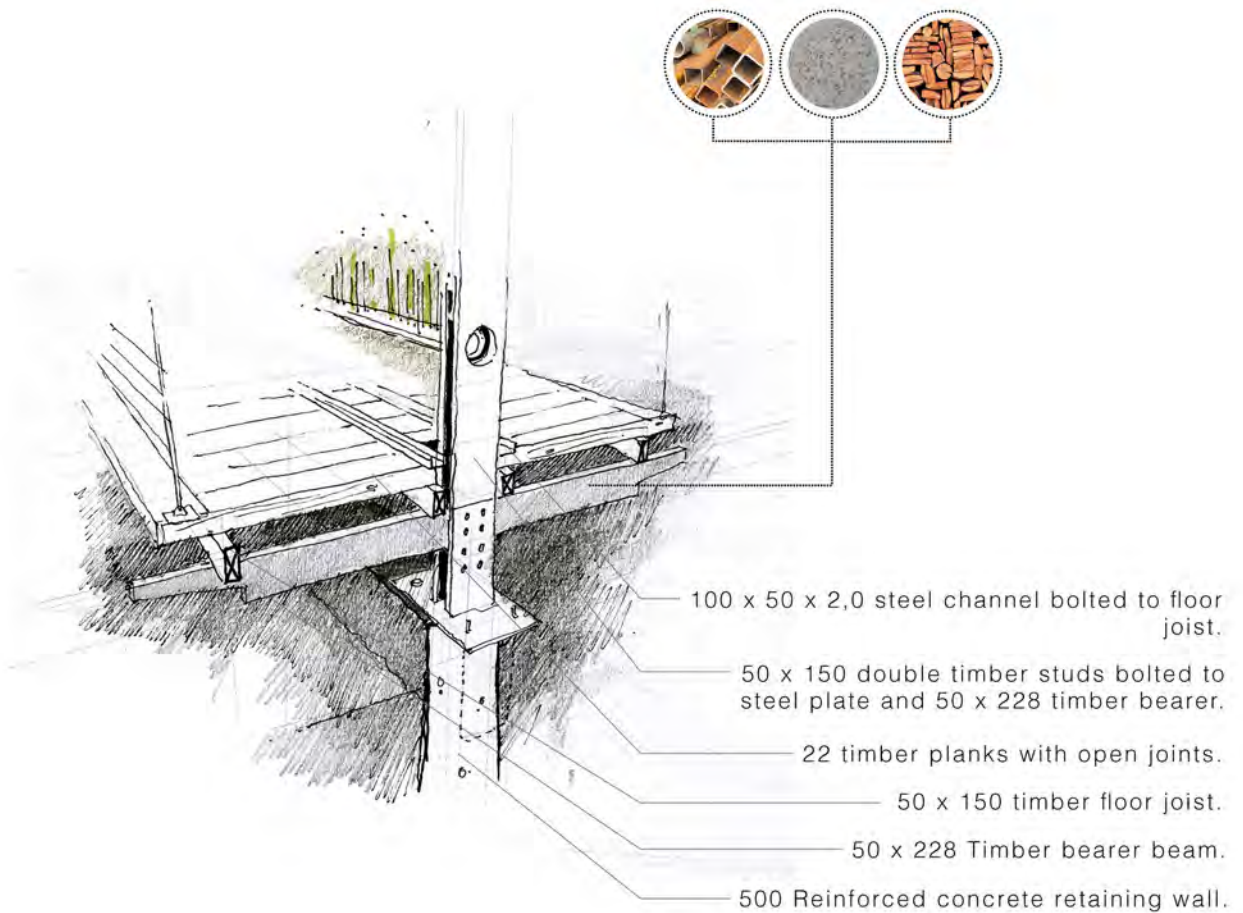


fig. 09.59_Detail A, Exposed walkway.

