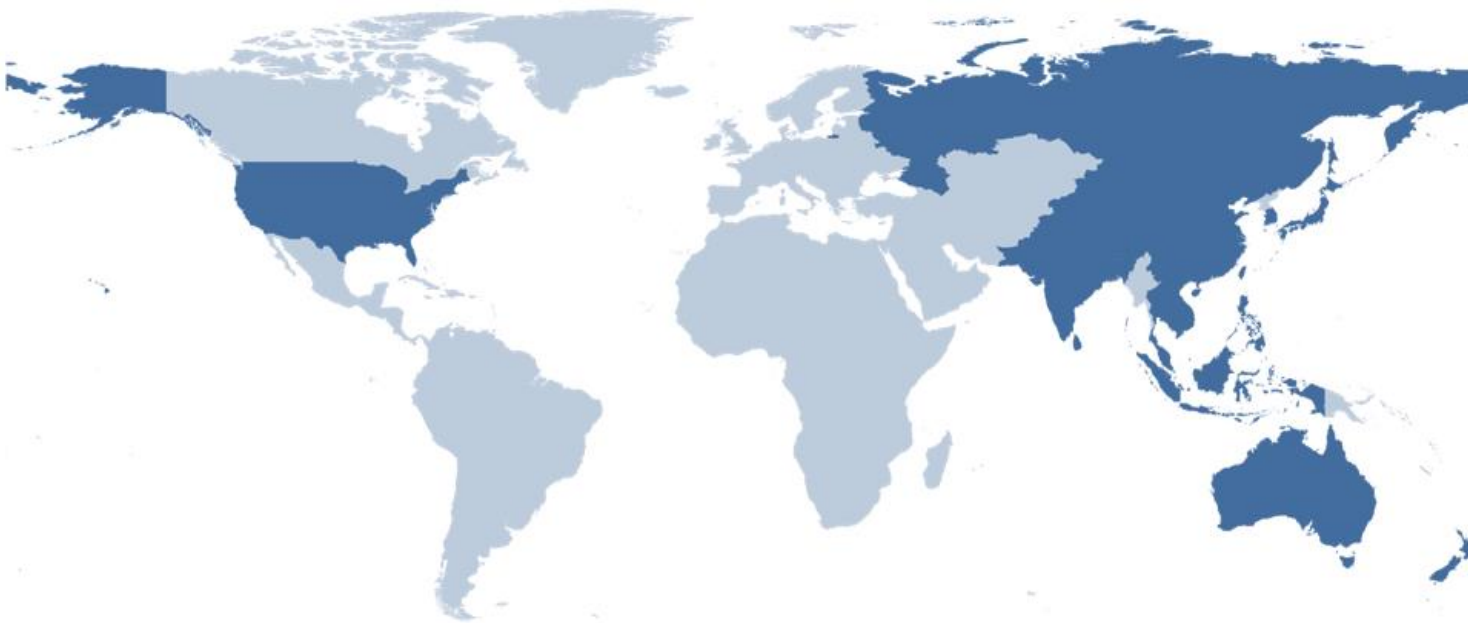


Project Reference Number: ARCP2013-26NSY-Patankar

***Characterizing Public and Private Adaptation to
Climate Risks and Implications for Long-Term
Adaptive Capacity in Asian Megacities***



The following collaborators worked on this project:

1. Dr. Archana Patankar, Regional Centre for Urban and Environmental Studies, All India Institute of Local Self Government, Mumbai, archana.patankar09@gmail.com
2. Prof. Anand Patwardhan, School of Public Policy, University of Maryland, apat@umd.edu
3. Dr. Wijitbusaba Marome, Faculty of Architecture and Planning, Thammasat University, Thailand, wijitbusaba@ap.tu.ac.th
4. Prof. Emma Porio, Department of Sociology-Anthropology, Ateneo de Manila University, Philippines, eporio@ateneo.edu

Report prepared with the help of:

5. Ms. Sravanthi Rallabandi, Regional Centre for Urban and Environmental Studies, All India Institute of Local Self Government, Mumbai, sravanthirallabandi@gmail.com



Project Reference Number: ARCP2013-26NSY-Patankar

***Characterizing Public and Private Adaptation to
Climate Risks and Implications for Long-Term
Adaptive Capacity in Asian Megacities***

Final Report Submitted to APN

©Asia-Pacific Network for Global Change Research

Part One: Overview of Project Work and Outcomes

Non-Technical Summary

Climate-related hazards are evident not just in case of low-probability high-consequence events but also for high-probability low-consequence events, which lead to recurrent impacts and recurrent costs of adaptation. The coastal cities of South and South East Asia are acutely vulnerable to heavy precipitation, sea-level rise, cyclones and typhoons. The cities face frequent weather events related to heavy precipitation resulting in flash floods, loss of life and property, heavy damages to infrastructure and disruption of economic and social services. In light of this, it is critical to assess the vulnerabilities and adaptation strategies used by the coastal cities to cope with future climate risks. The existing literature on adaptation measures and their typology focuses on the widely used public or institutional adaptation measures. However, the private stakeholders like households and commercial/industrial establishments also undertake adaptation measures that need to be characterized to understand their costs, burden on the stakeholders and effectiveness in enhancing adaptive capacity. This study characterizes public and private adaptation measures in the three cities, Mumbai (India), Bangkok (Thailand) and Manila (Philippines) by using primary data gathered from households and commercial/industrial establishments and secondary data obtained from government entities and also evaluates their effectiveness and contribution to long-term resilience.

Keywords [5 maximum keywords]

Coastal megacities, flash floods, adaptation typology, public adaptation, private adaptation

Objectives

The following are the key objectives of the study:

- Characterize the public and private adaptation measures in the selected cities – Mumbai, Bangkok and Manila – using primary and secondary data
- Examine various aspects of adaptation measures such as costs, burden on stakeholders and their effectiveness and contribution to the long-term adaptive capacity
- Examine the nature of recurrent impacts and recurrent adaptation
- Understand the policy implications of the findings for future city resilience

Amount Received and Number of Years Supported

The Grant awarded to this project was: US\$ 34,000 for Year 1

Activity Undertaken

The following activities have been undertaken as part of the study in the selected cities:

- Identifying adaptation measures through the primary and secondary data – For households and commercial sector, primary surveys have been carried out to understand how they cope with recurring floods, what measures do they take to protect themselves and the costs involved therein. For the public adaptation measures, we have relied on secondary data obtained from government documents and reports

- Analysis of costs, benefits, cross-linkages between public and private adaptation, participation of private sector in building public adaptation measures
- Analysis of effectiveness of adaptation measures in light of recent events of flooding in the three cities

Results

The study has identified and analysed the adaptation measures undertaken by the public and private stakeholders in the three cities. The most common public adaptation measures are – upgradation of storm water drainage network, improvements of existing infrastructure like roads and transportation systems, revision of building codes, early warning systems, maintaining and analysing database for rainfall across different areas in the cities, relocation and upgradation of informal settlements, public awareness, training and capacity building workshops. Private adaptation measures are undertaken by the households, individually or collectively, and by the commercial and industrial establishments. The identification, design, financing and implementation of these measures is done by the private stakeholders themselves. There are many recurrent measures implemented by the private stakeholders, such as, cleaning the surrounding compound, cleaning nearby gutter and repairing fence before rains and disinfecting premises and cleaning the compound of sewage and garbage during rains and floods. These measures are recurrent and have to be undertaken several times during the year with recurrent costs. Besides these measures, private stakeholders also implement structural measures such as increasing height of the surrounding plot, reconstruction with stilt parking, elevating electrical meters, modifying plumbing systems and water supply networks, etc. In Manila, the measures implemented by the middle and upper-income group are specifically highlighted. Some of these households have moved out of the area permanently to avoid floods. The measures identified in the three cities are classified into the existing typologies found in the literature as seen in the following table. We also find new dimensions in the form of effectiveness, frequency and financing of the adaptation measures.

