Floating Neighbourhood to anticipate Jakarta Flooding

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Abstract. The purpose of this paper is to offer alternative design solutions for the Kampung Muara Baru residence in Jakarta. Rapid groundwater extraction, population growth, infrastructure and construction development is causing land subsidence at an alarming rate. Thus, the capital city of Indonesia is on constant alert of potential flooding. Jakarta municipal government set policies under the Jakarta Coastal Defence Strategy to mitigate flood and urban planning. One of the major acts is the construction of the giant sea wall along the northern coast of Jakarta. However, the already built sea wall structure is showing signs of failing and cracking because the subsidence continues. In the meantime, report is saying the residence of Muara Baru still continue to experience flooding. The residents still have to raise the structure of their houses anyway possible to cope with the raising of the flood level. The finding suggests that vernacular, under the umbrella of sustainable and environmentally friendly (green design) should be considered as a better strategy towards the flooding disaster as it embraces nature to solve environmental issues and degradation.

1. Introduction
Jakarta, Indonesia capital city, just recently experienced major flooding on January 1st, 2020. The same torrential rainfall that caused similar major flooding also happened in February of 2007 that flooded 60% of Jakarta and displaced as many as 500,000 people. [1].

Due to the land subsidence and the raising of sea level as a result of recent climate change, Jakarta is under constant risk of flooding. The capital city of Indonesia, is experiencing land subsidence in an alarming rate of 1 to 28 cm per year within period of 1997 to 2011 [2]. Abidin adds that the major contributors to the land subsidence are rapid groundwater extraction, population growth, infrastructure and construction development, and tectonic activity. Andreas Heri from Bandung Institute of Technology (ITB) has been studied the Jakarta Land Subsidence. Heri predicts that if the pattern continues, 95% of northern part of Jakarta will be submerge by 2050 [3]. Global environment issue, such as global warming, does not necessarily helpful because it causes the sea-level to increase.

The Government formed the Jakarta Coastal Defense Strategy (JCDS) to mitigate the flooding and urban planning of the city. Under JCDS, the one of the major projects is to build a giant sea wall along the Jakarta Bay shoreline. The first phase of the major project is to reinforced the current Jakarta’s flood prevention wall. The next and final project is a combined effort to build a deep-sea wall called the Great Garuda wall. The project is in question because the current temporary dyke that was built to protect northern coastal of Jakarta does not do much to prevent the flood as the city continue to subside. One of Jakarta historical landmark, The Syahbandar Tower is leaning (about 5º) due to the sinking foundation structure. The Dyke itself has been in constant repair for cracking and sea water penetrates into the resident’s area. Dodo Gunawan, Chief of Center for Climate Change, Meteorological, Climatological,
and Geophysical Agency (BMKG) stated that the prediction of Jakarta is sinking is real based rate of sea level increase. Certain areas are predicted to be permanently submerged [4].

The following year, the same publication also covers the Jakarta land subsidence issue. Deutche Welle (DW), a German Public broadcast Service covers Jakarta land subsidence in the following year of 2019. The current dyke in Northern part of Jakarta (Muara Baru area) was built in 2002. Ever since it has been built, the dyke is constantly reinforced and raised to keep the sea water overflows into the residential area.

Muara Baru in North Jakarta is located in the area higher sinking rate. The dense residential area has been with living in a permanent condition of below sea level and the land has been subsided 4 meters between 1974 to 2010, which is in the rate faster than Venesia, Italy and Tokyo, Japan. Mr. Safroi, residence of the Muara Baru mentioned that he had risen his house twice (50cm each) as he told BBC that the flood level is just getting higher. Jakarta Fish Market and auction (Pasar Ikan) was also renovated and built 5 years ago. Today the floor slab and foundation is showing a large gap due to the sinking land (Figure 2) [5].

![Figure 1](https://example.com/image1.png)  
**Figure 1.** Color chart indicates the rapid subsidence within Jakarta metropolitan area.  
*Source: Geodesy Research Group, FITB-Bandung.*

![Figure 2](https://example.com/image2.png)  
**Figure 2.** The New Pasar Ikan foundation wall  
*Source: cknet-ina.org, 2019*

Reviewing the explanation of the current coverage. The Giant project of the Garuda Wall or Land reclamation will not reverse the condition of Muara Baru. The major project will become human intervention of the ecosystem of a massive scale. It will tip the balance of many aspect, environmentally, socially, and economically.

