

RESEARCH CENTRE FOR FLOODS AND SMALL COMMUNITY

Amany Osama Wahba¹, Nader Y. Azab², Khaled Nabil³

^{1,2,3}College of Architecture and Design, Effat University, Qasr Khuzam St., Kilo. 2, Old Mecca Road. P.O. BOX 34689, Jeddah 21478, Saudi Arabia

E-mail: awahba@effatuniversity.edu.sa, naazab@effatuniversity.edu.sa, knabil@effatuniversity.edu.sa

Received: 25.04.2020

Revised: 30.05.2020

Accepted: 20.06.2020

Abstract

Climate change has many effects on the environment and habitat. One of them is sea level rise, which may cause many people to be forced to leave their homes and may be homeless. Therefore, this study proposed a project that mixed-use component to address rising water challenges and the research centre for scientists to test, explore and come up with tangible solutions. Several case studies with similar research center were considered as the fundamental and idea development of the project. The components of the project consists of administration department, accommodation, recreational facilities, restaurants and bars, water sport and facilities, drop zone, health care facilities, commercial, and research centre. The site location of the project is located at North of Recife, Brazil, based on the site evaluation result with the criteria of location, accessibility, shape/ proportional, views, utilities, visibility, size, and environment aspects. The project encourages research on natural disasters, especially for floods and tsunamis.

Keywords--Research Centre, Community, Floods, Tsunamis, Natural Disasters

© 2020 by Advance Scientific Research. This is an open-access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>)
DOI: <http://dx.doi.org/10.31838/jcr.07.08.138>

INTRODUCTION

Climate Change is a hot topic all over the world in the recent years [1]. In line with the IPCC (Intergovernmental Panel on Climate Change), climate change will result in a hotter climate with the associated flooding or water shortages [2]. There are two main mechanisms that cause sea level rise. First, the land ice such as alpine glaciers and polar ice sheets is melts and shrinks, thus releasing water into the ocean. Secondly, as the ocean temperature rises, warm water expands. Water is trapped in a basin surrounded by continents, with nowhere to go, only to flow upward. In some parts of the world, especially low-lying deltas, local land is sinking and sea levels have raised a lot [3]. The consequences of rising sea levels include the risk of coastal communities and infrastructure from storm surges. Saltwater intrusion can lead to groundwater pollution, and also the erosion of stranded beaches, wetlands and engineering structures.

The sea level rise is resulting in a rise of environmental migrants. The United Nations estimates that 20 million people have been forced to relocate due to environmental reasons, and that about 50 million people may do so in the future [4]. People living in poverty and developing countries are 80 times more vulnerable to climate change [5, 6]. In other words, the poorest people lack the means to effectively respond to and recover from extreme weather events. Therefore, they are in an extremely weak position compared to developed countries facing the same challenges. Along with the facts of Brazilian flood history, the proposed project integrates research centers and communities for tsunami research and flood preparation.

CASE STUDIES

This study considered four similar projects for the case studies which has unique concept and creative design. The selected case studies are:

- LILYPAD: Floating City for Climate Change Refugees
- Solar-Powered Floating Island in Seoul, Korea
- Floating Ocean Metropolis
- The Ark

LILYPAD: Floating City for Climate Change Refugees

Lilypad was designed by Vincent Callebaut, and its design concept is a fully self-sufficient floating city designed to provide

shelter for future climate change refugees (Figure 1). The intention of the concept itself is admirable, but Callebaut's extraordinary design attracts our imagination.

Biological imitation is clearly the inspiration behind the design. Designed to look like water lilies, Lilypad aims to become a zero-emission city floating in the ocean. By envisioning multiple technologies, such as solar energy, wind energy, tidal energy and biomass energy, the project will not only be able to generate its own energy, but also be able to process carbon dioxide in the atmosphere and absorb it into the titanium dioxide skin [7].