Stimulus	Intent	Spatial scope	Degree of change	Driver of action	Form	Approach	Effectiveness	Frequency	Financing
Anticipatory	Autonomous	Local	Incremental	Disaster or extreme event	Technological	Resilience	Short term	Recurrent	Public
Concurrent	Planned	Regional	Transformational	Climate variability	Institutional	Targeted adaptation	Medium term	Permanent	Private
Reactive		National		Climate change	Behavioural	Social vulnerability	Long term		Insurance

Adaptation measures to cope with floods in the three cities are mainly reactive and have been implemented in the aftermath of extreme flood events. They are planned interventions at the local level and initiated by the local government in its role as the civic administrator and first responder to weather events. The changes brought about by these measures are incremental and have been able to reduce the depth of floods, but the problem of recurrent floods remains in many areas across the cities. The measures implemented by the local

governments have largely been institutional and not technological or behavioural that would have brought about transformational changes in the way the cities dealt with floods. The new dimensions we are considering here in the form of effectiveness, frequency with which measures are implemented and the source of decision-making and financing give unique insights into adaptation options exercised within a developing country context. The decisions here are driven by both public and private stakeholders and the focus is largely short to medium term. Such measures, therefore, are recurrent in nature. Private stakeholders, with limited resources and technical capability, are not in the position to visualize and implement measures which would have long-term effect on the capacity to cope with floods. Given the current set of measures and their overall effectiveness, not all measures would enhance the long-term coping capacity of the cities against floods.

Relevance to the APN Goals, Science Agenda and to Policy Processes

Better understanding of the process of responding and adapting to climate-related hazards is important for planning and implementation of adaptation interventions. There is a need to explore aspects of adaptation interventions, such as, public vis-a-vis private adaptation, underlying costs, short to long-term benefits and enhancement of overall city resilience. The present study is relevant to the theme of 'climate change and climate variability' as per the new strategic plan of the APN. The project findings will improve the understanding of human dimension to climate change by understanding the design and implementation of public and private adaptation interventions at the local level. The project will also lead to better characterization and documentation of public and private adaptation measures and their costs and benefits. In addition to this, there will be identification of policy implications for long-term city resilience and adaptation strategies and providing inputs in integrating them with long-term development plans. The study team has worked closely with the local government officials and other stakeholders and deliberated the findings with them before finalizing the city reports. The findings will be shared with the policy makers and the scientific and research community through publications and presentations at different workshops/conferences when opportunities arise.

Self-evaluation

The project has achieved its stated objective of characterizing the public and private adaptation measures in the three selected cities. The case studies developed here further examine different aspects of these measures, such as, their costs, burden on the stakeholders, their effectiveness over short to long-term and potential to enhance the future adaptation capacity. There are critical policy implications of the findings of this study, in particular, the recurrent costs of adaptation and short-term nature of many adaptation measures. Given the rapid growth of cities, it is important to ensure that the adaptive capacity of the cities to future climate risks is enhanced by the measures undertaken today and the policy environment for this is sensitive to the possibilities of mal-adaptation. Our study will help bring some of these issues into focus in the academic and policy making community.

Potential for further work

The findings of the project are quite relevant for the three cities which are in transition and on a development path. It is extremely important that these findings are shared with the larger

audience of policy makers, academia and local community to initiate a meaningful dialogue on climate risks, effectiveness of the current adaptation measures, general perceptions about the future adaptive capacity and mainstreaming adaptation into policy processes. Therefore, the project should culminate in journal articles as well as be presented in different fora to make it more relevant and useful. The next logical step would also be to study the policy processes further, especially the formulation of development plans in the cities to understand how climate risks and adaptation can be incorporated into them and how private adaptation measures can be facilitated by the government machinery to reduce the risk of maladaptation.

References

- Biagini et al., (2014), A typology of adaptation actions: A global look at climate adaptation actions financed through the Global Environment Facility, *Global Environmental Change*, 25, pp 97-108
- Brooks, N. et al., (2005), The determinants of vulnerability and adaptive capacity at the national and the implications for adaptation. *Global Environmental Change*, 15, pp 151-163
- Carmin, J. et al., (2013), *Urban Climate Adaptation and Leadership: From Conceptual Understanding to Practical Action*, OECD Regional Development working Papers, 2013/26
- Measham, T. et al., (2011), Adapting to climate change through local municipal planning: barriers and challenges. *Mitigation and Adaptation Strategy for Global Change*, 16, pp 889–909, DOI10.1007/s11027-011-9301-2
- Patankar et al., (2012), Enhancing Adaptation to Climate Change by Integrating Climate Risk into Long-Term Development Plans and Disaster Management,” APN E-Lib, accessed March 7, 2015, <http://www.apn-gcr.org/resources/items/show/1572>
- Porio, E., (2014), Climate Change Adaptation in Metro Manila: Community Risk Assessment and Power in Community Interventions *in* *Community Interventions*, Jan Fritz and Jacques Rheume (eds.), Springer Publications (Netherlands)
- Porio, E., (2014), Climate Change Vulnerability and Adaptation in Metro Manila: Challenging Governance and Human Security Needs of Urban Poor Communities. *Asian Journal of Social Science*, 42, pp 75- 102, Netherlands: Brill Publishers
- Smit et al., (2000), An anatomy of adaptation to climate change and variability, *Climate Change*, 45, pp 223-251

Acknowledgments

The implementation of this project would not have been possible without the financial support given by the Asia Pacific Network for Global Change Research. We would like to thank the APN Secretariat for providing us with adequate funding. We would also like to thank the APN Secretariat team for giving us timely and prompt support in all our activities. The research team is grateful to the public and private stakeholders in the three cities who provided us with valuable inputs. We worked with a number of local government officials dealing with disaster management, urban planning and other departments during our research work. We are grateful to them for their valuable inputs and for providing us with the necessary database including government reports. We would also like to thank the local survey organizations who helped us carry out the primary surveys in the flood affected

areas. Finally, we would like to appreciate the research associates who worked with us and put in lot of efforts to compile the information, analyse data and complete the reports on time.

Part Two: Technical Report

Preface

Climate-related hazards are evident not just in case of low-probability high-consequence events but also exist in high-probability low-consequence events, which lead to recurrent impacts and recurrent costs of adaptation in urban areas. There is a need to characterize adaptation undertaken by public and private stakeholders and understand the costs, their burden on the stakeholders and effectiveness in enhancing adaptive capacity of the cities in the long-term. This project has characterized public and private adaptation measures in Mumbai (India), Bangkok (Thailand) and Manila (Philippines) in response to heavy precipitation events and brought out the policy implications for the long-term adaptive capacity.