The Great Garuda project is not based on a feasible reality. Neither the deep-sea wall or any other land reclamation project fixed the deep root of the main cause of the sinking land. The project will
become an environmental disaster as it will destroy the ecosystem. It require enormous amount of natural materials such as boulders, concrete, aggregate, and sand, while the current private development of northern coastal of Jakarta already consumed fast amount of these resources, especially sand [6, p. 159].

The deep sea wall along with the land reclamation that comes as part of the grand design will significantly alter and degrade the already fragile environment of coastal Jakarta. The presence of artificial islands will change sea currents, which can lead to the erosion of nearby natural islands or even more flooding of the city. The mega project will also affect the have to go further out to sea to fish, increasing their gasoline expenses. Water salinity will also be affected as the seawater cannot get into the shore line while the fresh water will be keep coming in out of the Ciliwung Delta. Many sea water species will have to migrate and the mangrove forest in Northern Jakarta will disappear. [7] The 22,000 of traditional fishermen who still depend their live on the condition of the ocean will be affected. There has been significant decrease in their daily catch since the undergoing of Jakarta land reclamation and giant sea wall project [5]. Heriyanto also add that the estimated US 40 Billion dollar project will also cost other existing infrastructure such as the passage of ships in and out of ports along the northern coast of Jakarta (Muara Angke, Sunda Kelapa, Tanjung Priok and Marunda), including the telecommunications cables that were located under a number of the planned islets.

Regardess of the expert analysis and government effort, Muara Baru will be in permanently under the sea-level as it continues to increase due to the climate change, and the land continues sinking. The current condition makes the drastic measure of flood mitigation by JCDS in question because the researcher observation does not show reduction of the flood land subsidence problem. Instead, report shows a repetitive appearance of the same problem. The pattern continues and in 2019 the dyke part of National Capital Integrated Coastal Development (NCICD) collapsed. Even the location of the section that failed is far from the residential area of Muara Baru, the threat of bigger problem is real. [8]

![Figure 3. Wall Adhuha Masque, Muara baru shows that the Neighbourhood is permanently under the sea level. Source: Kompas.com, 2019](image)

2. Methodology

This research is conducted using a literature study on architecture design principle, vernacular, and sustainable design. The findings from each subject will be crossed reference to find commonality between the three literature studies. The common ground will be used to analyze and justify the design solution as ways to respond to the Jakarta land subsidence and its risks, in specific for the northern coastal of area of the city. Furthermore, the findings will used as tools to predict the actual design of the floating neighborhood as it is considered as possible solution for Jakarta land subsidence with all the risk involved.

3. Background Theory

Literature reviews that were collected suggest that to work along with nature instead of against it. The primary consideration of the thought is that the fact human influence nature and nature influence
people. Human is part of nature and do need nature to survive. (Bianpoen, 2011). If we were to fight (or exploit) the impact may not be immediate, but if not managed, the impact can be tremendous for any human race to handle as the current state of the earth in where we live (global warming, ice-cap melting, ozone depletion, flora and fauna extinction, pollution, etc.)

Experts may need to revisit the basic of architectural design. A design works is a method of creating a complex and contradictory process. Each design is done in respond to series of specific context as a result of deliberate and intense observation of a specific site. Within the subject of ‘context’ the design process covers 1) Landscape and climate (topography, sloping sites, climate-responsive architecture); 2) Urban Planning and Architectural context (Interaction between buildings, urban development parameters, Urban references and axis, property access, orientation, interaction between buildings and its surrounding); and 3) Social and socio-cultural factors (historical, socio cultural context, Regional architecture, internationalization, symbolism and iconography, link to other disciplines). [9, pp. 18-41].

The process can be described in figure 4. Harmony between human, nature, and design is established within the balance act of the 4 components, thus the balanced and harmonious can occur and sustain.

![Figure 4. Explains the guideline of a design methods and process where all 4 components (context, form, material & structure, and functions are inseparable. Source: Basic Architectural Design, figure 1 – design map.](image)

3.1. Vernacular Design

Vernacular design is part of the context quadrant of the diagram above (Figure 4). It is a human response to the changes of the environment (deteriorating, pollution, global warming). The character of it is explained in table 1. As Human live influenced by nature, human also adapt to changes, Culture and custom, then is altered according to their needs. Vernacular Design shows similar and consistent nature elements that composes a design as a whole. The vernacular theory has been existed since the beginning of upper paleolithic at 40,000 years ago. Archeologist found that first form of human being used what nature can provides to build and meet the needs within the context of dwelling. (Orr, 2006). It shows how design (and society) survive thru the centuries by adapting into the environment specific to the habitat.
Vernacular design works by bringing the design problem into the existing condition. The condition mentioned covers many aspects of the actual place (ecosystem and all of its component), culture, and tradition. Vernacular design is driven by the needs of survival (which sustainable design theory also describes) of shelter, weather, predators, and enemies. The design decision is done impulsively, but yet the solution often fits according to the needs. Vernacular design is not a thing of the past or characteristic only of less-developed societies. The necessity to build simply and make do with locally available materials, or the deeper need to build in ways that reflect and honor the place, will never disappears as it adapts to the environment and thrive with whatever the environment provides. Bedouin tent made of woven materials that block the sun but yet permit the air to pass provide an appropriate, cheap, and elegant shelter for desert environments (Orr, 2006).

