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Climate Change & Urbanization Risks in Coastal Cities

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1 Abstract

Urban populations in coastal contexts suffer increasingly from challenges and risks in both environmental and spatial terms. This research investigates risk in a global context, and urbanization challenges that relate to waterfront areas.

Case studies of selected contexts provide an overview of the sustainable approaches taking place on the intersection of urbanization-environmental risks, and establish an understanding of the interventions in the built environment. The case studies provide insight into the value and important assets of the urban poor population with regard to the general resilience capacity of weak populations facing risk, as well as the particularities of demography, economy and geography that constitute the necessity for adaptive instead of prescribed general solutions.

The results of the research allow an understanding of the complexity of 21st century challenges in this context as well as provide a basis for exploration of new typologies in relation to the graduation project and a framework for assessment of adaptive solutions.

The overlap between climate change and urbanization processes that are exacerbated by the conditions of poor migrant populations offers opportunities to explore new kinds of typologies, namely a floating habitat for a resilient community.

Keywords: vulnerability, climate risk, environmental risk, urbanization, coastal cities, floating, community, sustainability, resilience, prototype, modular, challenges, urban poor, water management

2 Introduction: Overview of issues

It is widely accepted that the earth is warming, that sea levels are rising, and that extreme weather events are getting more frequent. [1] This poses a great challenge to humanity, especially when in parallel the urbanization processes that are increasing into the 21st century bring urban population predictions especially in coastal areas and on riverbanks, to an all-time high.[2]

Architecture and urban planning are professions positioned favorably to offer inventive and powerful solution frameworks to these issues. Specifically the issue of managing water and its relation to the built environment offers an opportunity to address both the most populated contexts and the climatic risks they face.

How to approach these problems? How to successfully manage the development of the urban environment? Which elements pose the greatest risk and how can sustainable actions be taken to make the city more resilient? What are the implications of such actions in terms of costs and benefits? Most importantly, how can these factors be analyzed in a way that allows to assess their effectiveness as well as the capacity to transfer them into other context and new typologies?

Therefore the research question guiding the analysis is:

"How can sustainable interventions in dense coastal communities help improve urban and environmental resilience?"

Furthermore, the research considers the design proposal for the graduation project as a testable prototype of the methodological framework developed in the research proposal, namely a floating modular habitation unit for a small community, and how this typology can relate to the research question in terms of the same evaluation criteria applied for the case studies.

The research is structured into several chapters. The first chapter gives an understanding of the relevant climate challenges of the 21st century. The second chapter explores the current risks and challenges in the urbanization process, specifically in coastal contexts. The third chapter follows the previous analysis with case studies of cities with different characteristics, and establishes a common line in terms of the main risks that intersect environmental-urbanization processes, and looks into

[1] Alisdair McGregor, Stephen Cole Roberts, and Fiona Cousins, *Two Degrees : The Built Environment and Our Changing Climate* (Abingdon, Oxon ;: Routledge, 2013), 3.
[2] Department of Economic and Social Affairs United Nations, Population Division, "World Urbanization Prospects the 2014 Revision: Highlights," (2014): 2-3.

sustainable actions taken to address them. A fourth chapter briefly looks into best practices to be learned from existing interventions around the world. The fifth chapter described a formulated framework of urban resilience. The sixth chapter deals with the transferability of the analysis framework into other typologies from the viewpoint of a floating prototype which is the subject of the graduation project design. Finally the conclusion summarizes the main points gathered from this analysis and presents possible further investigations into the subject.

2.1 Method

The research will be constructed by looking at relevant literature and specific case studies that exemplify the problems discussed in multiple scales and locations.

From a climate perspective, relevant literature such as “Two Degrees” (McGregor, Alisdair, Roberts, and Cousins, 2013) helps shed light about up to date facts and climatic contexts both locally and globally, especially water related risk.

The main goal of the research paper is to help establish a framework for assessment of the resilience of new solutions to 21st century risks specifically in water-sensitive urban settings and clarify the costs and benefits associated with urban challenges and poor populations in order to understand which are the needs related to improvements in these areas, and the design project aims to explore an alternative floating typology as a possible prototype which can be adapted and evolved into different contexts.

In addition to the above since the research aims to address risks in large concentrations of poor migrant urban populations, the case study cities were selected based on their relevance in terms of risk index, geography, climate, urban typology and demographic conditions. Studies such as C. Moser’s urban poor assessment[3] will help to define the spatial demands and risks of the poor migrant demography and understand the assets that are in their disposal.

Data relating to risk was obtained by the World Risk Index (WRI). The Index sorts countries according to their risk exposure and coping abilities.[4] Specific locations were selected which presented relevant variability that allows different aspects of climatic and urban processes on different levels of urban fabric to be examined.

[3] Caroline O. N. Moser, "The Asset Vulnerability Framework: Reassessing Urban Poverty Reduction Strategies," *World Development* 26, no. 1 (1998).
[4] Matthias Garschagen et al., "World Risk Report 2016," in *World Risk Report*, ed. Lars Jeschonnek, et al. (Berlin: Institute for Environment and Human Security, 2016).

From the list of cities with coastal related area that are also densely populated, several are interesting especially due to recent climatic events. The case studies selected are:

1. Manila, Philippines

2. Dhaka, Bangladesh

3. Phnom Pen, Cambodia

2.2 Results

The research findings show how current urban strategies and existing projects fail to address the improvement of urban resilience in vulnerable contexts. A vision is offered for alternatives which will tackle the challenges facing urban populations today such as water and land management and infrastructural capacity, specifically in the form of the floating prototype as proposed by the graduation project. The case studies as well as the floating prototype are assessed in order to provide comparison and transferrable framework for the future.

3 Environmental Challenges

3.1 Global Warming

Since 1880 our planet has seen a 0.85 °C rise in average temperature.[5] This might seems like a small change, but there is an overwhelming consensus among scientists that the effects of global warming could be catastrophic. The IPCC reports state that "Warming of the climate system is unequivocal […] The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen."[6]

The IPCC report and many others outline that anthropogenic activity is "extremely likely (95-100%) to have been the dominant cause of the observed warming."[7] This responsibility in mind, and the extent of our emissions of greenhouse gases still high, we should consider the various effects that will be the consequence of these processes.

The effects of global warming do not stay confined to physical phenomenon such as ocean acidification and polar ice melting, but are a direct cause of many relevant changes to the planet's capacity to support the human species, such as ecosystem destruction and weather extremes which put large populations at risk in terms of food, energy, and land.

3.2 Sea Level Rise

In the last 100 years, average sea level has risen by 20cm. This rate is increasing and projections stand at a further 30cm by 2050 and 60cm by 2100. In the extreme event of 'business as usual', the melting of the Greenland ice sheet will cause a 7m rise during the next millennia. [8]

Sea level rise is propelled mostly by glacier mass loss and ocean thermal expansion from warming, which account for 75% of the observed measurements. Even if greenhouse gas emissions are stopped soon, the accumulated effects on the ocean will still cause it

[5] Ipcc, "Summary for Policymakers," in *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group Ii to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. C. B. Field, et al. (Cambridge, United Kingdom, and New York, NY, USA: Cambridge University Press, 2014), 2.
[6] Ibid.
[7] Ibid., 4.
[8] Ibid., 16.

to rise for some centuries beyond 2100, [9] which places sea level rise as a long-term risk for the global human population.

Human activity is stated as having "very likely contributed to Arctic sea-ice loss since 1979 and have very likely made a substantial contribution to increases in global upper ocean (0–700 m) heat content and to global mean sea level rise observed since the 1970s."[10]

Low coastal areas are particularly vulnerable to the effects of long term sea level rise and high-risk locations for such scenarios include places like the Gulf of Mexico and the East Coast of the USA, inland Brazil and Argentina, Denmark and the Netherlands, coastal North China, and many coastal areas in Southeast Asia.

3.3 Extreme weather: precipitation and storms

The effects of global warming are not restricted to long-term projections but pose very urgent short-term and high-risk issues. Extremes in high sea levels (storm surge), precipitation, droughts and heat waves are evident already today. The UN World Risk Index report shows that in the last three decades (1980-2015), the amount of reported storms has risen by about 200% and reported flooding events by 400%![11] Precipitation is likely to become more frequent and intense in wet tropical regions. Many areas experience more frequent and extreme monsoons, a trend which is expected to continue in these regions such as West Africa and Southeast Asia.

Another phenomenon caused mainly by rising sea levels and storm activity is storm surge, which can be described as a form of coastal flooding. Most casualties during these events are due to water surge, for example in 2008 Cyclone Nargis killed 138,000 people in Myanmar and in 2013 Typhoon Haiyan killed 6,000 in the Philippines.

