ADAPTIVE DESIGN IN URBAN FLOODING CONDITIONS CASE OF DAR ES SALAAM – TANZANIA

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By

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Title: ADAPTIVE DESIGN IN URBAN FLOODING CONDITIONS CASE OF DAR ES ALAAM

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DEDICATION

This Thesis is dedicated to my late Parents, Professor David Kapinga, and Evarista Mkulasyai who taught me to persevere and prepared me to face the challenges with faith and humility.

ACKNOWLEDGMENTS

The completion of this study cannot ignore the efforts of various individuals who in one way or another contributed enormously to making sure the study is fulfilled accordingly. To all these people I am extremely grateful.

My first and foremost gratitude goes to the almighty GOD for his ever ending love and glory of life that gave me the strength to carry on this thesis work from the conceptual stage through writing, collection of data and compiling the book to submission.

However, the extraordinary excellence must prevail to my committee members, Hinrichs Craig, John Humphries and Katherine Setser. I appreciate their powerful and constructive comments, encouragement, advice, and criticisms where I was seen out of the track. Also, I would like to give thanks to the whole staff members of the Department of Architecture and Interior Design for their constructive advice and guidance throughout my journey.

Sincerely, I will be guilty of serious omission if I do not acknowledge my beloved brother and sister Jackson and Jacquline Kapinga respectively who have always been supportive and understanding even in times when they needed me most but this research stood in the way.

I wouldn’t forget my friends and classmates whom I am glad to have to meet especially Mary, Grant, Sara, Winfrey, Medhi, Noushin, Miranda, Siv, Anna, and my roommate Natasha whose contributions and motivations have made my three years Masters of Architecture to be delightful.

ADAPTIVE DESIGN IN URBAN FLOODING CONDITIONS CASE OF DAR ES SALAAM

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ABSTRACT

Flooding hazards in urban areas is a worldwide problem. This is influenced by rapid urbanization, overpopulation, and the demand for a settlement that has exceeded the local housing stock. This leads to people living in an unplanned area that is prone to flooding.

In developing countries like Tanzania, flooding has been a challenge to the government and the citizens. The government has opted for the resettlement of citizens from flood areas to safer undeveloped land, but this method seems to fail whereby the residents want to stay in the area because of the opportunities in their daily life and not being prepared for resettlement.

Though the residents have tried to reduce the impact of the floods through various methods of

landscape design, trench construction, raising foundation, landfill, and constructing retaining walls, nothing has improved as there is always large amounts of water received by streams, rivers, and run-off water that rises above a normal entry-level construction every time the rainy seasons begin.

By analyzing several case studies worldwide such as the Netherlands, Nigeria, United Kingdom, and the United States, it has been found that there is the possibility of establishing safe and quality settlements in flood-prone areas that may adapt to the flooding environment by coping with climatic change. This can be successful if design considerations are based on both the built environment and individual building.

Therefore, as many flood-prone areas are in urban settings, they have the potential for economic activities, recreation, and even residential use and so it will be worthy to develop them into habitable areas of Dar es Salaam such as Masaki and Posta.

The research goal is to have the city remain functional regardless of the season being experienced. To remain functional, the goal is also to encourage the development of advanced infrastructure such as roads and drainage systems that will serve as water channels during rainy seasons.

Keywords:

Tanzania, Climate Change, Flooding, Rapid Urbanization, Resettlement, Infrastructure

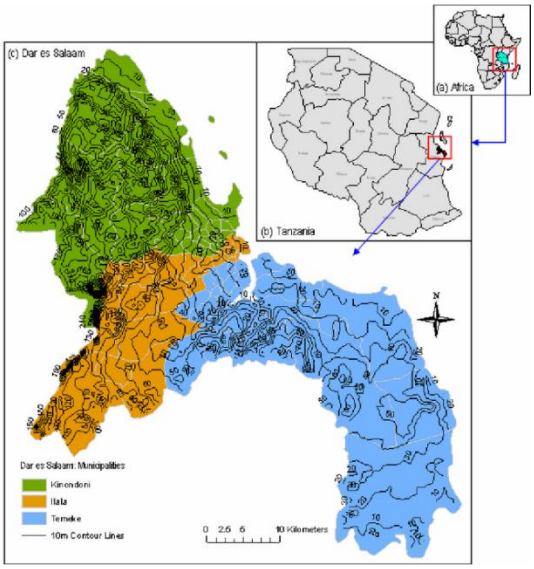


Figure 01
Dar es Salaam Location

INTRODUCTION

Flood

In general, we can say that flooding is too much water in the wrong place. It is considered a natural event or occurrence which occurs fast and disappears quickly or sometimes will take a longer time to build and discharge.

As a Tanzanian, I have decided to select Dar es Salaam – Tanzania as the study site that has been affected by floods. I am not a 100% flood victim, but I have relatives who have been and are still being affected by floods.

Dar es Salaam is in the Eastern part of Tanzania Mainland. To the East, the city borders the Indian Ocean, and the west, it is surrounded by the Coastal Region. Dar es Salaam experiences an equatorial climate with hot weather and high humidity throughout the year (21^0C – 35^0C).

Dar es Salaam is a fast-growing region of Tanzania, which leads to a greater challenge to supply planned plots leading to a situation where about 70% of settlements are in unplanned areas. This factored with other surrounding issues increased the vulnerability to climate change effects through rain, most parts of the area have experienced floods in every rainy season.

Dar es Salaam's History with Water

Dar es Salaam receives heavy rainfall during the rainy season. Due to the nature of its topography and amount of rain it receives, most parts of the area experience flood every rainy season. Dar es Salaam experiences five months of rain within the year, which are February/March, April, May, and

November. Many lives are lost due to torrential rains that cause floods.

In 2011, the city of Dar es Salaam experienced very heavy rains which lead to flash floods which have never happened and caused destruction in many areas of the city where about 23 people lost their lives and the other 4,909 were displaced. "The economic activities were closed, and thousands were left homeless as the city became inundated with floods."[1] This was the worst floods in 50 years.

In 2014 Dar es Salaam again experienced floods that left tens of thousands of people extremely affected. The reporter Richard Davies states, "Some of these suffered varying degrees of damage while others left completely inhabitable after their homes being submerged under floodwater".[2] More than 400 households which are equal to more than 2,000 individuals were dislocated.

The following year, in 2015 Dar es Salaam was underwater after 85 mm of rain fell for 24 hours which lead to the death of 12 people. Richard Davies of Floodlist website writes "A better picture of the damage caused by the floods will only become clearer once the floodwaters start to recede."[3]

In 2018 Dar es Salaam also experienced heavy rain that leads to the collapse of the buildings and killed 14 people. Richard Davies of Floodlist website writes, Dar es Salaam was underwater after 81.8 mm on the first day of raining and 99.6 mm for the following day for 24 hours that also leads to damage of infrastructure and schools were closed for two days.

During the flood, most of the flood-prone areas are not accessible, some infrastructures get damaged and some services like water get contaminated. Moreover, water takes a long time to dry hence hinder normal activities to take place in the area.

Flood effects in Da er Salaam

Figure 02
2011 Flooding – Dar es Salaam

Figure 03
2014 Flooding – Dar es Salaam

Figure 04
2015 Flooding – Dar es Salaam

Figure 05
2018 Flooding – Dar es Salaam

Figure 06
2019 Flooding – Dar es Salaam

Figure 07
2019 Flooding – Dar es Salaam

Research Methodology

The research methodologies are divided into four parts which are case studies, literature regarding flood-prone areas and ways to mitigate the damage to structure and life, questionnaire interviews, and photographs and sketches.

Architectural case studies in response to flooding areas in the Netherlands, Nigeria, the United States of America, and the United Kingdom are analyzed. Journal, articles, project reports, and newspaper articles offer a clear understanding of the study area as well as offer an understanding of how flooding has been perceived in the urban context. In questionnaire interviews, the residents of the selected site will be asked to answer the questionnaire and 5-10 minutes of interviews. Also, the questionnaires will be in two parts whereby the first part will be for urban planners, architects, and the office of disaster management of Ilala municipal and the second part

will be for a resident of the selected site.

Problem Statement

Since these flood-prone areas are inhabited by many communities with their life highly connected to their environments like economic activities and social relationships, it has been a problem to relocate communities to other areas where it has reached a stage by which they have opened a case in court opposing eviction from the areas. Reporter of Daily news magazine states, "There is an ongoing case in the courts filed by the residents, opposing eviction from the areas and thus there is nothing we can do for now. They should, however, mind about themselves, their families and property, which are at risk, as highlighted by the Dar es Salaam Regional commissioner".[4]

Though studies have been made and recommendations on construction in flood areas have been provided, still there is no connection with surrounding facilities like transport infrastructures, services, landscape, for proper functioning as an urban environment. It is in this case that, at an urban scale knowledge is needed to help mitigate flood in flood-prone areas.

The research asks four main questions, what are the architectural challenges people face dwelling in existing flood-prone areas? What are urban design strategies that have been considered globally to mitigate floods in urban flood-prone areas? What are the major causes of flooding in urban flood-prone areas? Why do people opt to establish their settlements in flood-prone (valley) areas while they are not safe to live?

The research objectives of this research are, to find out the architectural strategies that can be incorporated into the urban design to mitigate floods and its effects for sustainable settlement in urban flood-prone areas; to study and analyze the architectural challenges in urban design facing an existing built environment in flood-prone areas; to explore the urban design solutions in architectural perspective and construction methods suitable to solve settlement problems in flood-prone areas, and to recommend the architectural design strategies in the urban context that will be used to establish safe settlements within the flood-prone (valley) areas.

There are many people in Dar es Salaam and other cities in Tanzania dwelling in flood-prone areas, therefore through this study, the government of Tanzania will benefit from the following; the living standard of people in the valley dwellings will be improved hence there will be no more destruction of their properties during the floods, and this also will bring social and economic stability to people since there will not be any interference of flood to their daily activities.

The study will be done in one of the flood area settlements located in Dar es Salaam. It is limited to architectural and urban design considerations in flood-prone areas and it will focus on dwellings and their compounds.

FLOOD SOURCES AND MEASURES

According to the Royal Institute of British Architects (RIBA) climate change toolkit 2009, floods in urban areas have different sources as explained below.

Tidal Flooding: This type of flood occurs both in rivers and seas. It is due to the high amount of rainfall in an area that will lead to coastal sea level rises. This type of flood leads to high destruction hence it leads to public destruction like roads, rails, ports, and bridges.

Fluvial Flooding: This type of flood occurs when the place experiences heavy rainfall which lasts longer (extended the time). This situation causes the river to overflow its banks right into the settlement areas. This type of flood can also be caused by snowmelt.

Ground Water: In low lying areas that are over aquifers, there is the tendency of groundwater levels to rise periodically and when this gets extreme it leads to flooding. Prolonged heavy rainfall soaking into the ground can cause the ground to saturate and raise the groundwater level and lead to a flood. Since it is often seasonal and slow in its onset, it can be forecasted with good accuracy.

Pluvial Flooding: This type of flood occurs when heavy rainwater run-offs, mixed with the drainage system, leads to excess water that cannot be absorbed and controlled by the drainage system. This situation leads to an overflow of water from the drainage system and causes floods.