Table of Contents

1. Introduction	7
2. Methodology	8
a. Mumbai	11
b. Bangkok	12
c. Manila	12
3. Results & Discussion	13
a. Findings of Mumbai Study	13
b. Findings of Bangkok Study	17
c. Findings of Manila Study	18
4. Conclusions	22
5. Future Directions.....	22
References	24
Appendix.....	25
a. Mumbai	25
1. Introduction.....	26
2. Vulnerability to recurrent floods.....	26
3. Methodology and data sources	31
4. Institutional or public adaptation.....	33

5. Private adaptation	39
6. Assessment of the adaptation efforts	47
7. Conclusions	51
b. Bangkok	53
1. Institutional and Public adaptation.....	54
2. An Analysis of Short to Long Term Plans Related to Climate Change Adaptation.....	54
3. An Analysis of Short to Medium-Term Plans related to Climate Change Adaptation from Public Sectors.....	55
4. An Analysis of Long-Term Plans related to Climate Change Adaptation from Public Sectors	56
5. An Analysis of Urban Services Plans provided by the Public Sector	58
6. An Interview of Public and Private Response and Adaptation Plan	65
7. Cost and benefit analysis of Public and Private Adaptation.....	67
8. Critique of the adaptation efforts	76
9. Policy implications and way forward.....	76
c. Manila	78
1. Introduction.....	79
2. Exposure and vulnerability of the city	80
3. Methodology and data sources	82
4. Institutional or public adaptation.....	83
5. Private adaptation: Structural and Non-Structural Measures	89
6. Critique of the adaptation efforts	92
7. Summary and Conclusions	93
8. Policy implications and way forward.....	95

1. Introduction

Climate-related hazards are evident not just in case of low-probability high-consequence events but also for high-probability low-consequence events, which lead to recurrent impacts and recurrent costs of adaptation. The coastal cities of South and South East Asia are acutely vulnerable to heavy precipitation, sea-level rise, cyclones and typhoons. The cities face frequent weather events related to heavy precipitation resulting in flash floods, loss of life and property, heavy damages to infrastructure and disruption of economic and social services. In light of this, it is critical to assess the vulnerabilities and adaptation strategies used by the coastal cities to cope with future climate risks. Better understanding of the process of responding and adapting to climate-related hazards is important for planning and implementation of adaptation interventions. There is a need to explore aspects of adaptation interventions, such as, public vis-a-vis private adaptation, underlying costs, short to long-term benefits and enhancement of overall city resilience.

The existing literature on adaptation measures and their typology focuses on the widely used public or institutional adaptation measures. However, the private stakeholders like households and commercial/industrial establishments also undertake adaptation measures that need to be characterized to understand their costs, burden on the stakeholders and effectiveness in enhancing adaptive capacity. This study characterizes public and private adaptation measures in the three cities, Mumbai (India), Bangkok (Thailand) and Manila (Philippines) by using primary data gathered from households and commercial/industrial establishments and secondary data obtained from government entities and also evaluates their effectiveness and contribution to long-term resilience.

The following are the key objectives of the study:

- Characterize the public and private adaptation measures in the selected cities – Mumbai, Bangkok and Manila – using primary and secondary data
- Examine various aspects of adaptation measures such as costs, burden on stakeholders and their effectiveness and contribution to the long-term adaptive capacity
- Examine the nature of recurrent impacts and recurrent adaptation
- Understand the policy implications of the findings for future city resilience

The following activities have been undertaken as part of the study:

- Identifying adaptation measures through the primary and secondary data
- For households and commercial sector, primary surveys carried out to understand how they cope with recurring floods, what measures they take to protect themselves and the costs involved therein.
- For the public adaptation measures, secondary data obtained from government documents and reports
- Analysis of costs, benefits, cross-linkages between public and private adaptation, participation of private sector in building public adaptation measures
- Analysis of effectiveness of adaptation measures in light of recent events of flooding in the three cities

2. Methodology

The existing typologies in the literature (as given in Table 1(a) and 1(b) below) classify adaptation measures depending on the types of measures or actions undertaken by the stakeholders. The different typologies identified by various authors overlap in certain categories or actions. They attempt to bring in synergy between adaptation theory and practice to some extent. This is important given the implementation of various adaptation measures throughout the world and the need to understand the 'lessons learned' and the 'best practices' in the field¹. Adaptation measures are generally reactive and anticipatory or proactive² with local, regional and national scope³ and taking the form of technological, financial, behavioural or institutional interventions⁴. The primary drivers of action can be disaster or extreme event, climate variability or climate change⁵. Approach to adaptation can also target the social vulnerability, enhance system resilience or address specific risks⁶ such as heavy precipitation and recurrent floods. Similarly, adaptation actions can be classified in the form of recognition or awareness, groundwork action to prepare stakeholders and actual adaptation action targeting policies, programmes, built environments and institutions⁷. Different funded projects carried out over the last decade have initiated actions related to capacity building, policy, planning and management, practice and behaviour, physical infrastructure, warning systems, financing and so on⁸. Our study uses these typologies to characterize the adaptation measures undertaken by different stakeholders in Mumbai, Bangkok and Manila. ***The detailed reports for each of the cities are given as Annexure to this report.***

¹ Biagini et al (2014), A typology of adaptation actions: A global look at climate adaptation actions financed through the Global Environment Facility, *Global Environmental Change*, 25, pp 97-108

² Berrang-Ford et al (2011), Are we adapting to climate change?, *Global Environmental Change*, 21, pp 25-33 and Smit et al (2000), An anatomy of adaptation to climate change and variability, *Climate Change*, 45, pp 223-251

³ Smit et al (2000), An anatomy of adaptation to climate change and variability, *Climate Change*, 45, pp 223-251

⁴ *Ibid*

⁵ Smit et al (2000), An anatomy of adaptation to climate change and variability, *Climate Change*, 45, pp 223-251 and Cutter et al (2008), A place-based model for understanding community resilience to natural disasters, *Global Environmental Change*, 18(4), pp 589-606

⁶ Eakin et al (2009), Hidden costs and disparate uncertainties: trade-offs involved in approaches to climate policy, Adger et al eds., *Adapting to climate change: Limits to adaptation*, Cambridge University Press, Cambridge

⁷ Lesnikowski et al (2011), Adapting to health impacts of climate change: A study of UNFCCC Annex I Parties, *Environmental Research Letters*, 6(4) and Lesnikowski et al (2013), National-level factors affecting planned, public adaptation to health impacts of climate change, *Global Environmental Change*, 23(5), pp 1153-1163

⁸ Biagini et al (2014), A typology of adaptation actions: A global look at climate adaptation actions financed through the Global Environment Facility, *Global Environmental Change*, 25, pp 97-108

Table 1(a): Classification of existing typologies and adaptation measures depending on the types of measures or actions undertaken by the stakeholders