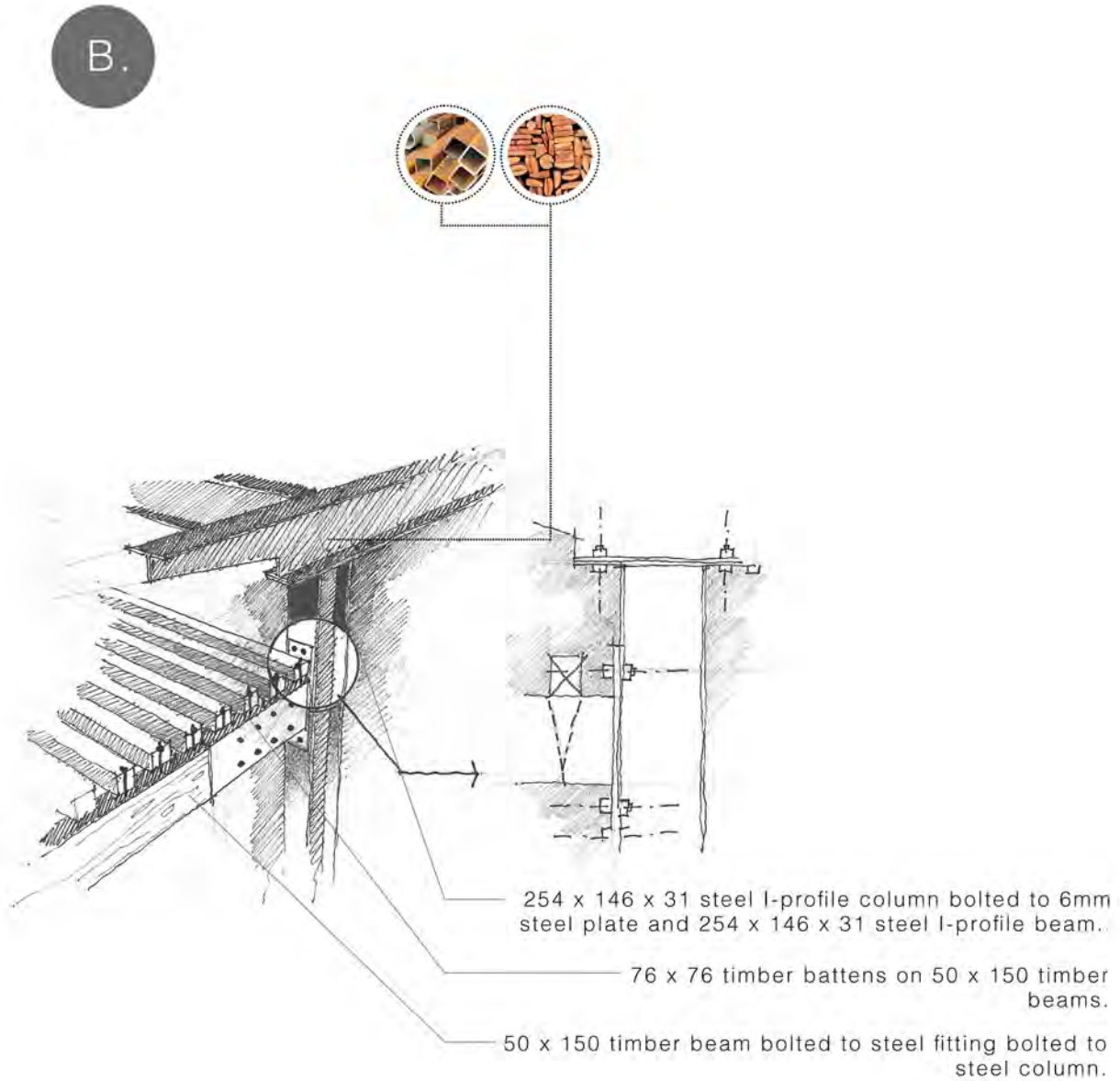


fig. 09.60_Detail B, Timber and steel roof connection.

C.

