VENICE OF LAGOS

Reviving the fishing culture in **Makoko** *through Aquaponics*

by

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I hereby declare that I am the sole author of this thesis.
This is a true copy of the thesis, including any required final revisions,
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the public.

ABSTRACT

Lagos, Nigeria is a rapidly growing mega-city that faces issues such as overpopulation, pollution, waste management, sanitation, poverty among a host of others. The coastal nature of Lagos causes the city to experience annual flooding with rising sea levels, cities need to start thinking of ways to adapt to such changes.

Makoko is a small fishing community in Lagos located on the Lagos lagoon, best known for its homes on wooden stilts. It is also one of the biggest and most prominent slum communities in Lagos which also boasts of a vibrant fishing and lumber industries. The fishing and lumber markets within this community are its major economic drivers, these markets attract costumers from all around Lagos and this ensures the survival of most of the inhabitants. It is also the major reason for the growth and sustenance of the community. This illegal settlement is also located on one of the most desired waterfronts and have been constantly met with threats of eviction by the government.

This Thesis explores the local economic drivers and local constructing techniques in play with Makoko, with an emphasis on tapping into the local fish and Timber industry for sustainable solution to some of the major problems within the community; Fishing practices, food security, Flooding and Accessible Water. It looks to study these problems to use them as guides in proposing a low-cost, easy to build architectural solution centered on community participation and local building techniques.

This project will study the local economic drivers within Makoko, as well as its construction industry and building techniques in order to propose a general upgradation strategy. This would be centered on the use of Aquaponics and the key technology to improve fish practices as well as help with food security and as a result improve the living standards and live quality. These interventions also help in preserving the knowledge of indigenous fishing and construction techniques.

ACKNOWLEDGEMENT

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LAGOS LAGOON
LAGOS ISLAND

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INTRODUCTION 1

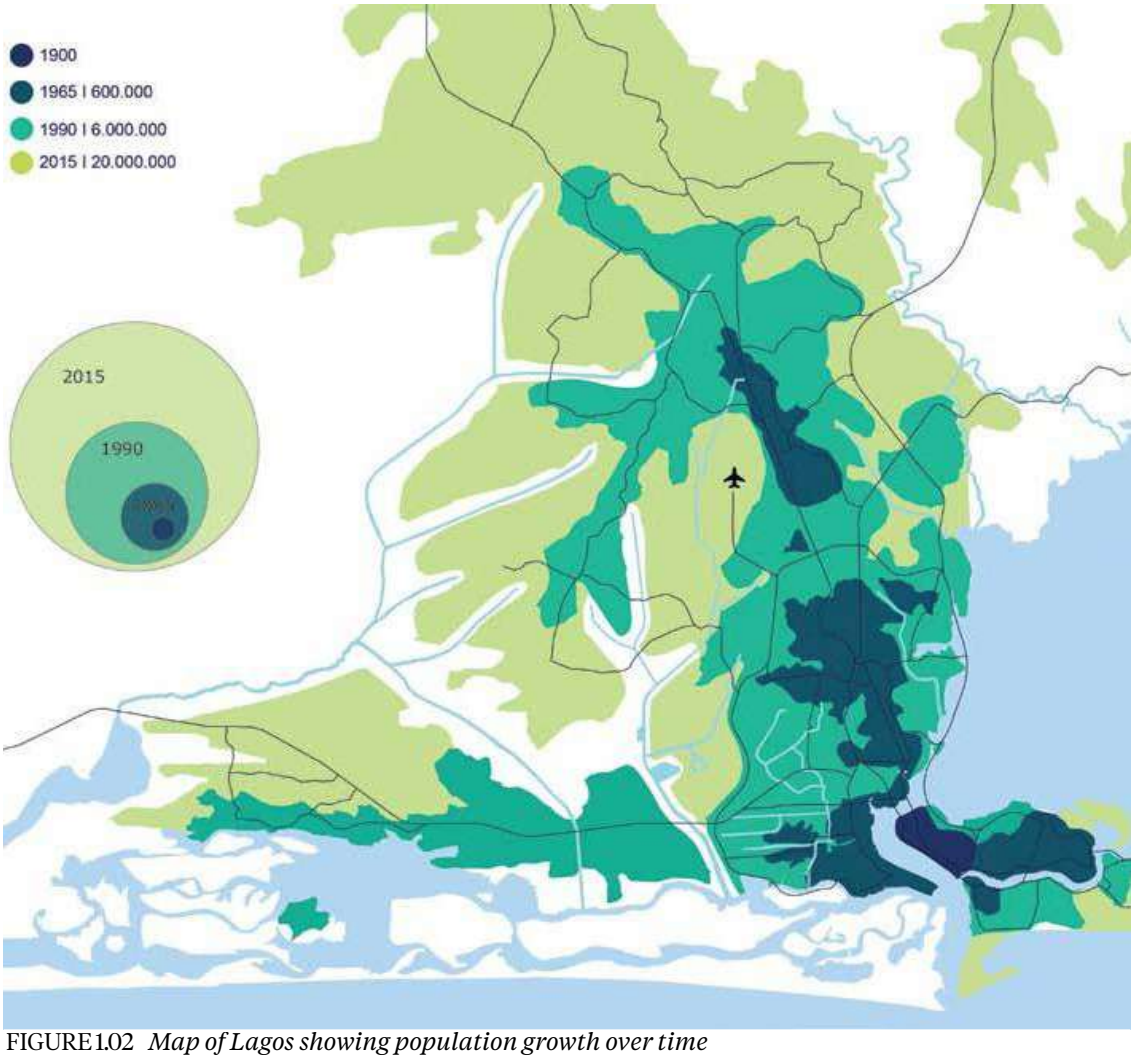
We live in a dynamic, ever-changing world in which everything, as we know it right now, is so much different from the way things were 50 to 100 years ago [1]. This change is due to two significant factors of climate change and a steady rise in the world's population. These two factors are a significant contributor to most of the world's major problems; such as Food insecurity, annual flooding, worsening housing conditions and even the slow decline and possible extinction of various animal species. [2]

This rise in population has also led to an increase in rural-urban migration all around the world. We see a constant and steady rise in the population of people moving into urban areas in search of a better quality of life. This brings with it a whole new set of challenges for urban planners and city dwellers. One of such challenges can be seen in the organic growth of informal settlements within urban areas. [3]

This thesis tries to take a closer look at how the inhabitants of such communities can improve the standard of living, using local farming and fishing techniques in order to try to help them adapt to the constantly changing environment around them. Makoko is one of such informal settlements in Lagos; one of the largest megacities in the world, with a population of 21million people [4]. This vast population is also steadily expanding at about 5% per year [5]. This community is a predominantly fishing community which experiences regular annual flooding, sanitation issues, poor housing conditions as well as food insecurity due to a combination of overfishing and climate change.

Makoko is a settlement built right on the Lagos lagoon and can easily be identified with its homes on stilts. It is a fishing culture that has flourished for about a hundred years. With a population of over 100 000 people and a density of 713 persons per square hectare [6], the family is forced to keep this community constantly expanding further into the water. This situation, combined with other climatic factors, are now threatening the fishing culture that has been in the community for over a century. Fishes are getting ever so hard to catch, and fishermen now need to venture further into the Atlantic Ocean to fish, which never has been the case. [7]

Something needs to be done in order to sustain the ever-rising demand for fishes and food sustenance in Lagos, and my work is centered on the use of aquaponics and architecture in order to propose solutions to the food security issues being experienced here. The promotion of locally grown, high-yield sustainable food production systems would be encouraged through community participation and incorporated into a communal aquafarm and residential retrofit kits. This is ultimately aimed at ensuring the survival of the local fishing and timber industries in the community as well as improving the general standard of living of community members. Such empowerment through a bottom-up approach is aimed at giving the people a chance of survival from the harsh living conditions they currently experience. We can see traces of what's going on in Makoko in other parts of the world. We see informal settlements like this springing up in different cities around the world.



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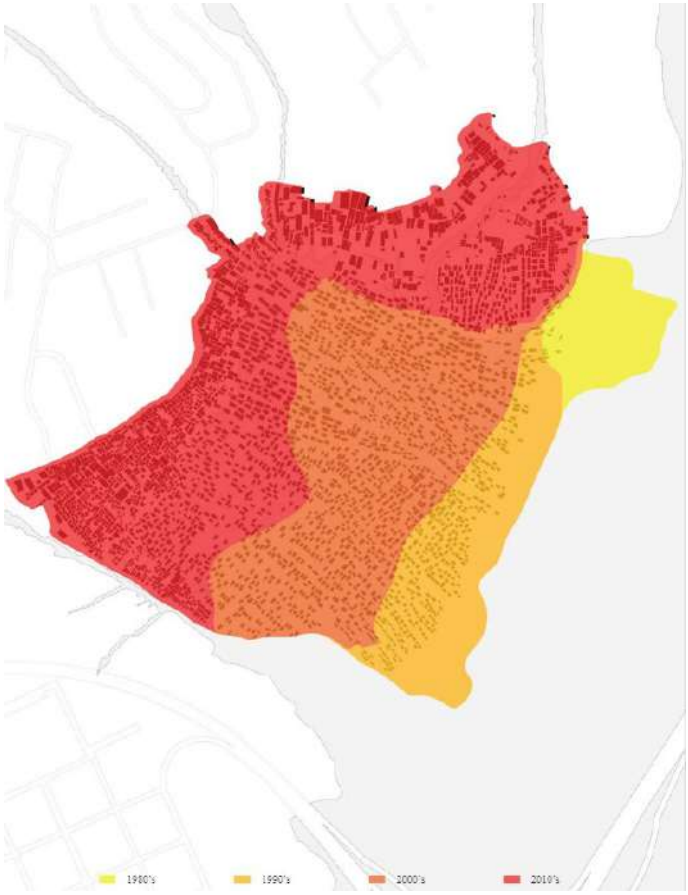
MAKOKO 2



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HISTORY OF LAGOS & MAKOKO

It is said that majority of the population in Lagos State live in shanty towns and informal settlements. Overcrowding in Slums is a huge problem and there are an estimated 4.6 people per home living in the informal settlements in Lagos [1]. Bad road networks, poor drainage and sanitation, lack of steady electricity and water supply and uncontrolled land use are some of the major problems facing such communities. Makoko is one of such communities and its located very close to the University of Lagos, and more importantly in very close proximity to the third mainland bridge. This is a core part of the Lagos urban structure as it provides a vital link between Lagos mainland and Lagos Island. [**2**]

The exact time Makoko was established is still unknown, but by the 18th century it had become a well-known fishing community and its cultural/ traditional leader is referred to as the *"Bàálè"*. Often called "The Venice of Lagos" due it being a community surrounded by water, residents of Makoko rely of the water as a source of livelihood. The major occupation here for men is being a fisherman, and most women are traders in the Fish markets [3]. Over the next decade, thousands of people have made it their home, though Makoko is still termed as an "illegal" settlement by the government. The population of Makoko has never been made exact, but the world Bank believe it's a population of just over 80 000 people. Formalized security is absent here, and Makoko is self-governed. It makes use of what it called "Area boys" to maintain a certain level of law and order. These area boys are basically unemployed young boys who often result in fighting and violence to resolve most challenges that arise. [4]

Fishing, sawmills, sand dredging and salt making are among some of the major economic drivers in this community. The narrow canals that move through the community help to form a network of access points through the community which all support the success of these industries. The depth of these water canal's typically ranges from between 1 to 5 meters in depth depending on the distance from land. [5]

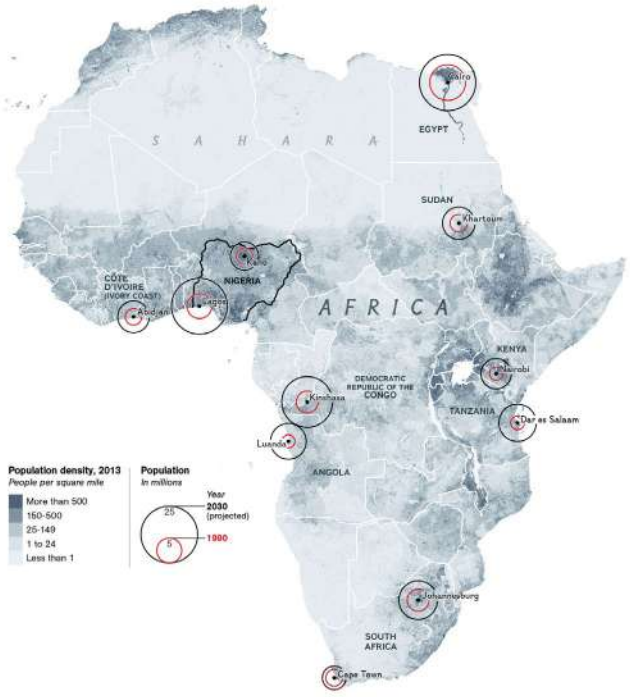

FIGURE 2.07 *Map of Africa highlighting Population density across it's major Megacities*

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FIGURE 2.09 *Typical condition between buildings*

FIGURE 2.10 *Transportation of fallen trees to the saw mills*

Most building here are made from locally-sourced bamboo, concrete blocks, corrugated iron, plywood and hardwood members. Analysis has shown that most of the residential homes in Makoko has stood for over 220 years and only about 10% of them have were constructed in less than 10 years. [6]

EXISTING CONDITIONS IN MAKOKO

Majority of the new construction of buildings within Makoko are make shift buildings on water, with very minimal structural stability in the super structure. Most of the sub structures are quite reliable as the local construction techniques on how to make steady wooden stilt foundations have been perfected. The housing conditions here tend to be deplorable. There is also typically a complete absence of toilet facilities within buildings and hence why the high levels of water pollution and poor sanitation conditions [7]. Majority of buildings are just one storey high and tend to face the street (waterway) which them gives easy access for canoes. Only about 10% of the buildings are duplexes or higher, and these are seen as luxurious and too expensive for most of its residents. These homes are usually occupied by the ever-rising migrant population coming into Lagos as a whole. Majority of which have very little education and no form of employment. [8]

A form of urban regenerations has already started to take place here, involving the reuse of old dilapidated lots and buildings.[9] These are mostly converted into new homes by migrants as this is a cheap and effective way to live. This could a crucial new way to slowly change the urban fabric of Makoko while still retaining its cultural and organic nature. [10]

Most of the building are oriented in the East-West direction to optimize wind and sunlight conditions and well as cater to the natural flowing waterways that move in that direction. This indigenous construction methods have been slowly improved over tie through a

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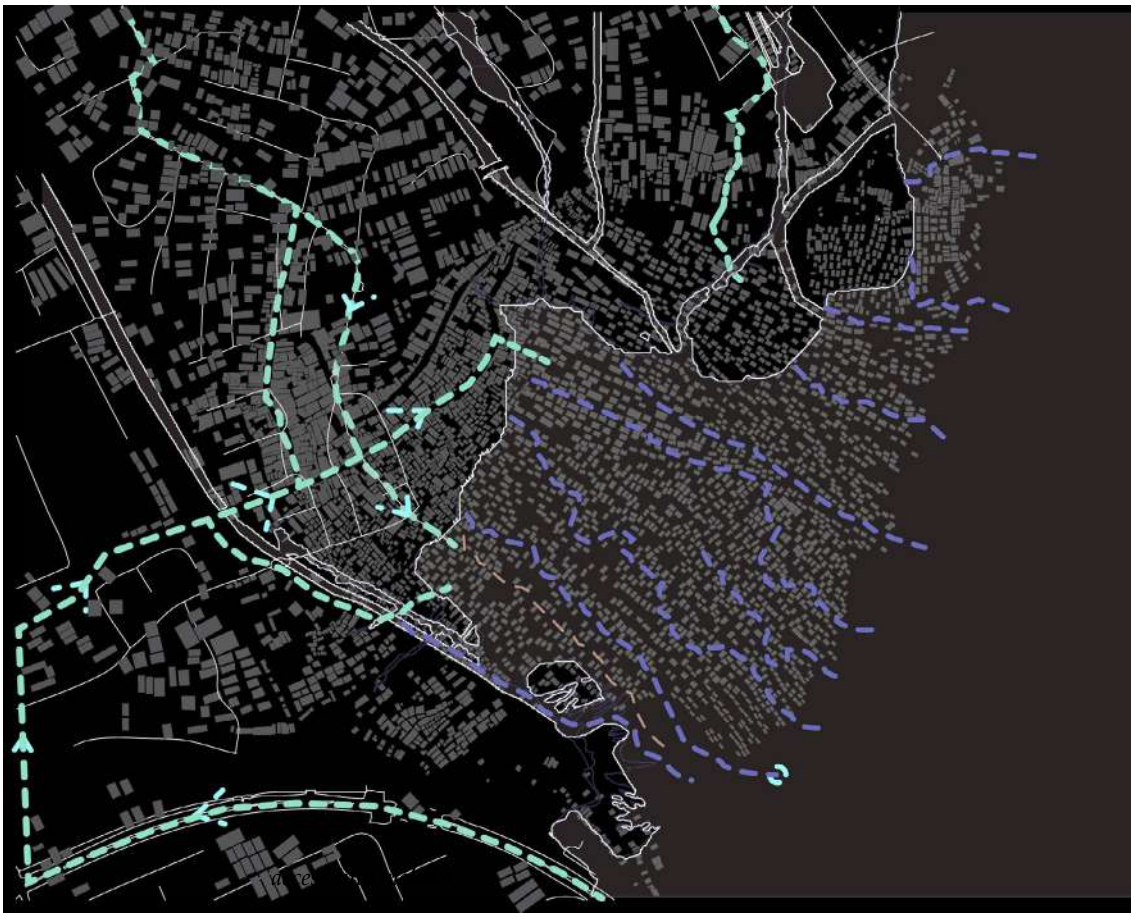

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series of trial and error. The need for education is extremely evident as there is only one school located within the community.[11]

ENDNOTES

1 (Leke Oduwaye 2011)

2 (Udoma 2014)

3 (Leke Oduwaye 2011)

4 (Simon 2013)

5 (Simon 2013)

6 (Olamiju 2017)

7 (Simon 2013)

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9 Couch and Fraser (2003).