Adaptation Activities						Approach to Adaptation			Adaptation Form v/s Action		Types of Actions		
Timing relative to stimulus	Intent	Spatial scope	Form	Degree of necessary change	Driver of action	Social vulnerability	Resilience	Targeted adaptation	Reactive	Proactive	Recognition	Groundwork	Adaptation actions
Anticipatory	Autonomous	Local	Technological	Incremental	Disaster/extreme event	Measures addressing social issues	Enhance system resilience	Actions to address specific climate risks	Avoid, retreat	Planning, monitoring	Demonstrating awareness but no action	Vulnerability assessment	Alter institutions, policies and programs
Concurrent	Planned	Regional	Behavioral	Transformational	Climate variability				Cope, accommodate, adjust	Awareness building		Adaptation research, conceptual tools	Changes to built environment and infrastructure
Reactive		National	Financial		Climate change				Spread risk	Enhancing learning and research		Stakeholder networking	Technology improvements
			Institutional									Policy recommendations	Awareness and outreach
													Financial support for autonomous adaptation
													Public health interventions
Smit et al 2000, Fidelman et al 2013, Carter et al 1994, Huq et al 2003, Smit and Skinner 2002, Smit and Vendel 2006, Wilbanks and Kates 1999)					Smit et al 2000, Cutler et al 2008	Eakin et al 2009			Berrang Ford et al 2011)		Lesnikowski et al 2013		

Table 1(b): Classification of existing typologies and adaptation measures depending on the types of measures or actions undertaken in actual projects

Adaptation actions in actual projects									
Capacity building	Management and planning	Practice and behaviour	Policy	Information	Physical infrastructure	Warning or observing systems	Green infrastructure	Financing	Technology
Training and workshops	Developing adaptation plan based on vulnerability and impacts	Rainwater harvesting	Mainstreaming adaptation into plans and policies	Information and communication tools	Climate resilient buildings and other infrastructure	Developing, testing and implementing monitoring systems	New or improved soft, natural infrastructure	Contingency funds for disaster	Develop climate-resilient technologies
Public awareness and education	Livelihood diversification	Resource management	Changes in land use policies	Creating and maintaining databases	Sea walls	Upgrading weather systems	Ecosystem services that would provide natural protection against climate hazards, like mangroves	Private funding	Climate proof infrastructure and services
Information disseminated to different stakeholders	Ecosystem based planning		Compliance with regulations		Reservoirs	Early warning system		Insurance	
Identification of best practices	Disaster risk management				Upgradation of storm water networks			Public private partnerships	
					Canal infrastructure				
Biagini et al 2014									

While many actions or measures do fit into the existing categories or types, there are certain unique characteristics of adaptation measures that we find in practice through the information collected from public and private stakeholders in the three cities. This knowledge base is used to suggest useful additions to the existing typology to cover different aspects of adaptation measures in practice. The existing typologies invariably focus on public adaptation measures given the types of measures, nature of decision-making and financing options for them. However, in the developing world, we come across private stakeholders like citizens, households and businesses initiating adaptation measures. The decision-making, financing and implementation is entirely in the private hands in such cases. The costs and benefits and sources of finance and implementation of privately initiated measures see cross-linkages between public and private domains, in particular, private provision of public adaptation goods. Similarly, there are recurring costs of adaptation given the recurring nature of the flood hazard.

The research project has developed three case studies for Mumbai, Bangkok and Manila. The project teams located in the three countries have jointly developed the methodology and have gathered the relevant information through primary and secondary data collection. Each of the studies have identified and characterized the flood adaptation measures undertaken by both the public (local governments) and private sector (commercial-industrial establishments and residential households), costs involved therein, short to medium-term benefits and their effectiveness in enhancing adaptive capacity in the long-term.

The following methodology has been used to identify and classify the adaptation measures and understand their overall effectiveness:

- Characterization of adaptation using existing typologies identified through extensive literature review
- Identifying adaptation measures undertaken by public and private stakeholders through primary and secondary data and bringing out different aspects related to these measures, in particular, the private adaptation practices and linkages between public benefits and private costs
- Classify the types of adaptation measures implemented in the city using the existing typologies and accommodating unique features that do not conform to these typologies
- Evaluation of public and private adaptation using parameters such as who initiates/undertakes the measures, who bears the costs, who is benefitted and how effective are they over short and medium to long-term

The following subsections give a detailed methodology used for the three case studies including the study areas, primary and secondary data sources and analytical techniques used.

a. Mumbai

In case of Mumbai, the study has relied on the following important sources of data to obtain useful information on different aspects of adaptation measures:

- Primary data from the civic authority Municipal Corporation of Greater Mumbai (MCGM): Detailed personal interviews of civic officials using open-ended questionnaires – departments of the MCGM covered under this study include

disaster management cell, storm water drains, development planning, water supply, sanitation, solid waste, roads and gardens and public spaces

- Secondary data from MCGM: Reports obtained from different departments of the MCGM
- Primary data from questionnaire-based surveys: Primary surveys carried out among 30 cooperative housing societies⁹ and 22 commercial establishments in the flood affected areas of the city
- Detailed questionnaires administered to the housing societies and commercial establishments consisting of questions on physical characteristics, issues related to floods, measures undertaken during pre-monsoon and monsoon period to cope with floods and long term or structural measures to reduce flooding

The adaptation measures undertaken by both institutional or public entities and private stakeholders are discussed in detail in the next two sections.

b. Bangkok

In case of Bangkok, the short term coping and the long-term adaptation of the various important sectors within public sphere and private sector have been evaluated for the following issues:

1. Response and limitation of the public and private sector
2. The preparedness for the future
3. The funding source
4. The preparation of the plan and participation of the public and private sector

These points are investigated through in-depth interviews, in order to analyse the coping and adapting abilities and private and public sector policies after the flood disaster in 2011.

c. Manila

In case of Manila, the study utilizes both primary and secondary sources to investigate the public and private adaptation measures of local governments, commercial-industrial establishments, communities and households in flood prone areas in the Metro Manila cities of Marikina City and Pasig City. The methodology followed and the data sources used are:

- For primary sources, the research team conducted household surveys, key informant interviews (KII), and focus group discussions (FGDs) among housing associations and residents in flood prone communities, local government officials and commercial-industrial establishment owners/managers
- The research team interviewed a total of 50 households representing 15 housing associations and 20 commercial-industrial managers/owners from the cities of Marikina and Pasig in Metro Manila
- Secondary data sources, focus group discussion (FGDs) and key informant interviews supplemented the household and commercial-industrial surveys

⁹ A cooperative housing society, as per the Maharashtra Co-operative Societies Act, 1960, is a society (group of housing units) whose object is to provide its members with the open plots of land, dwelling units or apartments and common amenities and services. Members also elect representatives who take decisions on behalf of the individual household members and look after the common services and their maintenance.