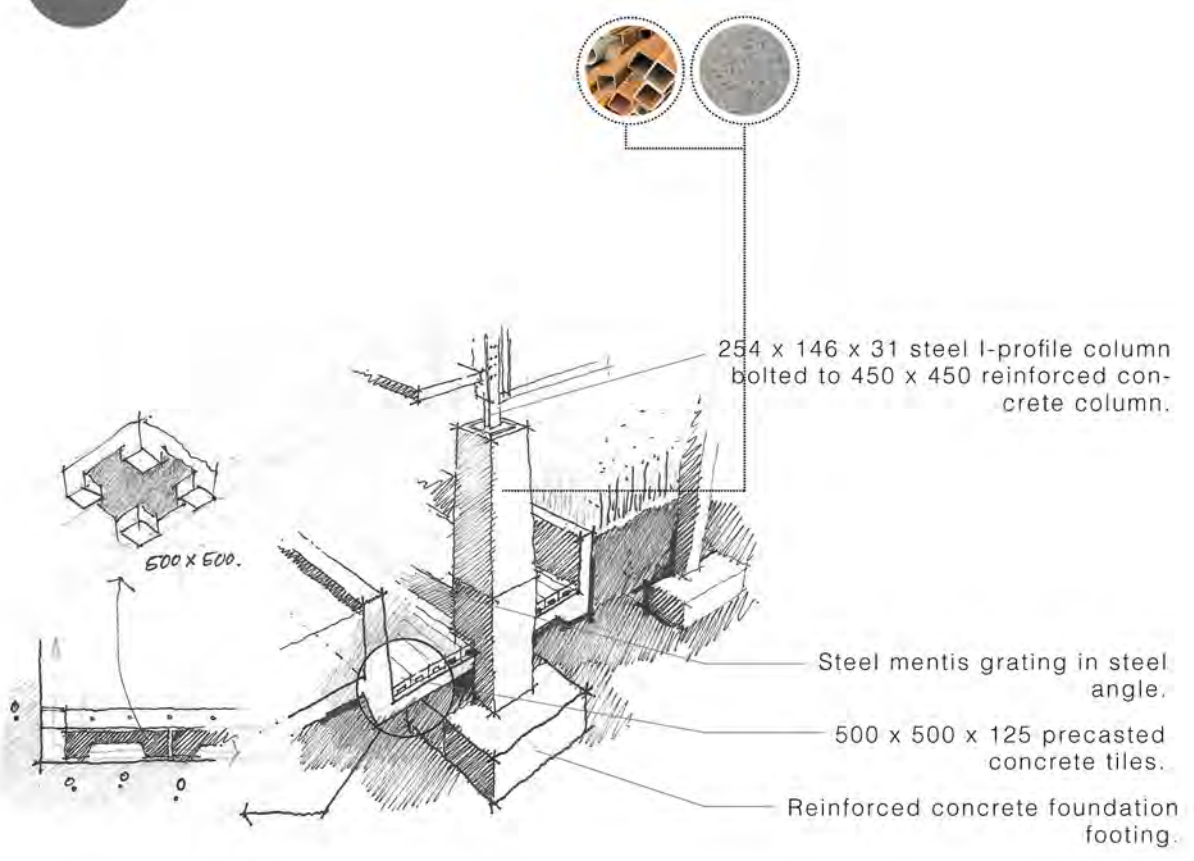


fig. 09.61_Detail C, Concrete foundation and waterproofing.

D.

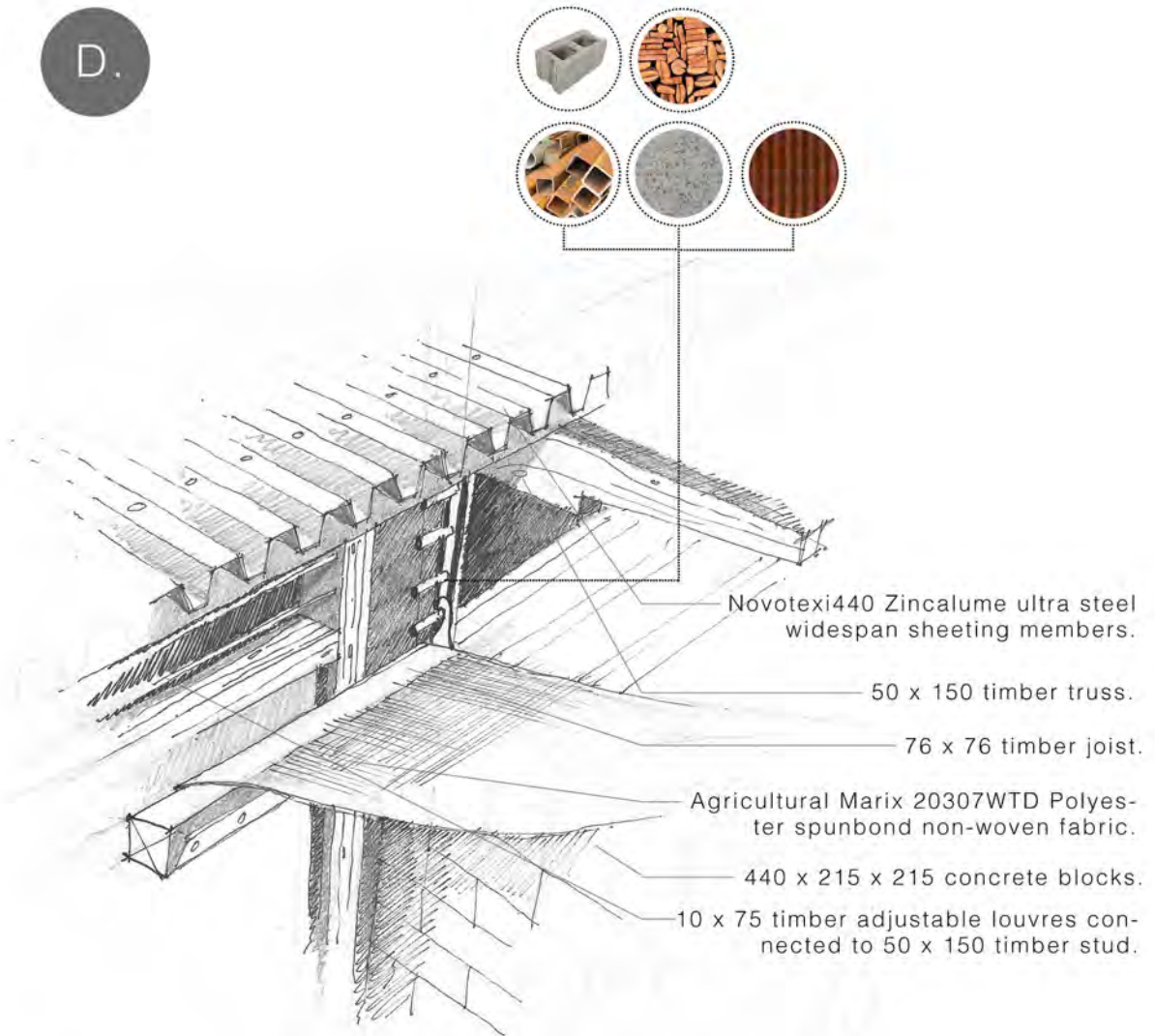


fig. 09.62_Detail D, Marix component and joinery.