[9] Ibid.
[10] Ibid., 5.
[11] Garschagen, Matthias, Hagenlocher, Michael, Comes, Martina, Dubbert, Mirjam, Sabelfeld, Robert, Lee, Yew Jin, Grunewald, Ludwig, Lanzendörfer, Matthias, Mucke, Peter, Neuschäfer, Oliver, Pott, Simone, Post, Joachim, Schramm, Stephanie, Schumann-Bölsche, Dorit, Vandemeulebroecke, Bruno, Welle, Torsten and Birkmann, Joern (2016). *World Risk Report 2016*. World Risk Report. Bündnis Entwicklung Hilft and UNU-EHS.

3.4 Flooding

The most urgent short-term risk in the coming decades is flooding. Sea level rise by itself will manifest over a long period but its effects and the cumulative watershed from heavy rains, storms, and changed landscapes has rendered major flooding events more frequent and damaging.

Rivers, basins and coastal areas are all subject to flooding events at an increasing rate. In recent years the Indian Ocean Tsunami of 2004 caused major inland flooding with over 200,000 people left dead. In the last 15 years, many places like the USA, UK, India, Brazil, and many countries in Southeast Asia suffered from serious floods that lasted for extended periods. These extreme events are happening on a global scale and thus constitute the most pressing problem to human communities.

3.5 Food, water, energy crisis: insecurity

Food security, water access, and stable energy supply are all linked to the protection that populations get against extreme weather and flooding.[12] When they occur, extreme events disrupt food supply chains, harvests and food storages, crucial infrastructure such as bridges and irrigation systems and much more.

Sea level rise damages soil quality in many farming areas and coastal agriculture is becoming more difficult and risk-prone. The salinity infiltration into the land also means reduction of fresh water fisheries in some areas.

Regions in Southeast Asia like Bangladesh and the Philippines are particularly at risk of suffering from these insecurity issues.[13] In recent years the repeated natural disasters hitting the region such as tsunamis, earthquakes and flooding events are subjecting poor populations who are already at risk and without means to further harm which leaves them unable to fully recover.

The instability of food and water can often reinforce social tensions and sometimes can be directly linked to migration and refugee crisis such as the current Syrian conflict,

[12] Ian Macauslan and Laura Phelps, "Oxfam Gb Emergency Food Security and Livelihoods Urban Programme Evaluation Final Report," (Oxfam, 2012), 11-20.

[13] M.A. Hossain, "Global Warming Induced Sea Level Rise on Soil, Land and Crop Production Loss in Bangladesh " in *19th World Congress of Soil Science, Soil Solutions for a Changing World* (Brisbane, Australia2010), 77-78.

driven in part by drought. At other times Asian farmers lose entire crops and fields to saline water that rains down in excess or coastal waters creeping onto the land.

3.6 Relation to urban contexts

The environmental risks that show increasing trends in storms and floods could well be contributing to the already continuous and mega-trending growth that urban areas are experiencing, and therefore goes to illustrate the very possible future of large concentrations of people in urban areas, especially urban poor migrants, whereby they are subjected to repeated floods, droughts, storms, and earthquakes that render them vulnerable.

The spatial and material nature of the modern urban landscape does not help alleviate the problem, since the current infrastructure lacks the capacity to deal with ever increasing pressures (especially water management) and is often built in a way that increases flooding and exacerbates the effects of earthquakes.

Since more and more people rely on urban services and their associated infrastructure and networks, disaster events gain a multiplier effect when these networks collapse or shut down. The different costs related to environmental degradation in the urban landscape, the social vulnerability associated with these damages, and the health impact especially on poor inhabitants, are compounded on top of each other in a way that affects the overall condition of entire regions and nations. The economy suffers repeatedly while needing to recover from a previous disaster and in parallel adapt and prepare for the next one.

Which urban areas suffer most from these trends? How do these contexts deal with the problems they face and have their actions been successful so far?

In order to answer these and other questions, the following chapters will introduce three Southeast Asian cities which are particularly vulnerable and will analyze them according to a framework of resilience in relation to water management, particularly viewed through the collapse of urban infrastructure due to precipitation events and river discharge.

4 Urbanization Challenges

4.1 Urban migration and poverty

By 2050 the world's population is projected to be 9.5 billion, and 66% of the people will be living in urban areas.[14] This scenario is due to the increasing migration of rural inhabitants into the cities, especially in Asia and Africa. While it is true that at the moment Europe and the Americas are more urbanized than Asia and Africa, the latter group will experience a faster rate of urbanization over the coming decades, which will intensify the pressures and challenges in those contexts.

The migration of the rural population into the cities is often due to economic incentives, where people feel they can have better opportunities for themselves and their families inside the city limits. Not exclusively but often, these migrations occur due to climate disasters such as flooding or droughts of crop fields which render farmers jobless, typhoons that destroy property, or social conflicts that drive people away from dangerous zones, also many times due to climate-related issues such as water shortage.

While many people living inside the city in relative affluence can shrug the effects of catastrophe, the impacts are particularly acute for the weakest and poorest of the migrating populations, where they are repeatedly weakened by disasters and face equal impotence due to misguided post-disaster governmental policies and priorities, and lack of resilient strategies that will effectively leverage their potential.

The phenomenon exacerbates the urbanization process and leads to congestion of cities in a manner that leaves municipal and governmental actions ineffective in dealing with the surge of migration, and they fail to provide for decent infrastructure, housing, and employment opportunities for the new arrivals.

4.2 Land rights and usage

The core of the urban problems happening in today's major cities stems from land use. The lack of land, the destruction of land and the eviction from land, are all issues which render the problems of the migrating populations, especially the poor, more severe.

[14] United Nations, Department of Economic and Social Affairs, Population Division. "World Urbanization Prospects the 2014 Revision: Highlights." (2014), 2.

The ever growing cities especially in Asia, are called 'Arrival Cities', due to their increasingly migratory population which has a typical demographic of unemployed and economically weak people. Once arriving to the city the migrants with their accompanying families cannot find a place to live in the already congested metropolis, and therefore settle in risk-prone areas such as marginal riverbanks, or city outskirts.

Not only have natural disasters such as droughts and floods driven many of these people from their rural landscape, but once they have settled in a city they are once again faced with infrastructural failure and lack of rehabilitation on the grounds they often illegally occupy. This positions them legally and economically in a particularly vulnerable situation.

Finally, in order to combat increasing risks and to try to offer solutions to urban problems, the local authorities prepare and plan relocation strategies for these 'informal housing families'. On paper these plans seem adequate, with provisions for water and sanitation, and economic support. However these plans rarely get executed to their full extent, often due to long bureaucratic processes which can hardly manage the problems stemming from a constant influx of migration and financial complexity which mismanages resource allocation and practical implementation. Many of the relocation sites are far away from economic opportunities, and often provide basic shelter but lack the corresponding water and sewage facilities.

The problem of land stems to a large degree from the status of land tenure and land rights of the inhabitants. More often than not the inner-city land occupied by settlers will have no legal status or will be already owned by the local authorities, and inhabitants will have no documents to prove their identification. A resilient and comprehensive look at the risks facing slum dwellers and poor urban migrants should include a stabilization of their legal rights towards lands they occupy or reside on in a way that will allow them psychological and social security coupled with the physical and environmental improvement of their surroundings.

4.3 Environmental effects

The problems of urbanization in the form of informal housing, congestion, and overloaded infrastructure are not new. They have been around for decades. But in recent years the problems have been growing beyond all proportion due to the combination of urban pressures with environmental disaster. In the African and Asian contexts especially, the increasing climate change effects of drought, flooding, heavy

rains and tropical storms create unprecedented infrastructural failure, and bring with them more sickness, poverty, and economic instability.[15] These effects should be viewed in very economic terms, since not only do they pressure specific vulnerable portions of the population but their externalities in terms of infrastructural pressures and costs in efficiency and resource allocation contribute to the lower capacity of the city as a whole.

At one time marginal areas of informal housing, the riverbanks, coasts, and floodplains of major city rivers have now become the center of this urban problem. The mass of informal dwellers resides in increasingly risk-prone areas to flooding and storms, leaving them to fend for themselves year after year.

As is clear, the problems of housing, poverty, infrastructure, and climate-risk are intertwined to the extent that it is impossible to understand or deal with them separately, and any attempt to address one without the others will fail due to the acute consequences of the interdependency of these factors.

In order to deal with the problems mentioned above actions are needed that tackle the sustainable aspects of water management, housing provision, land rights, infrastructural networks, economic opportunity, education and health. More importantly, it is crucial to view these elements as more than physical interventions but a complex set of parameters influencing the daily social and economic fabric of poor and vulnerable demographics in the 21st century urban context.

The following chapters will discuss several case studies in risk-prone areas which exemplify the current problematics regarding these issues.