Sewer Flooding: This type of flood occurs when there is a leakage from a sewer system like drains, pipes, or manhole from the toilets or shower. This type of flooding can also be caused by having poor maintenance and cleaning of the pipes.

Man-made Flooding: This type of flood occurs when people dig the land more than the property. This is mostly when people dig along the riverbank and when they are done with their activities, they leave the place open. Also, this type of flood can be caused when people start building houses in the water channel hence prohibiting the water flow hence causes the floods. Also, this type of flood can occur in industrial activities, dumping areas, and mining areas.

All these sources of flooding can occur depending on topographical nature, soil nature, location development on the ground, and available sources of water in an area.

There are some approaches that have been taken to mitigate urban

flood in some countries all over the world. Some of them are structural and others are non-structural. Since my research is intended to find out the visible strategies, the study must focus on structural strategies toward mitigating floods.

Structural measures are highly visible and may appear to be the best solution to flood problem, these are very important elements as they focus on the protection of human health and safety. These structural measures are viewed in the two sides i.e. the built environment (urban level) and the building (site level).

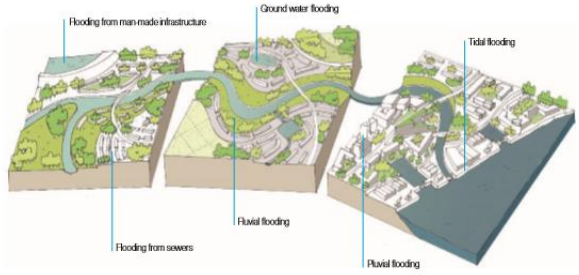


Figure 08
Flood Sources

Built environment (Urban scale)

Flood mitigation strategies on the built environment as the general urban environment are implemented in different perspectives like planning, designing, and mechanical perspectives.

The use of urban land-use planning can reduce both exposures to flood hazards and run-off into an urban area. Through this, the flood can be mitigated by making efficient use of land at risk by matching a mix of uses with the levels of vulnerability to risk which is established by considering the land topography and the distance from the flooding source. In the RIBA Climate change Tool kit 2009, RIBA proposed that the robust recreational uses like outdoor amenities and open spaces may be in the most hazardous part of the site adjacent to the watercourse when appropriate flood risk mitigation measures are put in place.

Various design measures can be incorporated into the urban design to mitigate flood in urban flood-prone sites like, construction of strong, high, steep-sloped embankment river walls, barriers, and barrages, construction of underground floodways to drain water away from urban rivers and canals, increasing river discharge capacity and plant trees with the deep and dense root system.

Site-scale.

It will be possible to avoid new development in the highest-risk locations in some cities/towns. But for most urban areas that have high pressure of development, preventing development in high-risk areas will come at an economic and social cost. In living with floods, there are various parameters to be considered in building design and construction as follows.

In designing houses in relation to the realm, the residents should not be placed in the high-risk areas instead have to be placed in low-risk areas. Even if the houses are placed

in low-risk areas, they need to be more than one story high. Also, all the houses will have to be built above the flood level.

In living with floods, the building construction in the flooding zone must obey various parameters that may help to reduce the vulnerability of building to flood damage and so improve the security of dwellers from the flood threats. These parameters can be incorporated to form the flood aware design that helps to design a flood aware building. The community awareness of flood design reduces flood damage to the sewer elements of the building that if destroyed can impair a building's structural performance. Minimizing the post-flood renovation costs, allows the people to return to their home faster after a flood.

CASE STUDIES

The selected case of studies are the Netherlands, Nigeria, U.S.A, and the U.K. The Netherlands and U.S.A are both located in coastal areas similar to Dar es Salaam that is also located in the coastal area. I also select Nigeria because the climate of Nigeria is almost the same as the climate in Dar es Salaam as is the one in the U.K is which located along the River Thames in Marlow.

Netherlands

The land of the Netherlands is below sea level that leads to severe floods in every generation or so for hundreds of years. Due to a warming world that leads to additional rainfall that causes the sea level to rise, the threat from floods is expanding worldwide, and the Dutch are leading the way in water management engineering. It is only half of the Netherlands that is more than a few feet above sea level while the rest is below sea level. This leads to the development of floods from time to time.

The Netherlands now is using the concept of floating houses. Float houses are flooded safe hence can move from one place to another. Jacob Shamsian and Chelsea Pineda state that "Floating houses are built by creating foundations of concrete, then filling them with Styrofoam, making them virtually unsinkable."[5] These houses are considered safe and affordable but also most sustainable as well because they can be adaptable to any climate hence living in floating houses you are no longer fixed to one location. They also have their HVAC system, plumbing, and an electrical system like the normal houses.

This method is useful in coastal areas where there is a gentle slope or in plain land. But it needs high financial support which would pose a major problem for low-income residents. The residents cannot afford the construction expenses. Since most people who live in a selected site are low-income residents, the government will need to support them in construction.

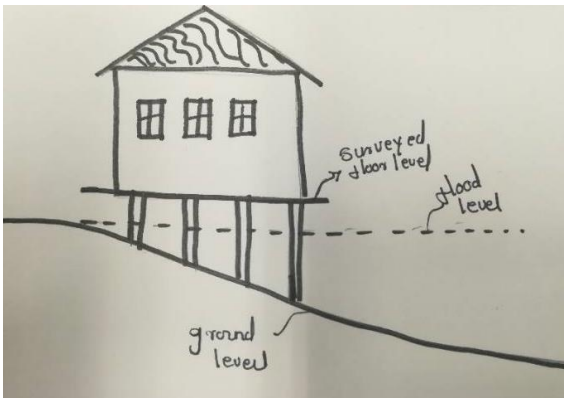
Figure 09
Floating House in Netherlands

Nigeria

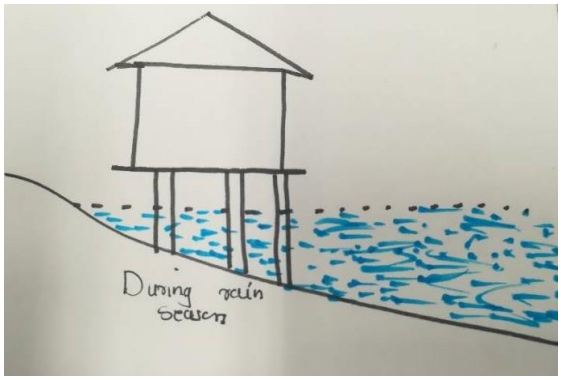
Flooding has become the most common problem in Nigeria and the rate of floods has been increasing each year. Nigeria has two big rivers that run through the country; the Niger River that flows from the north-west and The Benue river that flows from the eastern part. Both rivers meet at the center and then flow together to the south side of Nigeria into the Atlantic Ocean. Therefore, during rainy seasons the riverbanks overflow and cause flooding in Nigeria, killing hundreds of people.

Building above flood level.

The government of Nigeria has decided to use the new type of construction technology whereby they build above the flood level (foundation expansion) and the lower part can be used for other activities when there is no rain and during the rainy season, the place became useless. This construction seems to work in other places, but it is not working that much in Nigeria because of its poor infrastructures.



During Dry Season



During Rainy Season

Figure 10
Building Above Flood Level

Retaining Walls

The government of Nigeria also decided to start the campaign of encouraging its citizens to build retaining walls around their houses to help reduce the soil erosion during the rainy season

Figure 11
Retaining Wall

For a developing country like Tanzania, this method of building above flood levels will be one of the best solutions in preventing floods, but it will work better if the infrastructures will also be well designed to allow water to run smoothly during rainy seasons. To achieve the above, the government should work together with the urban planner and architect to plan the city masterplan again.

New York

New York City has been prone to flooding. Places like Queens, Staten Island, the Bronx, and Brooklyn, have experienced flooding frequently, and currently, the amount of flooding has increased which leads to huge damage to communities.

Due to huge damage, the planning department of the city of New York came up with a solution called Retrofitting Buildings for Flood Risk. Whereby they uplift the building for a minimum of 10’ depending on the topography and design of the existing building. And the first floor can be used as a porch or building storage or car park.

Figure 12
Retrofitting Buildings for Floods Risk Midland Beach, Staten Island

Figure 13
Site Condition Before Retrofitting

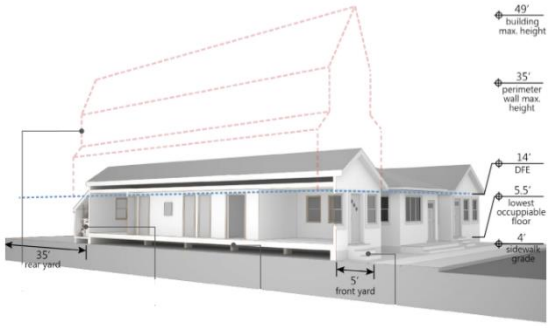


Figure 14
Building Height Before and After Retrofitting

Figure 15
Retrofitting Process

This method of construction is very advanced for work in flood-prone areas. However, it is very expensive, it needs a wealthy client or government support. The construction also needs high skilled labor. This method is applicable only if the existing building used timber frame structure or other light materials like bamboo. But for the concrete or masonry frame structure, this method can not be applied.

Figure 16
The Amphibious House

The Amphibious House

This is also a floating house designed by Baca Architects in the U.K. The difference between this floating house and the one in the Netherlands is that this house does not move from one location. The foundation of this building is fixed.

The house stays in a fixed foundation during the dry season but when floods occur the house rises in its dock. This type of construction is more applicable in a place that experiences extreme flooding.

The house uses the technology of marine and bridge construction to create smart flooding adaptive design which appears attractive to the society. The dock underneath the foundation prevents the house to move horizontally and makes the house move vertically only. The house will be able to rise to 2.7 m when a flood occurs.

Several tests have been done in this house and all of them happened to be successful and now people live in the house.

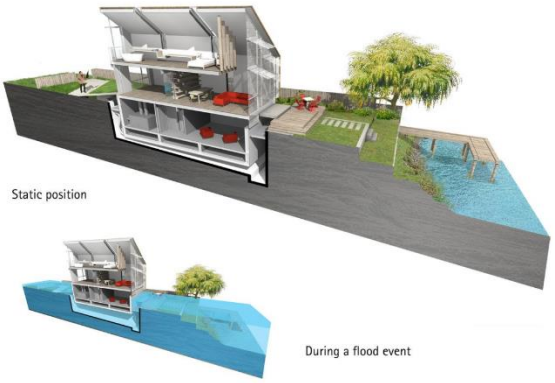


Figure 17
Dry season vs Flooding season

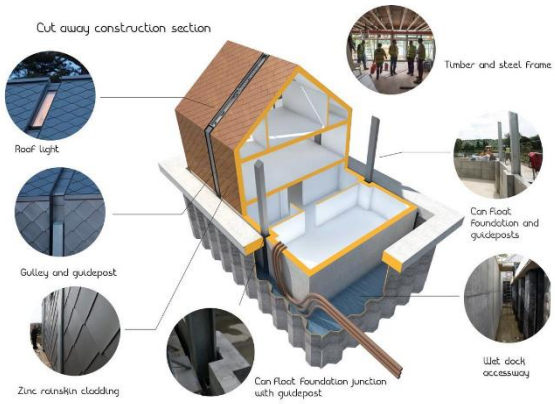


Figure 18
Construction analysis

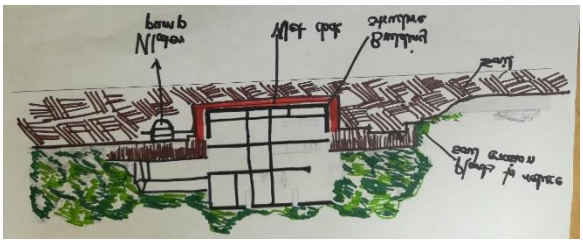


Figure 19
Building section

This method of construction is very advanced and works for flood-prone areas. In this method, the substructure part of the building is the most expensive while the superstructure part is affordable. It also needs high skilled labor in construction especially in the concrete floating base that requires in-depth physics principles.
Since one of the project goals is to use the local building materials that are available in Tanzania, this method will be helpful as the superstructure part of the building can be constructed by any building material.