10 (Olamiju 2017)

11 (NLe Architects, 2013)

FIGURE 3.01 *Communial floating boats*

AQUAPONICS & SUSTAINABLE TECHNOLOGIES

3

FOOD PRODUCTION AND SUSTAINABILITY

Urban farming has the potential to create cities / communities where collaboration is encouraged all along the supply chain, because farms close to people and giving people the access to how it is being produced and what it takes to produce the food we get on our tables. By doing so, we are reconnecting them with the whole story of their food and that helps them make better food choices. This could be used as our engines for restoration. 90% of fish we consume as humans are being fished or overfished currently [1]. Farmed fish in particular. Fish is a great helthy source of protein and within Makoko and most of Lagos it's a local delicacy with high demand. These are some of the most farmed Fish species across the world [2]:

• Tuna

• Salmon

• Pangasius / Penga

• Cod

• Sockeye

• Trout

• Perch

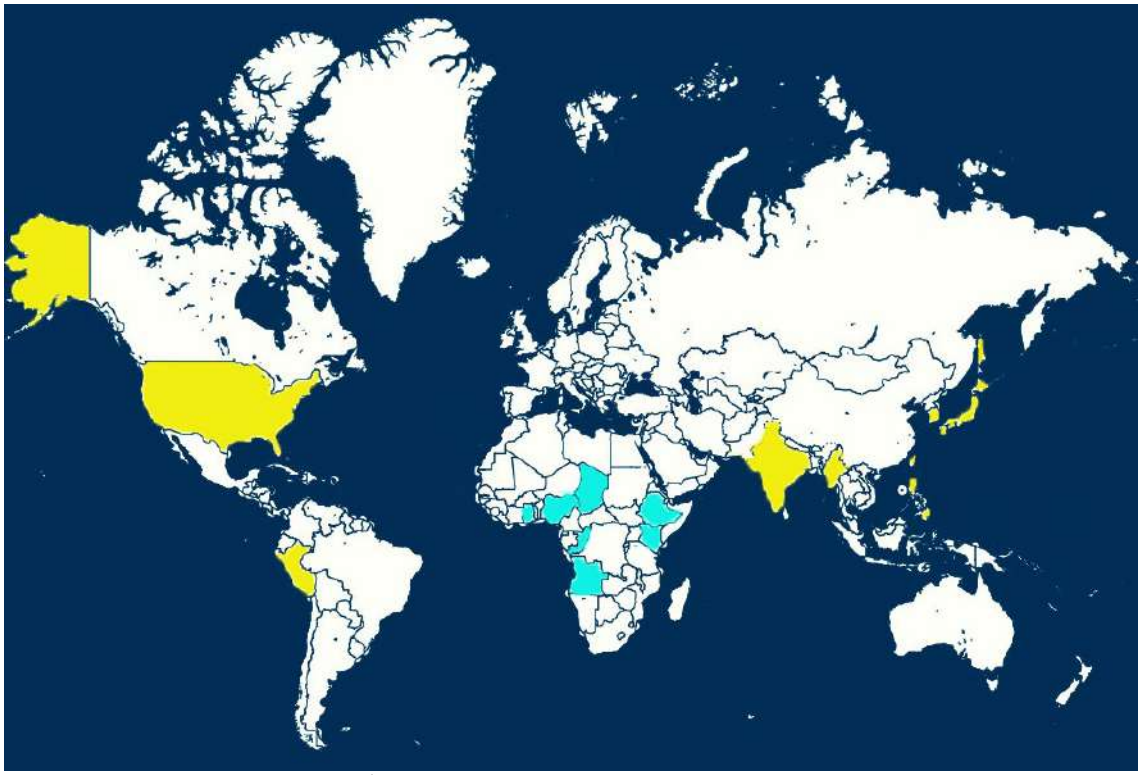


FIGURE 3.02 *Regions native to Tilapia*

CYAN *Areas where tilapia are are found in natural waters*
YELLOW *Areas where tilapia are are found due to migration*

• Tilapia

• Catfish

TILAPIA

This is a native species of Africa, found across developing countries around the world. It is easy to breed and farm and has been a constant source of protein for the poor, from Tokyo to Cairo; providing food for over 4 billion people worldwide making it the most farmed fish in the world.[3] There is a continuously rising demand for Tilapia and is important to a lot of people around the globe in terms of income and cheap food.

Fishes are born gender neutral and so the environment they are born in dictates the eventual gender. A mostly male monosexual population is farmed because males tend to grow faster. AIT in Malaysia have used certain hormones to condition the sex to be male to optimize these farms, these hormones are also bio-digestible. Tilapia growth cycle usually takes about 6 months. [4]

It is the mostly farmed using a recirculating system because of its size, rapid growth and ability to survive in high densities. While species such as Salmon require 3.8kg of feed to produce just 1kg of fish, Tilapia only requires about 1.7kg of feed to produce the same amount of fish, meaning 1 tank of fish approximately gives you 400 fishes (12 tanks can produce 4000kg of fish yearly) [5]. 30-40kg of vegetables can also be produced for every kg of fish produced if grown in an aquaponic setup. [6]

FIGURE 3.03 *Typical Tilapia Specimen*

AQUAPONICS AND CLOSED LOOP SYSTEM

Aquaponics is the production of food and crops together in one closed system. This lets us create new ecological systems in places where they naturally won't exist and still be capable of year-round crop production. It promotes bio-diversity and helps promote the culture of recycling waste into resources. Plants can be grown using this technique at up to 8 times the density per sq. meter because of the steady circulation of nutrients [7]. It can be found way back in history as far back as in the ancient Aztec civilization as well as in the ancient Chinese civilization to boost crop production. Use of less pesticides and involves the use of more recycled waste. It's an eco-friendly sustainable food production system that helps lower environmental impact with no agricultural runoff.

With aquaponics we can grow more crops faster with less amounts of input of resources required while using 70% less water compare to traditional methods; no fossil fuels or agro-chemicals are required as well [8]. It helps the seemingly impossible task of Cultivating plants possible, especially in urban areas and for every indoor acre used for Aquaponics, you can save 10 outdoor acres without any crop loss. With every element of this system is customizable and even plants grown can be customized to what people want to eat in the region its being grown in. They are locally grown, high-yield sustainable production systems with the potential to turn into a highly profitable business with a tremendous growth potential and can be extremely helpful in areas with low rainfall or continued ground water. For a project to survive, it must have; Financial resources to build, ease of access is also key and the man power to maintain the project to optimize profitability. The following are some basic things to note when setting up and maintaining an aquaponic system;

• Energy costs are the biggest expenses in the preparation and you would want to find ways to save on this.

• Room temperature also must be carefully regulated to optimize plant growth.

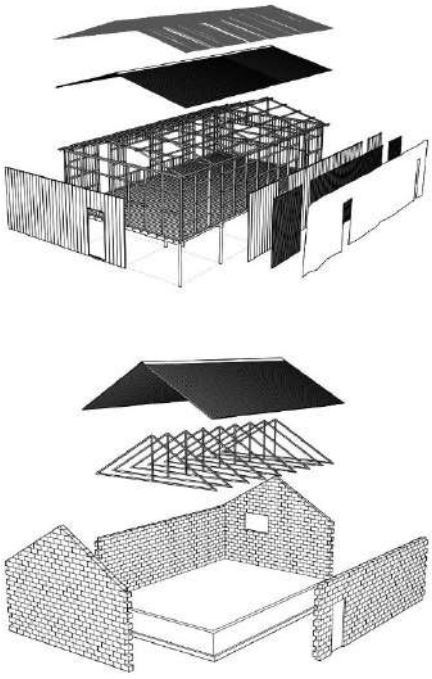


Fig. 4.7 | Typical Brick Construction, commonly found closer to the shore and on the land

FIGURE 3.04 *Typical construction technique used for Bamboo and Timber cstructures in Makoko*

• High ceilings should be afforded to enable the vertical growth of grow beds.

• Consistent testing of water quality is essential to keep diseases out.

• A consistent supply of water and electricity is required.

• Evaporation and run-off will always occur; hence the water levels need to be replenished every week.

• Iron and magnesium also need to be topped up in the fish tanks.

• For every pound of fish raised, one needs between one to two gallons of water.

LOW-TECH METHODS OF EXISTING BUILDING CONSTRUCTION:

Makoko is a self-governed community which basically relies on self-sustenance to survive. Its structures mostly consist of Residential, commercial, and a few religious buildings. Apart from the unused canoes, run down shacks, Makoko also receives loads of debris washed from all over Lagos and moved through the numerous canals into the community. This has been identified as a major reason for the frequent flash floods that happen here mostly between 3 to 4 times a year. Three major building typologies can be found within Makoko: [9]

• Hardwood/ Bamboo structures,

• In fills / Reclaimed land using plastics and sand,

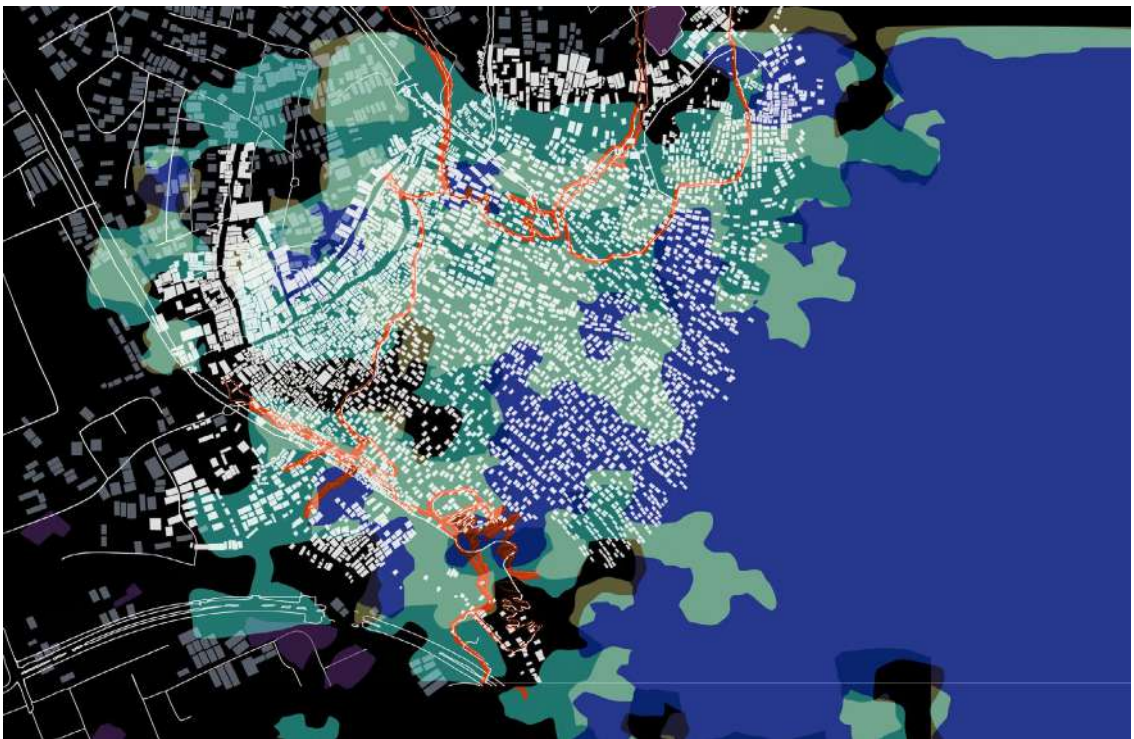


FIGURE 3.05 *Flood mapping showing water levels after a rise of; 1m, 2m & 3m*

• Sandcrete structures.

FLOODING IN LAGOS

Urban Flooding is a major challenge faced all across the world and affects both developing countries as well as the developed countries. The impacts of such have been on a steady rise and in more recent time we have seen record high floods happening and an amazingly frequent rate. Increased migration worldwide into flood prone areas combined with rising sea levels, change in rainfall is having an impact on making this an increasingly dangerous scenario. This is the case in Lagos metropolis. The rapid urbanization in such areas combined with the lack of infrastructure and a high rate of development has left Lagos exposed to high risks during such flooding situations.[10]

Flooding in Lagos, is so frequent and costs billions of dollars in damages of property and lives. These most often tend to be flash floods typically right after prolonged rainfall. **[11]**

Over the past few decades, research and literature has been taken to try to understand what measures should be taken to help combat the issue of flooding in Lagos [12]. The following are a couple of the measure that have been identified as potential solutions:

1. Expansion of drainage infrastructure in and around the city,

2. Annual debris removal from primary drainage facilities within the city.

3. Advise residents of flood prone plains and wetlands to relocate.

4. Demolition of homes in the flood prone areas which have alwaysbeen considered as the major sources of flood challenges especially in the low-income communities. [13]

5. Proposed resettlement scheme for the residents of Ogun river and its surrounding areas [14]

SOURCING WOOD

Timber resources have been exploited heavily in Nigeria ever since the British left in 1960. There are 4 major forest reserves in South-West Nigeria, the Ómó forest, Akure-Ofosu, Idanre and the Ijebu-ife forest reserves [15]. The following species are are the dominant species present in the Omo forest; which is the closet in proximity to Makoko and Lagos in general [16]. Here, we find thehese species of trees; Afzelia bipindensis, Antiaris africana, Brachystegia nigerica, Chlorophora excelsa, Cordia platyhyrsa, Entandrophragma angolense, Eribroma oblonga, Erythrophleum, Guarea cedrata, G. thompsonii, Khaya ivorensis, Lophira alata, Lovoa trichilioides, Mansonia altissima, Mitragyna ledermannii, Nauclea 11 diderrichii, Nesogordonia papaverifera, Piptadeniastrum africanum, Sterculia rhinopetala, Terminalia ivorensis, T. superba and Triplochiton scleroxylon [17]. Over time the number of psecies that were thought to be of significant economic value have increased from about 17 in 1952 to over 42 as of 1975. **[18]**

The vegetation within the Ómó forest reserve can be divided up in two; The wet evergreen part in the south and the mixed deciduous forest in the north. Most of the forest has a significant cover of tree plantation. The more than 640 hectares of strict nature resrve is host to an abundant plant family of Araneae, Compositae, Ebenaceae, Lilliaceae, Papilionoideae, Poaceae, Rubiaceae and Violaceae [19]. The most common tree species include Diospyros, Drypetes, Strombosia pustulata, Rinorea dentata and Voacanga Africana among

others. [20]

A lot of the early logging took place near the rivers in order to facilitate the floating of the sawn logs downstream [21]. This can still be found happening today. In order to ensure the continuous survival of the forests, many African countries have tried to ensure that their forestry departments take Silviculture in moist forests [22]. This movements started happening mostly in the 1950's, these methods mostly relied on natural regeneration, while the other relied on improving techniques on the dynamics of the stands and other artificial regeneration techniques. [23]

Bad governance, lack of funds and lack of proper management has led to exploitation of most forest reserves in Nigeria [24]. Interventions in Nigerian forests mainly started in the late 1800's when the British started creating departs and unions to regulate and protect the illegal sawing of timber in these areas. **[25]**

The Ómó forest reserve has opted to try to use education and raising awareness among the local communities about the significance of these forests as a tool to combat logging, poaching and uncontrolled farming. The ultimate goal is the ensure the survival of the Ómó forest reserve ecosystem for centuries ahead. [26]

OMO FOREST RESERVE

Ómó forest reserve is located in the most fertile and complex vegetation in Nigeria and occupies an area of roughly 132 000 hectares of land. It supports the growth of over 8000 different species of trees and is located about 20 Km due north from Lagos **[27].** The forest is located along the Ómó river and gets its name from the Ómó tree which grows naturally in this region and has huge traditional importance. [28]

The forest is in constant treat of poaching, illegal logging and uncontrolled farming is treating its biodiversity and survival **[29].** There are over 100 species of birds, 200 different tree species and a variety of endangered animals can be found in the Ómó forest. The outstanding natural beauty also makes it of great conservation importance. **[30]**

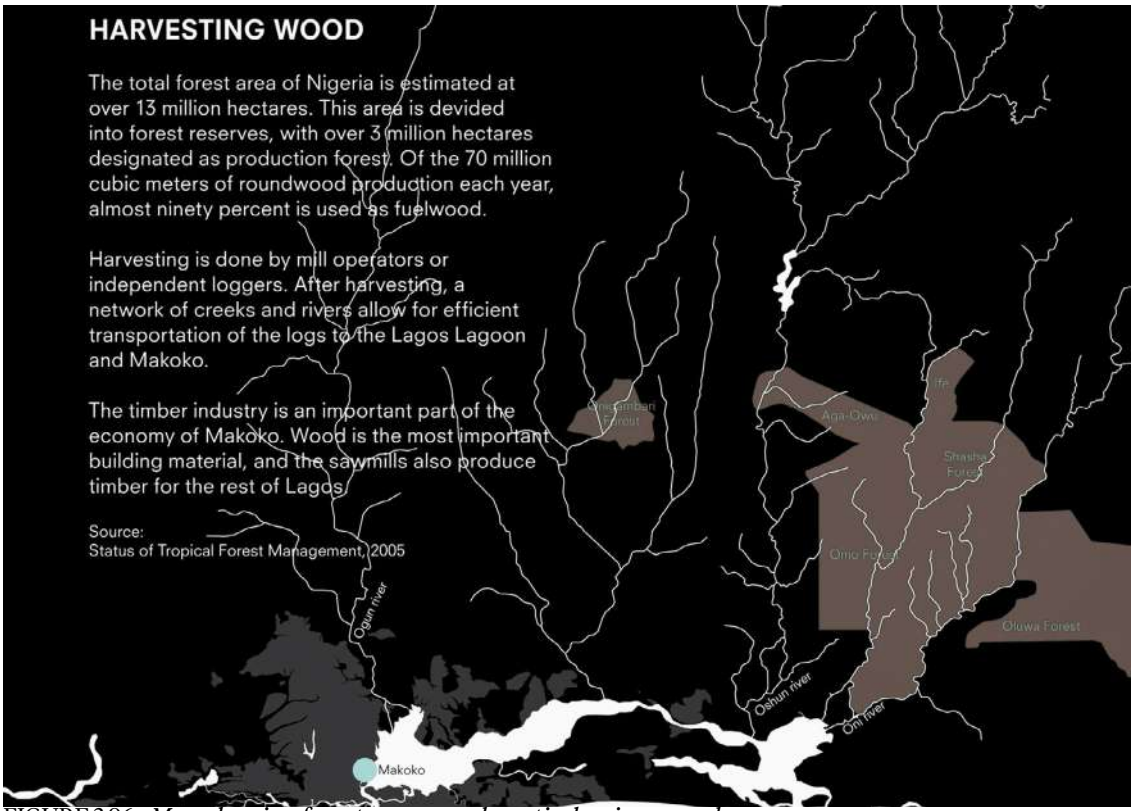


FIGURE 3.06 *Map showing forest reserves where timber is sourced*

ENDNOTES

1 (Osayanmon Wellington Osawe 2016)

2 (Roberto 2003)

3 (COMMITTEE 2014)

4 (Roberto 2003)

5 (UN n.d.)