3. Results & Discussion

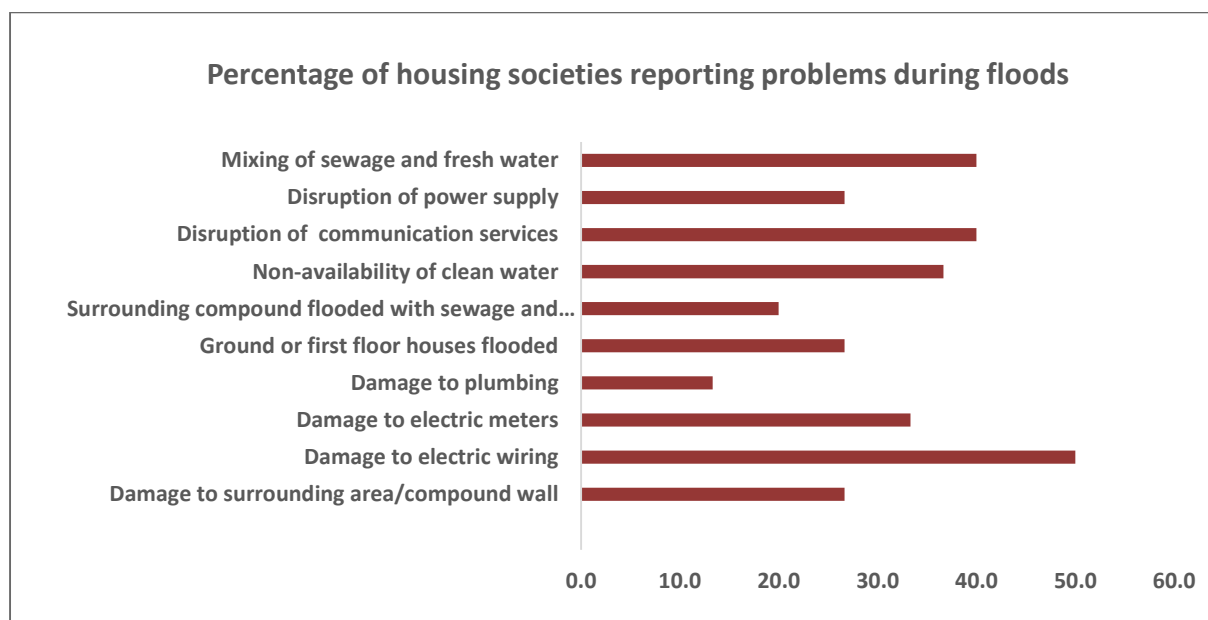
The project findings in the three cities highlight their vulnerability to climate risks due to their geographic location, flood prone topography, large population with a major percentage living a life of poverty in informal settlements, changing land use pattern, rapid infrastructure development often through reclaiming land from sea (as in case of Mumbai) and inadequate civic amenities. The study has characterized the public and private adaptation measures in response to heavy precipitation events in the three cities.

We describe in this section the results of the analysis carried out using primary and secondary data in the three cities. The following sub-sections give details of the adaptation measures undertaken by both the public (local governments) and private sector (commercial-industrial establishments and residential households), costs involved therein, short to medium-term benefits and their effectiveness in enhancing adaptive capacity in the long-term.

a. Findings of Mumbai Study

In case of Mumbai, MCGM is the Urban Local Body and therefore the primary agency responsible for city governance and provides civic amenities including education and public health. The civic body is the first and primary responder to recurrent floods and building storm water infrastructure to reduce the extent of flooding in the city. The DMC working under the MCGM is responsible for rescue and relief operations during floods. The other core departments responsible are Storm Water Drainage department, Solid Waste Management department and the Roads department.

Figure 1: Major problems faced by housing societies during floods



In case of private adaptation, in residential areas, households are the immediate and first responders when we consider private responses and adaptation practices. In cities like Mumbai, households organize themselves into housing societies, which take decisions on their behalf. The major problems faced by the housing societies during floods are shown in

Figure 1 and the measures undertaken by these housing societies during pre-monsoon and monsoon are tabulated in Table 2.

Table 2: Measures undertaken by housing societies during pre-monsoon and monsoon

Measure	% of HHs undertaking measure	% undertaking measure every year	Average budget (in Rupees (Rs.)) with range in bracket
Pre-monsoon			
Cleaning the surrounding ground / compound	86.7	84.6	20000 (2000-100,000)
Cleaning the nearby gutter or nullah	86.7	65.4	
Repairing the compound wall/fence	33.3	50.0	
Monsoon			
Cleaning the compound of garbage/sewage	83.3	88.0	6000 (500-12,000)
Disinfecting the premises	63.3	63.2	

In addition to this, after the unprecedented floods of July 2005, housing societies decided to undertake structural changes to achieve long-term solutions to the various problems faced by them year after year due to floods. Table 3 gives the list of these structural measures, their average costs and source of finance.

Table 3: Structural measures undertaken by housing societies to cope with floods

Measure	% of HHs undertaking measure	Average cost in Rs.	Source of finance
Increase the height of the surrounding plot	43.3	13000	Members' contribution/Society corpus
Reconstruction with stilt parking	13.3	50000	Members' contribution
Relocating electric meter room	26.7	9000	Members' contribution/Society corpus
Relocating/ Elevating water pump room	30.0	12000	Members' contribution
Elevating electric meters to a higher level	20.0	10000	Members' contribution
Modifying/repairing water supply network inside premises	30.0	5000	Members' contribution
Paver blocks	13.3	NA	Elected representative

In case of commercial establishments, the major problems faced by them during floods are shown in Figure 2 and the measures undertaken by these housing societies during pre-monsoon and monsoon are tabulated in Table 4.

Figure 2: Major problems faced by businesses during floods

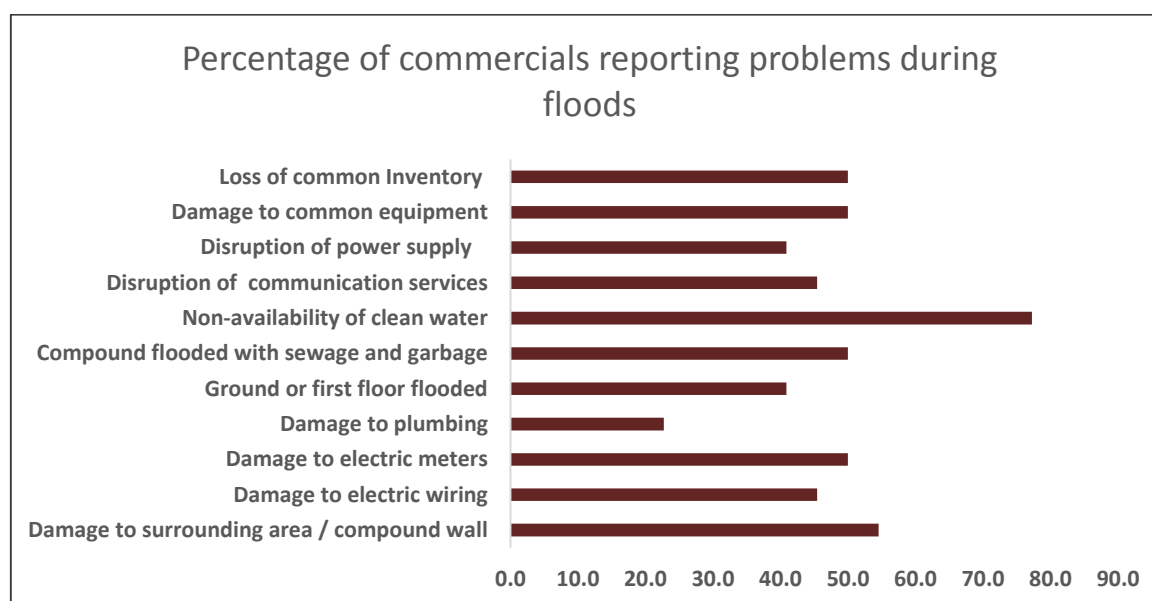


Table 4: Measures undertaken by businesses during pre-monsoon and monsoon

Measure	% of businesses undertaking measure	% of businesses undertaking measure every year	Average budget (in Rs.) with range in bracket
Pre-monsoon			
Cleaning the surrounding ground / compound	59.1	100.0	18000 (4000-100,000)
Cleaning the nearby gutter or nullah	63.6	100.0	
Repairing the compound wall/fence	59.1	61.5	
Monsoon			
Cleaning the compound of garbage/sewage	77.3	100.0	13000 (1000-60,000)
Disinfecting the premises	63.6	82.4	

Table 5 gives the list of the structural measures undertaken by the businesses to cope with floods, their average costs and source of finance.