Youth Village Farm

It is an indoor mixed-use building that includes market, agricultural activities, farm lab, and dormitories. Its concept based on the contemporary reinterpretation of traditional Italian farms.

Figure20
Village Farm Building

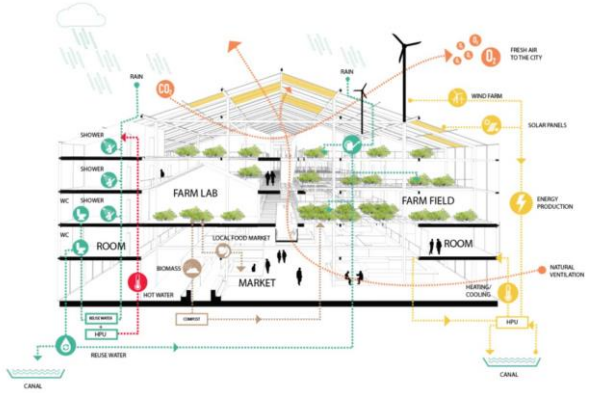
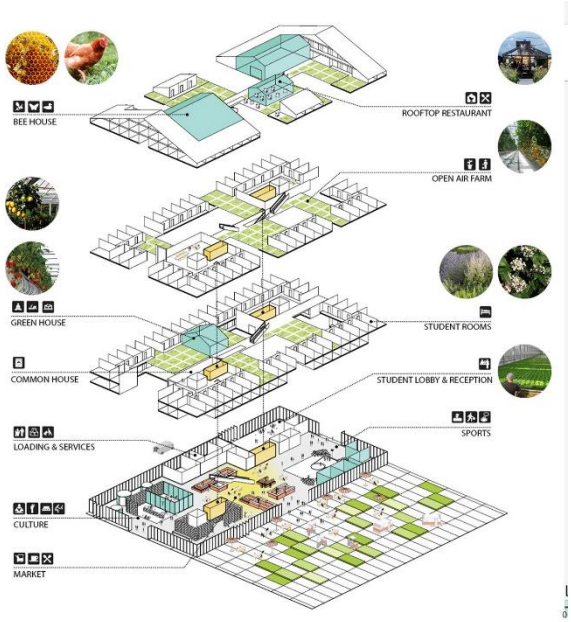


Figure 21
Building Section



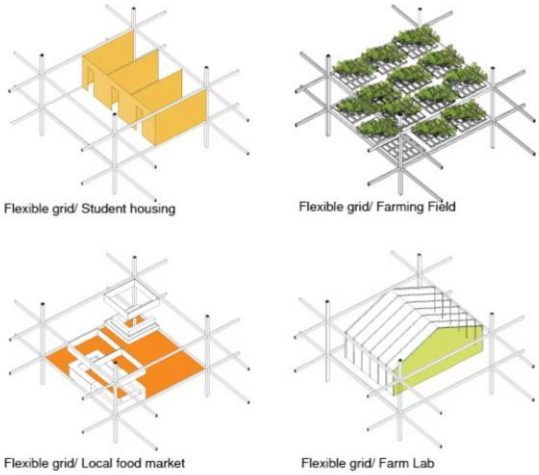


Figure22
Building Illustration

Notes:

[1] IPP Media web, 2012
[2] Kizito Makoye, Climate Change Triggers Disease Risk in Tanzania, February 2014 http://www.ipsnews.net/2014/02/climate-change-triggers-disease-risk-tanzania/
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[4] Daily newsmagazine webs 2014.
[5]Jacob Shamsian and Chelsea Pineda."The The Netherlands is building entire neighborhoods that float on water, 2015 https://www.businessinsider.com/netherlands-floating-houses-2015-12

All interviews conducted by the author, Irene Kapinga, have been approved by Miami University IRB. CITI Certificate number: 30904322

Figures:

Figure 01: Dar es Salaam Location
Source:https://www.researchgate.net/figure/Study-Area-a-Geographical-location-of-Tanzania- in-Africa-b-Dar-es-Salaam-in_fig1_267417178

Figure 02: 2011 Flooding – Dar es Salaam
Source:http://www.ask.or.tz/viewtopic.php?t=3103&start=30

Figure 03: 2014 Flooding – Dar es Salaam
Source:http://www.ipsnews.net/2014/02/climate-change-triggers-disease-risk-tanzania/

Figure 04: 2015 Flooding – Dar es Salaam
Source:http://floodlist.com/africa/tanzania-floods-dar-es-salaam-may-2015

Figure 05: 2018: Flooding – Dar es Salaam
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Figure 06: 2019 Flooding – Dar es Salaam
Sources:https://www.urbanafrica.net/news/rains-cause-havoc-dar/

Figure 07: 2019 Flooding – Dar es Salaam
Sources:https://www.urbanafrica.net/news/rains-cause-havoc-dar/

Figure 08: The floods Sources
Source: RIBA 2009 Designing for floods

Figure 09: Floating house in the Netherlands
Source:https://psmag.com/environment/are-the-floating-houses-of-the-netherlands-a-solution-against-the-rising-seas

Figure 10: The building above the flood level
Source: Author's sketch. 2019

Figure 11: The Retaining wall
Source: Author's sketch. 2019

Figure 12: Retrofitting Buildings for Floods Risk Midland Beach, Staten Island
Source:https://www1.nyc.gov/site/planning/plans/retrofitting-buildings/retrofitting-buildings.page

Figure 13: Site condition before retrofitting
Source:https://www1.nyc.gov/site/planning/plans/retrofitting-buildings/retrofitting-buildings.page

Figure 14: Building height before and after retrofitting
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Figure 15: Retrofitting process
Source:https://www1.nyc.gov/site/planning/plans/retrofitting-buildings/retrofitting-buildings.page

Figure 16: The Amphibious House
Source:
https://www.construction21.org/case-studies/h/the-thames-amphibious-house.html

Figure 17: Dry season vs Flooding season
Source: Author's sketch. 2019

Figure 18: Construction analysis
Source:https://www.construction21.org/case-studies/h/the-thames-amphibious-house.html

Figure 19: Building section
Source: Author's sketch. 2019

Figure 20: Village Farm Building
Source: https://www.world-architects.com/en/ddsand-brussels/project/youth-village-farm-lab

Figure 21: Building Section
Source: https://www.world-architects.com/en/ddsand-brussels/project/youth-village-farm-lab

Figure 22: Building Illustrations
Source: https://www.world-architects.com/en/ddsand-brussels/project/youth-village-farm-lab

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xiii. Wojtek Gurak, Floating homes in IJburg, Amsterdam, August 2017, https://psmag.com/environment/are-the-floating-houses-of-the-netherlands-a-solution- against-the-rising-seas.

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xvii. Jacob Shamsian and Chelsea Pineda."The Netherlands is building entire neighborhoods that float on water, December 2015, https://www.businessinsider.com/netherlands-floating-houses-2015-12

xviii. Armsterdam.info, Short history of Netherlands,2003-2019, https://www.amsterdam.info/netherlands/history/

xix. Jacob Shamsian and Chelsea Pineda."The Netherlands is building entire neighborhoods that float on water, December 2015, https://www.businessinsider.com/netherlands-floating-houses-2015-12

YouTube Link

https://www.youtube.com/watch?v=1SM6eZ-QuV8

ADDENDUM

IRENE D. KAPINGA
Miami University

Written Thesis to Design Approach

During summer 2019 I focused on the site selection to better understand the site and its environments to better fit my design requirements.

I initially studied three sites with severe flooding issues, which are showing in the site analysis drawings. After a thorough analysis of all three sites proposed, I had decided to go with the site at Magomeni, because it has more potential like transportation, main bus stop, agriculture activities and the population of the area is highly increasing, and I wanted to consider this as a factor in my design

Therefore, the final design will be one that aids in flood resistance and accommodates the increase of population. Even though the project will be based on flood resistance design, the design will also empower the women who live in that community by introducing indoor farming and provide spaces for women who do handcraft work.

Most of the women in Tanzania are treated as inferior to men to the point that they are not allowed to work. They are expected to stay home and do all domestic activities including cooking for their families, fetching water, and other daily tasks. Some of them are even denied the right to education. Being born a girl in those communities domestic works is seen as preparation for getting ready to marry.

Since women are left at home without income earning jobs, those who live along the Msimbazi river decided to start growing vegetables. In the beginning, they started growing them for their own families, but later, they decided to grow more vegetables for commercial sale.

Due to the high cost of market spaces, they had to organize themselves into groups of 4 or 5 to rent a single market space. Over the years, the number of women has expanded making them a large supplier of the vegetables sold in the markets. Currently, almost more than half of vegetables at Kariakoo market are coming from Msimbazi river. During the rainy /flood season, however, these women cannot grow vegetables anymore, hence, a decrease in vegetable supply for the market.

The above reasons are why I would like to introduce the concept and idea of indoor farming in the community which will allow women to grow their products in any

season. This will also help other women in Tanzania who are not living along the Msimbazi river. They will all get knowledge of indoor farming and they can apply it in their community.

There are other activities that women engage in aside from farming such as handicraft making. As part of the design, they will also get the space to do their work and sell it since some of them are selling it on the street as informal activities known as" Machinga"

The project is also intended to be energy saving. Since electricity in Tanzania is not guaranteed all day, I intend to have most of the equipment and machinery to be operated manually like children's playground for water pumping.

The end design will be divided into three zones, market building (indoor and outdoor), greenhouse building, and residential buildings.

THESIS CRITIC REFLECTION

After the final presentation comments, I believe this project would be a better solution for the people of Mgomeni Dar es Salaam, especially for the women.

Having the open ground floor will help the flow of water go fast which will help the site not experiencing the water for a long period.

Also, I believed the selection of materials was the better solution since concrete is good for water and is cheap in Tanzania. Also, the round columns will help the structure not to break when the pressure of water is high during flooding hence it will allow the water to pass faster compared to square columns.

However, before moving forward, there some stuff that I have to reconsider in my design. From Susan's critic, I will have to rethink the movement of people from market building to the greenhouse during flood seasons.

CONCLUSION

The entire project was challenging and enjoyable at the same time. This project allowed me to learn more about the city of Dar es Salaam and what is the most important thing in life apart from their houses for the people who live in a city.