Each of these floating cities will accommodate approximately 50,000 people. The mixed terrain artificial landscape provided by artificial water and three folds creates a diverse environment for residents. Each Lilypad is intended to be located near the coast, or floating in the ocean, traveling from the equator to the North Sea, depending on the location of the Gulf Stream [7].

Solar-Powered Floating Island in Seoul, Korea

The world's largest floating island and two other islands are designed to be installed on the Han River in Seoul, South Korea (Figure 2). The first-class entertainment center has attracts many audiences. The breathtaking building includes a 700-seat conference hall, restaurant and arcade, all powered by solar energy. After the development is completed, the three islands will be connected by 23 weatherproof chains [8].

The artificial islands in Seoul are different from the common artificial islands in Dubai, which are built by depositing sand on the sea floor. The entertainment center and its attached islands float on the surface of the river and are elastic. The island rises and falls with water level. If the island floats too far from its home due to changes in water level, then a high-tech tracking system will alert the controller. The center is supported by 24 giant airbags and weighs 2,000 tons, but can support up to 6,400 tons of construction facilities. The island will be chained to a 500-ton concrete block to keep it in place. This three-story building has all the facilities, covered with 54 square meters of solar panels, which can produce 6 kilowatts of electricity per day, provide electricity for the facilities, and illuminate the external walls at night [8].

Floating Ocean Metropolis

Floating Ocean Metropolis is designed by CCCC-FHDI & AT Design Office (Figure 3). The AT Design Office has developed a concept of an artificial floating island that can be inhabited at sea. Commissioned by the Chinese construction company CCCC, the AT Design Office used prefabricated hexagonal modules and designed the floating city built with prefabricated hexagonal modules using the same technology that CCCC used to build a 31-mile bridge between Hong Kong, Macau and Zhuhai [9].

It is foreseeable that the modules used to construct the island will be prefabricated in the factory and then floated to the site. According to the AT Design Office, the four-square-mile metropolis will achieve zero carbon emissions, be self-sustaining, and help combat the environmental impact of urbanization in major regions. The island will include vertical farms and fish farms that produce their own food, as well as garbage facilities for sustainable disposal of their own waste. Residential, commercial and entertainment infrastructure will be located above and below the water surface, while an underground tunnel system will establish a network of roads and sidewalks between buildings and islands [9].

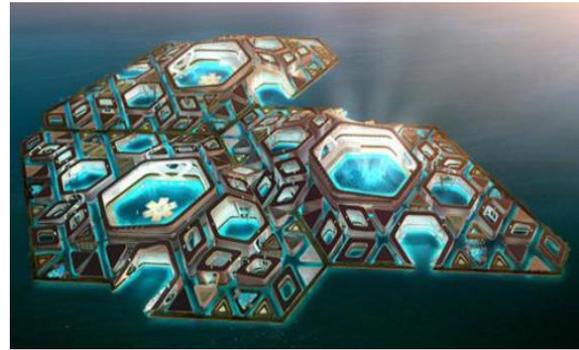


Figure 3. Floating Ocean Metropolis [9]

The Ark

The ark is a prototype of the Russian architect Alexander Remizov. He believes that a water structure that can accommodate 10,000 people will become a model for future life (Figure 4). The ark is made of wood, steel and sturdy ETFE plastic, which can adapt to all environments. The ark can be used for many purposes (including accommodation in emergencies and as a hotel) with high efficiency. Remizov believes that this structure can quickly build potentially floating facilities and is also a settlement that does not pollute the environment [10].



Figure 4. The Ark [10]

He and his colleague Lev Britvinom solved the electricity problem by installing a wind turbine in the center of the building, which was covered with solar panels on the outside. Remizev said that if the building is on the water, the thermal energy of the water can be used. Although it is a prototype, Remizov believes that the "Ark" can be used for various purposes, including apartments, offices and hotels, and can accommodate up to 10,000 people [10].