Table 5: Structural measures undertaken by businesses to cope with floods

Measure	% of businesses undertaking measure	Average cost in Rs.	Source of finance
Increase the height of the surrounding plot	41	30000	Developer/owner
Reconstruction of the building with stilt parking	41	50000	Developer/owner
Elevating electric meters to a higher level	27	8000	Owner
Relocating electrical meter room	27	6000	Owner
Relocating/ Elevating water pump room	14	5000	Developer/owner
Modifying plumbing system	9	5000	Owner
Modifying/repairing water supply network in the premises	9	10000	Developer/owner
Repairs inside premises to elevate furniture	5	5000	Owner
Repairs inside premises to elevate electronic gadgets	5	5000	Owner
Repairs to elevate equipment	5	5000	Owner

Apart from the cooperative housing societies and commercial establishments, groups of citizens organized into non-governmental organizations (NGOs) and advanced locality management committees (ALMs) have played a significant role in short-term responses to the extreme and recurrent floods in Mumbai. These institutions volunteer their help¹⁰ by creating temporary shelters for citizens stranded on the road and manoeuvring the solid waste by creating temporary dumping grounds. Some of the NGOs have also been involved in imparting training to the city youth through the community based Disaster Risk Management Programme, supported by the Disaster Management Cell (DMC) of MCGM. The training programme covers various aspects related to dealing with the disasters/extreme events and aims to create capacity among communities to handle disasters effectively and save lives of maximum number of people by initiating support activities.

The role of ALMs is also noteworthy here since they act as the support partners and coordinators between MCGM and citizens in housing societies. ALMs are groups of housing societies or buildings located on the same street and are formed with voluntary participation of the citizens living there. Although the main focus of their work as per MCGM is to participate in activities related to waste management, they are known to take up many civic issues critical for their respective areas. ALMs get financial support from the member

¹⁰ MCGM (2006), Fact Finding Committee on Mumbai Floods, Final Report, Volume I, March 2006

housing societies themselves and MCGM provides technical support required for waste management practices.

b. Findings of Bangkok Study

In case of Bangkok, the plans to cope with climate change can be separated into 7 main subject categories or sectors:

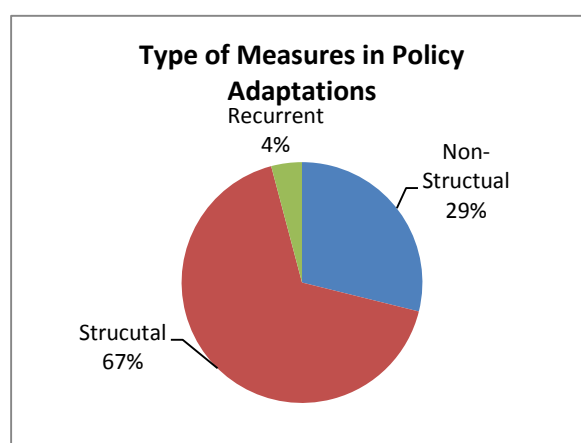
1. Urban planning – the development of cities to mitigate the impact of climate change
2. Water management – in response to the flood in 2011, plans to manage water in Thailand have been given priority in comparison to incidences arising from disaster event
3. Finance – the fiscal system which plays an important role in gearing flood management
4. Insurance – a sector that illustrates the importance of coping mechanisms to deal with future risks
5. Governance – good governance, for instance, participation, accountable resource management, decentralization of power to local governments
6. Infrastructure
7. Transportation

The short term coping and the long-term adaptation of the various important sectors in both private and public segments in this study have been evaluated for:

1. Response and limitation of the public and private sector
2. The preparedness for the future
3. The funding source
4. The preparation of the plan and participation of the public and private sector

Figure 3: BMA and some of BMR Urban Development and Climate Change Adaptation Policies: classification by type of measures: Structural and Non-Structural ¹¹

Type of Measures	Number of Projects
Non-Structural Measure	28
Structural Measure	65
Recurrent Adaptation	4
Total	97



¹¹ All programs are published on the Bangkok Public Relations division, are projects within Bangkok and its vicinities (outer ring 2 and some projects along the coast) since the year 2011-2012 (the post 2011 flood operations) and in the year 2014-2015 (the preparedness of flood coping mechanisms)

The adaptation projects within Bangkok are implemented repeatedly per year. This can be illustrated as follows:

Table 6: Adaptation projects in Bangkok

Project	Year of Budget	Budget amount
"dredge drainage systems of roads, lanes, alleys with areas of Bangkok" from the original an MOU agreement was made between the department of corrections and Bangkok in the year 2012 in a total of 50 districts in Bangkok	2012	271 million baht
"dredging of draining systems to cope with rain water" Department of Drainage has accelerate the cleaning of drainage pipes, where in Bangkok has approximately 277 lines and is 964,842 meters long (50 million baht)	2011	130 million baht
Dredge the outer canals to cope with floods from the eastern bank, with 16 canals, with 13 canals on the Eastern bank (67 million baht)		
The project to dredge canals in Bangkok districts, in total of 677 kilometers, in the agreement of the Department of Drainage and the Thai army.	2010	380 million baht

The above table illustrates the policies or measures for adaptation in Bangkok during the flood and rainy season and is repeatedly implemented each year to open the waterways. Other than dredging the canals, there is also the removal of water weeds along the river and canals, or waste collection. Each of the projects is often in cooperation with the different sectors such as the public sector, the army, or the department of corrections because of the need to use large quantities of personnel and limited period of time.

In case of private adaptation, the study complimented a small set of samples of household survey, to understand community recovery time after 2011 flood. A survey of 30 households found that the residential sector does not have the readiness to adapt to the effects of climate change due to the perception that the risks are not within their scope. There are no plans for such risks, where coping measures are still found in a more ad-hoc manner, among both the households and the community level.

c. Findings of Manila Study

In case of Manila, the study found that most of the adaptation measures initiated by national, metropolitan and local government agencies largely addressed the building of institutional, physical and/or infrastructural resilience. These really constitute the *hardware* of risk reduction and climate adaptation. But the *software* -- human resource capability building-- while acknowledged as having a central role by national and local policies role in building a "culture of safety and disaster preparedness" among local governments and citizens, the budgetary allocation for this component in adaptation investments is quite miniscule.