6 (Montgomerie 2015)

7 (Roberto 2003)

8 (COMMITTEE 2014)

9 (Makoko: 'Venice of Lagos' | OUR FUTURE CITIES. http://futurecapetown.com/2014/04/makoko-venice-of-lagos/ n.d.)

10 (Gill, 25 2004; CII 2001)

11 (U. C. Nkwunonwo 2015)

12 Oshodi (2013)

13 (D. Flood Management - University of Texas at Austin. n.d.)

14 (U. C. Nkwunonwo 2015)

15 Redhead (1971)

16 (Okali and Ola-Adams 1987, Lowe 1993):

17 Ola-Adams and Iyamabo (1977)

18 (COMMITTEE 2014)

19 (Adisa 2011)

20 (L.O. 2004)

21 Richards (1939)

22 (Schmidt 1991).

23 (COMMITTEE 2014)

24 (Lowe, 1990; Umeh, 1992; Kio et al, 1992; and Lowe, 1994).

25 (UN n.d.)

26 (Adisa 2011)

27 (Adisa 2011)

28 (Adisa 2011)

29 (Adisa 2011)

30 (Adisa 2011)

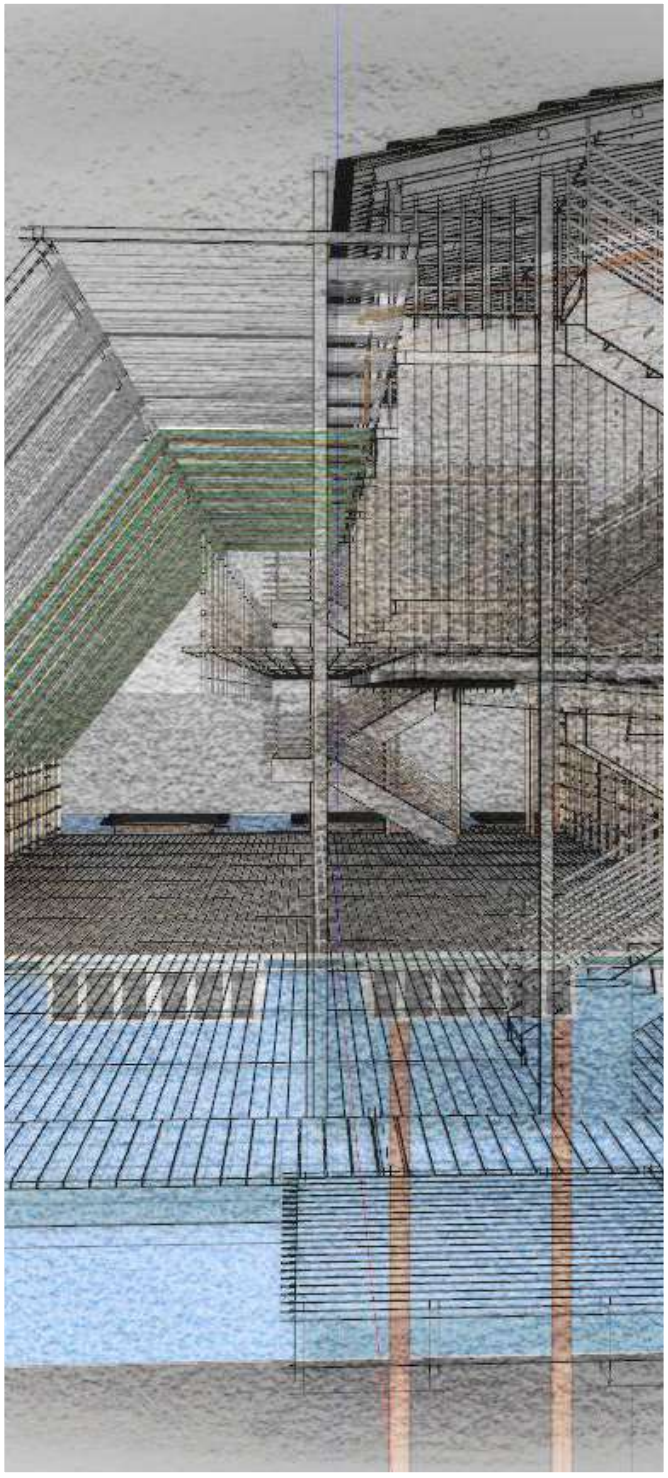


FIGURE 4.01 *MConceptual Farmhouse design*

FARM-TO-PLATE 4

The idea of the FARMHOUSE is to try to reconnect people back to food, and through this build a community-based connection between the farmhouse and the people. Urban farming has the potential to create cities / communities where collaboration is encouraged all along the supply chain, because farms close to people and giving people the access to how it is being produced and what it takes to produce the food we get on our tables [1]. By doing so, we are reconnecting them with the whole story of their food and that helps them make better food choices.

The farmhouse is meant to be a community project that uses the collective unions within the is fishing industry as well as that in the lumber industry. These unions would act as the main intermediary between the designer and the people within Makoko [2]. The aim of involving the community is to encourage and promote a sense of ownership and belonging of the aquafarms in the community.

Taking Kunle Adeyemi's floating school as a case study, one fundamental part of the project that was missing which I feel lead to it failure was the lack of real and substantial community involvement [3]. In as much as education plays a key part in changing the future of the community and its members, due to the current state of affairs in Makoko it hasn't been a surprise that community members didn't send their children to learn here. I feel community involvement has the power to not let this happen again and seeing as this intervention would aid the growth of their primary source of income; be it from the fishing industry or the Lumber industry, community members would most likely tend to want to reap the fruits of their harvests. [4]

FIGURE 4.02 *Makoko floating school A-frame structure by Kunle Adeyemi of NLE*

FIGURE 4.03 *One of the learning spaces in the floating school*

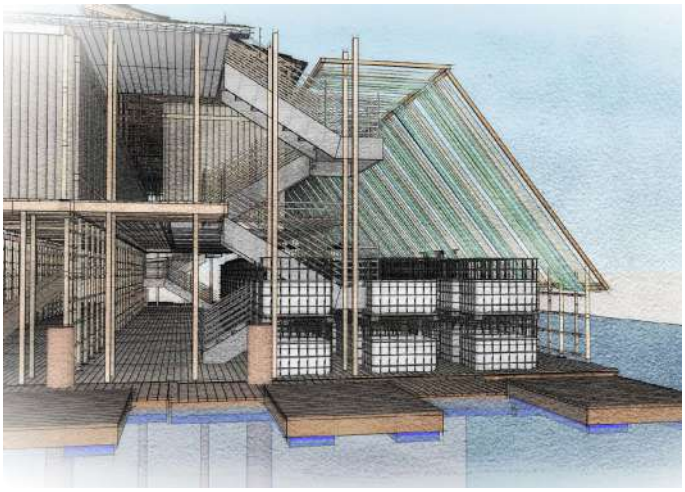


FIGURE 4.04 *Early FARMHOUSE design with adjustible fabric shading to optimize plant growth*

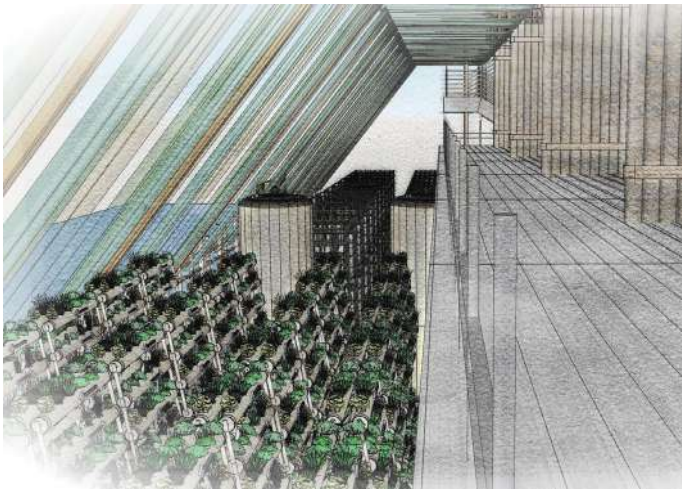


FIGURE 4.05 *Early FARMHOUSE design showing interior Aquaponic farm and Commercial spaces*

CONCEPT AND ORIGINS

The proposed Farmhouse building is a light weight floating farm prototype within Makoko that can be built using locally sourced, easy to find resources using local indigenous knowledge of construction to create a communal social space. The vision is for it to be a flexible dynamic building capable of growth and expansion as well as promote a variety of use for its interior spaces.

The aim of this prototype is to successfully grow a minimum of two cycles of fish as well as two full harvests of whatever crops are being grown in order to show the community that it works, and that it is worth investing in. The ultimate aim to be able to build multiple Aquaponic Farmhouses within Makoko to help boost the production of locally farmed Fish and at the same time reduce the effects of the food crisis by producing a variety of basic crops needed within Makoko.

Tessellation and the ability for this intervention to be replicated easily were important considerations during early phases of design. In order for the creation of central points within Makoko that would act as points of social and economic interaction this to be achieved, studies were done on the urban context and nature of Makoko to help identify potential sites for these interventions.

MAPPING POTENTIAL SITE LOCATION

The studies have shown that there are 6 major canals about 18 meters wide which act as the major parties for transportation and access throughout the community. These are the routes through which most of the sawn timber from Omó forest reserve gets to the saw mills on the periphery of the community. The width the canals provide a much-needed break from the clustered organic nature of Makoko. These canals are host to a wide variety of commercial activities, religious activities take place along these routes as well. Most public and social gathering spaces can be found along these canals hence making these routes extremely important to the economic and social heart of Makoko.

Makoko was divided into 6 major areas using the major canals as boundary areas. This helped to narrow down the collectives that would be responsible for each zone in terms of finances, mobilization and construction as well as maintenance of these farms over time.

Zone 1 is made up of a combination of the Fish market and the Timber Sawmills hence making zone [5]1 a bad zone to have our Farmhouse. This is majorly as a result of the high levels of noise, congestion and pollution existing in this zone, all of which aren't suitable for optimal plant growth.

Zones 2, 3 and 4 are deemed as ideal areas extremely suitable for hosting the construction of these lightweight Farmhouses, due to their close proximity to both raw materials needed for construction as well as quick access to the fish market's skilled labor force.

Zones 3, 4 and 5 also provides the chance to situate the intervention in sight of the third mainland bridge which could potentially act as a tool of protest against the governments obsession with bringing down this truly vibrant community. Placing the Farmhouse using the constant sight of the whole of Lagos would hopefully show the government that Makoko can thrive and is capable for having a significant economic footprint within Lagos as a whole and beyond if the right steps are taken by those in power.

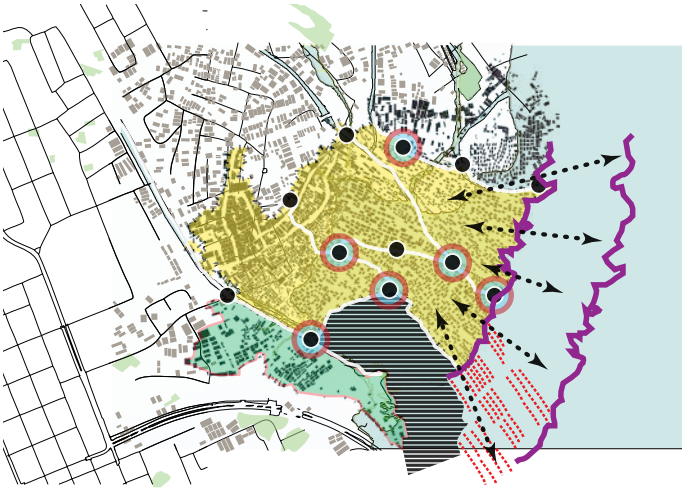


FIGURE 4.06 FIGURE 4.05 *or the Aquaponic farms*

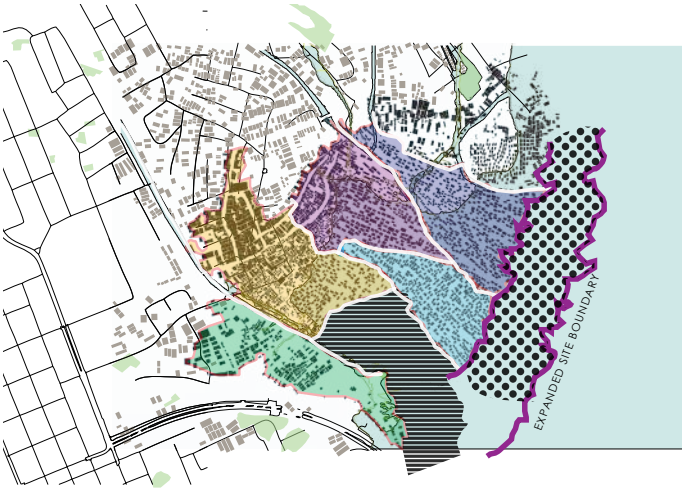


FIGURE 4.07 *Hatched zone highlighting the concentration of timber realted commercial*

FIGURE 4.08 *Using existing canals to zone Makoko*

FIGURE 4.09 *Map showing typical buiding orientation as well and predominant wind direction*

FIGURE 4.10 *Map showing Major Canals and Secondary Waterways cutting through Makoko*

FIGURE 4.11 *Map showing homes demolished by the Lagos state Government in 2012 leaving behing scores on fully functional sub-structures after fully or partially in some cases demolishing the super structures*

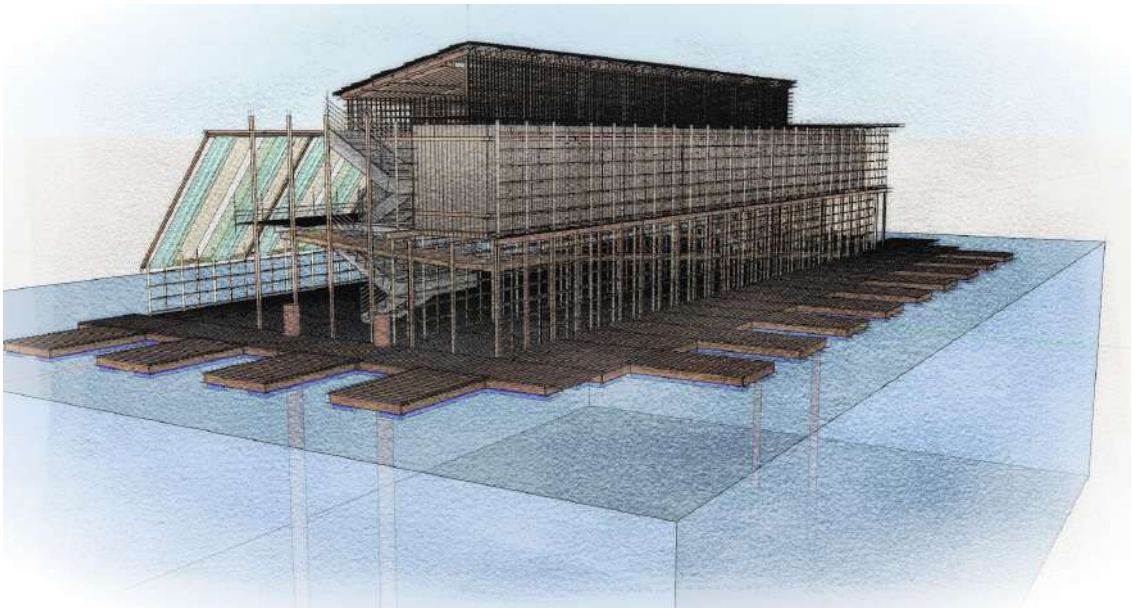


FIGURE 4.12 *Early Conceptual Model of Proposed Makoko Community FARMHOUSE*

Zone 6 has a very high density, is mostly landlocked and comprises primarily of mostly residential buildings and it extends slightly out onto the Lagoons. The density as well as distance from the saw mills and Markets make it difficult to imagine too many of these proposed Farmhouses being located here though the liminal conditions and canals that exists here might make it feasible to building this zone.