SPACE PROGRAM

There are nine main zones proposed in this project and Table 1 tabulates the space program of the project. Two types of accommodation are considered in this project, which area house and apartment. The recreational facilities dominated the biggest percentage about 24.5%, its include culture exchange culture, parks and gardens, sports facilities and public areas, spa and salon, and gym facilities (male and female). The water sport facilities include diving center, outdoor sports and aqua events. The drop zone consists of car parking lots and docks. The health care facilities include clinic and vet. Commercial zone consists of international conventional center, shops and super markets.



Figure 1. LILYPAD: Floating City for Climate Change Refugees [7]



Figure 2. Solar-Powered Floating Island in Seoul, Korea [8]

Table 1. Space program

| Zones | Use Percentage (%) | Gross Floor Area (GFA) (m ²) |
|----------------------------|--------------------|--|
| Administration Department | 1.5 | 600 |
| Accommodation | 21.6 | 8800 |
| Recreational Facilities | 24.5 | 10000 |
| Restaurants and Bars | 11.0 | 4500 |
| Water Sport and Facilities | 8.8 | 3600 |
| Drop Zone | 3.7 | 1500 |
| Health Care Facilities | 1.9 | 780 |
| Commercial | 12.3 | 5000 |
| Research Centre | 14.7 | 6000 |
| Total | 100 | 40780 |

SITE SELECTION AND ANALYSIS

There are four sites that are proposed for the site location of the project. Figure 5 shows site 1 can be accessed through a highway called Av. Engenheiro Antonio de Goes. The docks are located near the site, so this can also be easily access. It's even near the Recife International Airport. Figure 6 shows site 2 is located in

the open sea area, which near the sea ports, between two natural rocky docks. It's very far from the beach's coastline and the city, so it can be less noisy and provides a good sea views from all directions. Figure 7 shows site 3 is also located in the open sea area but it is near the docks containing boats, and it is even near the long high-way which will also facilitate accessibility. It's also located near the row of houses. Figure 8 shows site 4 is located near two separated islands, which near the docks, near site 1 and also it is surrounded by compacted residential houses and hotels near the coastline and in the middle.

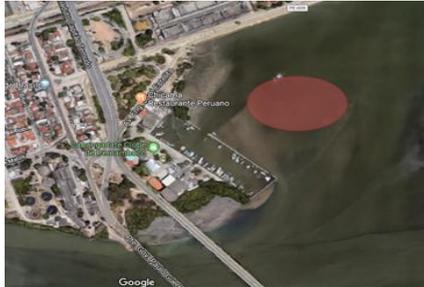


Figure 5. Site 1 [11]



Figure 6. Site 2 [12]

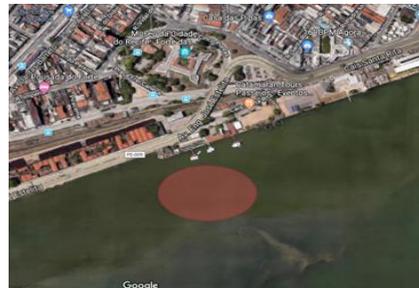


Figure 7. Site 3 [13]



Figure 8. Site 4 [14]

Several site evaluation criteria are considered for site selection namely location, accessibility, shape/ proportional, views, utilities, visibility, size, and environment aspects. Each criterion are assigned with a weighting factor, where 1 is not very important, 2 is somehow important and 3 is very important. The site evaluation result is tabulated in Table 2.

The site location should be located on the sea since part of it will be floating, preferable near the coastline. It's also desirable to have water approximately from all around the site or it can be surrounded by beautiful views or main landmarks to attract more tourists for example famous parks or beaches that are already located near the coastline. Furthermore, this project will benefit more if it's near the hazardous areas that are prone to floods for testing purposes. Especially if there are already buildings or residential areas near the coastlines that are at greater risk of flooding or getting damaged.