[15] Ipcc. "Summary for Policymakers." In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group Ii to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee*, et al.*, 1-32. Cambridge, United Kingdom, and New York, NY, USA: Cambridge University Press, 2014., 7-8

5 Summary

An understanding of the complex relationship between urbanization trends and environmental challenges in the metropolis of the 21st century reveals a connection between poverty, migration, infrastructural and economic risks and a vicious cycle of eviction and disasters that affects the weakest demographics in modern society.

The living conditions of the urban poor are one of the most crucial urban issues of our time, and currently these problems are being passed around from one party to the next or from one location to another without really solving the issues behind these symptomatic effects. Addressing them will go far to provide a deeper understanding of possible solutions in both architectural and infrastructural terms, in order to alleviate the multitude of problematic parameters affecting modern urban contexts and the vulnerabilities of the urban poor.

Current strategies of relocation to new settlements to solve urban issues stemming from congestion and infrastructural failure often ignore the basic need of inhabitants, especially the poor inner-city dwellers, to be in proximity to the urban core and their desire for centrality as part of their deepest motivation to exist in the sphere of the urban metropolis. These central areas are in fact crucial for any sustainable long-term solutions to the mentioned problems, particularly of an economic nature.

In order to assess any innovations proposed, such as the floating typology hypothesized in the graduation project, a framework of resilience and adaptation should be developed in order to compare new innovations to existing interventions and gain insight into the potential costs and benefits of such actions.

Only with a new outlook on the interdependence of water and waste management, economic empowerment, the alleviation of environmental vulnerability and the strengthening of resilience can the urban fabric hope to escape a dystopic reality in the 21st century. With this in mind, we look now to several contexts that exemplify the current paradigm.

6 CASE STUDIES

6.1 Case Study Selection

Since 2012, the United Nations has conducted the "World Risk Index" (WRI) which categorizes the world's nations according to their susceptibility to risk. Risk is not only considered from the perspective of climate change, but combines the exposure of countries to natural hazards with their capacity to cope with these damages, their health and economic development, and their social makeup.[16]

Over the last years the WRI has repeatedly placed many nations within the Southeast Asia region at the top of the list. In fact, out of the top ten most at-risk nations, five are in this region of our planet.

In order to understand the problems of urbanization and climate change and their compounding effects, the following analysis concentrates on several countries whose profile is extremely indicative of the issues at hand. These are the Philippines, Cambodia, and Bangladesh. These three countries have a high-exposure for natural disasters (especially water-related), and suffer from increasing problems of urban migration.

In each country the capital city was chosen not because of its national status, but due to the fact that it is the central place to which constant and continuous migration is occurring and where most of the poor urban population is concentrated, as well as having complex infrastructural systems that help illustrate the current problems on a large scale.

In each city, the subject of vulnerability and risk manifests on several scales, from the regional through the neighborhood to the individual dwelling. At all scales effects of vulnerability can be detected that show the resilience and nature of the particular context.

Each city will be viewed in terms of its climate risks, social and economic urban issues, and the interventions being conducted to offer solutions and alternatives to the rising challenges.

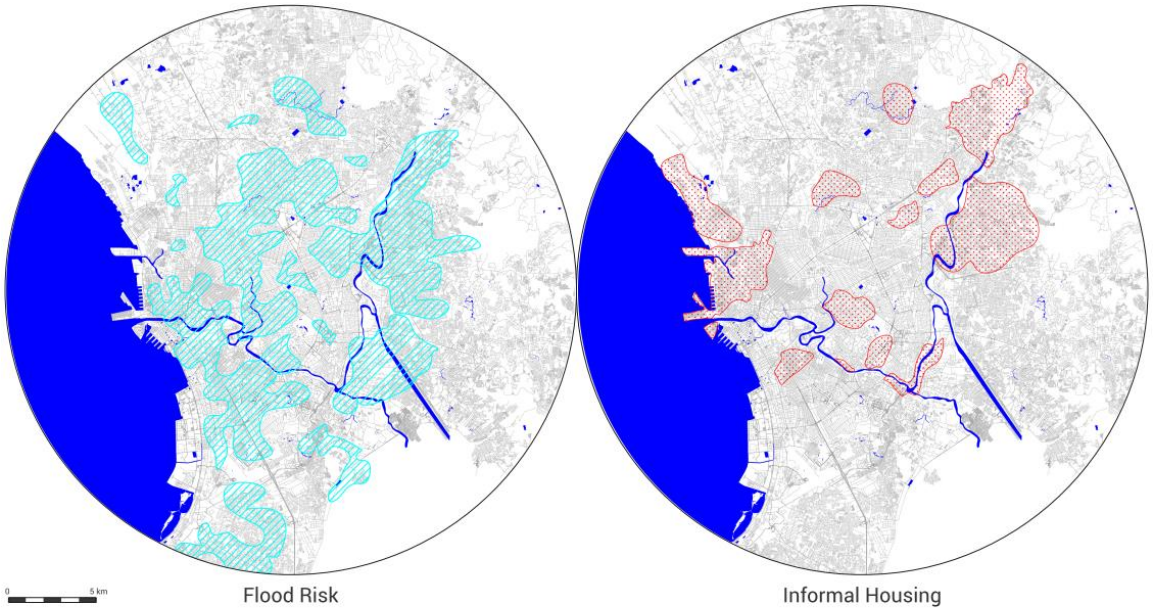
[16] Matthias Garschagen et al., "World Risk Report 2016," in World Risk Report, ed. Lars Jeschonnek, et al. (Berlin: Institute for Environment and Human Security, 2016), 7.

6.2 Manila, Philippines

6.2.1 Overview of context

The history of Manila City goes back to the 16th century and its Spanish colonization, but over the last 100 years it has developed into Metro Manila, a municipal aggregation of many urban expansions around the old city, today populated by over 12 million people. The west of the city and its port lie on the Manila Bay coast, an important trade point since its foundation and gateway to the west and mainland Asia. The bay is the natural watershed of a large portion of the geography of Manila, draining both the Pasig and Pampanga Rivers.

To the northeast the city is bound by the mountains in the Rizal region, while to the southeast lays the Laguna Lake, which drains to the Manila Bay via the Pasig River through the city center and provides much of the freshwater fish in the Philippines.



- Based on data from NOAH Project flood reports & Urban Poor Associates 2013 Eviction Monitor

6.2.2 Environmental Risks

Manila is situated in a region in Southeast Asia which experiences many tropical storms that form in the Pacific Ocean and move across the Philippines west and then north into China. Storms on this path usually intensify in the Philippine region and are accompanied by strong winds, high waves and rain. For example the recent Typhoon Yolanda (Haiyan) in November 2013 was responsible for more than 10,000 deaths and winds of above 200km/h.

West of the Manila Bay in the Pacific Ocean lays the Manila Trench. Its direction is north-south from Manila up to Taiwan, and in the case of an earthquake more than a magnitude of 9.0 it will produce a tsunami 9 meters in height. A recent 7.0 earthquake caused a 40cm tsunami in 2006.

Besides these storms and tsunami risks, Manila faces the threat of natural fault lines in the metro boundary itself. The Marikina Valley Fault System lays in the east of the city, running north-south along major districts of population concentration, especially slum relocation sites and poor housing which have urbanized in recent decades. In this area landslides are frequent in times of monsoons and an earthquake larger than 7.0 in magnitudes is predicted to take the lives of over 35,000 people. Smaller earthquakes on a scale of 1 to 5 occur frequently, 21 in the past year alone.

The last and perhaps the most pressing environmental calamity are the monsoon rains. The seasonal monsoon brings incredible amounts of water to the Manila area as well as to the Philippines in general, and happens usually around the month of August, relatively close to the typhoon season. The accumulation of rain in the urban fabric stops natural drainage into rivers and lakes due to poor infrastructure, the occupation of riverbanks by informal housing, and insufficient or mismanaged interventions of water retention. Large parts of the city are underwater repeatedly every year.

6.2.3 Urban Challenges

Manila's urban growth has resulted in large part due to the continuous migration from rural areas.[17] Leaving behind their homes often due to natural disasters and coastal erosion or simply seeking better economic opportunities in the city, large flows of people come into Manila and often find little place to settle or establish a stable life in

[17] Naik Singru, Michael Lindfield, and Ramola Lindfield, "Republic of the Philippines National Urban Assessment," (Philippines: Asian Development Bank, 2014), 5.

the already overpopulated urban fabric. With a growth rate of around 1.5%, the city gains around 500 new inhabitants each day.[18]

Out of the 12 million people inhabiting the city 4 million are poor, out of which nearly a million live in the most difficult slum areas which provide hardly any sanitation, water or safety. [19] These slum areas are the main issue with regard to much of the infrastructural and social problems of the city. Often neighborhoods in the slums catch fire due to improper electrical connections, disease runs wild through the population relative to a healthy population, and monsoon floods or storms wreak havoc in the already vulnerable situation. Poor migrants from rural areas have a hard time finding a place to live, and often settle illegally on river banks and risk-prone land, and when floods and natural disasters such as landslides occur, they affect the poor population most directly and intensely. The costs of such damages are repeated every year, and involve not only the symptomatic rehabilitation of homes, roads and drains, but directly affect social and health costs such as child mortality and destitution.