E.

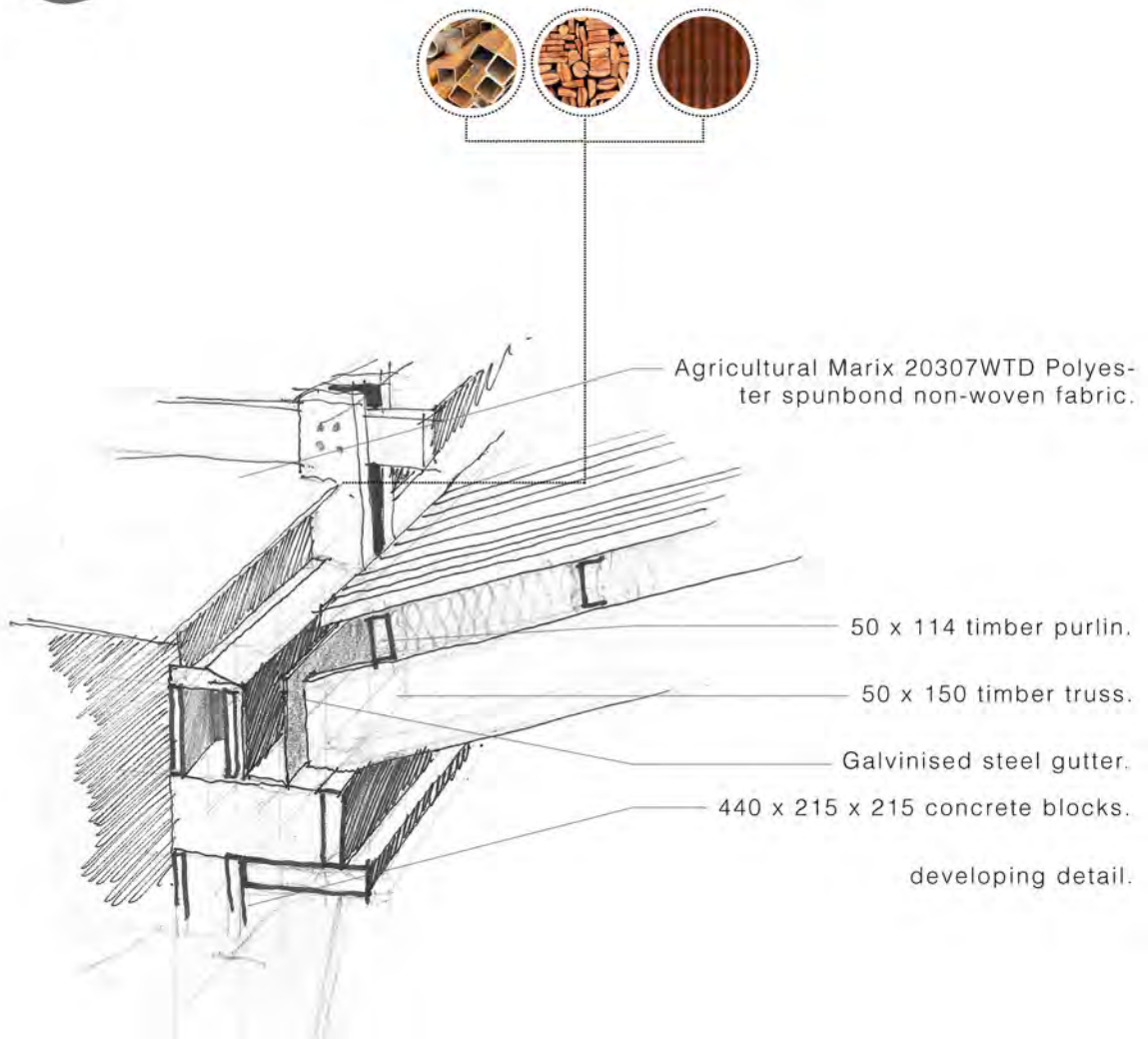


fig. 09.63_Detail E, Roof connection with internal gutter on hollow core concrete wall.

F.

