

Adaptive Architecture and Urbanism - Weave, Rethinking Dense Urban Coastal Cities Around World for Present and Future Scenarios to Make Sustainable and Egalitarian Habitat

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1 ABSTRACT

The aim and objective of the PhD research is to expand coastal cities to adapt as per rising sea level. Taking problem as opportunity to bring Science, Engineering, Government policies and Design together to make Resilient, Sustainable communities which shall float on water and stay on ground as well. Floating city shall be designed using existing and new methods / technologies under research envisioned for floating. The quest is to make sustainable habitat enabling people to live, work, learn and play. Aim is to instill sustainable recycling methods, energy conservation and optimum usage of land and marine Eco system. The research would serve as a model for evolving sustainable neighbourhoods designed in a modular way, which can be easily extended or re-arranged, so as to adapt for future socio-economic realities. The PhD research is being carried out in Innsbruck University, Institute of Experimental Architecture, Hochbau for Design, Architecture and Urbanism. The research is primarily focused on the coastal city region of Mumbai, India with flooding and other relative problems, the city is facing. The research shall undergo analysis of case studies, books and writings published on coastal cities, thus understanding its morphological, social, economic, political and environmental (marine, terrestrial and atmospheric) aspects. This research shall be beneficial for many cities in various countries across the globe which are in a similar situation of rising sea levels and flooding. Eg: Jakarta of Indonesia, Osaka of Japan, etc.

Key words: floating cities, extended or re-arranged, 3-C global warming, rising sea levels, coastal areas flooding, climate change, poverty, pollution, land cost and availability, adaptive architecture and urbanism, design, engineering, materials and social science, deliver resilient forms, sustainable.

2 INTRODUCTION

One of the biggest threat to cities around the world is rising sea-levels, caused by the expansion of water at higher temperatures and melting ice sheets on the north and south poles. UN climate negotiators meet for summit in 2017, there is a new figure on the table: 3C. Until now, global efforts such as the Paris climate agreement have tried to limit global warming to 2C above pre-industrial levels. However, with latest projections pointing to an increase of 3.2C by 2100, these goals seem to be slipping out of reach.

When it comes to flooding, the coastal cities are most vulnerable. Millions of people live in the urban areas and sea-level rise will reshape densely and sparsely populated areas, which has great impact. Many of Asia's fast-growing coastal megacities, with populations of 10 million or more, are vulnerable to multiple flood threats. Mumbai capital of Maharastra, India, Dhaka, capital of Bangladesh and Manila of Philippines, among others, face a future of heavier rainfall and higher storm surges. Cities like Indonesia's Jakarta, are also sinking fast. Some spots in Jakarta are sinking at a rate of 20 to 28 centimeters a year.

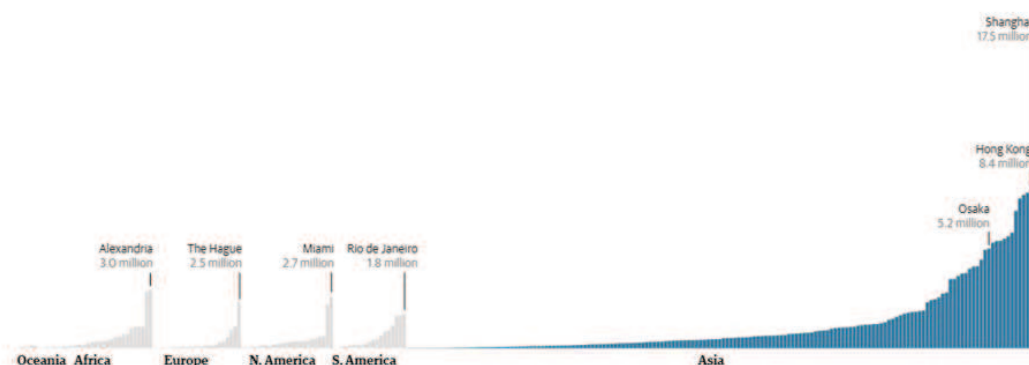


Fig-1 Asian cities will be worst effected (the regional impact of these changes is highly uneven, with four out of five people affected living in Asia) – Source: The Guardian

3 THE PROBLEM

Mumbai, capital city of the state of Maharashtra, according to United Nations, as of 2018, is the most populous city of India and seventh-most populous city in the world with a population of roughly 20 million. A large island was created from the former seven smaller ones (Colaba, Little Cloaba, Bombay, Mazagaon, Worli, Parel and Mahim) and the largest land reclamation projects were completed by 1862. Mumbai is the result of intensive land reclamation measures that continue to this day.