Local governments are the frontline actors/stakeholders in the implantation of climate adaptation and disaster risk reduction and management strategies. Some of the structural and non-structural measures undertaken are:

Table 7: Structural and non-structural measures in Manila

Structural	Non – Structural
<ol style="list-style-type: none"> 1. Installation of the state-of-the-art early warning system (EWS) connected to an integrated weather/climate assessment and monitoring system (e.g., CCTVs, GPS vehicle tracking, radio links to the national weather bureau, wide area alarm siren systems, etc.). This system also includes the installation of automatic weather station (AWS) in critical urban areas, increasing the efficiency of information gathering regarding rainfall levels in different parts of the city, which have potential but variable contribution to flooding. This integrated system increased the efficiency and effectiveness of flood warnings, especially to the informal settler communities and commercial-industrial establishments along the riverbanks and floodways, including those flood prone areas in other parts of the city. 2. Installed a more sophisticated fiber optic connectivity to increase the local government’s capacity to monitor and share information with the key units and stakeholders in different districts and communities (e.g., real time video streams transmitted to key decision-makers). 3. Acquired a sophisticated software for damage assessment and monitoring (e.g., REDAS in Pasig City’s Emergency, Rescue and Recovery Division), supported with a vehicle tracking system and weather bureau radio links. This is to increase the efficiency and effectiveness of the city’s early warning system of the city. 4. Construction and/or improvement of infrastructure: a) road/road dike construction/improvement along rivelines and water channels; b) DRRM office, c) pumping stations for flood water including portable pumping stations which is more effective for floodwaters in critical waterways, d) flood control gates, e) evacuation centers. This is to promote overall infrastructure resiliency of the city against floods and other climate-linked risks/dangers. 5. Dredging of rivers, creeks, canals and other waterways to improve efficiency of flood flow. 6. Strict implementation of the anti-pollution device law for commercial and industrial establishments. This is part of the clean air campaign of the city so as to decrease the air pollutants emitted by industries/commercial establishments. 7. Heightened implementation of “clean and green” programs including rehabilitation of parks, playgrounds, urban gardening/farm, buffer zones, green building, rainwater harvesting facilities, massive tree planting, regular waterways cleaning and/or upgrading and other water diversion techniques. This is one set of “green” interventions 	<ol style="list-style-type: none"> 1. In view of the flood impacts of Ketsana in 2009, the local government revised its comprehensive land use and development plans, including but not limited to the following: <ol style="list-style-type: none"> a. Revision of building codes (i.e., new building standards and designs like an ordinance mandating that habitation happens in the second floor and leaving the ground floor free for unimpeded floodwater passage); b. Designation and better design for new and safe resettlement sites; c. Revised city investment plan including incentives for relocation of industries to less flood prone areas. 2. Conduct of emergency community planning for effective disaster response by DRRM officials with key stakeholders, especially in vulnerable communities along the river, lake and coasts. 3. Continuous training and employment of “green police/aides” in partnership with local DRRM units (i.e., community- or <i>barangay</i>-based). 4. Public advocacy activities for “clean and green city” measures like solid waste management, clean air drive (carless Sundays, bike movement, e-jeep/trike, anti-pollution mechanisms, carbon-sink initiatives like tree planting), etc. 5. Capability building and training programs for disaster response, preparedness and resilience building for DRRM officials/staff and related units of the local government, including those in the communities or <i>barangays</i> (e.g., rescue, emergency and disaster training; community hazard mapping). 6. Multi-sectoral consultations/dialogues, community participation and other regular feed-backing mechanisms are key to the formulation and implementation of climate and DRRM-related ordinances and policies (e.g., the formulation of a climate and flood resilient framework for the city). This is to facilitate communication and delivery of support services across sectors. 7. Building livelihood resilience initiatives among informal settlers, women and youth: a) Eco-savers cooperative programs in partnership with schools and communities, b) crafts from recycled products and water hyacinths in the floodways, c) organizing women and youth into livelihood groups which are linked to a foundation, d) training informal settlers for “clean and green” jobs. 8. Building identity, pride and commitment to the environment and place. After the great floods in 2009, “The Pasigueno Spirit” in Pasig City or the

<p>supporting the climate resilience drive of the city.</p> <p>8. Relocation and upgrading of informal settlements along rivers and water channels to facilitate flood flow and reduce risk for the people residing in these areas. This also include other resettlement components like the “balik sa probinsya” (back to the province or countryside) schemes.</p> <p>9. Social housing programs (limited) for flood-displaced residents. This is to reduce the clogging of riverbanks/water channels with informal settler families (ISF).</p>	<p>“Marikit Na” (Beautiful Marikina) movement has been a concerted effort by residents and city/community leaders alike. This strategy is designed to strengthen community spirit and solidarity to support the climate and disaster adaptation initiatives of their city government.</p> <p>9. Disaster Preparedness and Resilience. The focus here was on improving access and standards of infrastructure related to delivery of basic services for distribution of potable water, electricity and health care. Investments in improving the distribution of emergency drinking water supplies, sanitation facilities—efficient networks of distribution</p>
---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

In case of Private adaptation, as shown in Table 8 below, an overwhelming majority (95 percent) took measures in preparing for the floods such as cleaning their surrounding areas or compound; cleaning the gutter or canal; clean compound of garbage/sewage and repair of compound wall or fence (55 percent). In general, the residents did these preparatory tasks several times a year. But slightly over half of them (55 percent) participated every year in the repair of a common structure like the compound wall/fence. But only 40 percent reported that they set aside a budget ranging from P200-P2000 (US\$5-50) to contribute to the repair of these structures before and during the monsoon period.

Table 8: Percent of Households/Residents Undertook Measures **prior** to the Monsoon Period (N= 50 Households)

Measures	% of residents	Frequency
Cleaning surrounding areas or compound	95 percent	Several times a year
Cleaning gutter or canal	95 percent	Ditto
Participated in the repair of compound wall or fence	55 percent	Ditto
Set aside budget for repair of compound wall or fence	40 percent	Irregular; when budget permits
Clean compound of garbage/sewage	95 percent	Several times a year
Disinfecting premises	75 percent	Several times a year

Table 9: Percent of Households/Residents Undertook Measures **during** the Monsoon Period (N=50 Households)

Measures	% of residents	Frequency
Cleaning of surrounding areas or compound	95 percent	Several times a year
Cleaning gutter or canal	95 percent	Ditto
Participated in the repair of compound wall or fence	55 percent	Ditto
Set aside budget for repair of compound wall or fence	40 percent	Irregular; when budget permits

Clean compound of garbage/sewage	95 percent	Several times a year
Disinfecting premises	75 percent	Several times a year

At the household and community level, the structural measures that the residents employ to cope with floods include adding additional floor to their house, reinforcing the posts/foundations and strengthening the roof/walls. They also helped in reinforcing the perimeter walls of the housing complex/compound. The above structural measures were supplemented with non-structural measures like cleaning the surrounding areas/compound, canals/water channels, and observing proper solid waste management practices inside the household and in the community.