Ease of access by land and water, predominant building orientations of exiting buildings in Makoko, possible future expansion locations as well as natural climatic conditions were also major considerations in the search for potential site locations in the initial design stage.

The studies provided us with a number of locations which would be ideal for the Farmhouse project. These do not necessarily have to be where the interventions would be located, but they are merely suggestions to the locals as of what to look for when choosing a potential site location. At the end of the day, the final decisions will be in the hands of members of the local unions. Ultimately, they are responsible for ensuring a suitable site is found, adequate skilled man power is provided, good quality construction materials are used as well as smooth operation and maintainace of the farms post construction.

THE COMMUNIAL FARMHOUSE

This proposed Farmhouse is a lightweight floating aquaponic farm in which vegetables, small grains and fruits are grown organically, to aid the steady supply of carbon dioxide to Fish ponds in which either Tilapia, catfish or Cod is grown to complete this aquaponic cycle. All construction materials required for this farm are all locally-sourced.

The saw mills within Makoko is capable of providing all dimensions of sawn wood required to build each module of the Farm.

All Steel members are gotten from the Ebute Metta Neighborhood, which is directly adjacent to Makoko. Ebute Metta is famed for its light industries that focus on recycling old and disposed steel members collected all over Nigeria. These steel members are melted

FIGURE 4.13 *Makoko Community FARMHOUSE*

down and repurposed as a variety of new Steel products, ranging all the way from storage drums to construction elements like beams, columns and even bolts and nuts. The close proximity and presence of skilled workers to help create the custom elements needed to the Farmhouse would be extremely important.

Access to the farm is typically by Canoe and hence why docks are located on three sides of the farm. These docks act an extension of the farm and provide a link between the administrative part of the farm and the general grow area. The docks on the south side of the farm is dedicated to the proposed Makoko Aqua Taxi system, while the rest is open for general docking of small to medium sized boats. A ramp is also present on the farm, to welcome as many members of the community and general public to come use this farm. Makoko has a significant population of old and elderly people and physically challenged people, and they need to also have access to this farm.

The major entry point into the farm is from the Reception, which is located on the ground floor of the farm. Information about all aspects of the aquaponic processes and setup involved in the farm can be obtained here as well as general information on Makoko and directions as to what fishes and vegetables are being grown on each farm. Donations and charitable items Can also be received at the reception. Access to the market stalls above can also be accessed from here. The main floor of the Farm is made up of primarily the

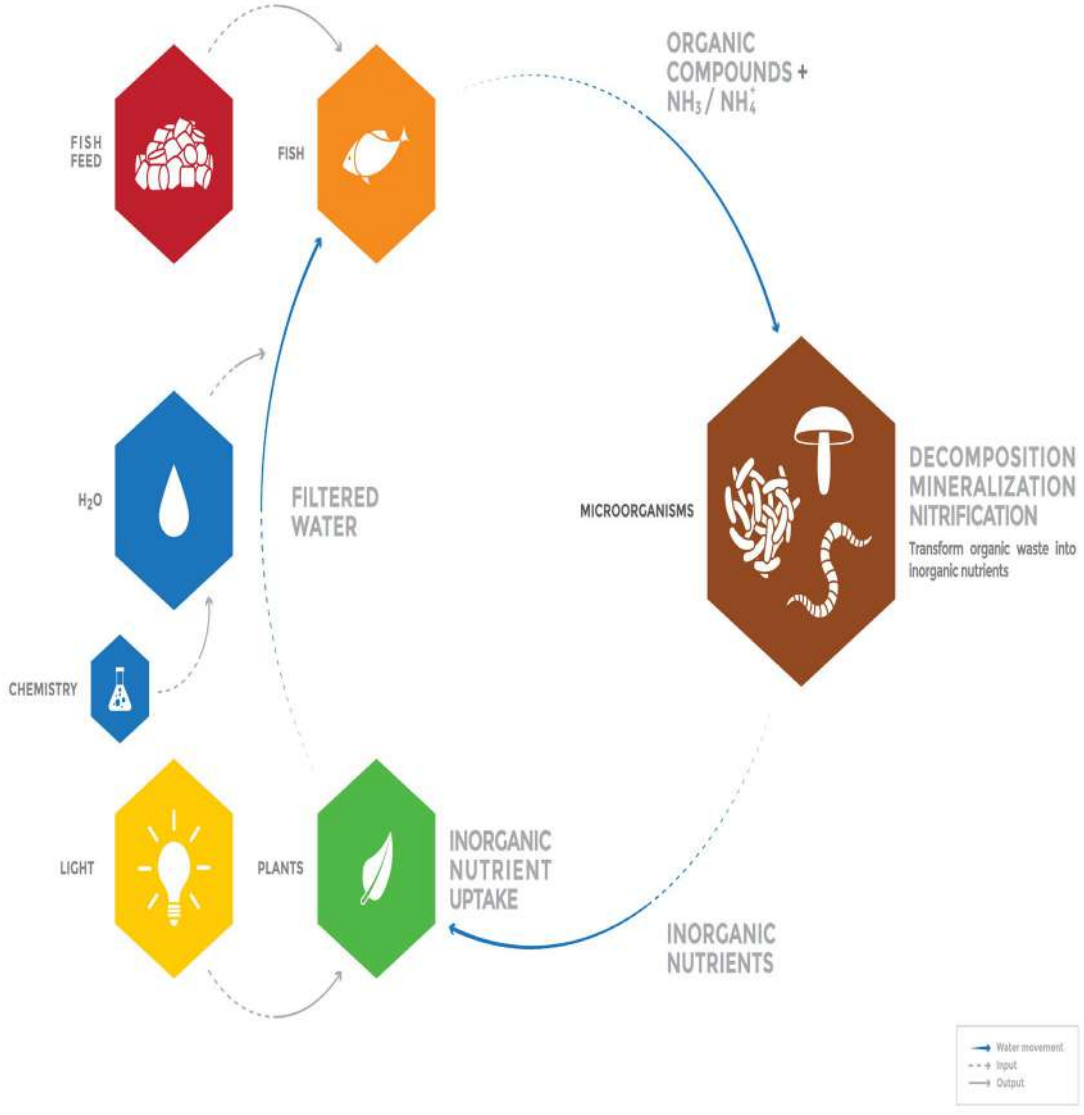


FIGURE 4.14 *Illustration of how the Aquaponic system works in the FARMHOUSE*

Aquaponic setup, processing and packaging areas, restrooms, a mechanical room,24 Fish ponds, and bamboo grow beds which span along most of the south side of the building.

The top floor consists of a huge open space which serves as market stalls most of the time, but can also be converted into learning spaces or event spaces when required. Dynamic walls within this space lends itself to allowing the transformation of this spaces whenever is required.

The rest of the second floor consist of restrooms, a storage space as well as a Café space that could also serve as a communal kitchen during events, meetings or in the extreme cases when the farms get converted into temporary shelters. The café is meant to replicate the indigenous culture of eating and communing in small groups that happens mostly in the market area.

AQUAPONIC SYSTEMS

The aquaponic system consists of three major elements:

• The Fish ponds

• The Bamboo grow beds

• The Bio-filtration Tank

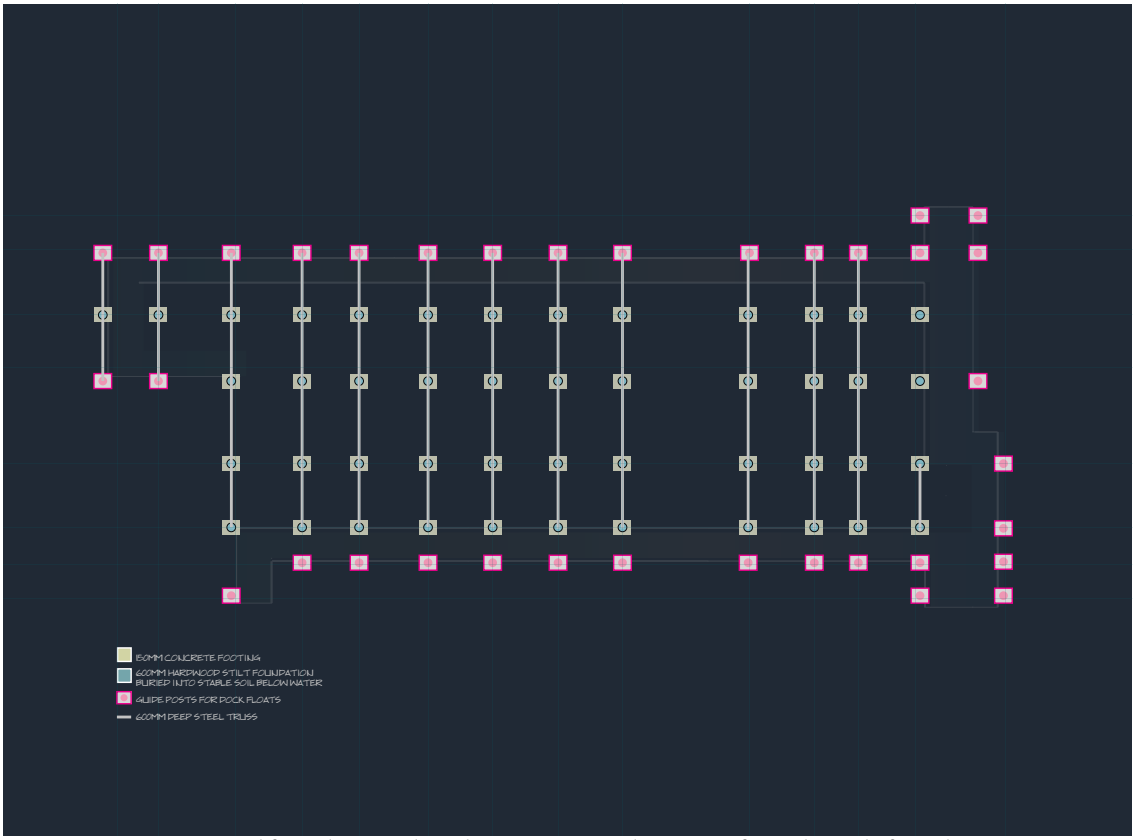


FIGURE 4.15 *Structural foundation plan showing precise location of wooden pile foundation*

The whole process starts at the fish ponds when the tanks are drained of their water and all the fish waste gets collected and piped into the mechanical room. In here, the Bio filtration tanks would take this wastewater and convert all the nitrates from the fish faeces to Nitrites which can easily be absorbed by the roots of whatever plants are planted in the grow beds [6].

The water then moves on and is redirected into the 7 Bamboo grow beds located along the south side of the farm. Here the nitrified water runs through the grow beds and the roots of the plants slowly absorb as much Nitrites as they require for growth and release carbondioxides back into the water stream as a waste product. The water is then pumped back into

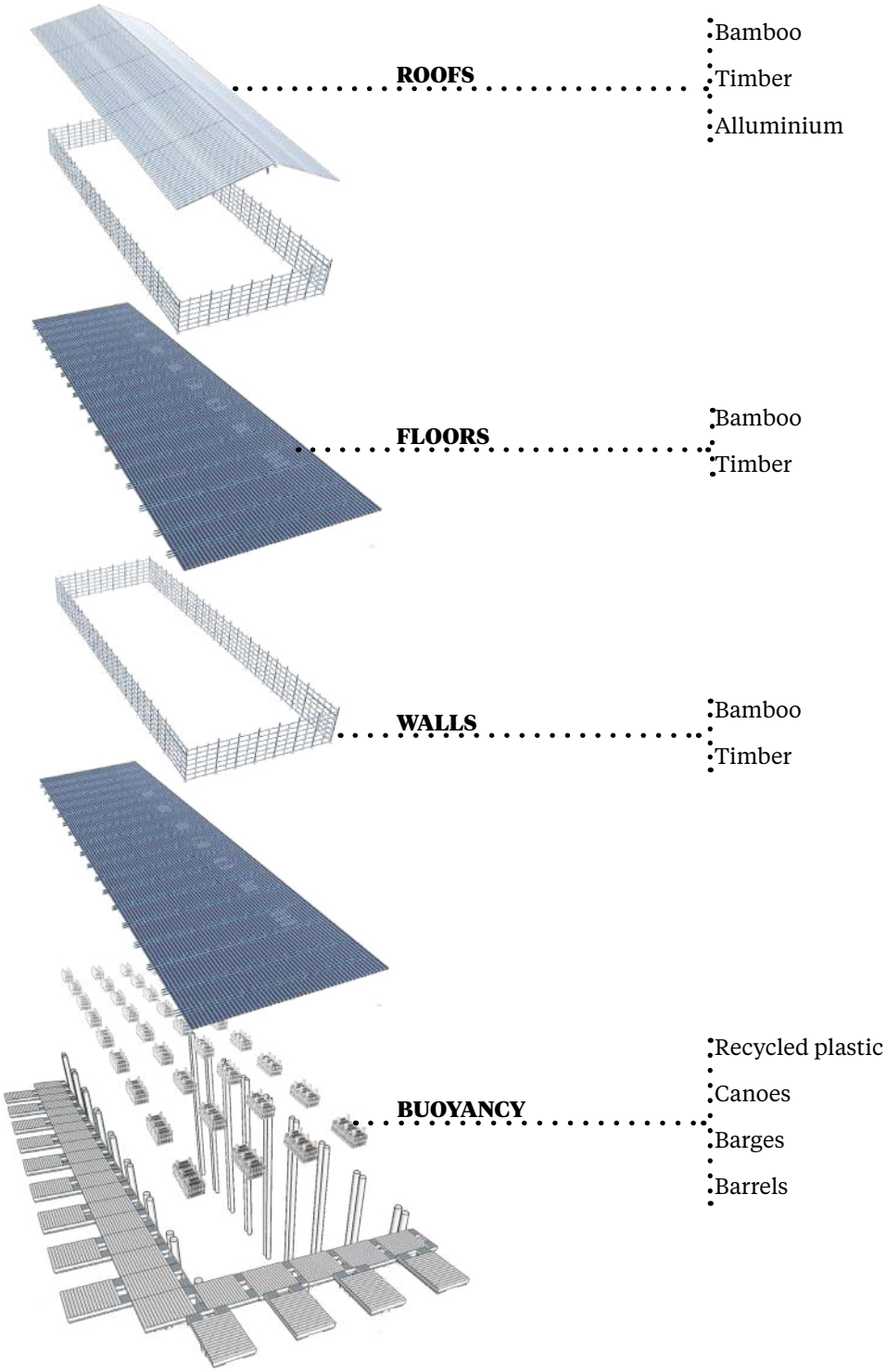


FIGURE 4.16 *Structural elements and potential materials to be used in the constructiobn of the FARMHOUSE*

the fish tanks and complete the cycle.

STRUCTURAL ELEMENTS

The farm is made up of 3 types of construction materials:

• Hardwood

• Recycled steel

• bamboo

600mm wide hardwood stilt foundations are buried into the stable soil below the lagoon. Typically, the depth of the lagoon varies anywhere from 1 meter to 5 meters deep. At the location of this proposed site it is roughly estimated to be at 2.4 meters deep. These stilts have tapered ends and all have to be manually rammed into the stable soil. This provides enough structural stability to erect structures but at the same time it is a huge factor why most of the buildings in the community are only a maximum of two – three floors high.

600mm deep Open Web Steel Trusses and then bolted onto the foundation in order to host the floor panels. A series of 120mm deep C channels run perpendicular to the OWST and provide rigidity and stability to the first-floor wooden panels.

Structurally, the first and second floor are held up with a series of wooden columns and beams. Each column is sized at 450X600mm and the beams are 450 X 600mm. Both of these elements are connected using different recycled steel members depending on its location. For instance, each column is held in place by steel base plates which are bolted into the OWST below. This system of Columns and Beams hold in place the second-floor panels in place. The beams on the top floor are inclined at an angle to accommodate the roof slope.

A simple aluminum long span shed roof is used to maximize the amount so solar energy that can be captured from the PV cells placed on the roof. The generated energy is used to power the aquaponic pumps and bio-filtration equipment on the first floor. If additional energy is collected it is then stored and used as a back-up source for the rest of the building.

A structural bamboo structure is also located on the East and West façade which help to provide laterally stiffening to the whole structure. Vertical movement between floor levels can be found within the bamboo structures on both ends of the building. The stairs are made of sawn dimensional timber.

The docks which extend out from the farm are independent of the structural system holding up the main farm. The wooden floor panels on the docks float on recycled metal barrels and slide along wooden guide posts which ensure that they always stay in the same vertical axis. The docks connect to the first floor by a metal ramp which slides along a rail to accommodate the varying rise and fall of water levels. This ensure the Farmhouse is always Universally accessible to everyone all year round.

FIGURE 4.17 *Proposed Market stalls*

FIGURE 4.18 *Proposed Alternate learning space*

A proposed Aquaponic wall is a prototype that can be used all across the community in homes, commercial/ public buildings or even in the market buildings. Its aim is to help combat the food crisis in Makoko and Lagos as a whole. These walls are capable of growing any fruits, vegetable or cereal all year round. It uses the same principles as the aquaponics is the farm, but on a much smaller scale. This would be perfect for retrofits of the residential and small commercial buildings in the community.