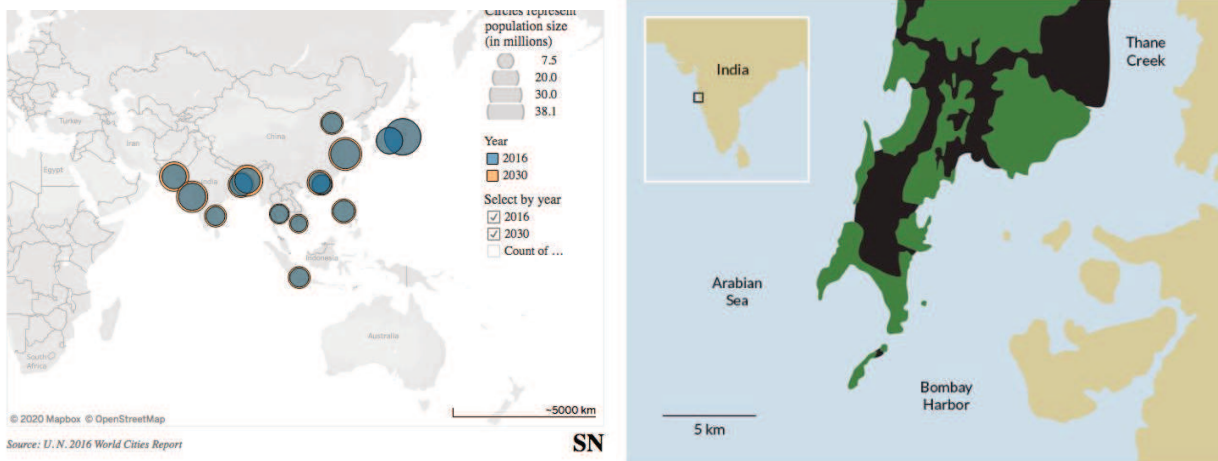


Fig. 2 Mumbai is built atop landfill (black) that connects several islands (green) in the middle of Bombay Harbor. Those passages once allowed water to flow through the system at high tide and during monsoon rains. Source: T. Riding/J. Hist. Geography 2018.

Fig.3 Population estimation for asian coastal megacities, 2016 and 2020. Source: U.N 2016 World Cities Report

Mumbai's flood risk makes the city a "high risk" place for climate change vulnerability. The second most worrying category after "extreme risk," according to Verisk Maplecroft's 2018 hazard index. Among the world's 31 mega cities, Mumbai ranks as the ninth riskiest, based on about 50 factors ranging from preparedness to exposure to climate shocks like heat waves, drought, hurricanes, and flooding. Mumbai's high population density, high poverty rates and poor sewage and drainage systems "heighten the risk posed by climate-related events like flooding".

3.1 Industrialization & Urbanization related issues

Typical issues: slums and neglected communities, air pollution, water contamination, industrial solid waste and poor urban sanitation.

Causes: rapid industrialization, low rates of emission treatment and lack of efficient waste management

Major impact: housing, industrial pollution disasters like the one in Bhopal, India, disturbance to the eco system, health issues, like tuberculosis due to air pollution

Spatial extent of impact: local and regional.

3.2 Poverty related issues

Typical issues: neglected communities, slums, low access to safe drinking water, and contamination of water bodies

Causes: inadequate housing and infrastructure, rapid population growth, income disparity and migration

Major impact: increased incidence of infant mortality, no proper air and ventilation in homes, sanitation related health impacts such as diarrhea, cholera, tuberculosis etc.

Spatial extent of impact: local

3.3 Rapid economic growth related issues

Typical issues: CO₂ emission, Nox emission, noise, municipal solid waste

Causes: Increased mobility, more emphatic economic activity, heavy Industries, less priority on environment

Major impact: Global warming, acid rains, heaps of garbage, blockage of sewers, deadly floods bring India's financial capital to standstill.

Spatial extent of impact: local and regional

3.4 Wealthy lifestyle related issues

Typical issues: Over burdening of energy resources, dioxins, obesity

Causes: High consumption, rich lifestyle, non-nutritious food consumption, low incentives for improvement

Major impact: Chemical ingredients and dioxin-caused abnormalities, over extraction of resources

Spatial extent of impact: Regional, global

Mumbai “is an extremely important city in terms of the economic wealth it generates”. The city’s economy rivals that of some developed nations in Europe. Its stock exchange is valued at around \$2.2 trillion - almost twice the entire GDP of Mexico or Australia. Its Hindi-language Bollywood entertainment industry generates billions of dollars in global revenues each year.

4 WHY FLOATING OVER LAND RECLAMATION

Most of the coastal cities are expanding on sea, building artificial land by land reclamation. Eg: Pulau tekong – Singapore, Central and wan chai – Hong kong, Palm Jumeriah - Dubai etc.