This project also helped me to explore more my passion of architecture, not only in design but also how I as an Architect see problems in the society which are not the architectural problem, and how can I use my knowledge to solve it and be able to empower people with low-income especially women in the society.

Design Process

PROPOSED SITES

Site One:

Magomeni – Dar es Salaam

- Located in Kinondoni District.
- It is within the urban context
  and has high population growth.
- It is within high density area.
- People lives in the community
  are low income class.

Site Two:

- Magomeni Makuti – Dar es Salaam
- Located in Kinondoni District.
- It is within the urban context.
- It is within high density area.
- People lives in the community are low income classPeople lives in the community
  are low income class.

Site Three:

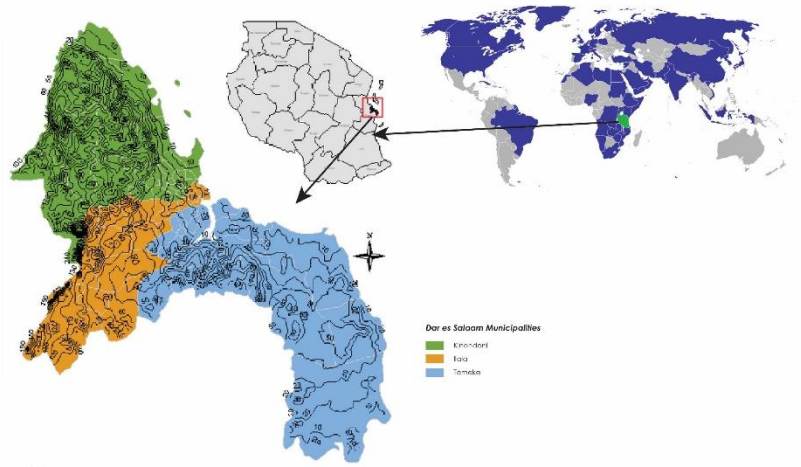
- Jangwani – Dar es Salaam
- Located in Kinondoni District.
- It is within the urban context.
- It is within high density area.
- People lives in the community are low income class and most of them are fisher men community
  are low income class.

INTRODUCTION

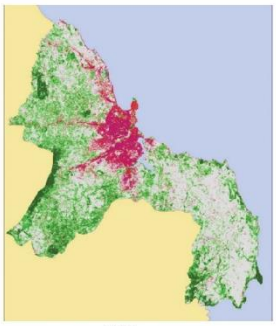
STUDY AREA

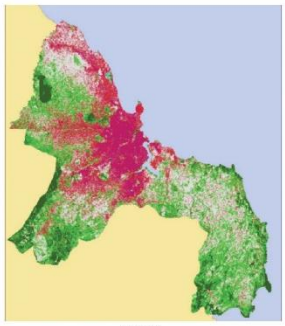
City : Dar es Salaam
Square meter: 1.59 billion msq
Population: 6,368,272 people

Dar es Salaam is a fast-growing region of Tanzania, which leads to a greater challenge to supply planned plots leading to a situation where about 70% of settlements are in unplanned areas. This factored with other surrounding issues increased the vulnerability to climate change effects through rain, most parts of the area have experienced floods in every rainy season.



Popuation Growth


2008


2008

Economics Growth

Commercial BUildings

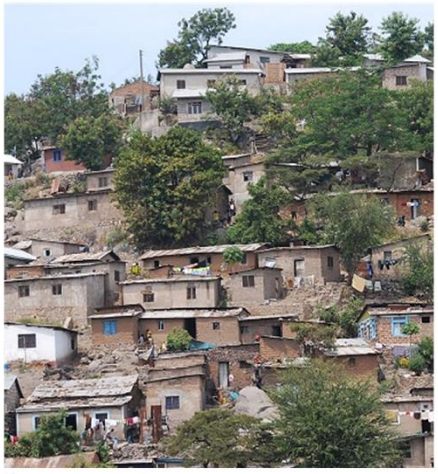

Areal view of the city

THESIS STATEMENT

Since these flood-prone areas are inhabited by many communities with their life highly connected to their environments, like economic activities and social relationships, it has been a problem to relocate communities to other areas where it has reached a stage by which they have opened a case in court opposing eviction from the areas.

RESEARCH QUESTIONS

How can people adapt their family home in flood-prone areas?


Dry season


Rain season

SELECTED SITE

SITE INFORMATION

Existing condition during dry season

Agriculture activities

Morogoro road

Msimbazi river and residential area

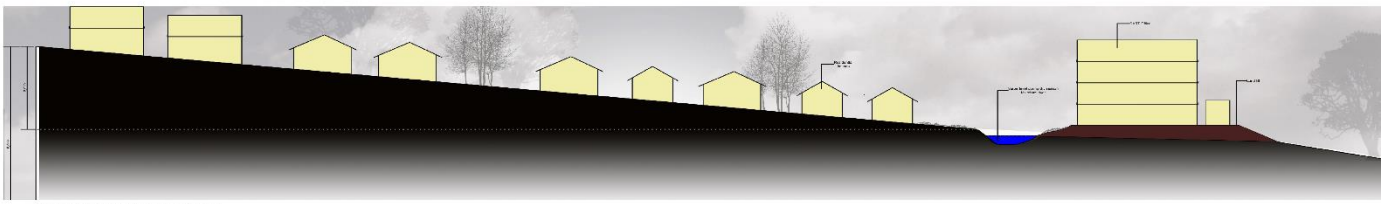
Existing condition during rain season

Residential areas

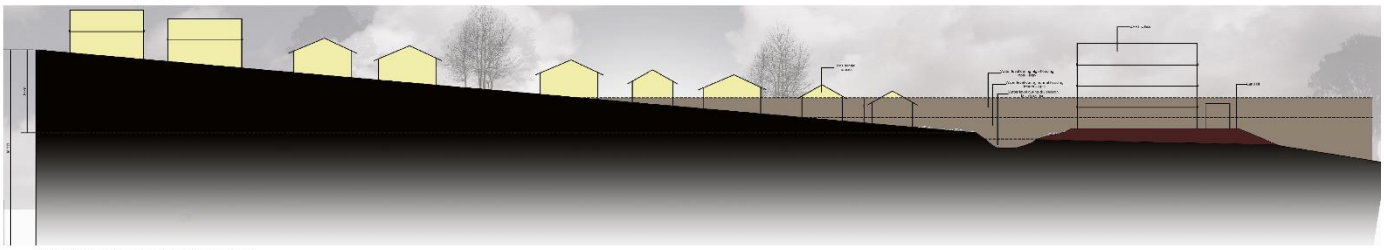
Morogoro road

Bus stop

SITE SECTIONS



Section during dry season



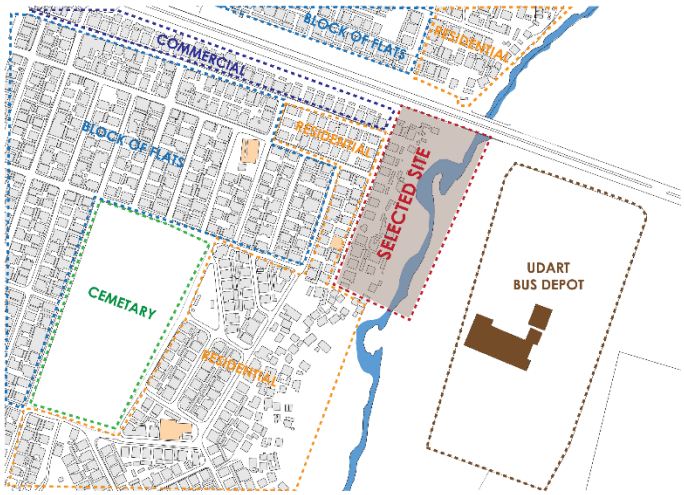
Section during rain season
March - May

Section during rain season
November - December

SITE INFORMATION

SITE DIAGRAMS

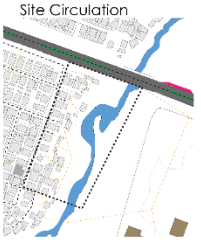
Land Use



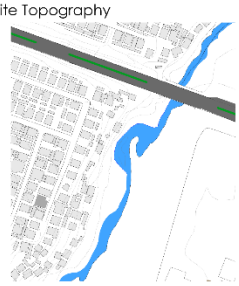
Site Accessibility

Site Vegetation

Site Circulation

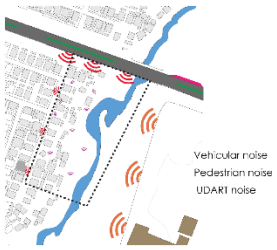


Site Topography



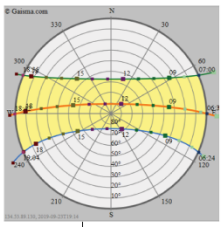
Sun Path

Site Acoustics

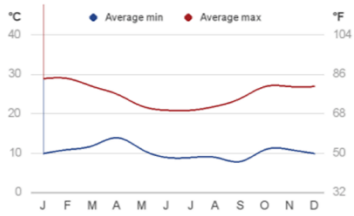


CLIMATE DATA

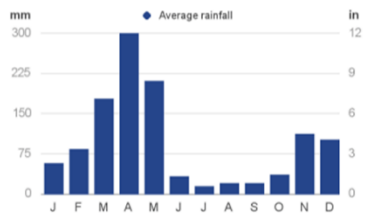
Sun Path



Average Temperature



Average Rainfall



SWOT

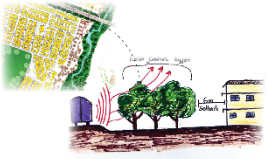
STRENGTHS	WEAKNESS	OPPORTUNITIES	THREATS
- Site is located within the urban contexts. - Site can be accesses easy. - It is surrounded by the river	Too much noises from the Morogoro road. -Site can't be accessed by the vehicle from other sides. Site has high steep slope.	Presence of river and sloping site offers a great landscape and recreational design for the community. -Investor's opportunities for the housing business. -The site will contribute in decreasing the congestion in Morogoro road by making new commercial area there.	Problem in convincing residents of the area to agree their houses to be destroyed and building new ones. -Problem in establishing new area, where people only focusing in the main town.

ANALYSIS OF SITE IMFORMATION

BUFFER ZONE

Due to lack of trees on the site, the place is experiencing a lot of noises especially from Morrogoro road.

By introducing garden buffer will halp to reduce the noises to the area. Also will create the sense of privacy with the site and will also help to reduce soil erosion especially when it raining.



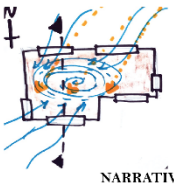
INFORMAL ACTIVITIES

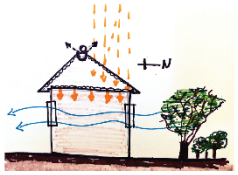
Presence of informal activities such as food vendor and "Machinga" in the site contribute a lot for the congestion especially along Morogoro road.

By providing spaces for them to sell their products in the building with conducive environment will help to reduce congestion at the site.
Also providing space for restaurant will serve as an opportunity of bringing and attracting local and visitors to the site.