From the authority's point of view these slum areas are considered "informal housing", meaning that the inhabitants lack any legal rights to the land and are therefore subject to frequent eviction. Over 6,000 families were evicted in 2012, and a large portion of these were involuntary.[20] The government does allocate funds and plans strategically to improve the inhabitants' lives by providing new housing on paper, but more often than not the families are relocated to the city outskirts where they lack economic opportunities, and many times infrastructure for sanitation and water are hardly provided for on the needed scale. This again shows that due to a lack of comprehensive solutions for urban risks, the problems get 'moved around' rather than addressed.

Faced with these new conditions many families simply turn back and seek another place inside the city. These situations lead not only to the suffering of the poor, but fail to alleviate the pressures on important city infrastructure such as drainage of flood waters, polluted river canals and health costs.

[18] http://worldpopulationreview.com/world-cities/manila-population/
[19] Asian Development Bank, "Poverty in the Philippines: Causes, Constraints, and Opportunities.," (Manila, Philippines2009), 19.
[20] Urban Poor Assocciates, "2013 Eviction Monitor," (2013). See http://www.urbanpoorassociates.org/whatwedo.php# for more information

6.2.4 Poverty alleviation strategies

What has the city of Manila done to try and address the problems stemming from floods, earthquakes and the poor housing situation of almost a third of its citizens?

The Pasig River Rehabilitation Commission (PRRC) for example, is carrying out projects to improve riverbank conditions in order to provide better river overflow drainage in extreme events and allow water to drain to the Manila Bay on an urban scale. This is often accompanied by the mentioned resettlement of informal housing families. Since 2011, the PRRC through their Pasig River Development Plan (PRDP) has managed to relocate 1,175 families from the canal risk areas, which are only 11% of the total families situated directly on riverbanks at the time of survey (this means they occupy areas on or within 10 meters of the river path). [21] It is unknown precisely how many of those families have stayed in their relocation sites. The PRRC is also responsible for about 32 km of improved canals in the city, turning them into green areas and cleaner estuaries. These improvements nonetheless occur on the condition that the informal housing families in the 10 meter offset from the river are relocated. Often this poses problems due to land rights issues when inhabitants feel ownership of the land or makeshift housing and riot against forced eviction. The annual budget dedicated to such projects by the PRRC is around 2 million euros. Over time, the rate of exacerbation of the problems of congestion and waste pollution in the river and city canals is too fast to deal with in this piecemeal way, and other more robust solutions must be investigated that permanently deal with the inadequacy of the current housing and land issues.

On a neighborhood and individual family scale, the city's "Medium-Rise Public Housing Program" initiated in 2012 has plans to deal with relocation of families in more adequate terms, building replacement housing for them as close to their work areas as possible.[22] This is a positive step since it shows recognition by the municipality of the poor population's assets such as labor and economic ability, which they use to support themselves and their families. Such efforts have begun but only a few families have been relocated in the course of two years. The scale of such solutions needs to grow.

Concerning mobility, since 2012 the local government has tried to improve traffic congestion by organizing better management of bus stops and routes on the main EDSA highway, a major circulatory transport ring around the main city area, identifying buses

[21] Pasig River Rehabilitation Commission, "Annual Report 2014," (Manila, Philippines2014), 9.
[22] Based on data from the Housing and Urban Development Coordinating Council (HUDCC). See http://www.hudcc.gov.ph/s022613

as the most addressable problem.[23] The magnitude of infrastructural change and expected costs seems doubtful to contain the problem and shows little promise for alleviating issues related directly to poor housing areas. In terms of inter-related problems to connectivity, these proposals do nothing to address failure of systems due to water risk and do not offer any kinds of out-of-the-box thinking in terms of redundancy.

As is clear from the lack of effective implementation of solutions regarding mobility, housing and flooding management, the city of Manila is able to deal only sparsely and symptomatically with the effects of the phenomenon. Planning for large-scale and comprehensive urban improvement that integrate all aspects of the vulnerabilities in the context of existing urban fabric can be deemed almost impossible under the current political and entangled strategies whereby the multitude of actors and municipal organizations distribute the responsibility among many parties and render actions ineffective, lengthy and expensive.

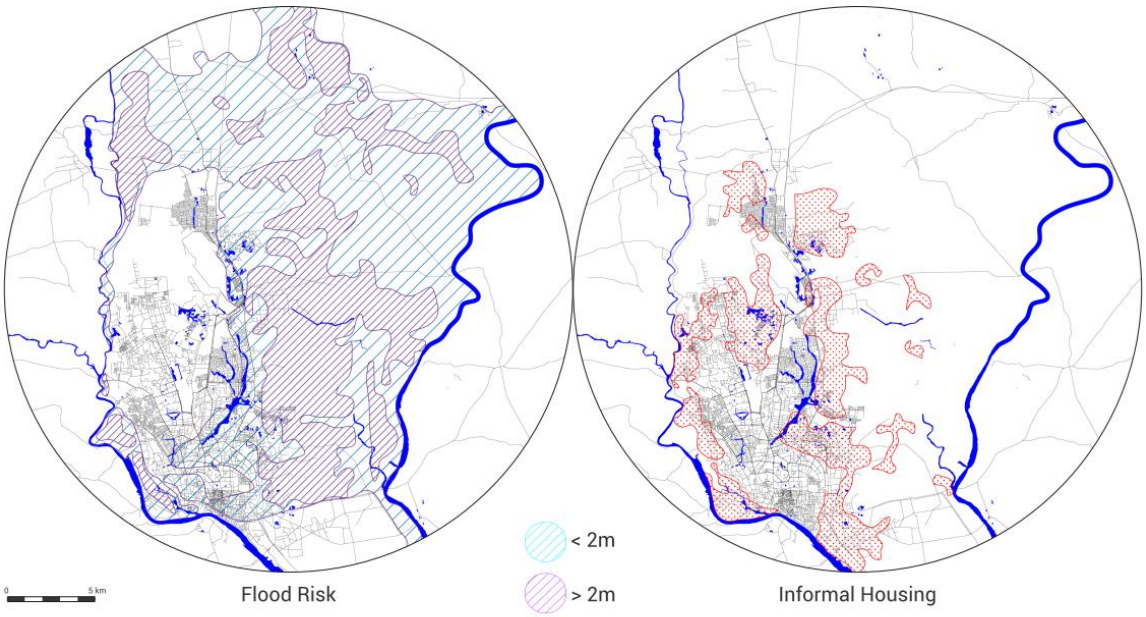
6.3 Dhaka, Bangladesh

6.3.1 Overview of context

Dhaka is one of the most populated places on earth. It is currently inhabited by at least 18 million people, and lies in the heart of the Bengal Delta, a crucial river system for the entire geographical region. The historic city grew on the east bank of the Buriganga River as a commercial capital, but declined during the 19th century occupation by British rule. The city's fabric has expanded over the centuries and now mainly occupies the land between the Buriganga and the Shitalakshya riverbanks.

Since 1995 the population has doubled due to a constant influx of migration of the poor from rural areas into the capital in search of better economic conditions and escape from natural hazards. The climate is tropical, and has the characteristic monsoon rains of the Southeast Asia region.

[23] Yves Boquet, "Metro Manila's Challenges: Flooding, Housing and Mobility," in *Urban Development Challenges, Risks and Resilience in Asian Mega Cities*, ed. R. B. Singh (Tokyo: Springer Japan, 2015), 460-61.



6.3.2 Environmental Risks

Dhaka is situated in a delta region, and is prone to frequent floods due to rains and cyclones that cause river overflow. The city is virtually surrounded by rivers, making it very susceptible to natural hazards resulting from water mismanagement. Much of the swamp and marshland in the city's surroundings was filled-in and built upon in the last 100 years to accommodate urban expansion. Floods are very extensive; in 1988 for example, 85% of the city was inundated. In 1998 a very severe flood due to heavy rains lasted for two months in some areas in the east, while the west part of the city was flooded for one month despite river embankments that should have protected it. The damages to the city's infrastructure amounted to 27 million euros.[24]

Dhaka is also at risk of large earthquakes occurring due to the Indian and Eurasian tectonic plates colliding. A severe earthquake could kill tens of thousands of people in the city.

[24] Sudipta Barua and Jacko A. van Ast, "Towards Interactive Flood Management in Dhaka, Bangladesh," *Water Policy* 13, no. 5 (2011): 699-700.