Orr also adds that the high-lite of vernacular design is practicality, durability, simplicity, repairability, and reliance on local resources. To be precise, it adapts and adjust to the environment in harmony. The product of vernacular design is a result of design intent, size, materials, and their resources, energy intensity, convenience, ecological impacts, cultural information, and how they fit particular places.

Regional architecture pays attention to local materials and constructions techniques because of tradition. It often incorporates trial and error solutions that are sustainable. More importantly regional architectural is optimum to respond to climate, light, temperature, humidity (or any subject related to the ecosystem [9])

| No. | Category                     | Current Practice                      | Vernacular                      |
|-----|------------------------------|---------------------------------------|---------------------------------|
| 1   | Scale                        | Large                                 | Small, localized, fitted to place. |
| 2   | Material Intensity and availability | High                                 | Dependent on local              |
| 3   | Energy Requirements          | High                                  | Low, locally sourced            |
| 4   | Convenience                  | High, design for automobile           | Adapted to Function             |
| 5   | Comfort                      | High                                  | Moderate to high                |
| 6   | Control/Technology           | High, 72F year round                  | Low                             |
| 7   | Ecological Impacts           | Global                                | Local                           |
| 8   | Cultural Information         | Low                                   | High, mostly local skills       |
| 9   | Design Strategies            | Professional                          | Public, participatory, educational. |

Source: Authors, 2019

3.2. Sustainable Design

The sustainable design theory plays a role as a bonding umbrella of all ecological friendly oriented design. Within the literature review of sustainable theory, vernacular design and the basic architectural design appears interchangeably and consistently bringing the design subject towards the direction of sustainable design. Sustainable design mentions the use of materials, resources, application, energy, air/environmental quality, in harmony with human life in order to achieve its subjective of fulfilling current needs without compromising the future generation to fulfill the same needs [10].

Common ground appears within the foundation theory of this paper that; Both vernacular design and sustainable design principle share a common interest of human survival by responding to the surrounding environment. By means, water or near water living condition require sets of specific architecture adjustment in order to make form, context, material & structure, and function synchronize. The simplest example of this adjustment can be seen in house on stilt architecture of Bajo Tribe, in South East Sulawesi. A different approach is used for similar architecture of further inland communities.
Living on water by all means (adjacent, on structure or floating) is no longer fantasy. It has been recognized within the design, architecture, science, and engineering community internationally. (Figure 6). Deputy Secretary General of United Nation, Mr. Amina Mohammed noted in his remark during the High-level Round Table Discussion that sustainable floating cities can offer solution to the climate change that threatens urban areas. Mohammed mentioned that today’s world must build cities that respond to the current climate change with all of its related risk. Mohammed also add that floating cities can be part of human arsenal in facing global climate change. The current urban environment condition pushes people closer towards the water. However, altering the environment can be seen more difficult than adapting to it [11].

Figure 5. Bajo tribe house, South East Sulawesi.  
Source: loveandroad.com

Figure 6. Oceanix City, UN Floating City.  
Source: bbc news/bbc.com [12]
4. Result & Discussion

There are three points of discussion that can be withdrawn based on the theoretical analysis. All three shown an interdependence from one and another in creating the adaptive and responsive environment.

4.1. Responding by Maintaining Environmental Balance.

Design solution that is most suitable for northern coastal line of Jakarta, specifically Muara Baru area must be well-respond to the surrounding environment. There are 3 of the nature components within the Muara Baru Ecosystem, which are: the nature itself, human, its needs, and development. The three components must be in balance to maintain the balance and sustainability [13]. The three components by nature goes in cycle and perfect balance if maintained. Altering one or all will tip off the balance. It will result in unbalance cycle that placing the entire ecosystem at risk of negative cycle (counter-sustainable). Giant seawall or land reclamation are mega project that reacting to the nature and climate change by altering the environment can tip the sustainable balance, leading the city towards bigger environmental issue.