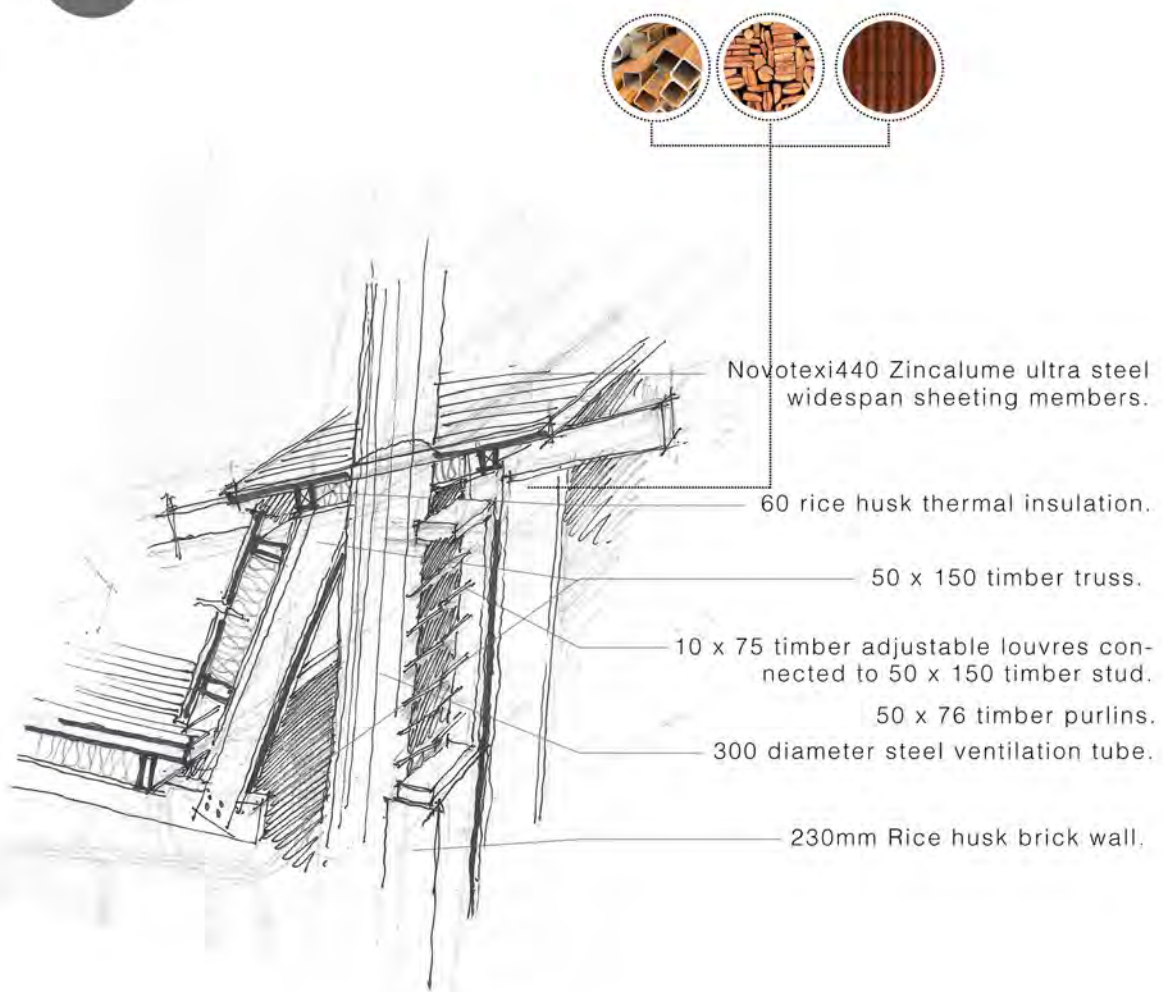
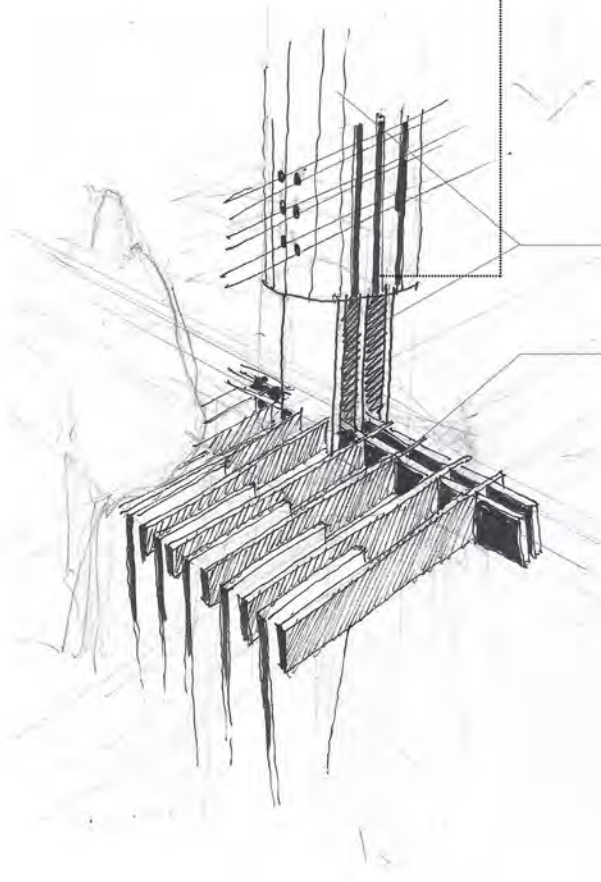
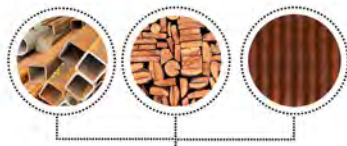


fig. 09.64_Detail F, Louvre system with hot air extraction points.

G.