MODULAR ELEMENTS OF FARM

The Farmhouse can easily be broken down into 4 overarching modular elements: Roofs, Floors, Walls and Buoyancy elements. Each of these elements can be made from a couple of optional materials which mostly consist of Bamboo, Hardwood and recycled steel or aluminum sheets. The choice of materials to be used in each Farmhouse will differ based on the choices of the members of the organizing body, based on prevailing cost prices of certain given construction materials, based on availability of materials in the markets, as well as aesthetic preferences.

Once the wooden stilt pile foundations are in place, the structural grid of the design let's all Floor panels, walls, rooves and buoyancy elements to be fixed sizes based on the width of the spacing between the structural grids. The space between two girds end up becoming on modular bay as can be seen in the structural floor plans above.

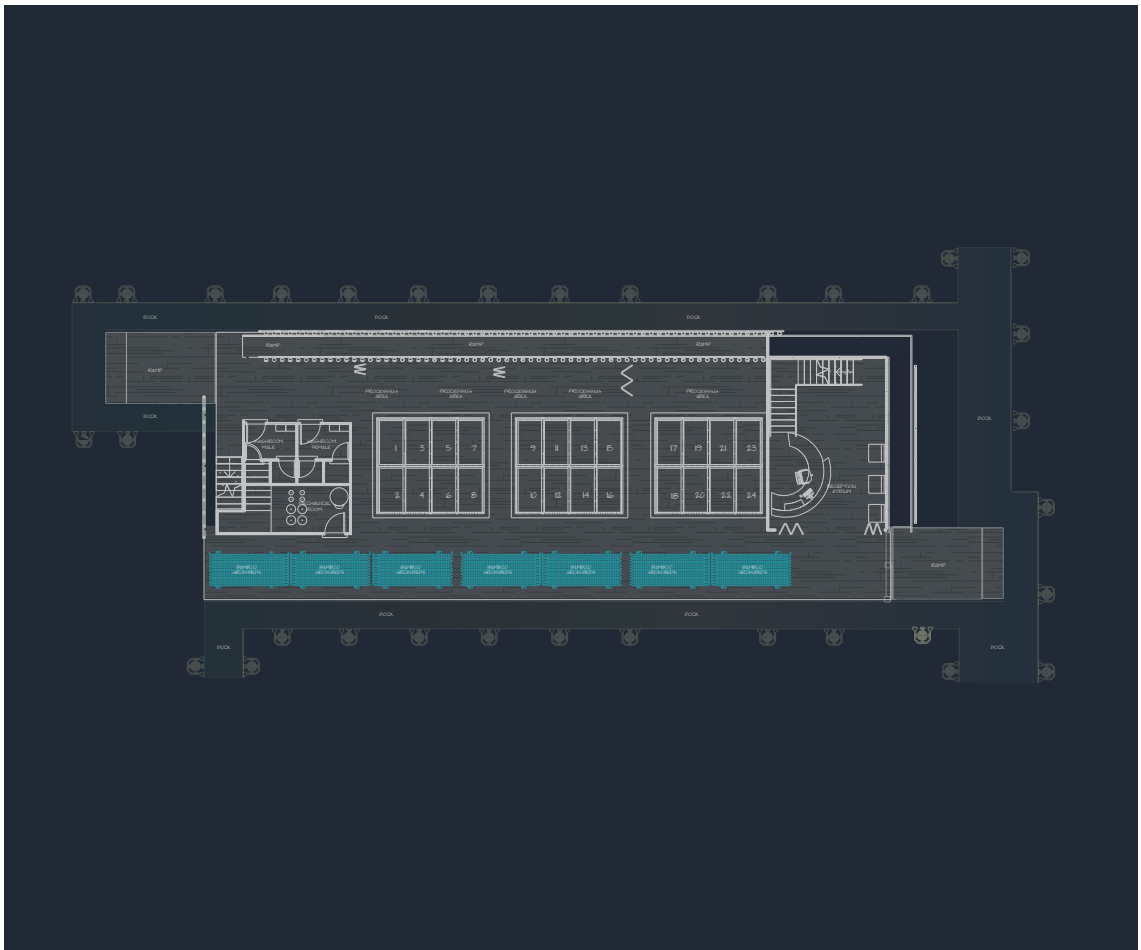


FIGURE 4.19 *1st floor plan*

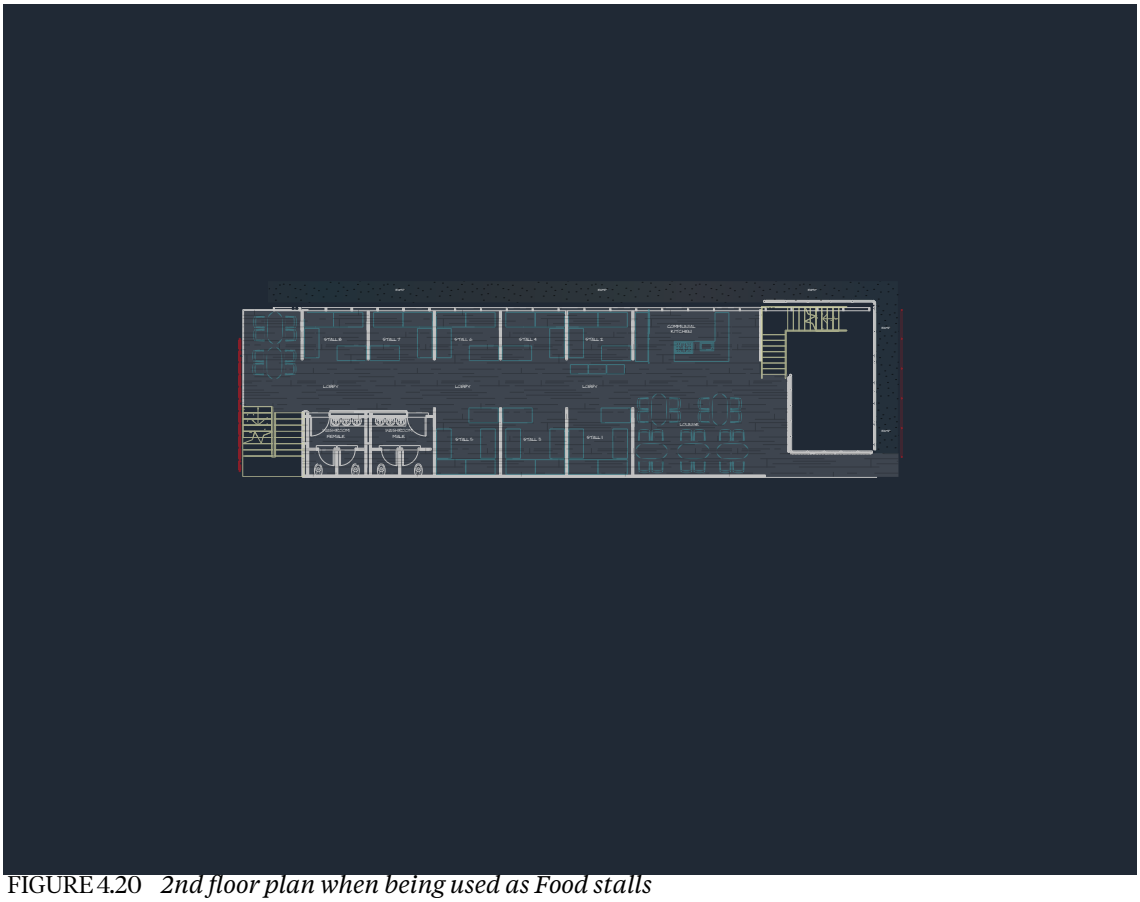


FIGURE 4.20 *2nd floor plan when being used as Food stalls*

FIGURE 4.21 *2nd floor plan when being used as a temporary shelter during extreme flood conditions*

LABOUR UNIONS

It is typical in most parts of Lagos to have Labour Unions among tradesmen. Usually there would be local branches of the overall state chapter, where each branch is run as independent organizations and mostly are required to contribute a certain percentage to the state chapter for a certain period of time. These local branches are usually in charge of collecting a fixed fee from each merchant or trader within their jurisdiction. This money goes towards improving or rebuilding the markets in which they carry out their businesses, help pay for important subsidies for its members as well as provide general welfare services among a host of others.

The Farmhouse project will look to tap into this existing framework and try to use it to help organize the financing, construction and maintainace of this intervention. The idea is for members to collectively build these farms using a part of the yearly budget collected to be set aside for this. Alternatively, a group of investors (interested members of the union) can come together to generate the capital needed to fund each building. This organizing body would be responsible for:

• Generating enough revenue for the whole project.

• General financial activities involved at the different stages of construction.

• Ensuring the right quality and sizing of construction materials are used for construction.

• Hiring a skilled labour force to work on each Farmhouse.

• Selecting what exact species of Fish and vegetables to grow and in what amounts.

• Maintaining a balance of the aquaponic system at all points to optimize possible output and potential revenue.

• Maintainace and repair of aquaponic equipment in each Farmhouse.

• Maintainace and repair of the structural framework of the Farmhouse.

• Providing and organizing trainings, seminars and classes on benefits of aquaponics as well as training members of the community of valuable techniques involved in modern day aquaponic systems.

The profits from each Farmhouse would go back to each member of the Union involved in this scheme. Each farm house would also generate income by leasing out shops available in each Farmhouse to both investors and general members of the union.

CONCLUSION

Infill Architecture is the process of creatively reclaiming old or abandoned buildings,

parking lots or publicly unused spaces and repurposing these spaces into new functions. Due to government demolitions that took place in 2012 [7], Makoko now provides us with such opportunities to use Infill Architecture to create new public and social spaces where the bulldozers and machete have removed the superstructures of buildings leaving behind stable foundations on which to repurpose.

When the Aquaponic Farmhouse prototype has been successfully tested and is accepted by the community, members of the community could decide to replicate the same principles used to build the communal Farmhouses to build single storey Aquaponic farms on such abandoned plots within Makoko. These farmed would be smaller in scale and could potentially be financed by cluster of families that live close to such sites. Communal family gardens within a cluster the residential buildings could also be converted created. This could lead to the start of a green sustainable revolution of Makoko and push it ever so close to evolving from being seen as a slum to being a burgeoning community with vibrant industries and a much better quality of life than there is today.

Rapid urbanization especially in developing countries in major cities around the world is directly contributing to the creation of numerous unplanned settlements. These unplanned settlements have proven to be an effective and economically viable solution to the housing problems low income earners face. Efforts need to be taken by governments and organization to start thinking about the urban futures of such coastal cities which experience such problems like we see in Makoko. Projects like the Aquaponic Farmhouse could potentially serve as a prototype for other coastal cities around the world to emulate in order to try to make their cities sustainable and survive against nature. **[8]**

FIGURE 4.22 *!st floor showing the floating docks, Fish tank platforms and wooden floor panels*

FIGURE 4.23 *!st floor highlighting the Fish tanks, accessible Ramps to the 2nd Floor and the packaging & processing area*

FIGURE 4.24 *!st floor highlighting the Aquaponic grow beds over the fish tanks as well as those on the south side of the building*

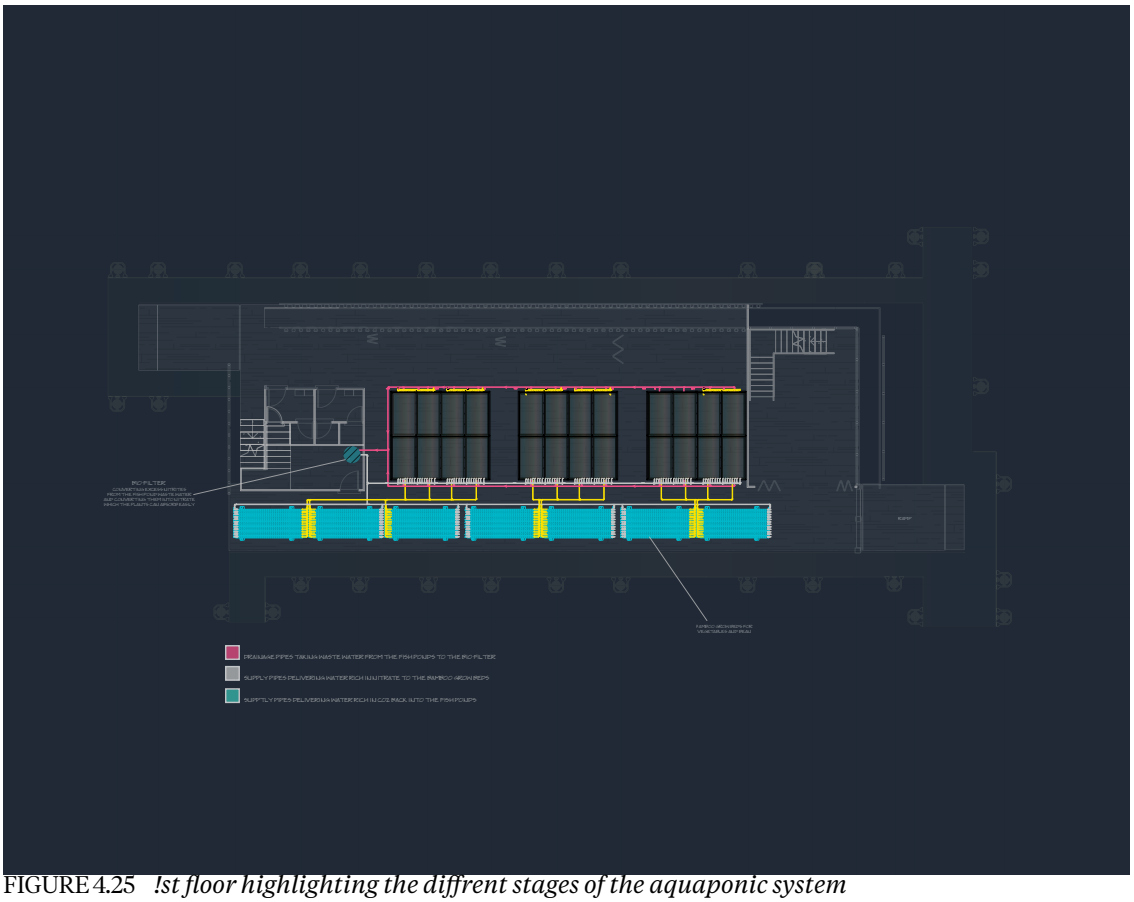


FIGURE 4.25 *!st floor highlighting the diffrent stages of the aquaponic system*

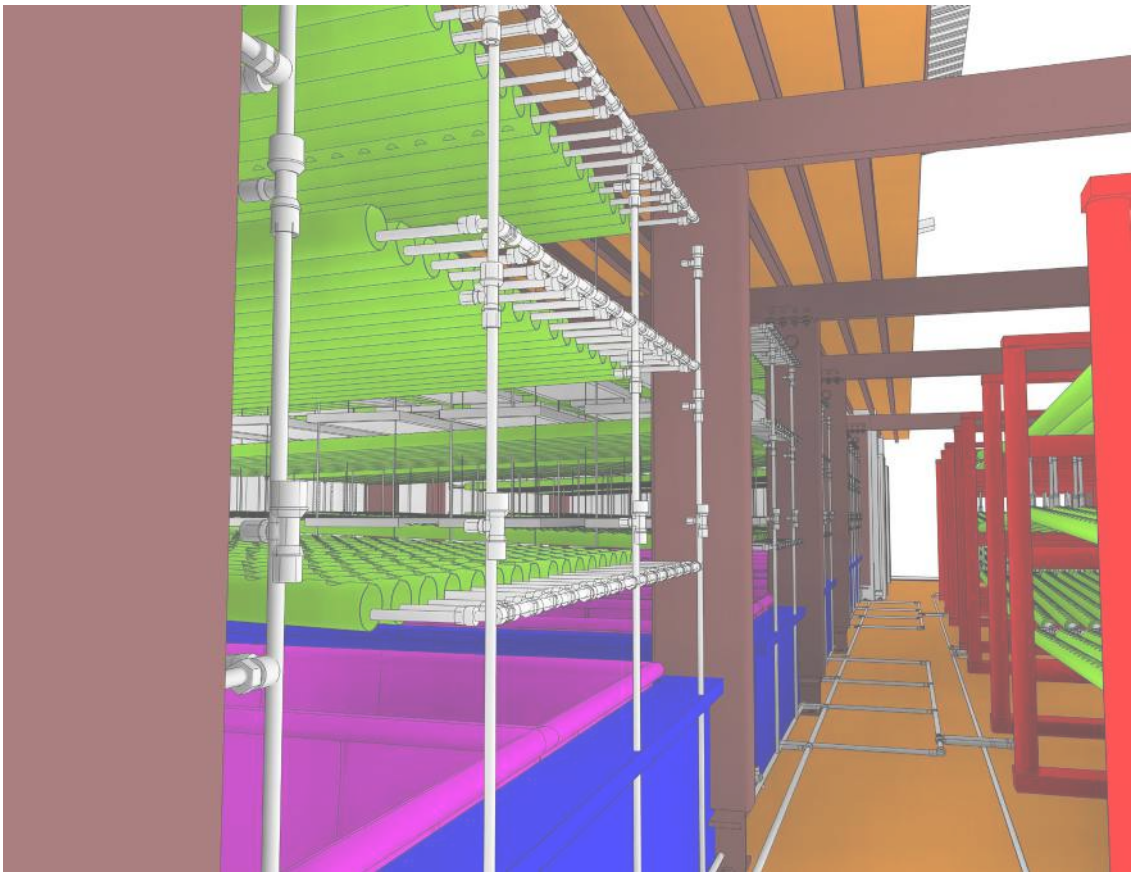


FIGURE 4.26 *Lobby between the Aquaponic system grow beds on the south side of the farm*