The site should be able to have an easy accessibility in order to make it easier for tourists to find it easily or in case of emergency it can be accessed without causing havoc or overcrowding, so near docks might be a good idea. Near the airport can also be a crucial point in this project.

Sites with rectangular in shape are usually easiest to plan, but in this case the site is likely to go horizontally along the coastline to have a maximum sea view; a site that have the characteristic and atmosphere of islands. On the other hand, it can also be designed in an organic form and it can also capture good views in a 360 degree.

The main view is the sea, but it must take into consideration how to manipulate the wanted views and avoid the unwanted views, the bad odours and noisy areas.

The presence of electrical, water, sewer and other services should be made possible using sustainable or green techniques, like the water thermal energy, solar panels for sun energy and of course wind turbines for wind energy and finally the use of technology in controlling the magnetic field in the sea to help facilitate slight movements from these islands.

The project should act as a landmark in order to alert people whether it's for entertainment purpose or when flooding emergency happens so it can be easily found. The project will be huge in size.

The site of the land should not be less than 40,000 sqm to fit all the requirements, and the maximum area to contain such a project keeping in mind the capacity of people not less than 5000, so the maximum square meter area for this project will be around 35,000 to 45,000 sqm.

The site is desirable to be surrounded by the natural environment, and have multiple levels to enhance the visibility and provide more spaces for the occupants. Furthermore, it must take in consideration that noise pollution is unwanted as well as for air, water and earth pollutions. Therefore, sustainable aspects will be induced into this project to make it self-sufficient in terms of energy and cost.

Table 2. Site evaluation

| Site criteria | Weighting Factor | Maximum Score | Site 1 | Site 2 | Site 3 | Site 4 |
|---------------------|------------------|---------------|-----------|-----------|-----------|-----------|
| Location | 3 | 15 | 13 | 12 | 14 | 15 |
| Accessibility | 3 | 15 | 13 | 10 | 13 | 14 |
| Shape/ Proportional | 1 | 5 | 5 | 5 | 5 | 5 |
| Views | 2 | 10 | 6 | 8 | 8 | 9 |
| Utilities | 2 | 10 | 7 | 8 | 8 | 9 |
| Visibility | 3 | 5 | 3 | 5 | 5 | 5 |
| Size | 3 | 15 | 15 | 15 | 15 | 15 |
| Environment Aspects | 3 | 10 | 7 | 8 | 7 | 10 |
| Total | | 85 | 69 | 71 | 75 | 82 |

Based on the site evaluation result shown in Table 2, the selected site location for the project is Site 4. This site is located near two separated islands, so in terms of accessibility it can be accessed through water or main roads. This site is also near site 1 which means the International Recife Airport is still near. The site is surrounded by compacted residential houses and hotels near the coastline that are prone to flooding. In terms of location and visibility, it is in the centre of the sea between two coastlines that are separated by a famous bridged highway. It is perfect since it can be visible from far away and can be easily accessed as well.

PROJECT DESIGN

The design concept of this project is UNITY where it integrates the elements of nature, multiculturalism and modernism together. Regarding sustainable methods, permeable pavements can be used in conjunction with underground drainage systems to slow down runoff and reduce the pressure on sewer systems. The second is the high-albedo pavement, which reduces the urban heat island effect. This reduces the cost of cooling, helps the survival of urban vegetation, and improves air quality, which can help alleviate the symptoms of certain respiratory diseases. Similarly, recycled concrete aggregates can be used in concrete mixtures or as the basis for paving. In order to achieve energy-saving effects, the lamps that meet the dark sky are specially designed to guide the light downwards and focus the light where needed. In addition, solar panels were used in collecting energy as well. Thermal and energy from waves were used to produce electricity too. Figure 9 and Figure 10 demonstrate the site plan and main perspective view of the project respectively. Figure 11, Figure 12 and Figure 13 show the view of culture exchange centre, small international convention centre and research centre respectively. There are two kind of accommodation which shown in Figure 14 and Figure 15. Lastly, Figure 16 shows the water Sport Facilities Small Centre.