The Disadvantages of land reclamation are

- (1) High costs of construction
- (2) Enormous material needed to fill the depth and reclaimed land must be wary of soil subsidence
- (3) Construction time to build projects takes long due to its process
- (4) Damaging marine eco system and environment
- (5) Flooding and earth quakes can create more damage and problems in future.

Floating structures are structures which stay afloat by relying on the buoyancy force of the water

- (1) Floating platforms can adapt and adjust as per rising sea levels and flooding
- (2) Floating cities, platforms, structure can be build easily and quickly
- (3) Floating platforms are more environment friendly
- (4) Floating platforms does not damage marine eco system
- (5) Floating cities can be protected from earthquakes
- (6) Floating structures are easy and fast to build
- (7) Floating modular form is easy to fit and can be rearranged as per requirement
- (8) They don’t suffer differential settlement as they are flat in form

5 FLOATING STRUCTURES

Very large floating structures have been used for a variety of purposes like roads, bridges, mobile offshore base airports. Their presence is largely due to a severe shortage of land and the sky-rocketing land costs in recent times. There are basically two types of very large floating structures, namely the semisubmersible-type and the pontoon-type. Semi-submersible type floating structures are raised above sea level using column tubes or ballast structural elements to minimize the effects of waves while maintaining a constant buoyancy force.

5.1 Hood Canal Floating Bridge, USA

Type: Pontoon bridge with retractable draw span, Location: North West United States, Year of completion: 1961, Total length: 2398m , Clearance: 17m, Material: Concrete and Steel

5.2 Floating Airport Runway, Japan

Type: Modular mega-floats (4 large steel pontoons), Location: Tokyo Bay, Japan, Year of completion: 2000, Total length: 1000 m, Width: 60 m Height: 3 m Material: Steel



Fig.4 Hood Canal Floating Bridge, USA, Fig.5 Floating Airport Runway, Japan.

6 FLOATING ARCHITECTURE AND URBANISM

People are already living on water for centuries in some places around the world example floating village in cambodia. The idea of floating structures is not a new revolutionary concept. However, the concept of building on water has been reintroduced with a new idea to live, work, play, instead of bridges, airports and roads. The new idea is to accomplish a very large floating structure which is as big as a city which can accommodate housing, institutions, commercial, recreation spaces, sports complex, offices, industries and more. Floating city concepts from various architects in making urban scale to small scale homes. One of them is Kiyonori Kikutake ‘Marine City’ and Koen Olthuis ‘Offshore housing’

Kiyonori Kikutake’s ‘Marine City’ was one of the first main actors in the movement, describing a new radical idea of designing a floating city in the ocean; self sustainable, flexible, clean and safe, earthquake-proof, impervious to flooding and away from urban sprawl on the main land. the circular foundations would float on bottle-like forms boasting rich aquaculture farming. a surely radical idea for his time, breaking all traditional conventions and addressing issues important even today, sustainability, modularity and alternative living concepts. the project is based around steel rings, measuring over two miles in diameter, on which towers would sit holding 1250 magnetized living units that could be easily replaced without causing any damage to the structure.



Fig.6 Tokyo Bay Plan, project of the Metabolist and Structuralist movement, 1960 (Kenzo Tange). Fig.7 The architects of Waterstudio.NL not only design floating houses in the luxury segment in the IJburg district of Amsterdam but also in the rest of the world. © Koen Olthuis – Waterstudio.NL

Floating houses in Amsterdam designed by Koen Olthuis: Mr. Olthuis’s architectural firm waterstudio has completed more than 200 floating homes. which allows the buildings to get much bigger and be a lot more stable. They have a patented technology to create special “floating foundations” with foam and concrete – what he calls as floating land. These foundations move up and down on piles. This allows to go up to 200 x 200 meters in dimension and create larger structures. And they use the term amphibious to describe these floating foundations that rest on piles. The foundation is set on dry land, and when the water comes, the foundation comes loose from those piles and floats upward, and become a floating house.

7 SCIENCE, ENGINEERING AND TECHNOLOGY FOR FLOATING STRUCTURES

Floating cities are only possible in reality with the advanced science, engineering and technology in construction industry. Architects and Engineers are constantly working on and building with floating system called mooring. A mooring system is necessary to ensure that the floating structure is kept in position and prevented from drifting away under critical sea conditions and storms. A freely drifting floating structure may lead to damage to the surrounding facilities and infrastructures.