FIGURE 4.27 *Fish tank where Tilapia or Catfish would typically be grown is connected to the grow beds hanging over the ponds in a closed controlled system*

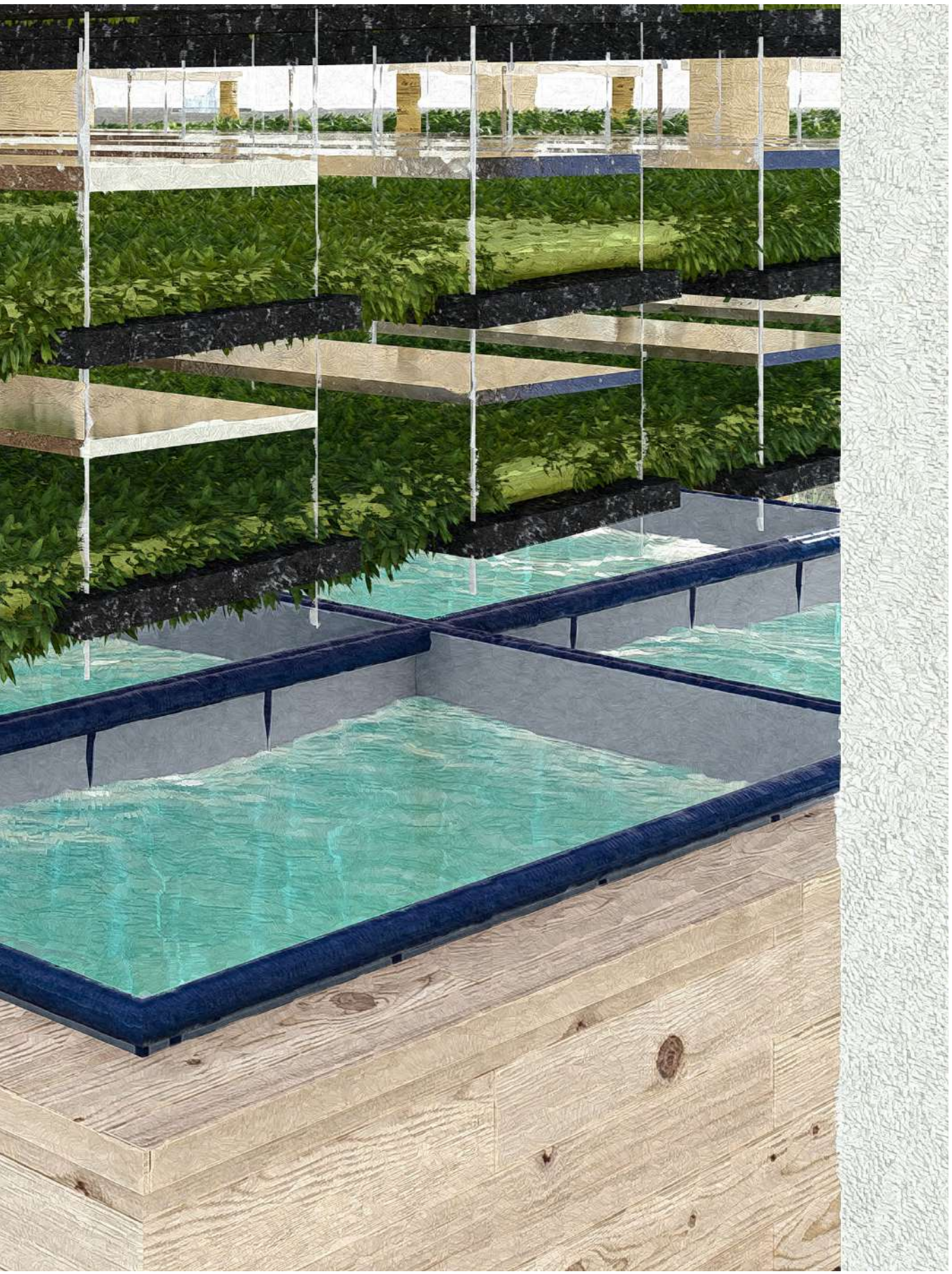


FIGURE 4.28 *view of the farmhouse*

FIGURE 4.29 *C Girds running perpendicular to the structural beams hold the second floor panels in place*

FIGURE 4.30 *2nd Floor plan when being used as a communial market space and cafe*

FIGURE 4.31 *P.V solar panels installed on the roof to supply electricity primarily to the Mechanical room andalso act as a back supply of electricity for the rest of the building*

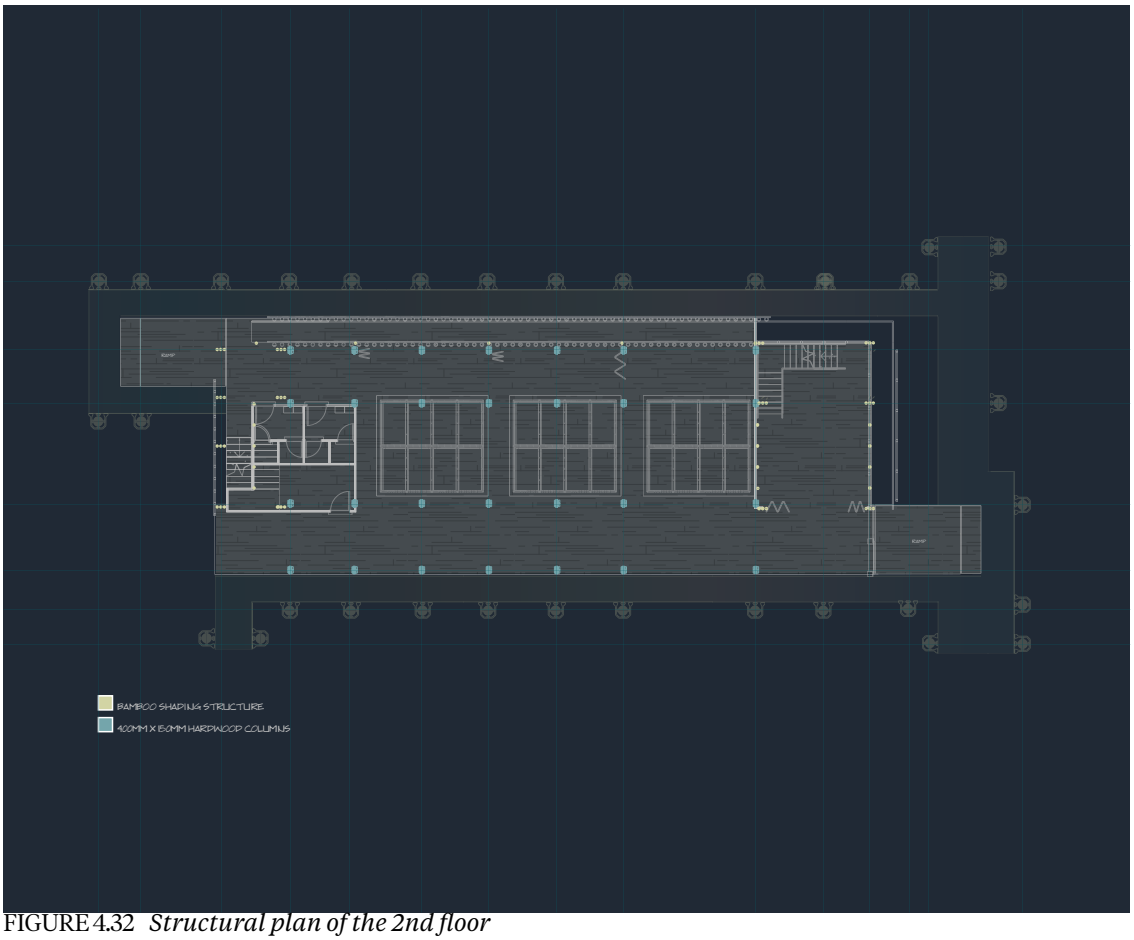


FIGURE 4.32 *Structural plan of the 2nd floor*

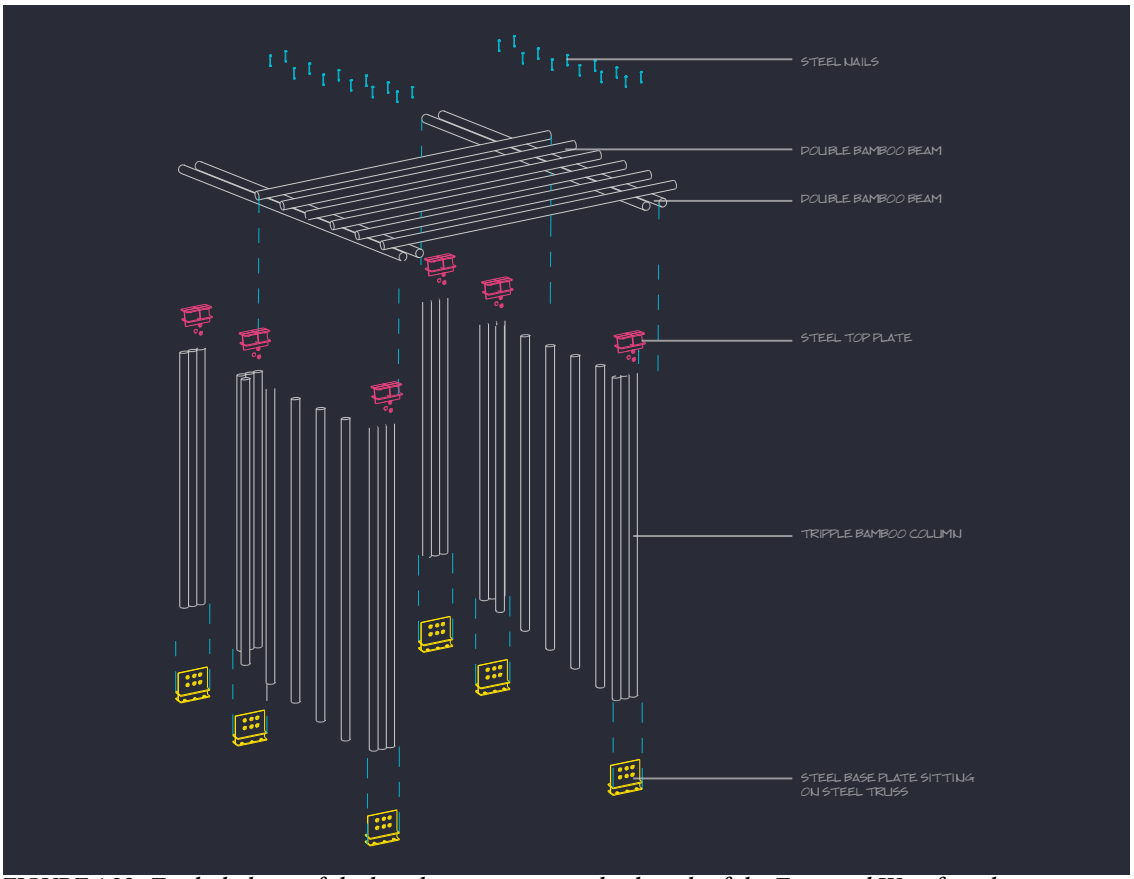


FIGURE 4.33 *Exploded axo of the bamboo structure at both ends of the East and West facade*