6.3.3 Urban Challenges

As a striking example of an 'arrival city' for poor rural migrants, Dhaka grows by about 400,000 new inhabitants each year. This enormous urban growth puts the city's infrastructure under heavy stresses and overcapacity, and leads to high rates of pollution and waste mismanagement due to failure of infrastructure.

The main Buriganga River itself, a core natural pathway and life source for the city in history, is diminished in width and function due to the overcrowding in many areas in which informal housing is set up. The sheer scale of such problems overwhelms the relevant city-scale institutions that are responsible for offering solutions, and the speculative nature of urbanization leads to massive destruction of the natural conditions of the soil and surrounding land, leading to irreversible expanding urban fabric which exacerbates the challenges stemming from both environmental and social issues.

The main problem in trying to solve these issues is the lack of land. In effect there is not enough land to sustainably improve living conditions for some without harming others. In many cases economically poor inhabitants live without access to sanitation, water and education. Not necessarily a result of purposeful neglect, these housing conditions do reflect the massive scale of migration and the impotence of current infrastructural paradigms in dealing with demands of the population for suitable living environments. Vulnerable populations are unable to purchase land or housing due to increasing real estate prices, and are frequently evicted from their makeshift housing conditions.

6.3.4 Poverty alleviation strategies

Although dealing with the urban problems in Dhaka is a daunting task, some organizations are trying to approach it with sustainable solutions. Habitat for Humanity (HFH) has implemented a pilot program from 2012 to 2013 based on its "Building Resilience in Urban Slum Settlements" campaign. Tackling the individual family, in the northwest slum of Talab Camp for example 650 houses were subject to improvements.[25] Such programs help to show specific and targeted construction methodologies that if applied on a large scale and translated correctly in consideration of varying geographic and economic parameters, could reduce the scale of some issues to be more manageable.

[25] Habitat for Humanity Bangladesh, "Project Conclusion Report: Building Resilience of Urban Slum Settlementsm a Multi-Sectoral Approach to Capacity Building in Dhaka, Bangladesh," ed. Habitat for Humanity Australia (HFHA) (Melbourne, Australia: Habitat for Humanity, 2013), 3.

Identifying vulnerabilities such as flooding and water-logging, health risks and pollution, improper waste management and crime as well as electrical-related fire hazards, the HFH implemented these improvements in several ways. Firstly drainage was cleaned and repaired, then a new public restroom provided and an underground water storage tank was installed. Furthermore, rickshaws and bins were provided for waste collection services, and 26 household floors were raised above flood levels and replaced with concrete.[26]

While these actions are commendable, it is doubtful whether the improvement of 26 households and the cleaning of drainage will do anything to reduce the vulnerability of these locations to future flooding in the long-term. Therefore the transferability of such interventions is crucial if anything is to be learned and applied by larger institutions and other locations.

A particular action can be reflected upon critically; why were floors replaced with a concrete finish to assist in water drainage if they were already being raised above flood levels? This suggests that the flood levels are unknown and therefore there is always a chance of recurring flooding, rendering the improvements useless in the long term. Current solutions such as this do offer some alleviation of immediate risks and help stabilize a secure shelter for some time, but the actors promoting these actions themselves are unsure about effectiveness of strategies that only deal symptomatically with water risk for example, and therefore we should seek in any intervention to deal with the issues from the core, eliminating the root cause of flooded housing areas. This consideration is implemented in the design process of the graduation proposal.

6.4 Phnom Penh, Cambodia

6.4.1 Overview of context

Phnom Penh is located in a very sensitive geographical region south of the Tonlé Sap Lake and on the banks of the Mekong River, which connects Cambodia with Vietnam and drains via the Mekong delta into the South China Sea.

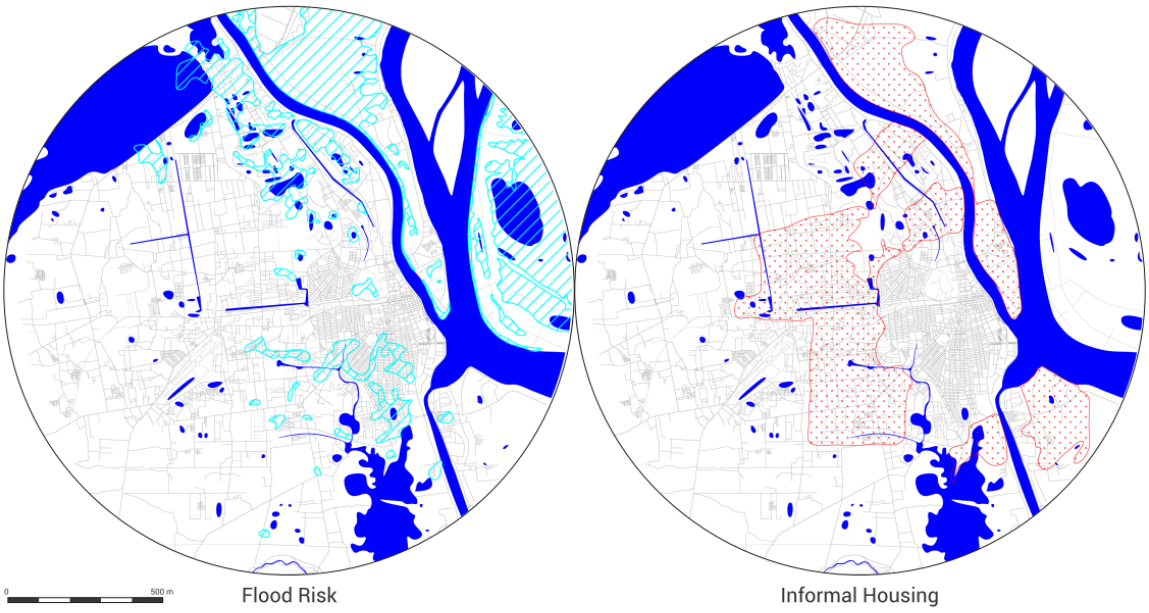
The urban fabric of the city is constrained between the Mekong, Tonlé Sap and Bassac rivers, and is home to more than 2 of the 15 million people of Cambodia. Since the

[26] Ibid., 11.

1980's, the city's population has quadrupled and urban poor inhabitants now count above 250,000. The city also lies on a floodplain area which is typical of the country, and often experiences monsoon and river flooding.

Like many other Southeast Asian urban centers, Phnom Penh is having difficulty in dealing with management of proper infrastructure for the incoming rural migration of poor populations that seek better economic conditions and relief from natural hazards. Slum areas in the city experience a poverty rate higher than that of the rest of the city. In the particular case of Phnom Penh, access to sanitation poses a more urgent risk than access to water.[27]

The context of urbanization in Cambodia and the expansion of Phnom Penh should be viewed in relation to the country's intense civil war in the years 1970-1975. During the civil war large populations escaped danger into the city, and were violently forced back out by the governing powers in the years after the war, leading to a decade of poverty and war, after which the urban center was repopulated very quickly and in an unorganized manner.



- Based on data from Urban Voice Cambodia flood reports & Sahmakum Teang Tnaut 2014 urban survey

[27] People In Need, "Phnom Penh; Multiple Indicator Assessment of the Urban Poor," (UNICEF Cambodia, 2014), 11.

6.4.2 Environmental Risks

Cambodia is a tropical monsoon nation, meaning that like Manila and Dhaka, Phnom Penh experiences heavy precipitation events which cause extensive flooding of urban areas, shutting down daily economic activity. On a regional scale, the Tonlé Sap Lake and river and the Mekong experience vulnerability to agriculture during flooding such as the 1998-2000 period when 70% of rice crop production was lost.[28] In 2009, Typhoon Ketsana (which heavily impacted the Philippines as well), affected rural areas and displaced around 66,000 people in Cambodia. In 2011 severe flooding events occurred which caused 630 million USD in damages.[29] The effects of rural disasters increase the migration to urban centers and influence pressures on the city's infrastructure.

Not only are rural areas and Phnom Penh subject to heavy flooding during rains, but the extreme lack of rain during other periods causes droughts which effect farming yields and food security. As a growing city for which economic growth and stable industry is crucial, at least for the proper provision of basic services, these kinds of events are disastrous in both the short and long terms.

6.4.3 Urban Challenges

The profile of the urban poor in Phnom Penh is similar to other Southeast Asian contexts. A third of the city's poor communities do not only reside in flood prone areas but are also threatened by government-led eviction.

Nonetheless, being the capital of the country, Phnom Penh is an attractor for vast numbers of migrants that seek to exploit better economic opportunities in the expanding manufacturing and service industries in the city. Lacking any formal settlement processes, these migrants often settle in opportune locations that lack legal tenure status such as railroad tracks, main roads and alleys, and rooftops of existing buildings.