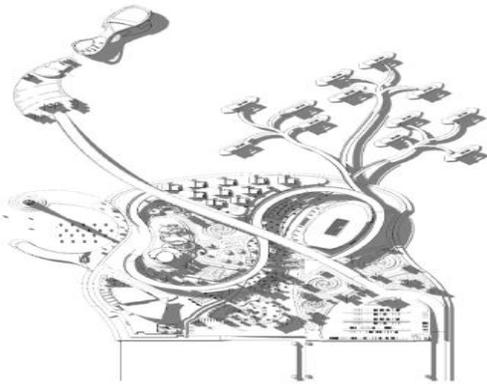


Figure 9. Site plan

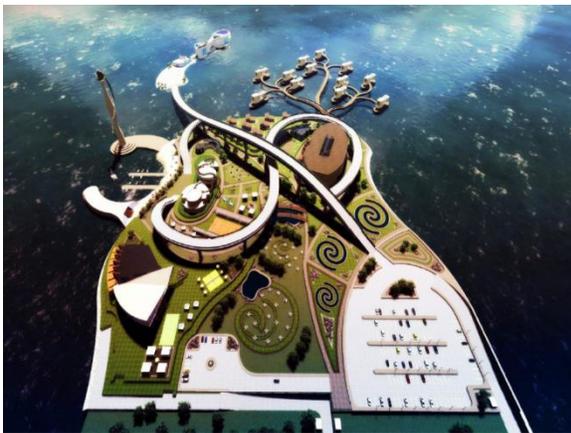


Figure 10. Main perspective view of the project



Figure 11. Culture Exchange Centre



Figure 12. Small International Convention Centre

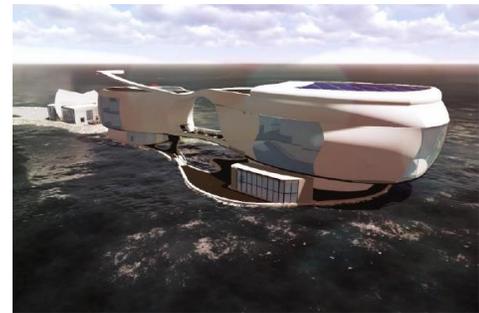


Figure 13. Research Centre



Figure 14. Residential Type A



Figure 15. Residential Type B



Figure 16. Water Sport Facilities Small Centre

CONCLUSION

This proposed research centre and community emphasizes the tsunami research and preparation in response to the many flooding history and also the recent flooding in Brazil. The research center and community consists of various components and the space program covered administration department, accommodation, recreational facilities, restaurants and bars, water sport and facilities, drop zone, health care facilities, commercial, and research centre. The site location of the project is located at North of Recife, Brazil. The considered evaluation criteria are location, accessibility, shape/ proportional, views, utilities, visibility, size, and environment aspects. Moreover, the proposed project enables the scientists to study, research and interpret the developments and forces of tsunami waves.