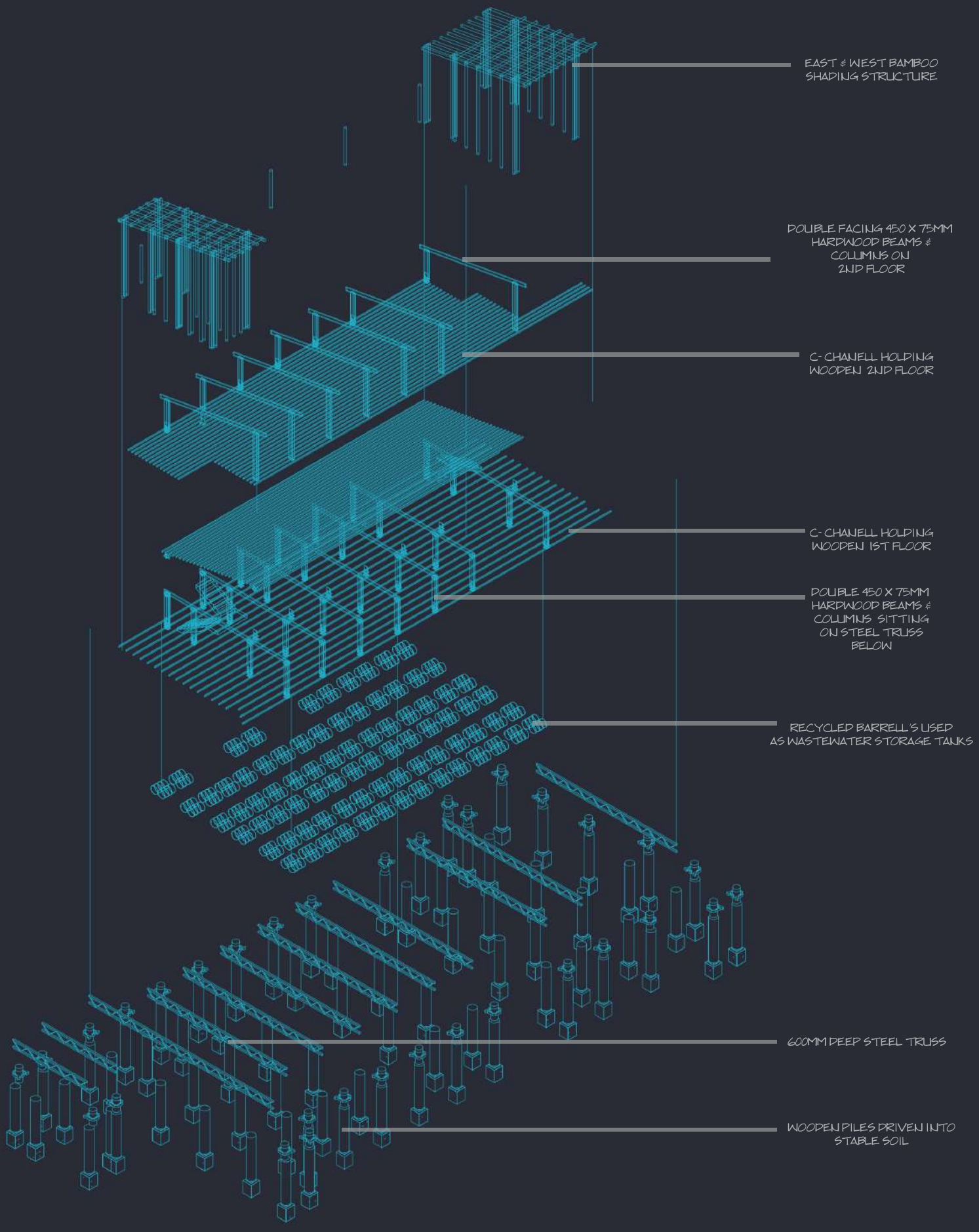


FIGURE 4.34 *Exploded structural axo entire Farmhouse building*

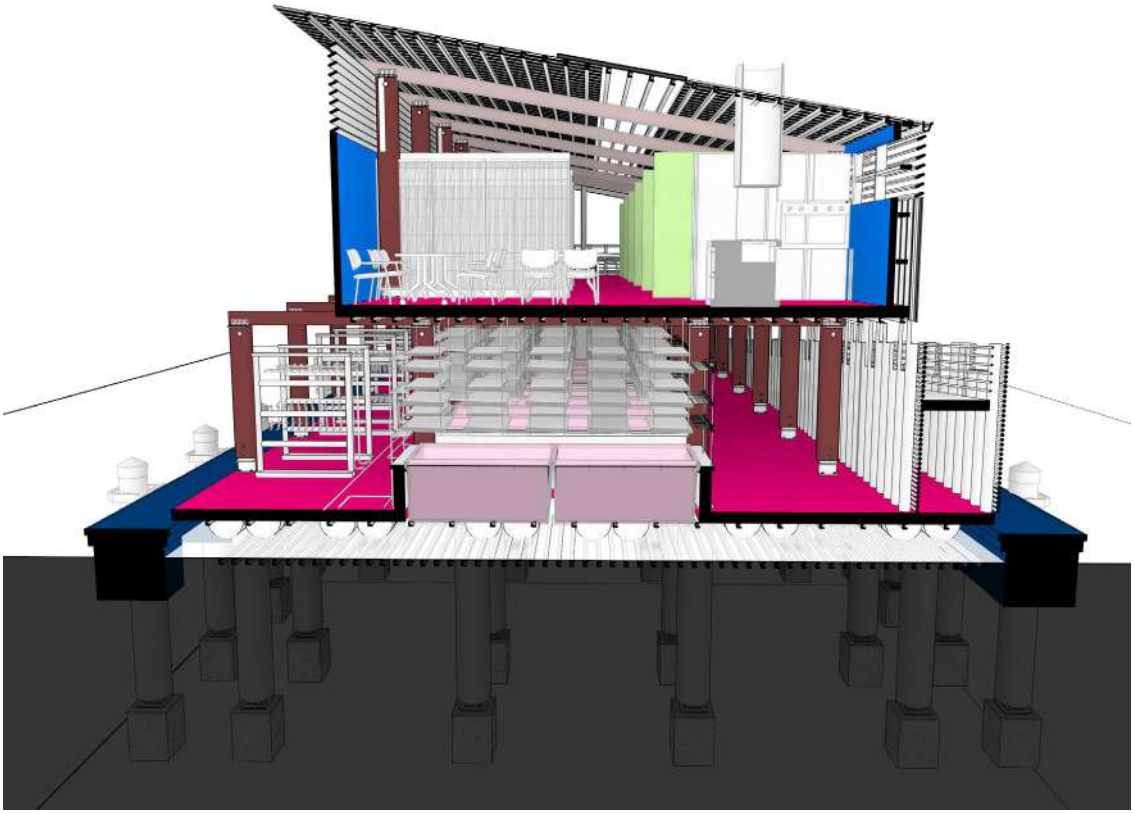


FIGURE 4.35 *Latitudinal Section*

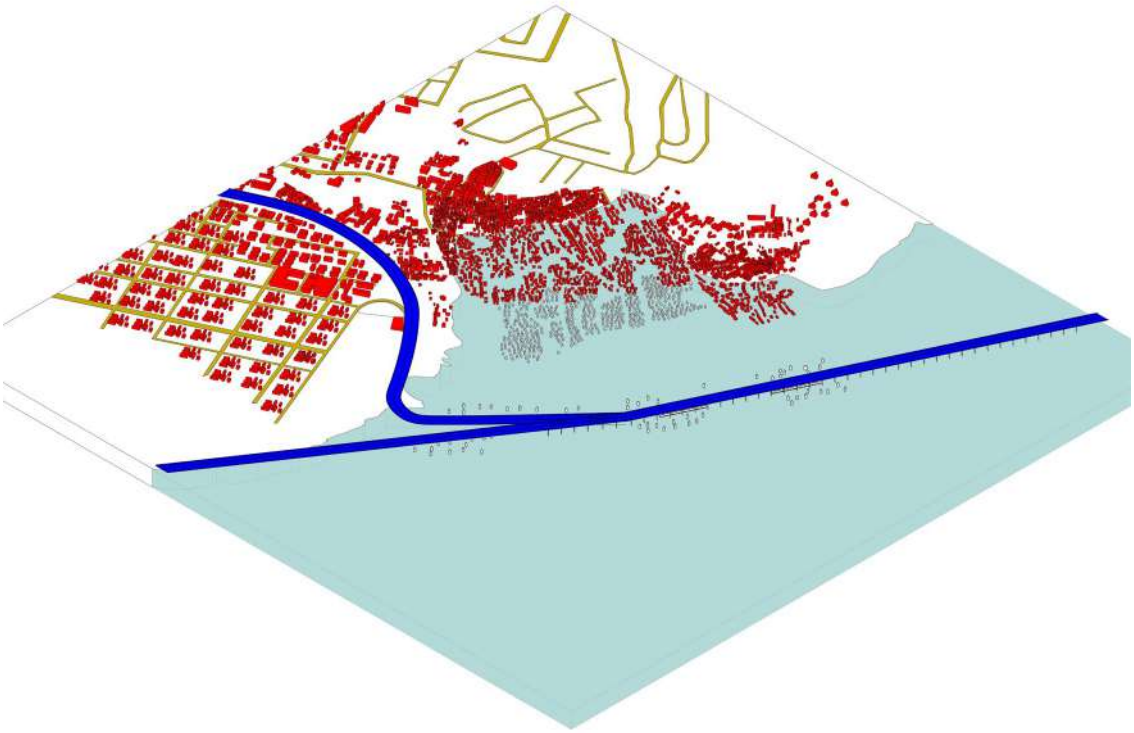


FIGURE 4.36 *Site Axo*

FIGURE 4.37 *Aquaponic grow-beds on the South facade*

FIGURE 4.38 *Interior view of the Communial Cafe*

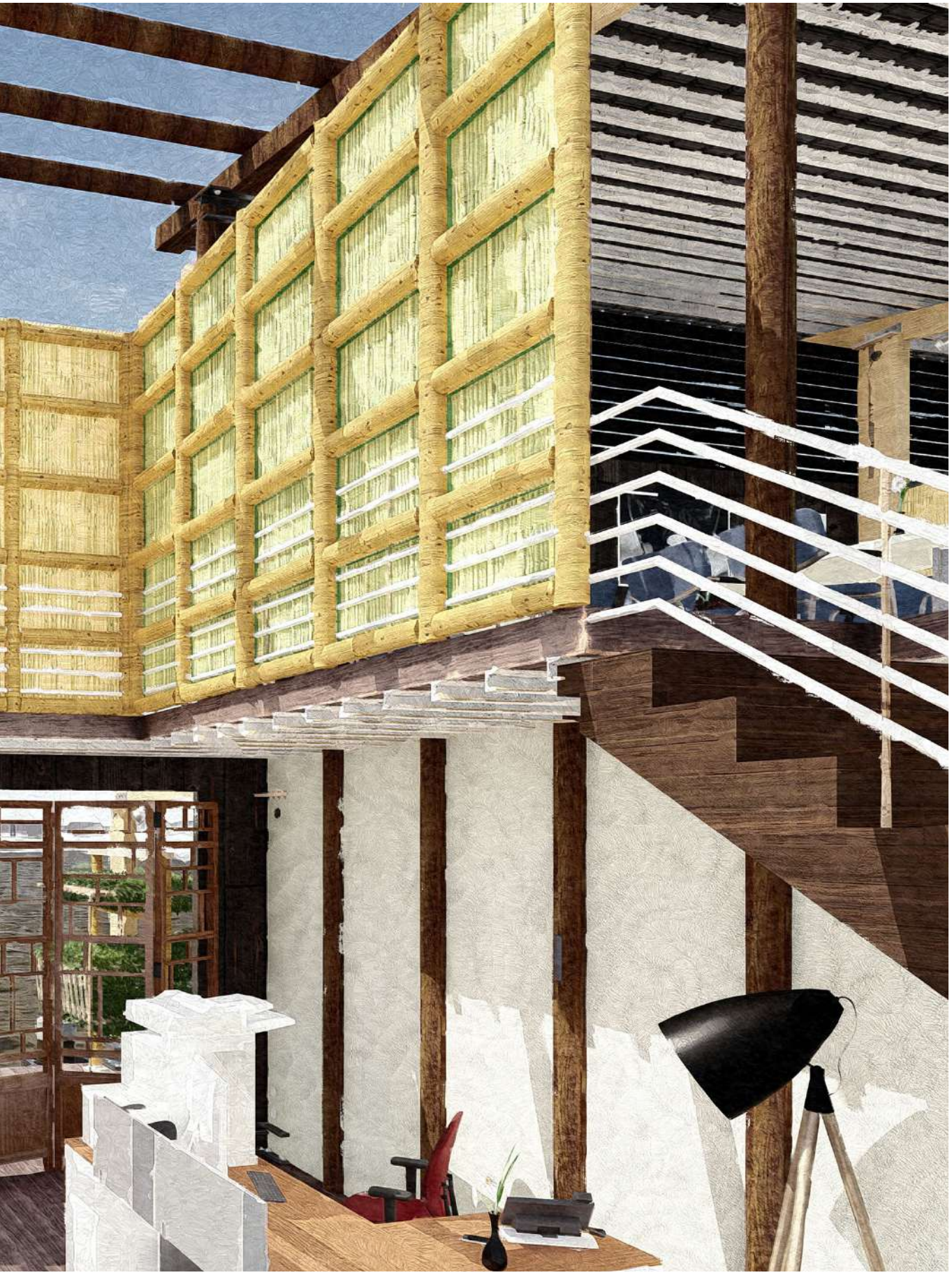
FIGURE 4.39 *Interior view of the Market stalls*

FIGURE 4.40 *EXterior view of the Reception Entrance*

FIGURE 4.41 *View showing the entrance to the Communial Kitchen*

FIGURE 4.42 *View entering the Reception*

FIGURE 4.43 *Reception*



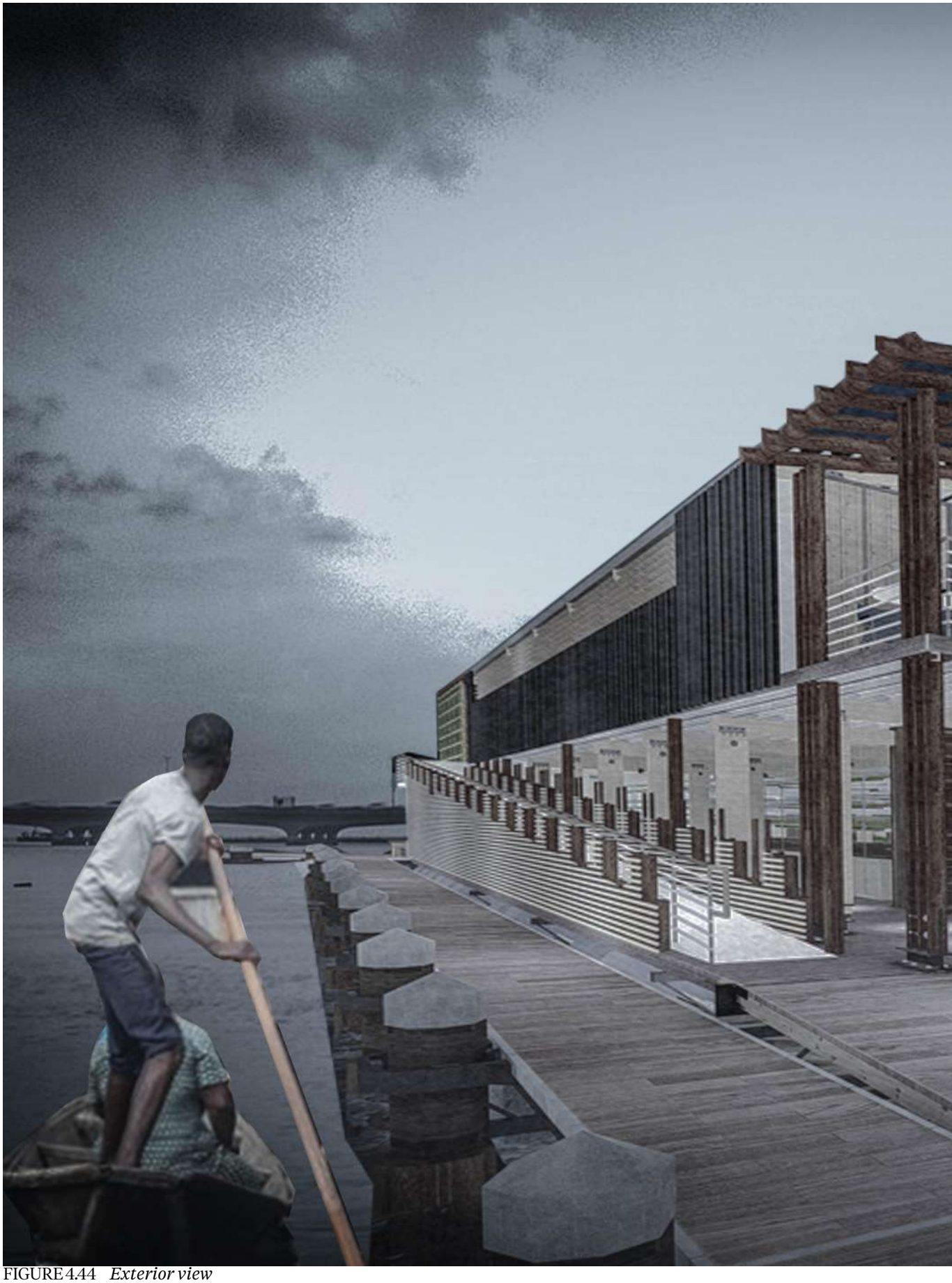


FIGURE 4.44 *Exterior view*

FIGURE 4.45 *Areal view*

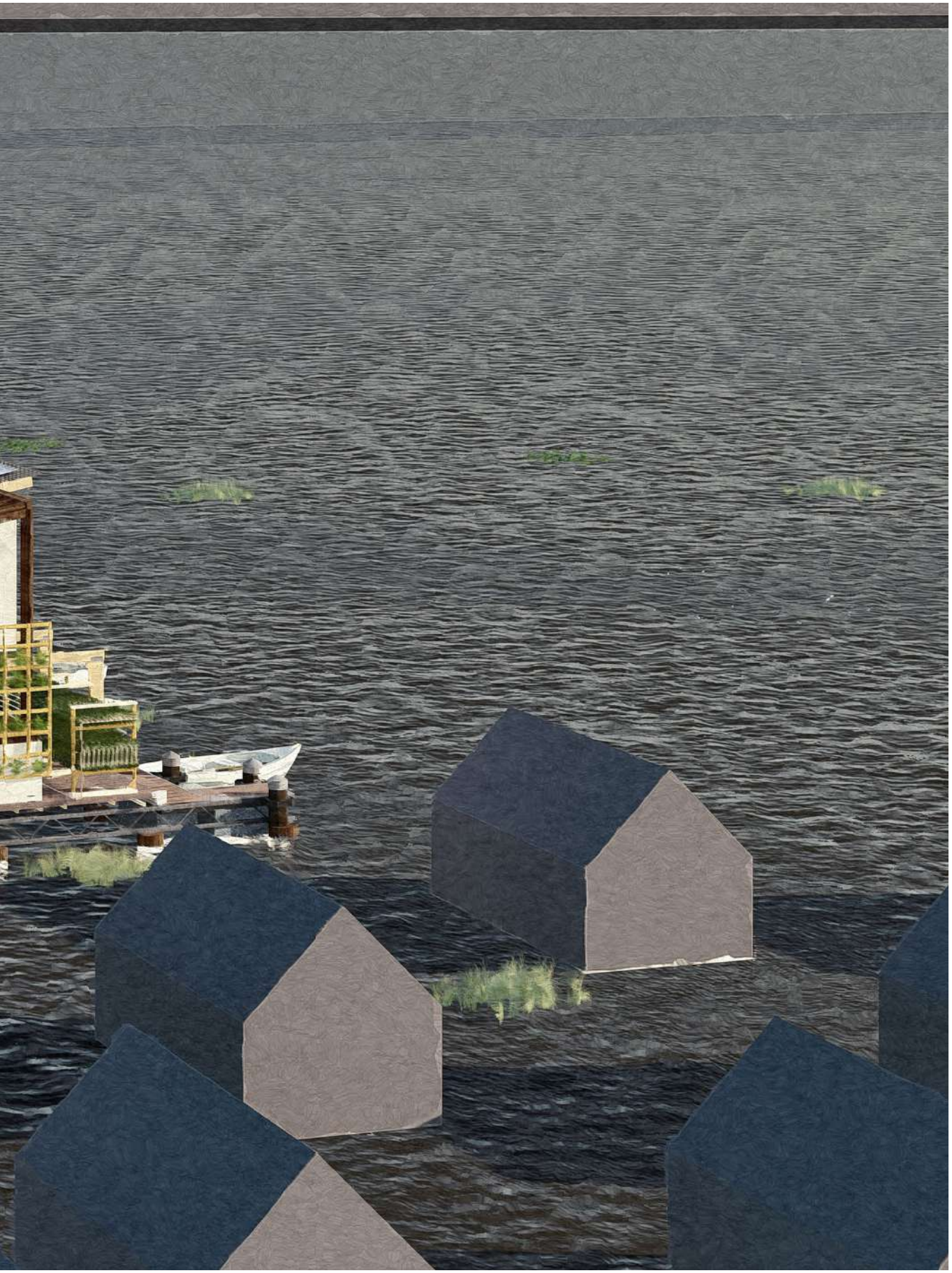


FIGURE 4.46 *West facade showing the use of the proposed Aquaponic Wall*

FIGURE 4.47 *Bamboo structure on the East facade*

ENDNOTES

1 (B. E. Emmanuel 2010)

2 (Makoko: ‘Venice of Lagos’ | OUR FUTURE CITIES. http://futurecapetown.com/2014/04/makoko-venice-of-lagos/ n.d.)

3 (Makoko: ‘Venice of Lagos’ | OUR FUTURE CITIES. http://futurecapetown.com/2014/04/makoko-venice-of-lagos/ n.d.)

4 (Omo Forest Reserve | ZODML. https://zodml.org/discover-nigeria/heritage-and-culture/omo-forest-reserve n.d.)

5 (Makoko: ‘Venice of Lagos’ | OUR FUTURE CITIES. http://futurecapetown.com/2014/04/makoko-venice-of-lagos/ n.d.)

6 (B. E. Emmanuel 2010)

7 (THE CHALLENGE OF SLUMS - United Nations. https://www.un.org/ruleoflaw/files/Challenge%20of%20Slums.pdf n.d.)