Since 2000 a resettlement process for more than 85,000 inhabitants has been conducted,[30] mostly to outskirts of the city where, as noted for other case studies, the bureaucratic and infrastructural efforts are insufficient and provide little hope for the

[28] World Bank Group, "Climate Risk and Adaptation Country Profile: Vulnerability, Risk Reduction, and Adaptation to Climate Change, Cambodia," (World Bank Group, 2011), 6.
[29] Leng Heng An, "Country Report of Cambodia - Disaster Management," (Asian Disaster Reduction, 2014), 8.
[30] Thea Anderson and Mark Hildebrand, "A Rapid Urban Diagnostic and Proposed Intervention Strategy for Dig in Phnom Penh," (2009), 29.

settlers. Often these evictions happen to satisfy inner-city speculative development and interests of a political nature.

The city's main concerns are water management in terms of sewage and storm water, coupled with the poverty alleviation of large communities. The fast rate of migration puts pressures on the regulatory and development strategies of the city, therefore many of these processes occur in an unregulated manner, adding to the already existing problems. While local inhabitants try to upgrade and improve their living conditions, often these efforts are thwarted or challenged by the lack of any legal tenure of land, which shows the value of land as a crucial asset of the urban poor.

6.4.4 Poverty alleviation strategies

Phnom Penh and Cambodia in general seem in invest planning resources on the regional and national level through strategic planning for risk management. Since the mid 2000's, plans like the National Adaptation Program of Action to Climate Change (NAPA)[31] and Strategic National Action Plan for Disaster Risk Reduction (SNAP)[32] have detailed agendas for dealing with national risks of environmental, social and economic natures. Nevertheless, these plans seem to be far removed both from the realities of the urban condition as well as actual implementation or long-term flexibility. In recent years no clear signs of effective implementation of the contents of these plans have been noticed.

On a different scale, the one of the family or neighborhood, there is little involvement from the municipal or governmental institutions. Rather, the only help urban poor populations receive is from organizations such as Habitat for Humanity, which for example has provided over 600 improved houses since 2004.[33] The effort is commendable and similar to what HFH is conducting in other risk-prone cities, but relative to the scale of the problems, a charitable action of 50 houses per year doesn't amount to much.

[31] Royal Government of Cambodia, "National Adaptation Programme of Action to Climate Change (Napa)," ed. Ministry of Environment (2006).
[32] Kingdom of Cambodia, "Strategic National Action Plan for Disaster Risk Reduction 2008-2013," ed. National Committee for Disaster Management and and Ministry of Planning (2008).
[33] http://habitatcambodia.org/what-we-build/phnom-penh/

7 Floating projects: best practices

The vision for alternative solutions to the problems of the urban poor mandates examination of many scales, not only the regional and urban. Therefore in order to better understand the physical actions needed to improve resilience on these smaller scales, several existing projects can inform as to *how to provide more secure assets for the urban poor, helping them to improve their own lives. Such examples include both social facilities as well as construction.*

In order to improve the capacity of the urban poor to help themselves in times of need and to improve their own lives rather than rely on donations and charity, the main assets of housing, labor and education are key factors of resilience. Every small scale intervention should be viewed through the extent to which it addresses and involves the various aspects of resilience such as water management, transferability and connectivity.

7.1 Makoko Floating School

The architecture office NLÉ led by Kunlé Adeyemi created the design of this prototype floating school in 2013 as a resilient educational facility for the floating community of Makoko in Lagos, Nigeria.[34] Makoko has 100,000 inhabitants that live semi-informally on stilt houses on the water surface itself, using only canoes for transport. The philosophy of the intervention stems from a view that in order to deal with climate risks in an urban environment we must seek to incorporate water into daily life rather than combat it. Using bamboo and timber on a floating barrel foundation, a 220m2 structure enables sustainable use for the local children via solar cells, water collection and compost toilets.

What can this project teach us? From many aspects it is a positive intervention, since it avoids the water related risks that normal urban fabric deals with, as well as offering an accessible project via the current water-based transport system of the local inhabitants. It also contains multiple layers of functions such as water storage, energy production and social activities, giving it a considerable level of multifunctionality. The project nevertheless ignores important aspects of resilient intervention such as modularity and risk-spreading whereby the structure cannot be easily reconfigured, does not have any

[34] http://www.nleworks.com/case/makoko-floating-school/

connectivity to other infrastructural services, and is not scalable due to its method of construction.

7.2 Resilient homes in Southeast Asia

No large scale national or international strategy is being implemented for urban development as a whole in Southeast Asia, particularly none or housing or alleviation of the stresses of the urban poor population or empowerment of their natural assets such as labor or land tenure. There are, though, many smaller interventions that do a great deal to reduce the vulnerability of local urban poor inhabitants.

One such intervention is the work done in Vietnam by the Development Workshop France organization. To deal with repeated financial risk due to housing damage from storms, DWF works with families and teaches them key points in better housing reconstruction after disaster or eviction, such as locating the home properly on the land, the roof angle and the volumetric form of the house.[35] These aspects relate well to transferrable models which can be taught locally and are based on similar principals throughout Southeast Asia due to similar climatic extremes.

Another organization working internationally is ACTED. In response to the 2013 Typhoon Haiyan damages, ACTED identified the two most urgent needs of the urban poor as sanitation and housing. Using a "Build Back Safer" approach, ACTED educated local carpenters for better construction Materials used were mainly the local Coco Lumber sourced from fallen trees during the storm.[36] These interventions are mainly targeted at reconstruction, and doubtful they will improve the resilience of a meaningful portion of the population. The projects usually lack any larger scale integration with local or regional infrastructure or community, and are targeted very specifically at individual dwellings. Overall we can learn much from them on a very particular scale, but almost no positive strategies can be learned on any important resilient and medium-to-large urban scale.

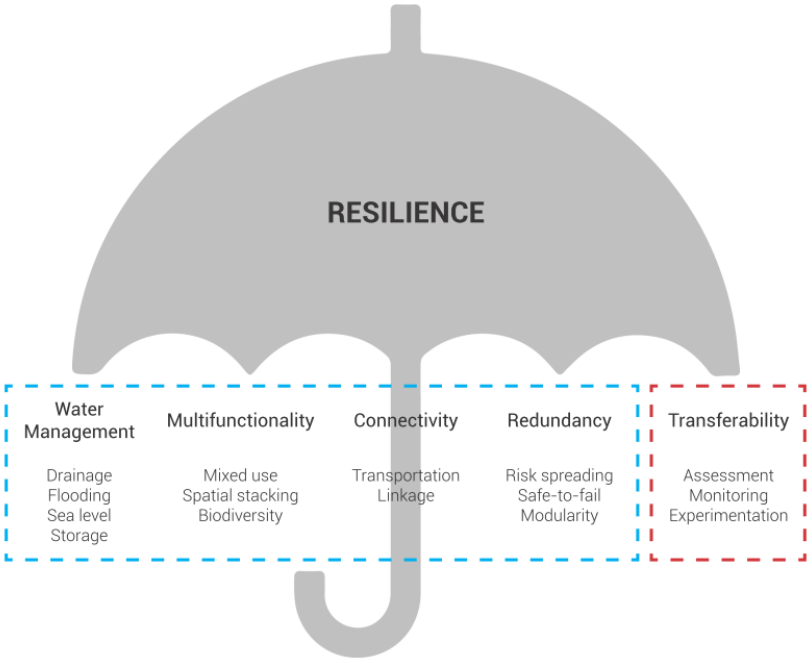
[35] http://www.dwf.org/en/content/vaccinate-your-home
[36] http://www.acted.org/en/typhoon-haiyan-one-year

8 Resilience Framework: methodological assessment of interventions in risk cities

It is important to be able not only to understand and monitor the processes that attempt to improve the management capacities of urban contexts in times of environmental and demographic crisis, but to learn how to assess them through a comprehensive framework that makes them comparable to each other and transferrable to other contexts.[37] Such a framework needs a robust definition of Resilience.

Resilience is defined generally as “the ease and rapidity of a system’s recovery from stress”.[38] In the case of climate and urbanization risks it means the extent and speed at which urban populations and infrastructure, especially for the urban poor, can recover from damage to important assets such as housing, economic capacity, education and health.

Resilience improvement is part of urban adaptation, which views the entire urban region as an entity responding to challenges over time. Many different aspects of resilience can be categorized according to the following scheme.



[37] Laura Burkhalter and Manuel Castells, "Beyond the Crisis: Towards a New Urban Paradigm," in *The 4th International Conference of the International Forum on Urbanism (IFoU)* (Amsterdam/Delft2009), 23-24.
[38] Caroline O. N. Moser, "The Asset Vulnerability Framework: Reassessing Urban Poverty Reduction Strategies," World Development 26, no. 1 (1998), 3.