SUNPATH AND WIND ANALYSIS

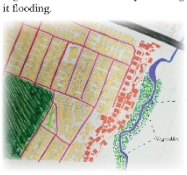
Building Orientation	Building's Shape	Windows	Roofing
The large face of building will be oriented on North-South direction to avoid East and West sun. Also to have all windows facing the prevailing wind, this will help maximize cross ventilation of the rooms. Typically, the north and west sides of the house will provide the most breeze and ventilation.	The design concept will base in courtyard design, this will help to minimize the solar radiation impact from the outside walls by creating a cool, shaded area within the building. It also gives the structure added safety and privacy.	The main windows of a building, for both light and ventilation, should face north and south. Ideally, these windows should have insulated shutters that can be closed in the day and opened up at night.	Roofing made of highly reflective materials, like white metal roofing or white concrete tile roofing, work well to reflect the heat and make the building's occupants comfortable and should also have wide overhangs, ideally half meter wide or wider.





AGRICULTURE ACTIVITIES

The site is also well known for growing vegetables. It contribute almost 50% of vegetables at the food market. But when its raining the amount of vegetables reduced hence they can not grow when it flooding.



By introducing indoor farming to the site will help the women who grow the vegetables to continue growing them even where there is heavy rainfall.

RIVER EXPANSION

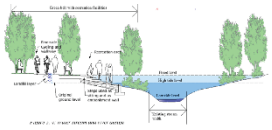
The river is too narrow which contributes alot for flooding when there is heavy rain, this situation cause the slow flow of water in the river.

By expanding the river will increase the flow of water in the river hence reduces amount of water that cause flood at the site.

LANDSCAPE & RECREATIONAL AREA DESIGN

The site has no green areas or recreational areas. Lack of green spaces contribute a lot of soil erosion, and lack of recreational area/ play grounds make the site be not active.

By introducing public green spaces to the site will help protect from soil erosion and also will help people to interact and socialize.



Recreational areas and play ground will also help people to interact. Childre play ground will will also be used as part of water pump to the building from the ground which will be used for the indoor farming. This will help save energy.

NARRATIVES

My name is Asha and I am 36 years old and I am a single mother with 3 kids. Flood has been a huge problem in our place. I must move to my relative twice per year when its flooding. And sometimes I do sleep at the bus stop to take care of my stuff hence people used the flooding as an the opportunity of stealing our furniture and dishes.

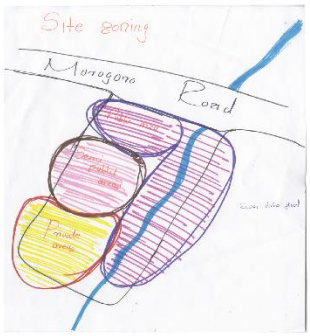
My name is Amina. I am 46 years old, I am married and have 5 kids. I do grow vegetables along the Msimbazi river and that is my only source of income. During flooding season all my crops are washed away with water and I have to wait for another 2-3 months to start growing again.

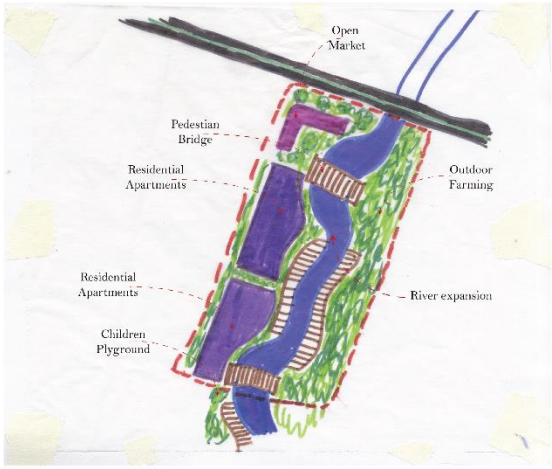
My name is Ali, I am 44 years old. I have lived here for 20 years. I know this place floods a lot twice per year and it is not safe for my life, but it is so close to my office and school for my children. I wouldn't want to move to another area, I am only asking the government to help us to control the flood when it raining.

My name is James, I am 14 years old. I was born in this area and is closed to the city and school. Even if floods but this is a nice place when it not raining, I get a nice view of the city from home and also it is closed to the beach and bust stop.

My name is Anna, I am 29 years old. I was born here and get married here too. My grandparents and my father were buried here, so this land belongs to us and there is no way I will leave. When it is flooding, I go to my relatives and stay there for a few months and come back when it stopped raining. I would like the government to help us to maintain the infrastructures I believe will help to reduce the amount of floods.