300 diameter column bolted to galvanised steel member bolted on to reinforced concrete footing cladded with coral stone.

22 x 114 timber planks bolted to steel member.

fig. 09.65_Detail G, Timber seating connected to timber column.

H.

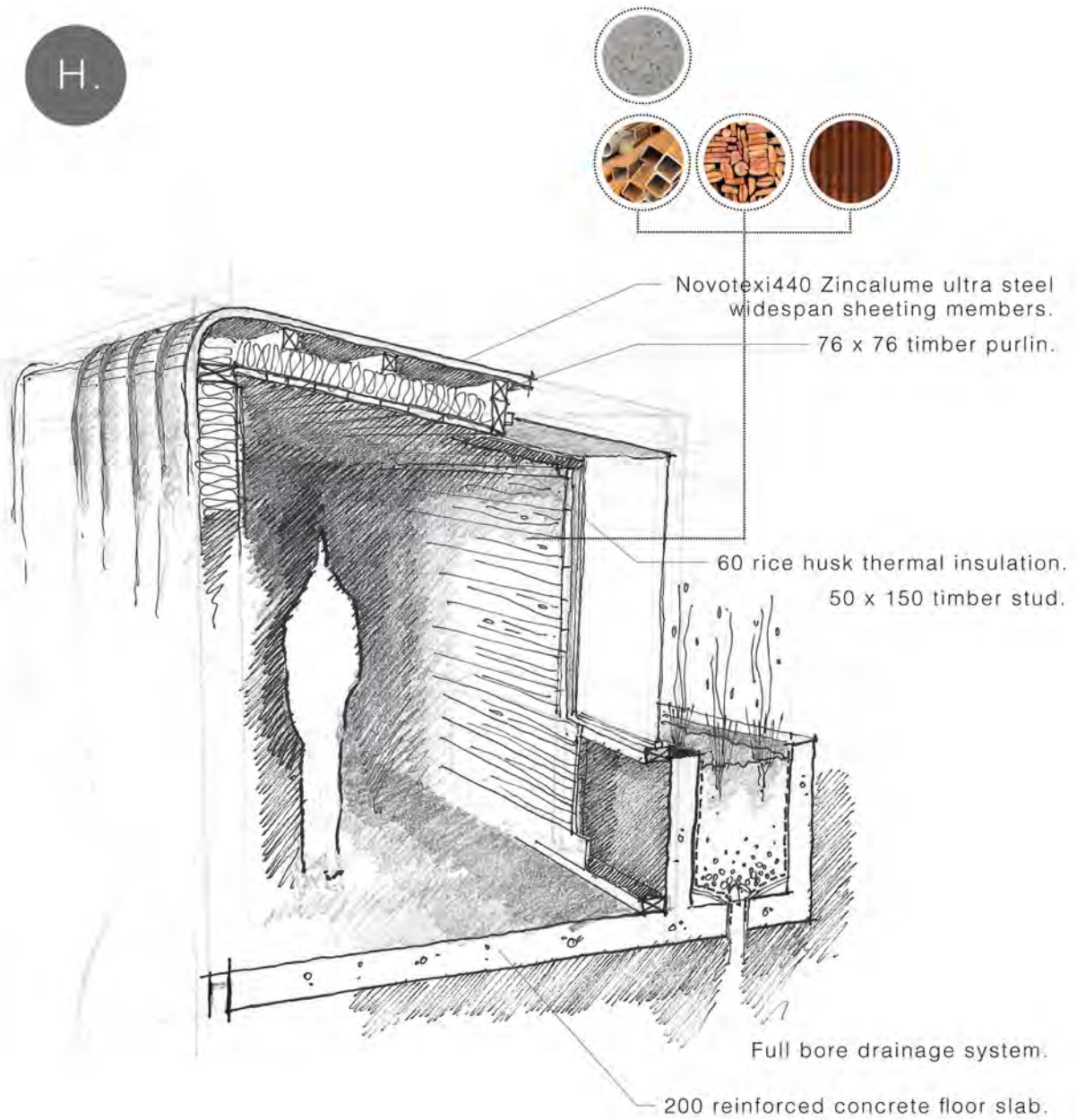


fig. 09.66_Detail H, Internal walkway with vistas to the surrounding context.