Water Management

The core of urban risk is literally surrounded by water. Urban centers are either coastal or lay on riverbanks, and are often in monsoon regions. This vulnerability makes the aspects of storing water, draining discharge from rains and overflowing rivers, and protecting infrastructure from long-term sea level rise as crucial to the strengthening of resilience on all scales. In terms of the challenges of the 21st century urban metropolis, it can be considered the most important issue.

Multifunctionality

Mixed use, spatial stacking of urban functions and ecosystem biodiversity are important. These actions try to integrate different components of urban activities and the built environment with natural systems and spatial efficiency in order to gain cumulative effects and easier management of services.

Biodiversity of urban contexts is particularly important since it is taken to be part of the larger regional ecosystem, having strong impacts on the surrounding landscape as well as experiencing any externalities or benefits that relate to the urban degree of ecosystem incorporation (green areas, native species, watershed, soil quality etc.).

Connectivity

The robustness and amount of links and mutual relationships between different layers and networks of natural ecosystems (such as land types, forests, water bodies), and urban infrastructure such as drainage and transport strategies, as well as the individual extent of each layer, benefits resilience by improving both response and efficiency in times of disaster. By improving the quality and quantity of interconnected systems, mobility and disaster management becomes more comprehensive and effective. Demographically congested urban contexts, especially in the Southeast-Asian region, are now attempting to deal with these aspects using interventions to modify existing systems and strategies, but most lack an integrated approach where one system co-benefits another. For example in Manila, projects for improving river waterfronts have been executed as well as strategic visions for reducing congestion on main ring-

highways of the city, but unfortunately there is no coordination or exploration of the beneficial effects should these issues be joined and innovative solutions proposed.[39]

Redundancy

Any element of the urban fabric is made more resilient by providing certain risk-spreading aspects such as systems which are "safe-to-fail" (distributed and decentralized) and modular (applicable throughout different scales). By adding modularity to a system, it is not only more flexible to additional changes that will strengthen other aspects of resilience (connectivity, multifunctionality), but in itself provides a stronger resistance to urgent events and a more effective way of assessment.

Transferability

In order to leverage the achievements of interventions into other contexts in need of resilience strategies, they need to be transferrable. This means that a way to assess the different components of the interventions is needed, as well as tools for monitoring parameters and results, and a degree of experimentation that will allow the specific solution to be adapted to other locations rather than re-invented. Most small scale interventions do show a large degree of transferability when viewed in a geographical context,[40] but large urban interventions show the opposite, often supplying proposals tailored to a particular situation without consideration of the lessons that could be applied elsewhere such as the large scale metropolitan strategies of Manila.[41]

[39] Boquet, Yves. "Metro Manila's Challenges: Flooding, Housing and Mobility." In *Urban Development Challenges, Risks and Resilience in Asian Mega Cities*, edited by R. B. Singh, 447-68. Tokyo: Springer Japan, 2015., 460-462

[40] Interventions of small quantities of housing improvements introduced in the Southeast-Asian region by Habitat for Humanity for example, show how relatively straightforward and simple construction methods can be applied to the whole geographic context. Nevertheless, these are true only at a very small and local scale and do not have any proper relationship with larger regional plans.

[41] Ibid.

9 Resilience Assessment

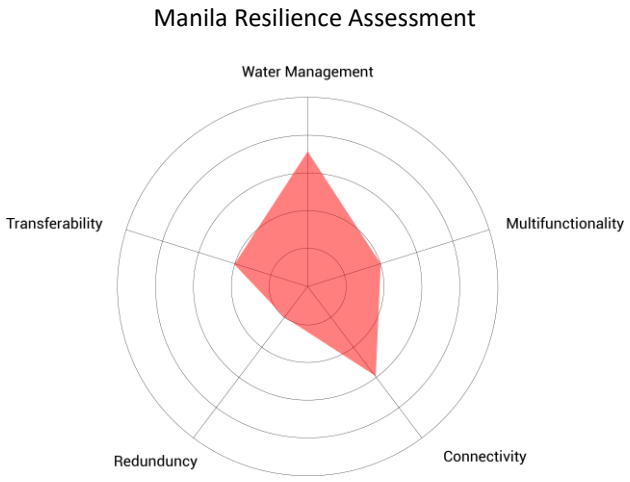
How can we provide better solutions? How can current projects and interventions be compared to future proposals?

Based on the case studies outlined and the Resilience Framework developed, each city is respectively assessed according to the five main categories of resilience. This assessment will allow identifying effective contexts and their degree of transferability to propose solutions in vulnerable locations. The framework identifies both in which areas actions are taken, and the measure of effectiveness that these actions can produce in order to improve the conditions of the urban poor.

Manila, Philippines

The city tries to address Resilience mostly through Connectivity and Water Management. On the urban scale, these seem to be the main points for change regarding such complex infrastructural networks as the city contains.

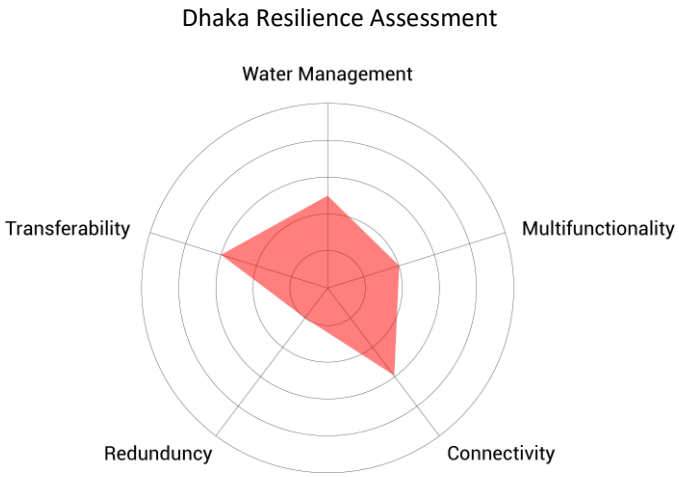
Given that, the efforts to improve mobility are doubtful to solve any long-term problems and the improvement of water management comes at the expense of social unrest and ineffective strategies to relocate dwellers, as well as being extremely long-term in contrast to the yearly costs imposed but the current situation. The rehabilitation of rivers and canals does offer some lessons in assessment and quantification of such efforts, therefore these could become transferrable to other similar urban operations in river cities.



Dhaka, Bangladesh

There is hardly any implemented large scale work done to improve the city's resilience. This is very worrying, and is obscured by the fact that many reports, strategies and plans exist but are not actualized. Some regional water management has been performed over the last years such as dike improvements, but these are not part of any comprehensive understanding of the situation.[42]

The only notable work done in the city is by international organizations, such as Habitat for Humanity, and while they do not form part of the municipal institutions they provide insights and effective work on the neighborhood and individual family scales. These contribute to the aspects of Water Management, Connectivity and Transferability through experimentation and monitoring. The city nevertheless suffers from a deficit in comprehensive proposals, and especially little is done to address the ever increasing rate of water management failure.

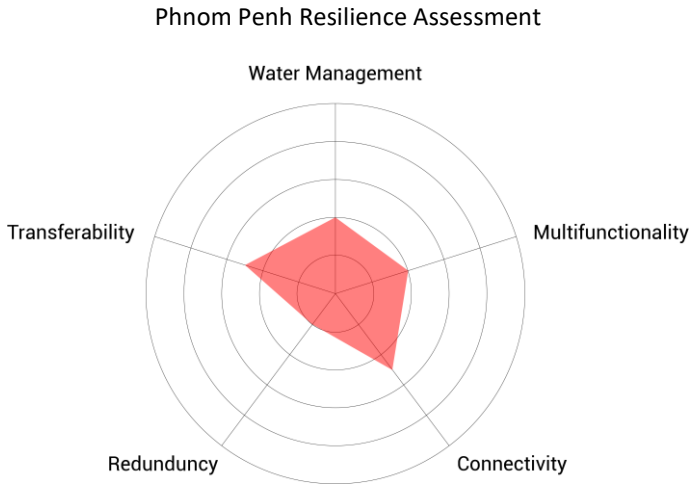


Phnom Penh, Cambodia

The condition in Phnom Penh is very similar to the one in Dhaka, both with much national and regional level planning and strategic frameworks, but almost no practical implementation in sight and hardly any relation to the lives of the urban poor.