8 (Olumuyiwa O Ajayi 2014)

FIGURE 5.01 *Bamboo home*

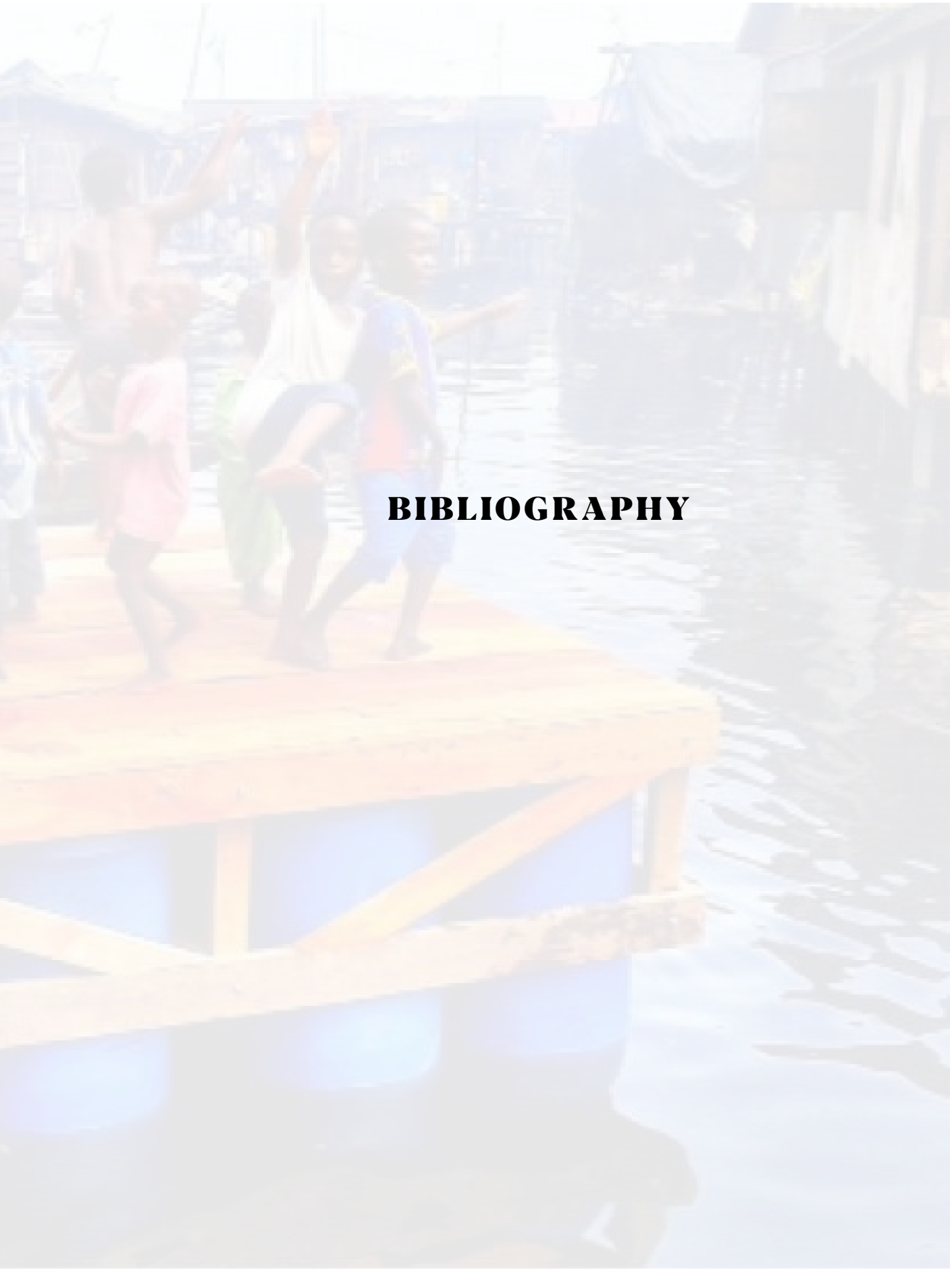


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FIGURE 6.01 *Man peeping out of wooden window*

APPENDIX

REDEVELOPMENT OF SLUMS

Rapid urbanisation and urbanisation of poverty are the major factors which cause millions of people to live in impoverished or informal settlements often described as slums.

I explore the concept of slums, the factors that lead to its formation as well as policies and practices that could help redevelop and reintegrates these slums back into the societies in which they exist. Slums are in a sense two-faced demon, with both negative and positive aspects.

Majority of informal settlements are located in areas that are generally considered undesirable or are located in areas with extremely terrible conditions which are prone wo all sorts of dangers like flooding, lack of infrastructure, hazardous land, overcrowding, land tenure insecurity, and poor sanitation. This leads usually to the marginalization of the dwellers and tends to worsen their situations. This marginalization is a major reason for the high rates of unemployment, broken families, and economic and social exclusion found in such communities. [1]

The positives of such communities are that it provides its residents with affordable housing and really helps new migrants to integrate into the society slowly rather being on the streets. Slums tend to actually keep a lot of economies running through the presence of local industries that sometimes have clientele all across the cities. Majority of residents in such communities earn a living from such businesses and at the same time help contribute positively to the economy of the countries at large. [2]

A lot proposed solution to slums have been about trying to provide adequate housing and basic amenities in such communities, but they all have mostly failed as they haven't addressed the main reason of Poverty. Without tackling this, residents would more likely than not tend to fall back into the trap of poverty and this isn't a long-lasting solution. Future policies have to address this issue and try to ensure the creation of support systems for their livelihoods of the urban poor, this could include the easy geographical access to jobs, transport and more appropriate low-income settlements. [3]

I hope to explore ways of reducing marginalization of slum communities and investigate ways redevelopment and transformation can take place from within. paper attempts to examine the concept, characteristics and policy interventions to improve living conditions of slum dwellers.

MEGACITIES

Megacities are cities with a population of over 20 million people[4]. The rise in number of megacities around the world show a direct relationship with the percentage rise in the world populations, and with this comes an inevitable increase in number of slums that exist in these cities. The total global of slum population is 924 million, 94% of it (870 million) is in developing countries and 6% (54 million) is in developed countries. Coefficient of correlation between the two variables i.e. urban population and slum population at the regional level show a strong correlation (0.89) confirming that the increasing slum population is the result of increasing urban population.

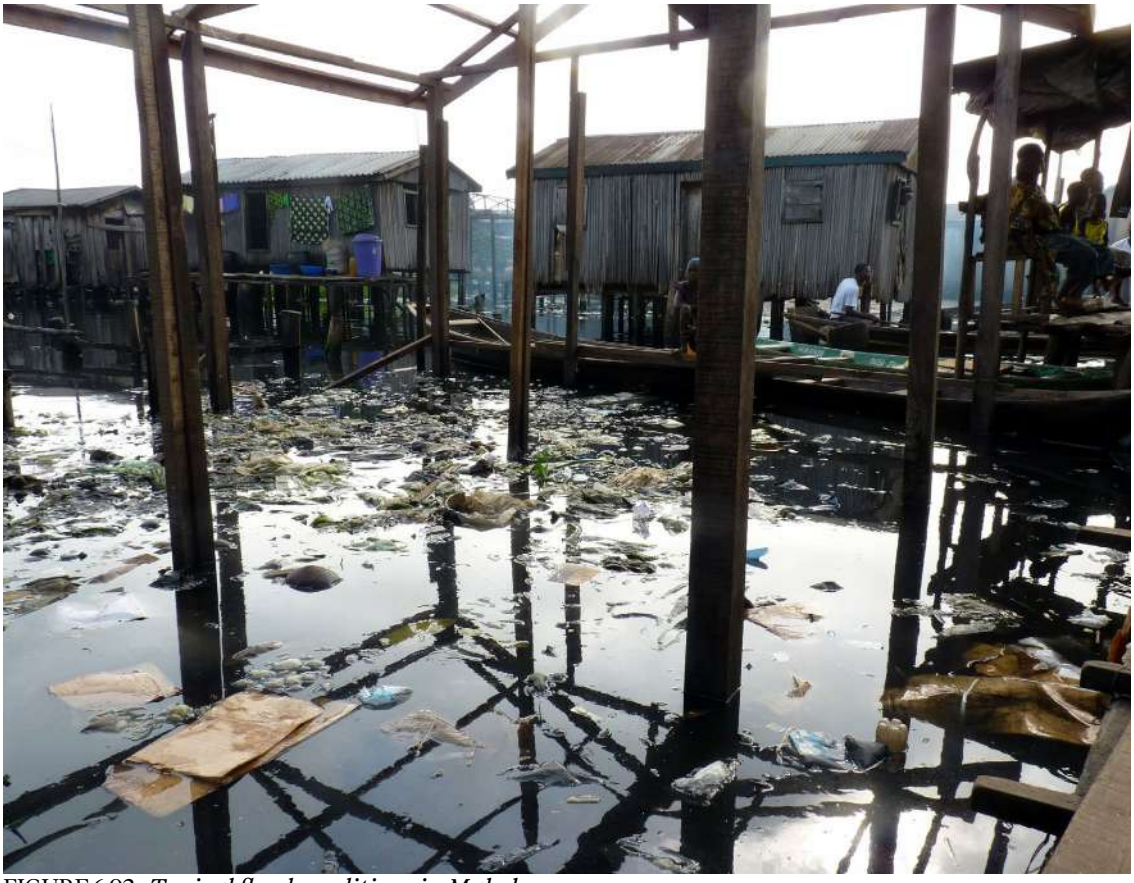


FIGURE 6.02 *Typical flood conditions in Makoko*

FIGURE 6.03 *Existing school conditions in Makoko*

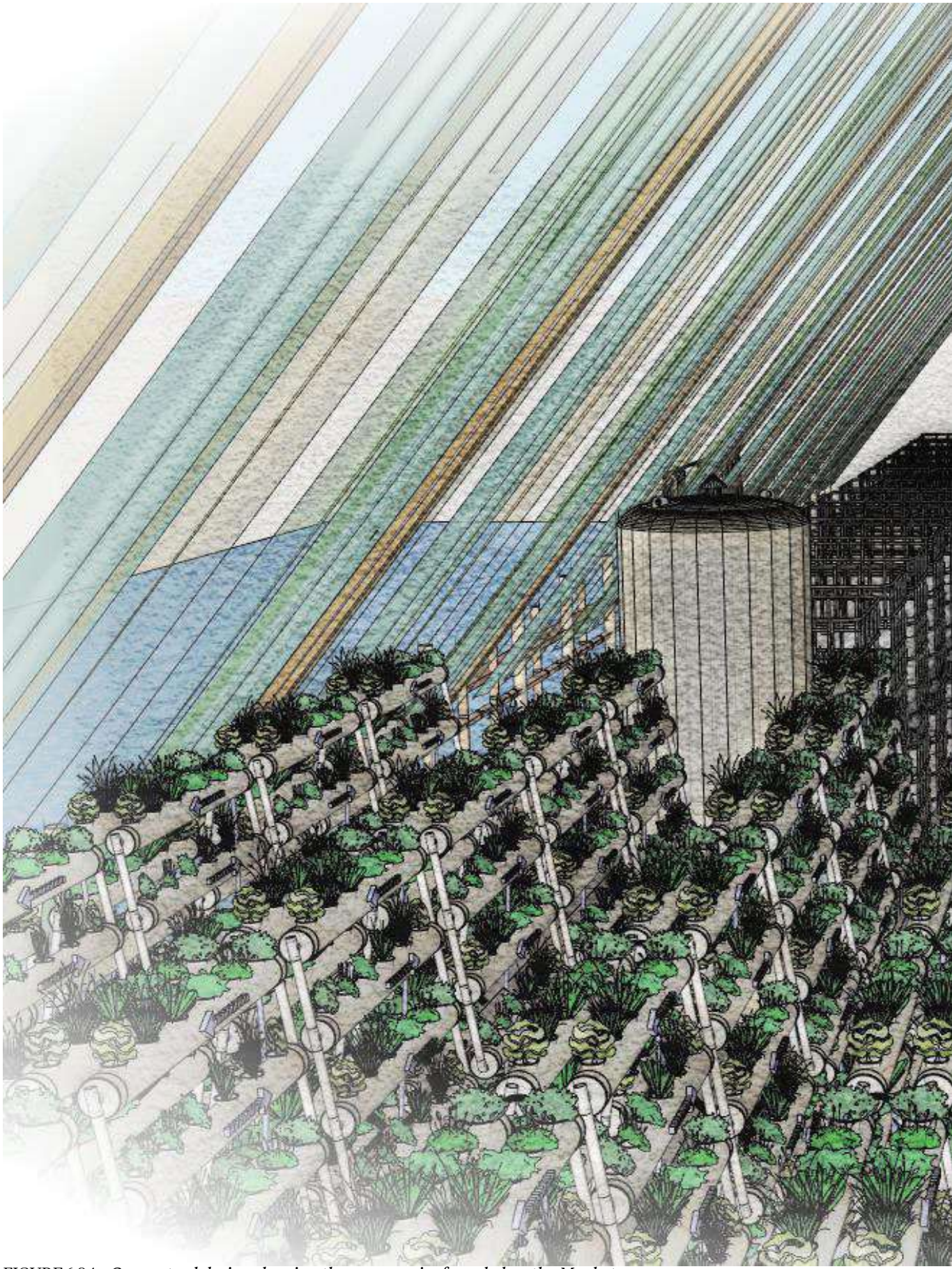
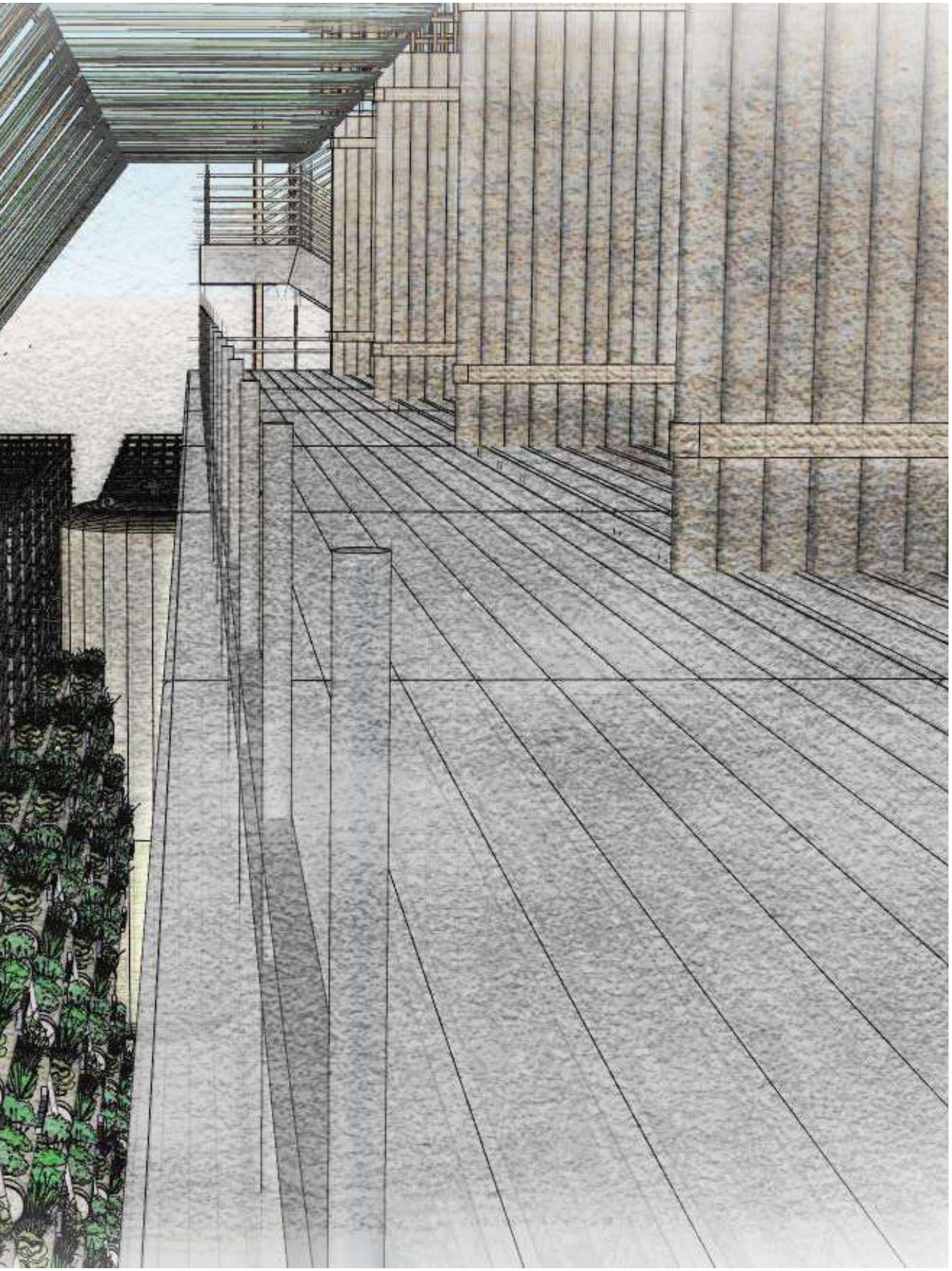


FIGURE 6.04 *Conceptual design showing the aquaponics farm below the Market area*



SLUM REDEVELOPMENT

In addition to corrupt government officials, a general lack of enough monies hinders effective implementation of Top- down approach to redevelopment and reintegration of slums. Government policies are often the fastest ways to transform slums, but it often involves huge amounts of investment that most governments aren't willing to spend. Here I would analyze the six major types or forms of redevelopment, which include;

(i) Turnkey Projects

(ii) Site-and-service

(iii) Slum Upgradation

(iv) Reproductive small towns

(v) Structural reforms

(vi) The NGO revolution

INFORMAL COMMUNITIES

In today's world, slums and their existence are a reality in urban areas across the globe. They are physical manifestation of factors like rapid and uncontrolled urbanization, rural-urban migration, acute poverty, ill-conceived policies, inappropriate urban planning and weak institutional capacity. Yet they are integral part of urban society and contribute significantly to its economy both through their labour market contribution and informal production activities.

The United Nations characterizes slums sharing one or more of the following features:

(i) Poor structural quality and durability of housing;

(ii) Insufficient living areas;

(iii) Lack of secure tenure;

(iv) Poor access to water; and

(v) Lack of sanitation facilities. [5]

ENDNOTES

1 (Programme 2003)

2 (Programme 2003)

3 (Programme 2003)

4 (Alexandra150 2019)

5 (Parry 2015)