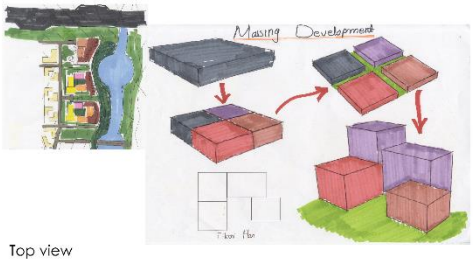
DESIGN DEVELOPMENT - SITE





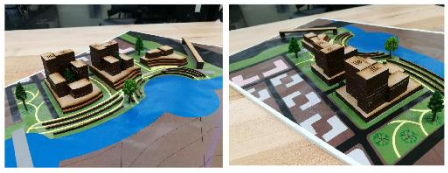
INITIAL IDEAS

CONCEPT ONE



Top view

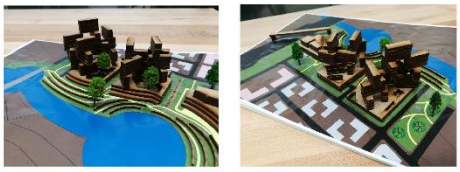
Working models



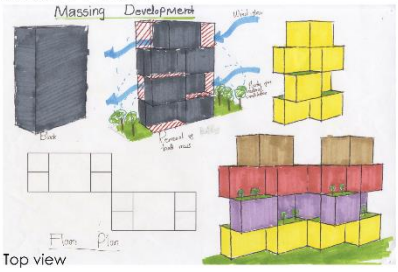
CONCEPT TWO

Top view

Working models



CONCEPT THREE



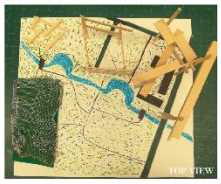
Top view

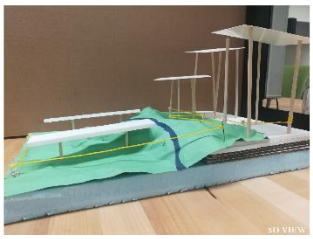
Working models

WORKING MODELS

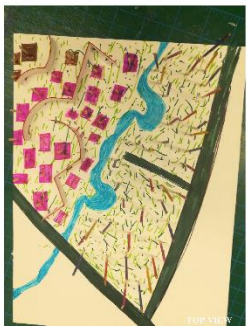
MODELS - SITE

MODELS - COLLAGES

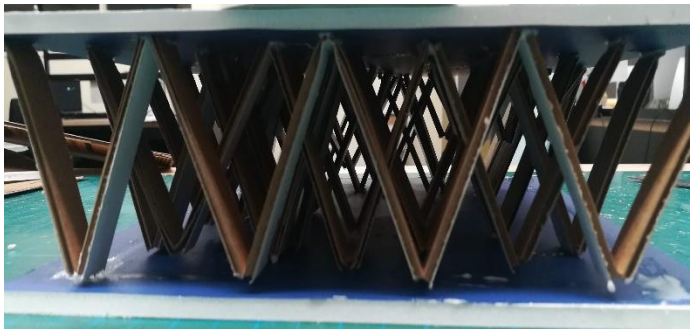


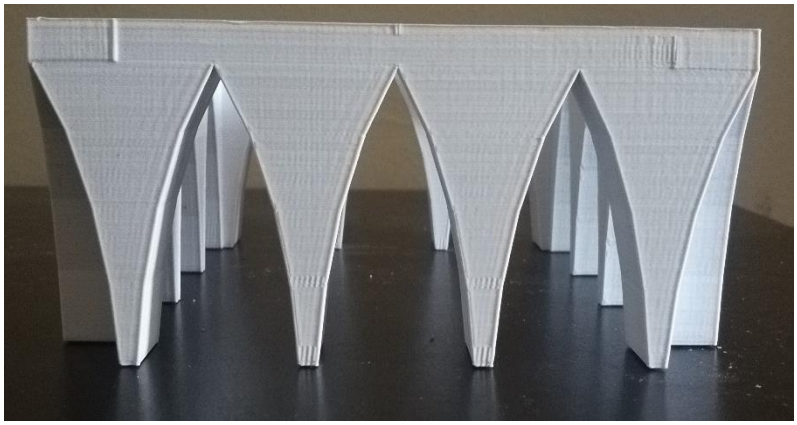


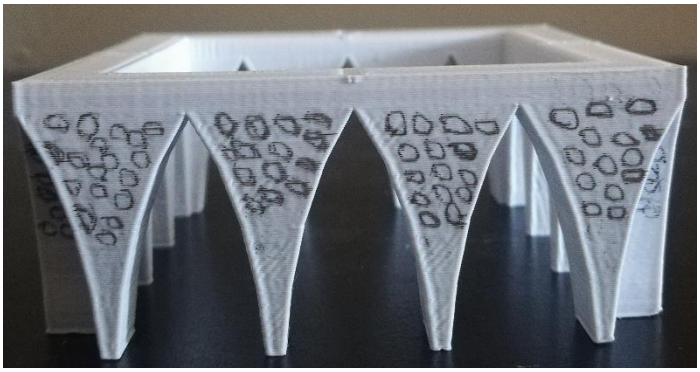
MODELS - COLLAGES



STRUCTURE MODELS







ROGRAMMING

GREEN HOUSE

First Floor
1522.226 sm
16,385.1 sf

Second Floor
951.771 sm
10,244.78 sf

Third Floor
1723.170 sm
18,548.05 sf

Forth - Seventh Floor
945.020 sm
10,172.11 sf

MARKET BUILDING

First Floor
3914.034 sm
42,130.31 sf

Second Floor
2499.357 sm
26.908.99 sf

Third Floor
2,123.159 sm
22,853.49 sf

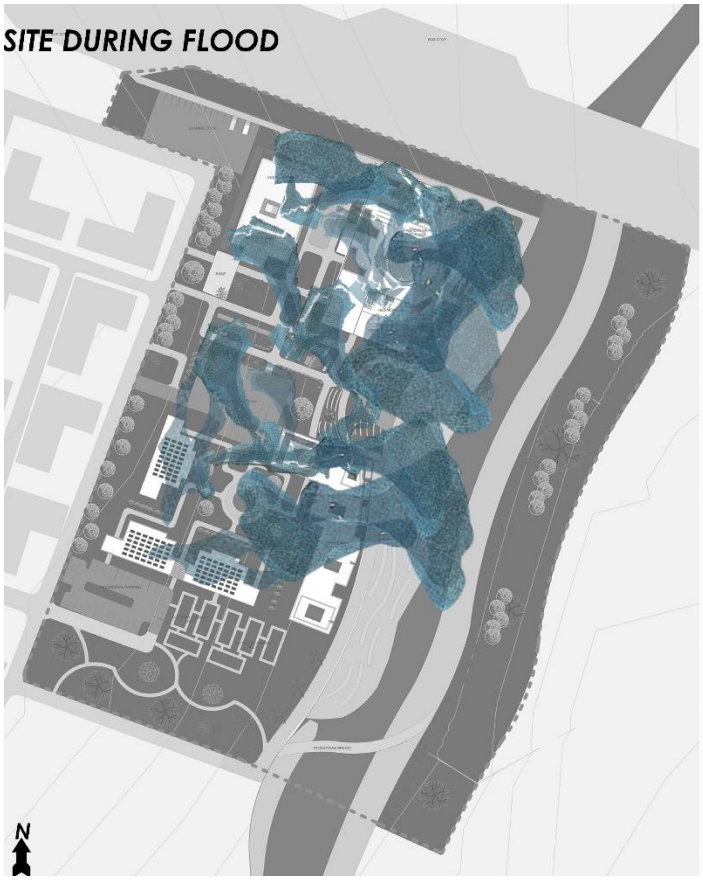
Forth Floor
2,906.374 sm
31,283.95sf

RESIDENTIAL BUILDING

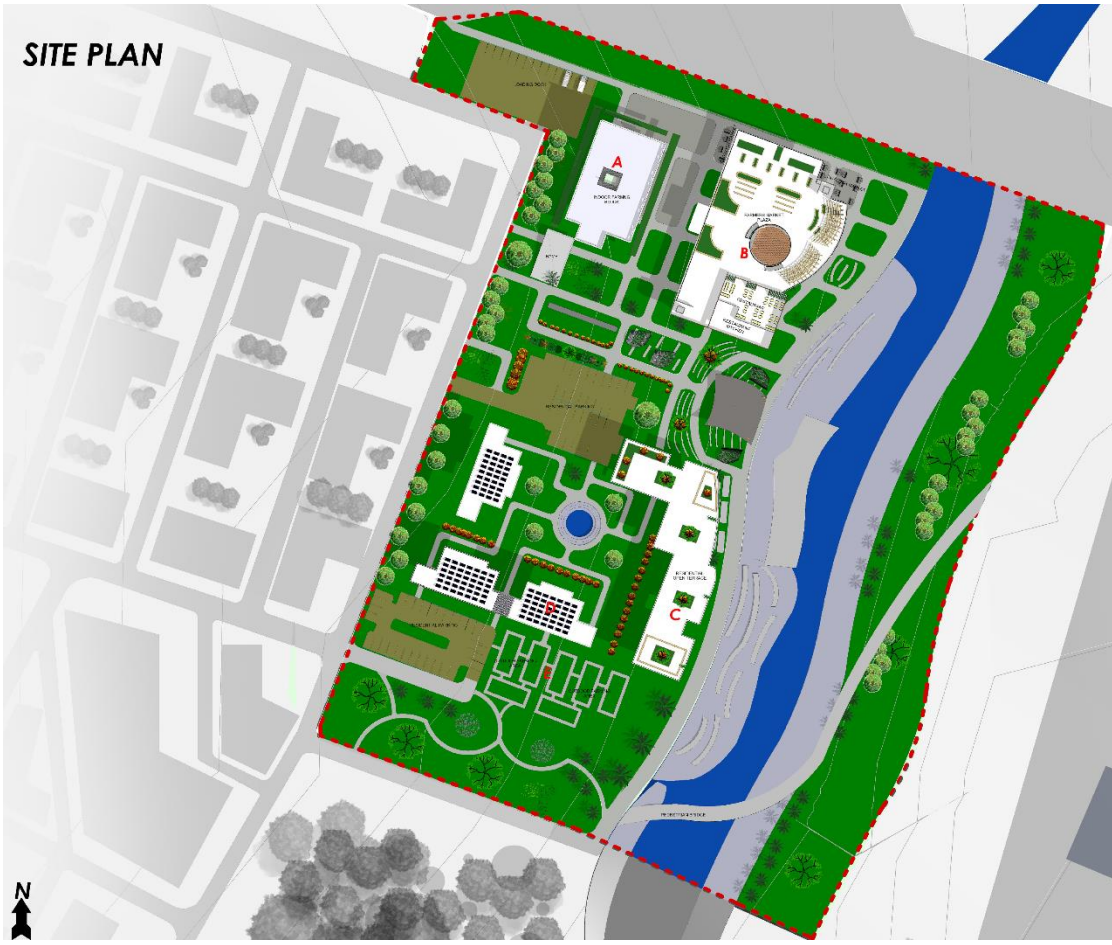
2 Bedroom Apartment
166.732 sm
1,794.688 sf

3 Bedroom Apartment
213.970 sm
2,303.154sf

SELECTED SITE



SITE PLAN



Legend

A
Green House
Vegetables and fruits growth
Livestock farming
Poultry farming
Fish farming

B
Market Building
Indoor market
Shops
Workshops
Restaurant
Market plaza

C
Residential Building
Residential open terrace

D
Residential Building
Residential solar panels

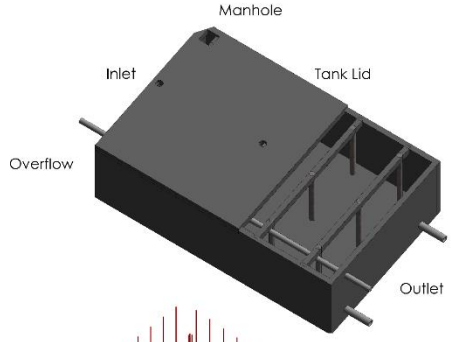
E
Residential Building
Outdoor farming

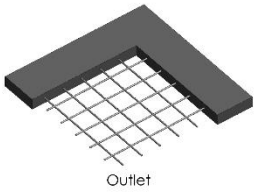
SITE DETAILS

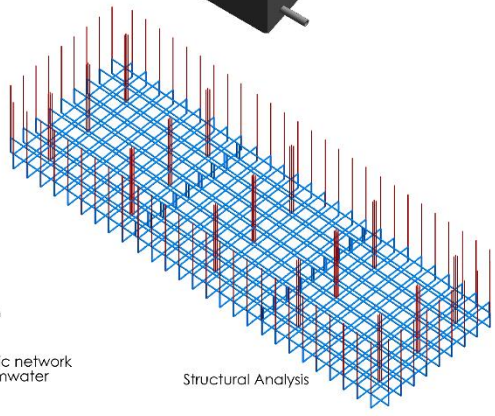
Permeable Pavements

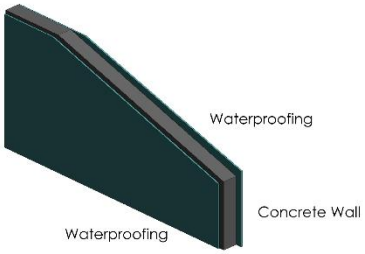
Help to reduce water runoff volume and take some to underground water storage