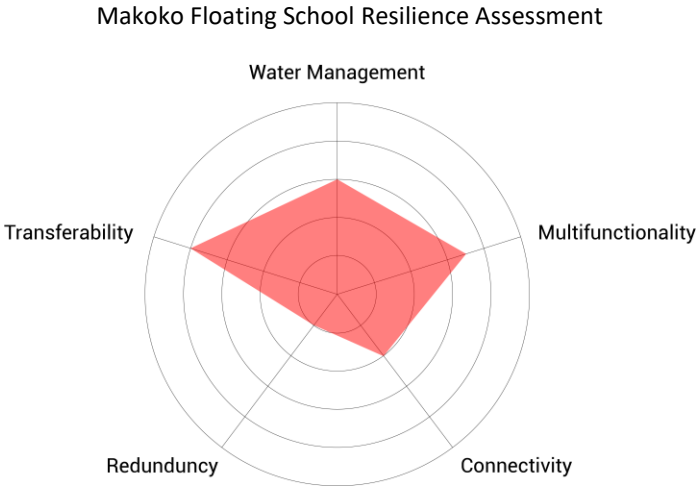
[42] Tibor Aßheuer, Insa Thiele-Eich, and Boris Braun, "Coping with the Impacts of Severe Flood Events in Dhaka's Slums – the Role of Social Capital," *Erdkunde* 67, no. 1 (2013): 22-23.

Here, as in Dhaka, the only notable actions in the city's fabric are the work of international institutions such as Habitat for Humanity, building and improving homes and locally acting to strengthen the resilience of individual families and neighborhoods.



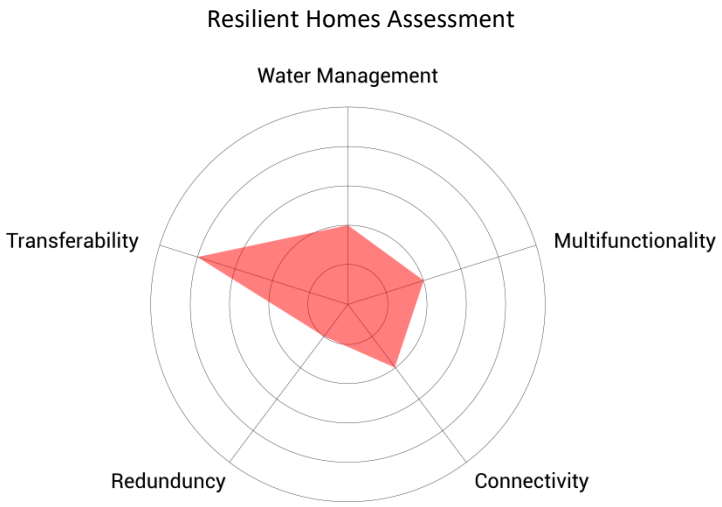
Makoko Floating School in Lagos, Nigeria

As mentioned, the school offers good multi-layered functionality and services to the community, but lacks any real infrastructural connecting to existing fabric, scalability, or a risk-spreading element.



Resilient homes in Southeast Asia

The benefit of such approaches as adopted by the projects for different kinds of resilient homes in Southeast Asia is the element of transferability. These projects, while lacking any large scale application, serve as pilot and prototype interventions which are specifically directed to teach and reinforce previous knowledge of local and global actions towards resilient homes.



9.1 Floating prototype assessment and proposal

A design addressing the vulnerability and risk of urban infrastructure and the urban poor population needs to answer to the categories of a robust resilient framework. Such a design should identify the critical aspects of resilience and propose alternatives to the current mismanagement throughout all scales, and pay particular attention to the relationships between small scale housing improvements and large scale urban strategies taking into account the intermediate neighborhood and community scale as an important link that taps into the social and individual assets of the urban poor population in urban centers. A prototype of such kind will allow continuous testing and assessment, and adaptation through time by modularity and transferability. Alternatives now should step up to show how a correct framing of the problems and opportunities of the modern urban risk can be beneficial and can be leveraged to provide effective solutions. Learning both from small scale projects around the world as well as large

scale strategies of specific locations, proposals can tackle some of the biggest challenges that the 21st century poses to the human population on this planet and turn costs into benefits.

For practicality and feasibility alternatives should be as economic as possible, not falling into the same trap of current efforts where the extent of funding needed is simply too long-term and too impractical. Since the most crucial aspect to the foundation of a risk-free urban fabric is management of water and flooding, the design includes a high capacity to manage and store water as a primary consideration. It has as well to offer possibilities for flexible use of space and services such as spatial stacking and integration with natural systems, and to address issues of transport connectivity, redundant networks and modular components in order to handle long-term adaptation. As a prototype, the proposal needs to have enough transferrable qualities in terms of both monitoring but especially design of architecture and construction that will be applicable in other contexts.

In terms of the core issues at hand, the simple fact of flooding water poses the greatest risk, and resettlement even if done without forced eviction often results in negative economic effects. Since the availability of land is the restricting factor both in the creation of new settlements and the resettlement of existing informal housing, new land should be provided for inhabitants where flooding does not occur. If achieved, it will address directly some of the most important aspects of this issue.

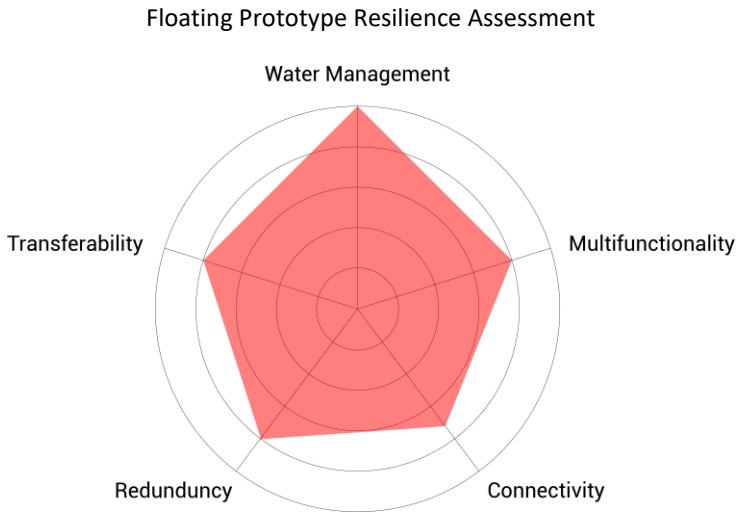
Seeing as large-scale projects are often halted for various political and economic reasons and are hard to execute, the design should strive to offer a smaller scale solution. On the other hand, addressing the needs of only several families at a time is too lengthy and sparse and has limited reach. The design alternative is to address the intermediate scale, that of the neighborhood, and bridge between the extreme ends of the spectrum of problems.

The single most important aspect of the physical construction of such an alternative is modularity. By being modular not only does a design offer flexible management of transport and connectivity networks, but allows experimentation and incremental development of housing typologies, green areas and public spaces. Modularity also allows for risk-spreading and mixed utility provision that is resilient and adaptive, and does not fail globally as urban systems do today.

As a floating typology and a medium-scale intervention, the proposal of the design project seeks to address first and foremost the core aspects of flooding and eviction, in order to facilitate relocation of informal housing inhabitants to a place where risks are

greatly reduced, especially over time. Furthermore, the location of such a project takes into consideration the economic stability of the inhabitants and makes sure not to place them far away from their current important assets of labor, meaning to locate them in proximity to the urban center where their economic lives are strengthened,[43] and to provide them with new opportunities for local and resilient employment such as in the form of integrated aquaculture on a floating wave breaker. The design is meant to be as modular as possible, offering not only multi-layered functionality to each sub-component, but an overall flexibility in configuration in both medium and long term time scales. The modular concept provides as well for a larger capacity of reduced risk by spreading utilities and access.

Although such an endeavor could be considered very innovative from many perspectives, it exactly because of this that we should test and explore it, experiment with its effects, assess them in time and in the end turn costs into benefits for the vulnerable populations in our major cities of the 21st century.



[43] Moser, Caroline O. N. "The Asset Vulnerability Framework: Reassessing Urban Poverty Reduction Strategies." *World Development* 26, no. 1 (1998/01/01 1998), 5-10.

10 Conclusion

The increasing overlap between urbanization trends and climate change bring about worrying predictions for the future of the increasing population of urban poor and slum inhabitants. As seen, urban migration is the most vulnerable aspect of today's ever growing metropolis regions, and the numbers of urban poor populations are climbing.

In the face of all of this, it is still possible to analyze current contexts from a resilience perspective and assess their ability to manage these urbanization risks and offer solutions. From the analysis it is almost exclusively seen that with the application of efforts in current strategic paradigms, sufficient change is not implemented and if so only on a regional or urban scale, never addressing the intermediate or small scales of neighborhoods and families with any long-term significance.

These communities where the urban poor try to survive are full of people with important assets which they use to sustain themselves. It is important to recognize these assets such as housing, labor and education which are crucial to the success of any attempt to improve their lives on a meaningful and long-term scale.

Therefore the proposal for improving the lives of the urban poor in the 21st century stemming from this research is a floating, modular and resilient alternative land that does not flood, which will provide integrated utilities and services and empower residents to use their particular skillsets to enhance their education, health, economic situation and pride in the proximity of existing urban centers.

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