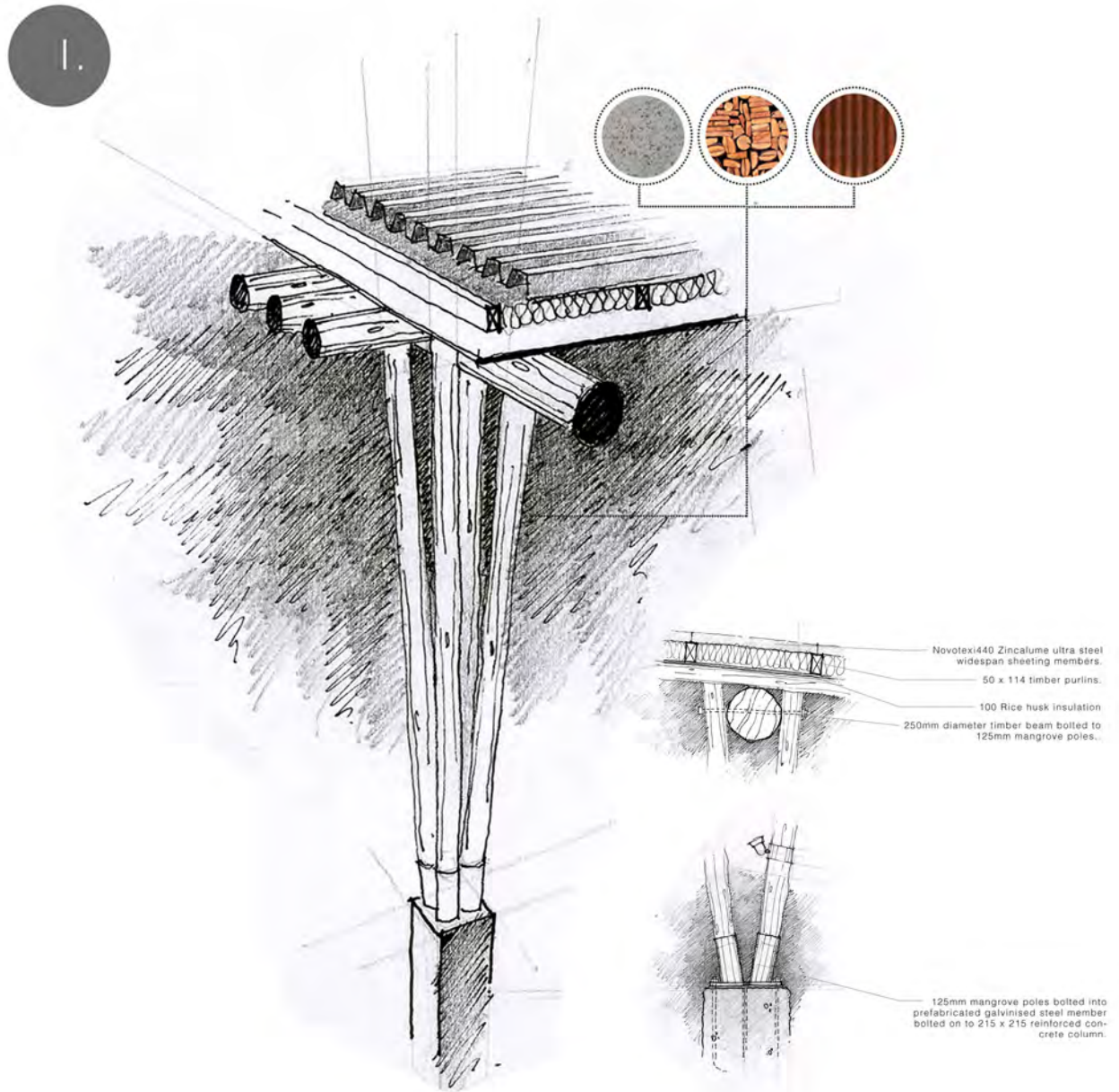


fig. 09.67_Detail I, Timber columns on concrete footing.