Underground Water Storage Tank



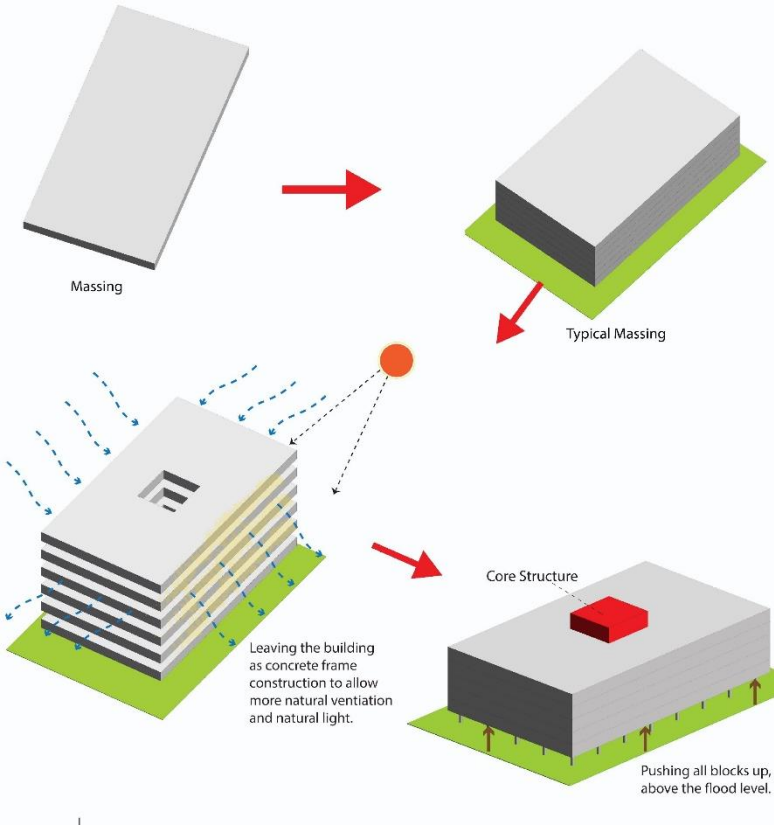




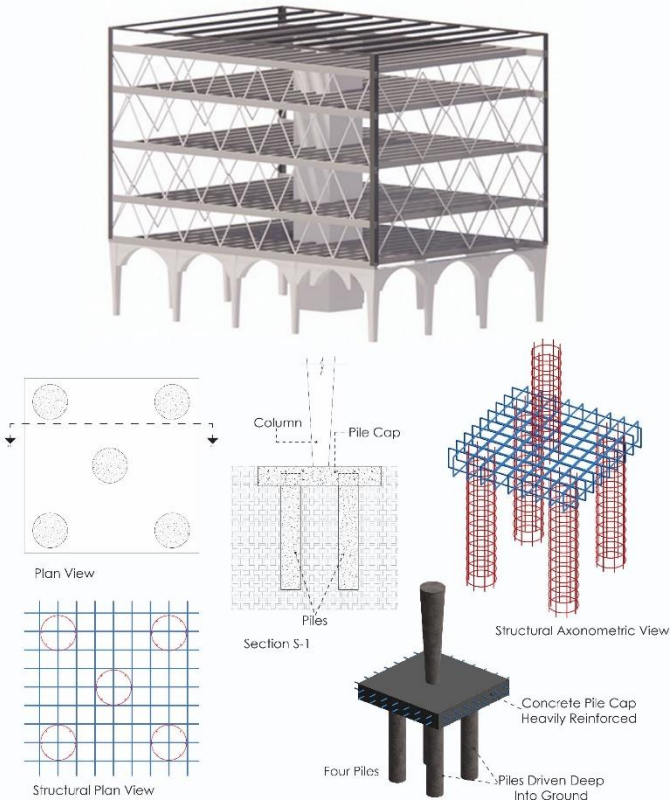


Storm Water collection

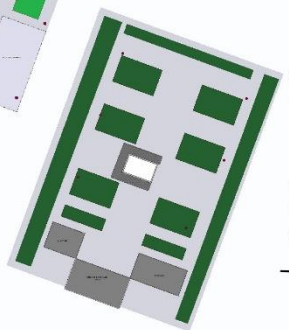
CONCEPT DIAGRAM OF GREEN HOUSE

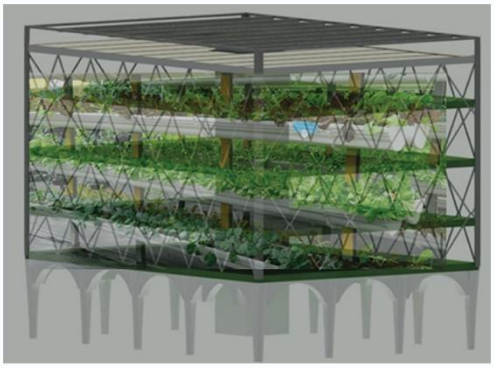


Structural Analysis

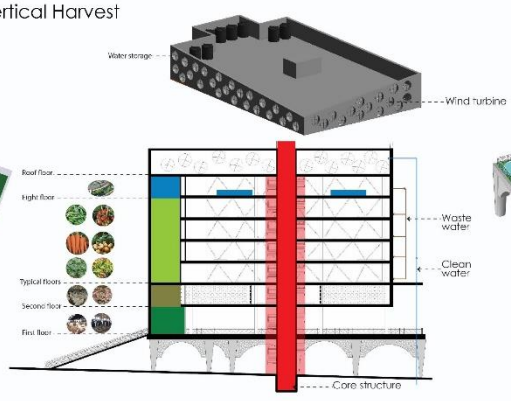


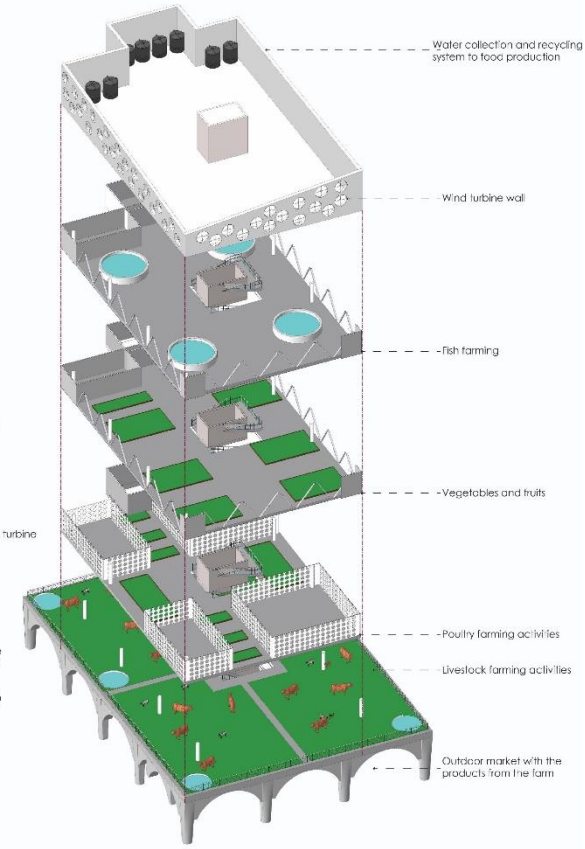
GREEN HOUSE BUILDING





Vertical Harvest





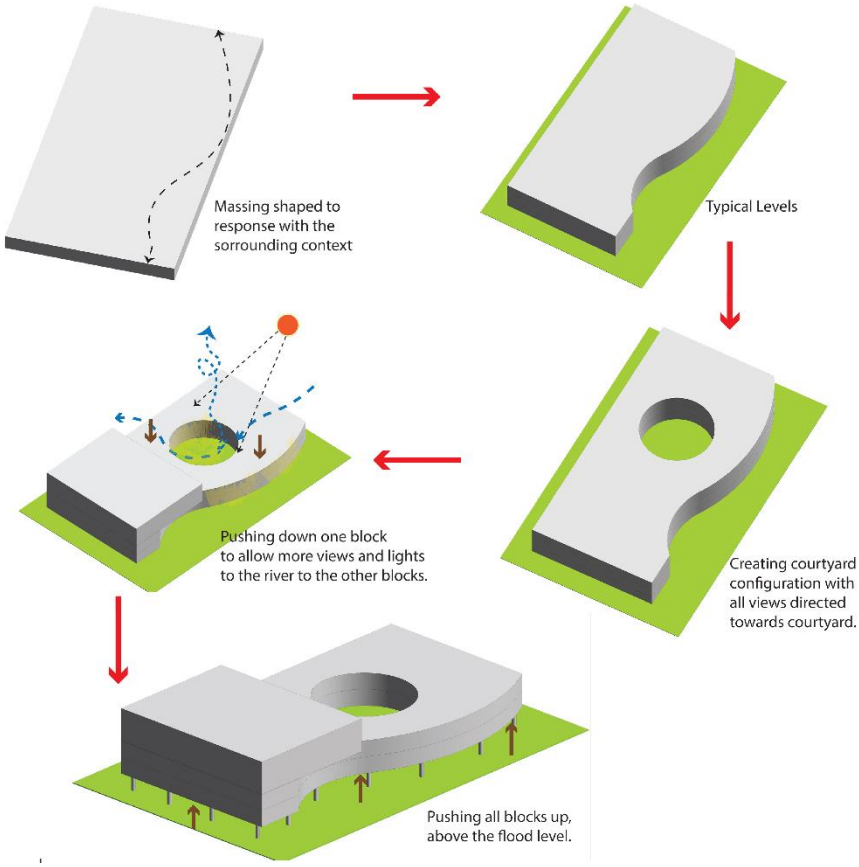
Green House Building

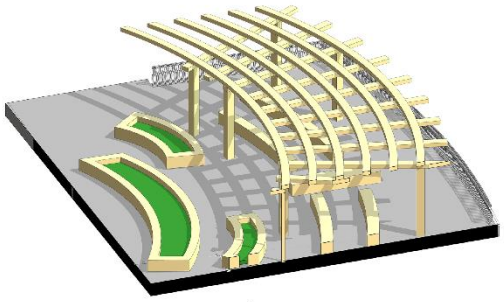
3D view

Green House Building

3D view

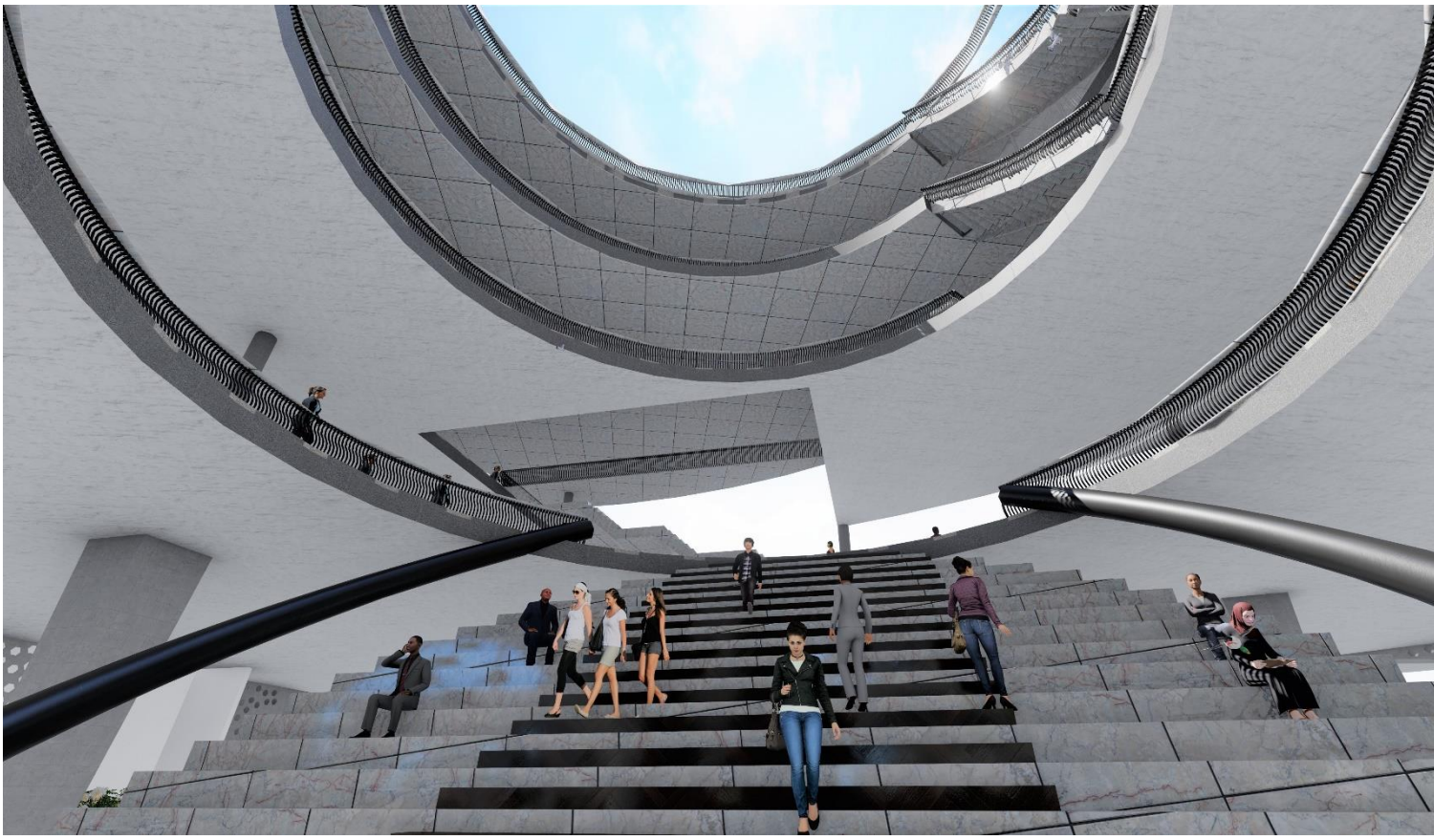
CONCEPT DIAGRAMS OF MARKET BUILDING





Pergola

Section box- Market Building



Interior View

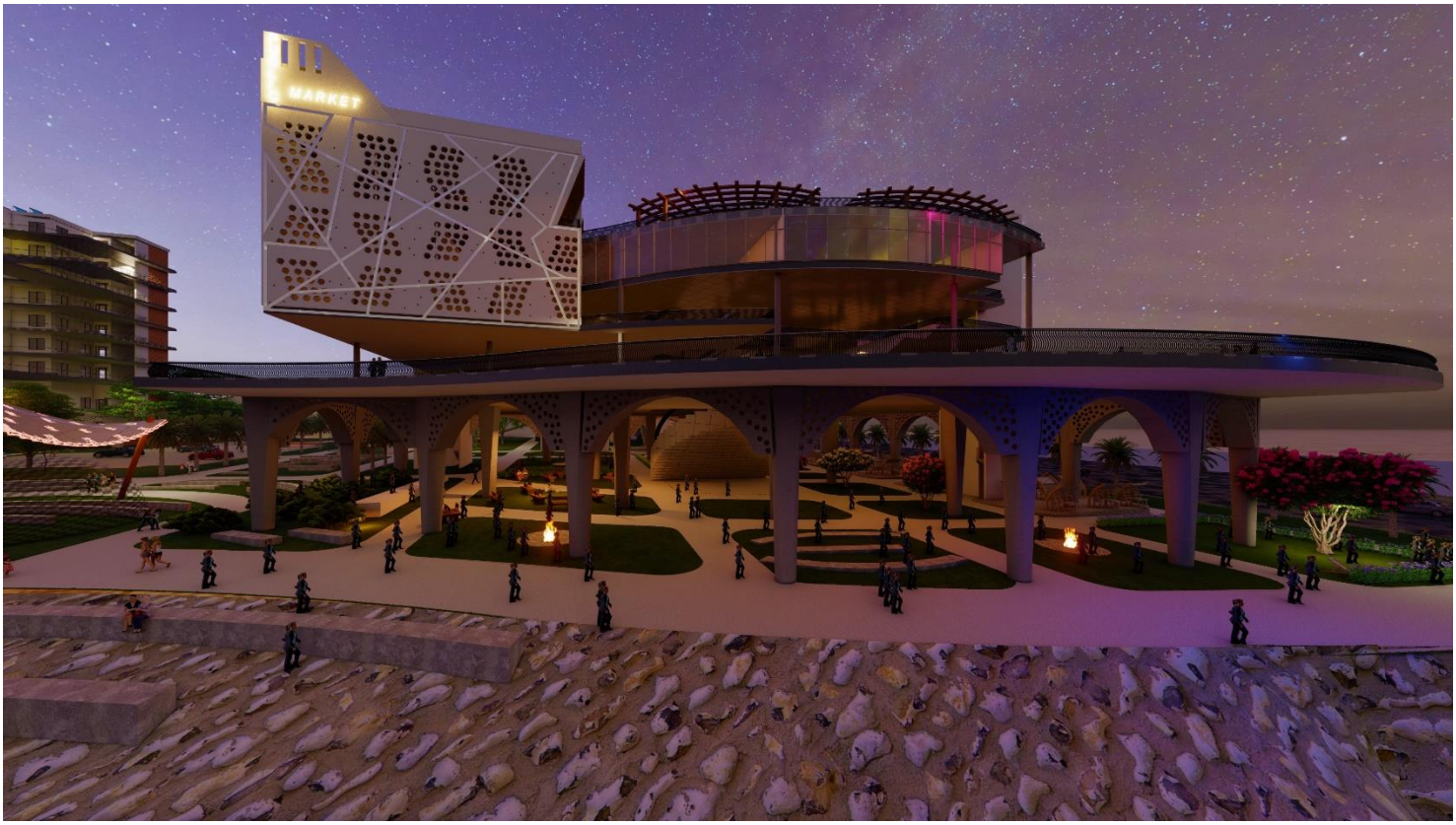