4.2. Adapting to the Environment

Muara Baru Village is already below sea level. It is almost unavoidable to accept that the most adaptive design solution is to go afloat because human habitat/living environment is not created to be under the water. It is human survival instinct and intelligence to create tools to adapt and survive in its environment. The oldest boat called Pesse canoe is kept at the Drent Museum, Netherland. This Pesse canoe artefact shows that the vernacular principal has already applying the same measure since the beginning history of human existence. The scale of floating habitat can be managed into relatively small or localized area compare to land-reclamation or the giant seawall initiated by JCDS. of impacting the environment in a larger scale. Materiality required is available domestically and. Using the sustainable principle of energy usage, the source of energy requirement can be harvested thru nature (wind, sun, and water). The fact that most residence in impact are fishermen makes the adjustment process of living a lot easier because the residence will be placed in their natural ecosystem. Removing them creates series of social and economic damages.

4.3. Vernacular design leads to Sustainability.

Human settlements in many forms and its complexity that lies thru coastal line must be designed to adapt with the environment and in-sync with the ecosystem. Altering, removing, deleting, relocating, or blockading one or some the ecosystem element (in this case: water). Adapting with water means to going afloat. Water, with all of its potential must be embraced, thus it will create its own ecosystem that promote sustainability of the settlement itself.

Table 2 shows the writer’s analysis on how vernacular naturally fits into the existing environment. Vernacularity will naturally enable the Jakarta coastal environment to adapt into the existing environment, and create a sustainable environment.

Table 2. Adjustment and application of vernacular.

| No. | Category                        | Vernacular                          | Adjustment Effort                                                                                                                                                                                                                                                                                                                                 |
|-----|---------------------------------|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Scale                           | Small, localized, fitted to place.  | 22,000 of the population are fishermen or earn their living from the ocean.                                                                                                                                                                                                                                                                              |
| 2   | Material Intensity and availability | Dependent on local                 | Building Technologies and construction methods are available domestically. Technology to build a floating city already exist such as pontoon, mooring system, underwater farming, ships, etc.                                                                                                                                                                         |
| 3   | Energy Requirements             | Low, locally sourced               | Using sustainable methods, energy requirement can be made efficient by harvesting from surrounding environment (sun, water, and wind) to subsidised the government provided infrastructure.                                                                                                                                                                           |
| 4   | Convenience                     | Adapted to Function                | For the 22,000 traditional fishermen who make their living from the ocean, the living condition is natural habitat for them.                                                                                                                                                                                                                                                                                   |
| 5   | Comfort                         | Moderate to high                   | Compare to environment that adjusts naturally, it is more suitable.                                                                                                                                                                                                                                                                                                                                       |
5. Conclusion

There are several points that can be concluded based on the analysis. The design solution in respond to the Muara Baru area (as a result of Jakarta land subsidence issue) require a design solution that adapt to the existing condition and ecosystem. Jakarta is sinking in average of 10-25cm annually and needs a design solution that embraces the ocean coast line ecosystem.

The design solution that adapts to the existing environment is a floating neighborhood. Attempt to reverse or altering the environment such as land reclamation, dyke or giant sea-wall) requires major investment, including time. To go floating, is the most adjustable and responsive design solution of many forms human vernacularity in context of adjusting oneself to the current living, in where neighborhoods is surrounded with water or below the sea-level.

Here are some of the illustration of the floating neighborhood. The figures below are showing some of the design alternatives that fits into the Jakarta Coastal Environment. The component configuration consists of enclosed system of city infrastructure such as dwelling unit and can be developed into many other supporting functions such as water reservoir, roads, and utility, small industry platform, power plant, municipal building etc. The series of platform is anchored to the sea-bed using flexible mooring system to manage minimal damage of the underwater/sea-bed ecosystem. Therefore, the configuration will stay afloat and adapt to the high and low tide of the ocean naturally.

Each unit is built in with a closed-loop system of sewage and clean water management, power plant, rain-water catchment, waste-disposal facility, and water reservoir. Depending on the purpose of the unit, the sustainable design process will adjust accordingly. For example, the power plant unit may host more wind power electric generator in comparison to the dwelling or industry unit. The interconnected components will form a floating environment in where neighborhood can co-exist with the surrounding environment without interrupting the ecosystem (Figure 7 & 8).

![Figure 7. Example of Dwelling Unit. Source: Authors, 2019](image-url)
Figure 8. Configuration sample showing residential, commercial, and public facility zoning.
Source: Authors, 2019

Figure 9. Area view of the Floating Village.
Source: Authors, 2019
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