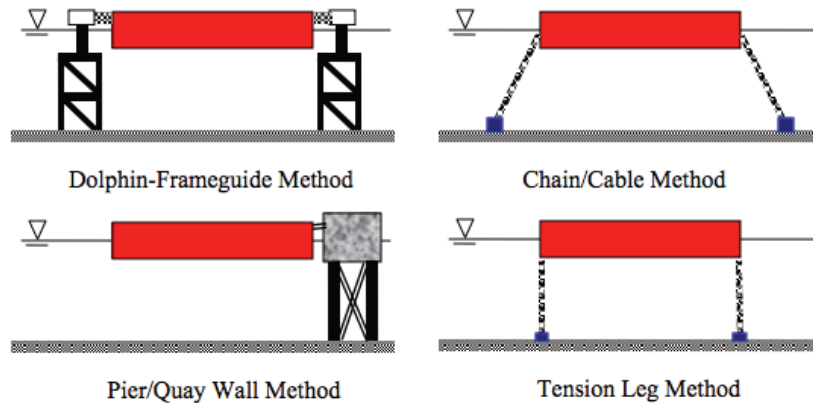


Fig.8 Various Types of Mooring Systems

8 SUSTAINABLE DEVELOPMENT GOALS:

As per United Nation, The 17 Goals are all interconnected to make sustainable cities and communities. Sustainable Development Goals are the blueprint to achieve a better and more sustainable future for all cities, addressing the global challenges facing, including those related to poverty, inequality, climate change, environmental degradation, peace and justice.



Fig.9 U.N. 17 Sustainable Development Goals

9 SUMMARY

The above study research will be further developed and applied to make Architecture and Urban Design Strategies for Mumbai's floating city. Taking Mumbai problems – flooding, high population, pollution, land costs and construction in city as an opportunity to expand its future proposals as floating city instead of land reclamation method. the research further focuses on its immediate context's need and requirements to bring design, science, engineering and policies together to make resilient and sustainable floating communities. Construction of housing, institutions, sustainable recycling industries and recreational facilities as per socioeconomic realities which benefit for poor and middle class. To accomplish a cost effective sustainable method in collaboration with Public, Private, Institutions and Government.

10 REFERENCES

- Josh Holder, Niko Kommenda and Jonathan Watts. The Guardian, Fri 3 Nov 2017 06.45 GMT. www.theguardian.com/cities/ng-interactive/2017/nov/03/three-degree-world-cities-drownedglobalwarming,
- Science News, Independent journalism since 1921, as waters rise, coastal megacities like Mumbai face catastrophe, article by Katy Daigle and Maanvi Singh, august 15, 2018. www.sciencenews.org/article/waters-rise-coastal-megacities-mumbai-face-catastrophe.
- Mumabi City, edited on 27 July 2020, at 07:08. www.en.wikipedia.org/wiki/Mumbai.
- Urban environmental evolution: the case of mumbai, Author dr. sudhakar yedla, assistant professor, Indira Gandhi Institute of Development Research, Mumbai, India, Commissioned Report Prepared for Institute for Global Environmental Strategy (IGES), Japan 2013, www.pdf.semanticscholar.org/72a4/c5b8892ebf168bc184703232ca6cfc92b588.pdf
- Very Large Floating Structures: Applications, Analysis And Design, Aurtherors E. Watanabe, C.M. Wang, T. Utsunomiya and T. Moan, Centre for Offshore Research and Engineering National University of Singapore. CORE Report No. 2004-02, www.eng.nus.edu.sg/core/Report%20200402.pdf
- Kiyonori Kikutake (1928 – 2011), Author danny hudson, designboom, oct 11, 2012, www.designboom.com/architecture/kiyonori-kikutake-1928-2011/
- Kikutake Assocs, May–June 1970, "EXPO Tower", The Japan Architect, [www.wikiwand.com/en/Metabolism_\(architecture\)](http://www.wikiwand.com/en/Metabolism_(architecture))
- Interview Inhabitat Editor-in-Chief Jill Fehrenbacher conducted with architect Koen Olthuis of Waterstudio.nl. 10-25-2017. under Architecture, Carousel Showcase, Design, Disaster-proof Design, Floating Houses. <https://inhabitat.com/interview-koen-olthuis-of-waterstudion/>
- United Nations, Sustainable Development Goals, 2019 - 2020 www.un.org/sustainabledevelopment/sustainable-development-goals/

11 ACKNOWLEDGMENT

This paper is the result under the supervision of my main supervisor Prof. Marjan colletti, Head of the Insitute of Experimental Architecture and former supervisor Prof. Rames Najjar (2019) of Institute of Experimental Architecture, Hochbau and special thanks to Robert Klar and BEQ's Team, for great working experience on BEQ's project - funded by the European Regional Development Fund and FFG exploration No. 853662 "Prepare BE", Institute of Hydraulic Engineering, University of Innsbruck and other partners. This research is supported by scholarship grant by University of Innsbruck (Doctoral Dissertation - Young Researcher Grant from Vice Rectorate for Research, Prof. Dr. Ulrike Tanzer, 1.Tranche 2020). And special thanks to Ketham's Atelier Architects team for supporting in doing studies and workshops in India. And this conference is supported and financed by Institute of experimental Architecture, Hochbau, University of Innsbruck.