Section 01
During Dry Season

Section 01
During Rain Season

Outdoor Market

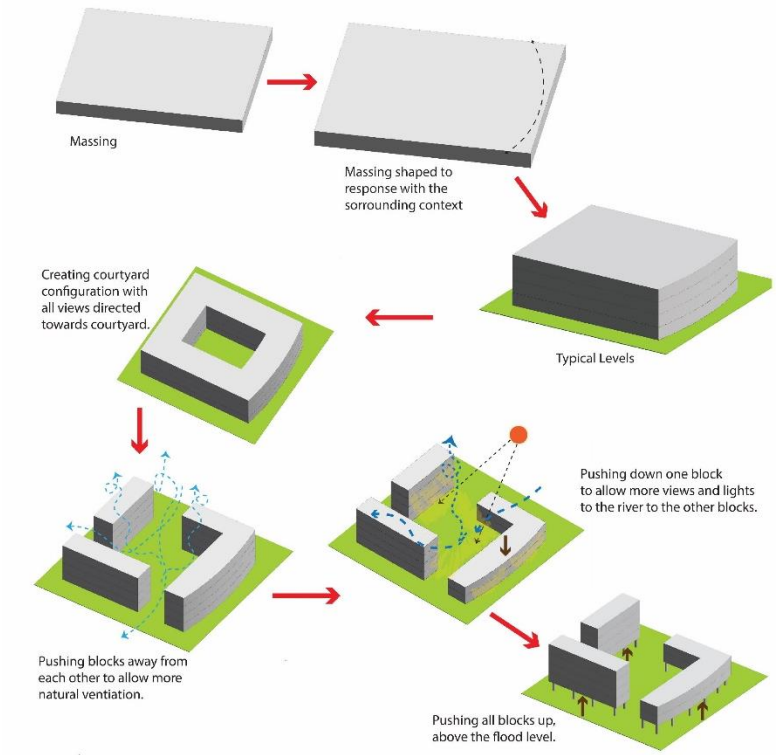
Exterior View

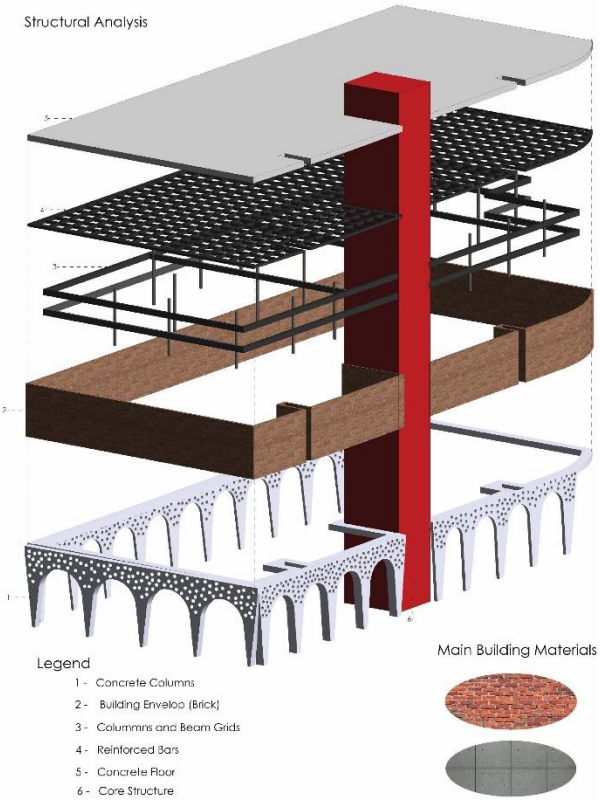
Exterior View During the Day



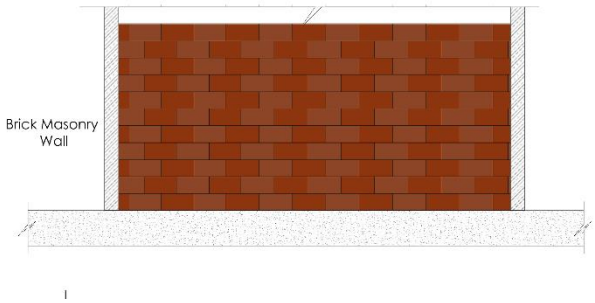
Exterior View at Night

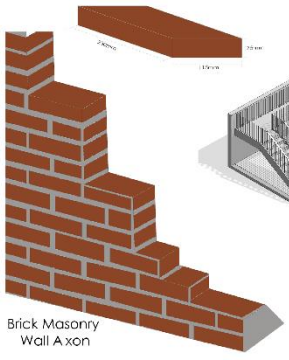
CONCEPT DIAGRAM OF HOUSE





RESIDENTIAL BUILDING





Section 02
During Dry Season

Section 02
During Rain Season

Residential - Entrance

Residential – Interior View

Outdoor Farming

Residential – Garden Area

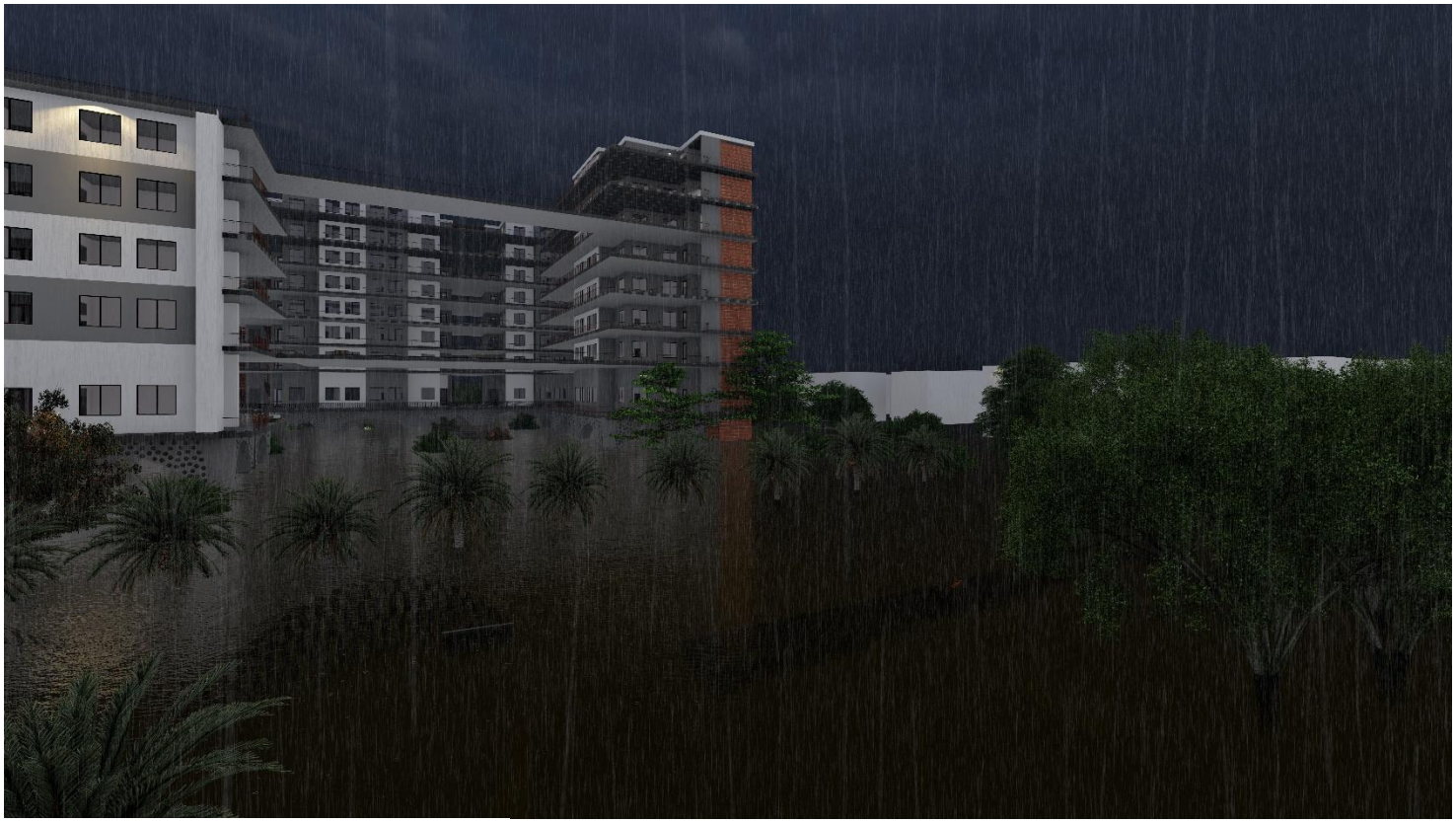
Site - Exterior View

Site – Exterior View

Site - Exterior View in the Evening

Site – Ariel View at Night

Site View – During Flooding



Site View – During Flooding