REFERENCES

1. Friend D. Climate Change- A Hot Topic [Internet]. The Source. 2019 [cited 27 June 2019]. Available from: <http://the-source.net/climate-change-hot-topic/>
2. The Impact of Climate Change on Water Resources [Internet]. Water Footprint Calculator. 2018 [cited 27 June 2019]. Available from: <https://www.watercalculator.org/water-use/climate-change-water-resources/>
3. K. Willis J, Kemp A, H. Strauss B. Sea Level Rise [Internet]. Smithsonian Ocean. 2018 [cited 27 June 2019]. Available from: <https://ocean.si.edu/through-time/ancient-seas/sea-level-rise>
4. International Migration Report 2017 [Internet]. Un.org. 2017 [cited 27 June 2019]. Available from: https://www.un.org/en/development/desa/population/migration/publications/migrationreport/docs/MigrationReport2017_Highlights.pdf
5. Barbier E, Hochard J. The Impacts of Climate Change on the Poor in Disadvantaged Regions. Review of Environmental Economics and Policy. 2018;12(1):26-47.
6. Levy B, Patz J. Climate Change, Human Rights, and Social Justice. Annals of Global Health. 2015;81(3):310.
7. Paul R. LILYPAD: Floating City for Climate Change Refugees [Internet]. Inhabitat.com. 2008 [cited 27 June 2019]. Available from: <https://inhabitat.com/lilypad-floating-cities-in-the-age-of-global-warming/>
8. Zimmer L. World's First Solar-Powered Floating Island Opens in Seoul! [Internet]. Inhabitat.com. 2011 [cited 27 June 2019]. Available from: <https://inhabitat.com/worlds-first-solar-powered-floating-island-opens-in-seoul/>
9. Frearson A. Floating City concept by AT Design Office features underwater roads [Internet]. Dezeen. 2014 [cited 27 June 2019]. Available from: <https://www.dezeen.com/2014/05/13/floating-city-at-design-office/>
10. Yoneda Y. Remistudio's Massive Floating Ark Battles Rising Tides [Internet]. Inhabitat.com. 2014 [cited 27 June 2019]. Available from: <https://inhabitat.com/remistudios-massive-ark-building-can-save-residents-from-flood/>
11. Google Maps [Internet]. Google Maps. 2019 [cited 24 June

- 2019]. Available from: <https://www.google.com/maps/place/8%C2%B004'43.5%22S+34%C2%B053'19.2%22W/@-8.0787467,-34.8908427,738m/data=!3m2!1e3!4b1!4m14!1m7!3m6!1s0x7ab196f88c446e5:0x3c9ef52922447fd4!2sRecife++State+of+Pernambuco,+Brazil!3b1!8m2!3d-8.0522404!4d-34.9286096!3m5!1s0x0:0x0!7e2!8m2!3d-8.0787515!4d-34.888654>
12. Google Maps [Internet]. Google Maps. 2019 [cited 24 June 2019]. Available from: <https://www.google.com/maps/place/8%C2%B003'02.5%22S+34%C2%B051'24.3%22W/@-8.0506867,-34.8589467,738m/data=!3m2!1e3!4b1!4m14!1m7!3m6!1s0x7ab196f88c446e5:0x3c9ef52922447fd4!2sRecife++State+of+Pernambuco,+Brazil!3b1!8m2!3d-8.0522404!4d-34.9286096!3m5!1s0x0:0x0!7e2!8m2!3d-8.0506916!4d-34.8567578>
13. Google Maps [Internet]. Google Maps. 2019 [cited 24 June 2019]. Available from: <https://www.google.com/maps/place/8%C2%B004'28.4%22S+34%C2%B052'51.5%22W/@-8.0745597,-34.8831547,738m/data=!3m2!1e3!4b1!4m14!1m7!3m6!1s0x7ab196f88c446e5:0x3c9ef52922447fd4!2sRecife++State+of+Pernambuco,+Brazil!3b1!8m2!3d-8.0522404!4d-34.9286096!3m5!1s0x0:0x0!7e2!8m2!3d-8.074565!4d-34.8809664>
14. Google Maps [Internet]. Google Maps. 2019 [cited 24 June 2019]. Available from: <https://www.google.com/maps/place/7%C2%B050'27.2%22S+34%C2%B050'21.4%22W/@-7.8408962,-34.841258,668m/data=!3m2!1e3!4b1!4m14!1m7!3m6!1s0x7ab406c8ff571e5:0xa803dba4444e8ae8!2sR.+Anchovas++Maria+Farinha,+Paulista++PE,+Brazil!3b1!8m2!3d-7.8452209!4d-34.8386654!3m5!1s0x0:0x0!7e2!8m2!3d-7.8409009!4d-34.8392797>