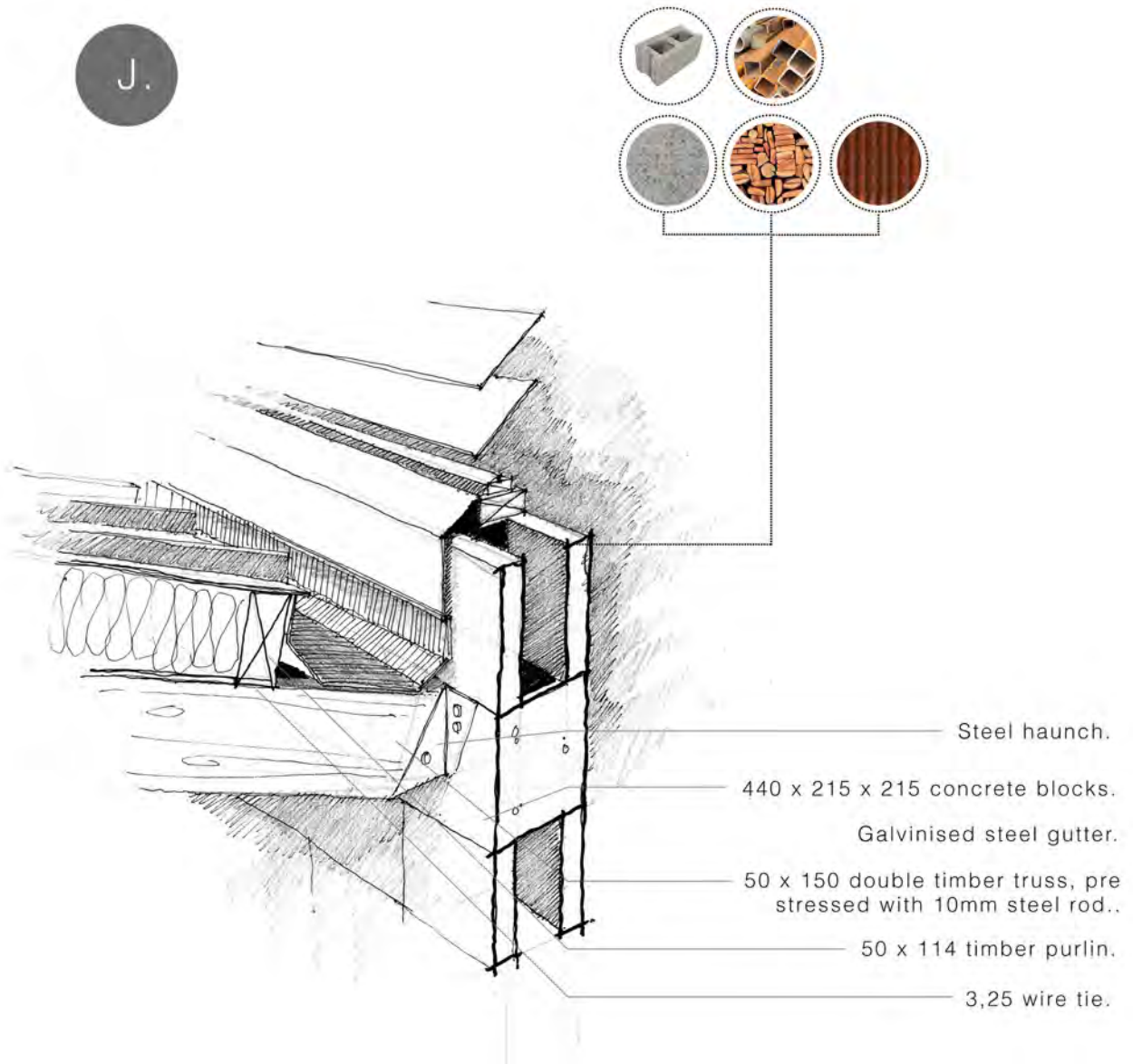


fig. 09.68_Detail J, Internal gutter on Double truss system.





09.69 Perspective of research facility entrance.





Figure 2: Perspective of Agricultural research and educational facility.

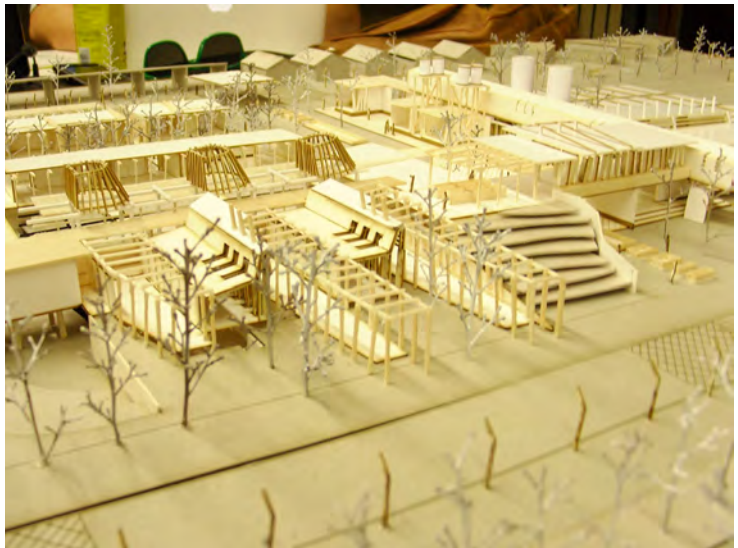
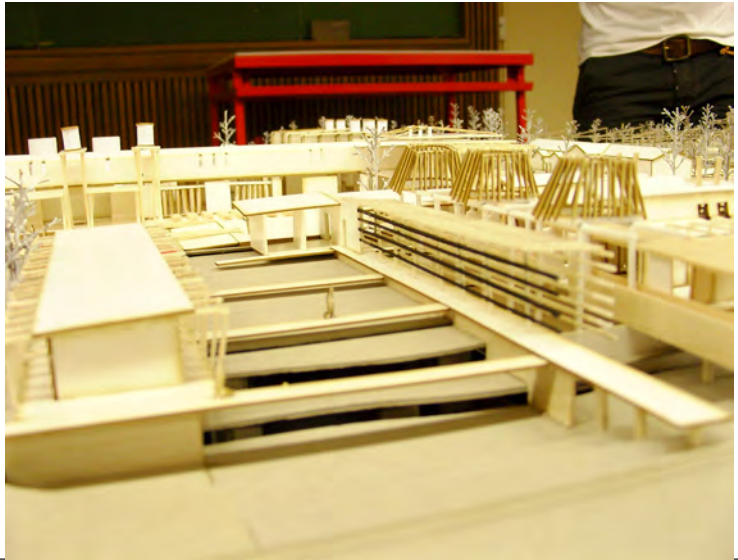




fig. 09.71_Digital images of Physical model built of the agricultural research and educational facility.

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