Table 10: Percent of Households/Residents Undertaking Long-term Measures

Measures	% of residents	Cost and source of financing
Increase height of the surrounding plot	30 percent	P5,000-P15,000 private financing
Reconstruction w/ stilt parking	20 percent	No data
Relocating Electric meter	20 percent	P550-P3000 private financing
Relocating/Elevating Water Pump room	10 percent	P3000, members' contribution
Elevating electric meter to higher level	30 percent	P600-P2200, members contribution
Modify plumbing system	30 percent	P200-P5,000, members' contribution
Modify/repair water supply network	15 percent	P2,00-P3000, members' contribution
Covering terrace w/ permanent roof	10 percent	P2,000-P16,000, private financing

(US\$ 1 dollar = P43.00)

In case of Commercial establishments, based on a survey of 20 commercial-industrial establishments along the Pasig-Marikina River System, the following are the adaptation measures of the private sector:

1. Structural measures include but not limited building and design adaptation of roof, walls, floor to the intensity of monsoon rains and winds; strengthening/reinforcing of building structures; escape/evacuation routes clearly delineated; length of ground floor and storage raised/increased above the highest flood length during Ketsana. Other adaptations include:
 - a. Transport—structural adaptation of transport vehicles like elevated wheels so the flood waters will not damage the machine or the passengers; buying insurance for damages from flood (learning from the *Ondoy* (Ketsana) where insurers refuse to compensate for “acts of God” like natural calamities like floods;
 - b. Infrastructure—elevating the roads, building bigger culverts, water channels, flood resilient roads, bridges;
 - c. Services—relocating, elongating and reinforcing their electricity connections/posts and water pipes.
2. Non-structural measures adapted include early warning system in place for the employees (flood level warning displayed in front of the factory post),

information/communication materials displayed in the bulletin boards of each floor, multi-graded evacuation sites for different levels of flood length

3. In general, commercial-industrial establishments along the flood lines concentrated in “fortifying” their structures and surroundings in preparation for the next flood.
4. Linking and coordinating the establishments’ disaster preparedness to that of government bodies like the local government and the Metro Manila Development Authority.

Comparing the patterns of responses and adaptation measures of government, commercial and industrial establishments and urban poor communities shows the increasing emphasis of non-structural measures alongside structural/engineering-based solutions or initiatives. This is a significant change after the great Ketsana floods in 2009. Our earlier studies (e.g., Porio, 2011) showed heavy emphasis by city governments on structural and/or engineering measures such as infrastructure resilience-building/construction or improvement of roads, bridges, pumping stations, river dredging and the like.

Among local governments, there is also an increasing consciousness regarding the importance of building non-structural measures like increasing community awareness and participation through training and other capability-building programs in building community and city resilience.

4. Conclusions

As stated earlier, this research project characterizes adaptation undertaken by public and private stakeholders and understand the costs, their burden on the stakeholders and effectiveness in enhancing adaptive capacity of the three selected cities Mumbai (India), Bangkok (Thailand) and Manila (Philippines) in response to heavy precipitation events and bring out the policy implications for the long-term adaptive capacity. The project has developed case studies for the selected cities, which are given as Annexure to this report.

Each study is based on the analysis of primary and secondary data pertaining to the flood adaptation measures undertaken by both the public (local governments) and private sector (commercial-industrial establishments and residential households), costs involved therein, short to medium-term benefits and their effectiveness in enhancing adaptive capacity in the long-term. After characterizing these adaptation measures, the analysis has focused on the effectiveness of the measures i.e. short term or long term, wherein, we have examined the responses of the civic administration as well as citizens themselves.

The project findings in the three cities highlight lack of coordination among various civic entities to work towards an integrated approach, public – private integration, need for developing incentive structures that will make people follow policies and program norms and/or change their behaviour, focus on short-term and recurrent adaptation measures instead of cost effective and long term adaptation measures.

5. Future Directions

The project has achieved its stated objective of characterizing the public and private adaptation measures in the three selected cities. The case studies developed here examine different aspects of these measures, such as, their costs, burden on the stakeholders, their effectiveness over short to long-term and potential to enhance the future adaptation capacity. There are critical policy implications of the findings of this study, in particular, the

recurrent costs of adaptation and short-term nature of many adaptation measures. Given the rapid growth of cities, it is important to ensure that the adaptive capacity of the cities to future climate risks is enhanced by the measures undertaken today and the policy environment for this is sensitive to the possibilities of mal-adaptation. Our study will help bring some of these issues into focus in the academic and policy making community.

The project findings will improve the understanding of human dimension to climate change by understanding the design and implementation of public and private adaptation interventions at the local level. The project will also lead to better characterization and documentation of public and private adaptation measures and their costs and benefits. In addition to this, there will be identification of policy implications for long-term city resilience and adaptation strategies and providing inputs in integrating them with long-term development plans.

The findings of the project are quite relevant for the three cities which are in transition and on a development path. It is extremely important that these findings are shared with the larger audience of policy makers, academia and local community to initiate a meaningful dialogue on climate risks, effectiveness of the current adaptation measures, general perceptions about the future adaptive capacity and mainstreaming adaptation into policy processes. Therefore, the project should culminate in journal articles as well as be presented in different fora to make it more relevant and useful. The next logical step would also be to study the policy processes further, especially the formulation of development plans in the cities to understand how climate risks and adaptation can be incorporated into them and how private adaptation measures can be facilitated by the government machinery to reduce the risk of maladaptation.

References

- Biagini et al., (2014), A typology of adaptation actions: A global look at climate adaptation actions financed through the Global Environment Facility, *Global Environmental Change*, 25, pp 97-108
- Brooks, N. et al., (2005), The determinants of vulnerability and adaptive capacity at the national and the implications for adaptation. *Global Environmental Change*, 15, pp 151-163
- Carmin, J. et al., (2013), *Urban Climate Adaptation and Leadership: From Conceptual Understanding to Practical Action*, OECD Regional Development working Papers, 2013/26
- Cutter et al., (2008), A place-based model for understanding community resilience to natural disasters, *Global Environmental Change*, 18(4), pp 589-606
- Eakin et al., (2009), Hidden costs and disparate uncertainties: trade-offs involved in approaches to climate policy, Adger et al eds., *Adapting to climate change: Limits to adaptation*, Cambridge University Press, Cambridge
- Lesnikowski et al., (2013), National-level factors affecting planned, public adaptation to health impacts of climate change, *Global Environmental Change*, 23(5), pp 1153-1163
- Lesnikowski et al., (2011), Adapting to health impacts of climate change: A study of UNFCCC Annex I Parties, *Environmental Research Letters*, 6(4)
- Measham, T. et al., (2011), Adapting to climate change through local municipal planning: barriers and challenges. *Mitigation and Adaptation Strategy for Global Change*, 16, pp 889–909, DOI10.1007/s11027-011-9301-2
- Patankar et al., (2012), Enhancing Adaptation to Climate Change by Integrating Climate Risk into Long-Term Development Plans and Disaster Management,” APN E-Lib, accessed March 7, 2015, <http://www.apn-gcr.org/resources/items/show/1572>
- Porio, E., (2014), *Climate Change Adaptation in Metro Manila: Community Risk Assessment and Power in Community Interventions* in *Community Interventions*, Jan Fritz and Jacques Rheume (eds.), Springer Publications (Netherlands)
- Porio, E., (2014), *Climate Change Vulnerability and Adaptation in Metro Manila: Challenging Governance and Human Security Needs of Urban Poor Communities*. *Asian Journal of Social Science*, 42, pp 75- 102, Netherlands: Brill Publishers
- Smit et al., (2000), An anatomy of adaptation to climate change and variability, *Climate Change*, 45, pp 223-251

Appendix

a. Mumbai

Mumbai Case Study

By Archana Patankar¹², Sravanthi Rallabandi¹³ and Anand Patwardhan¹⁴

¹² Senior Research Fellow, Regional Centre for Urban and Environmental Studies, All India Institute of Local Self Government, Mumbai

¹³ Program Officer, Regional Centre for Urban and Environmental Studies, All India Institute of Local Self Government, Mumbai

¹⁴ Professor, School of Public Policy, University of Maryland, USA

1. Introduction

The coastal cities in South Asia are acutely vulnerable to the risks of heavy precipitation, sea-level rise, cyclones and coastal erosion. These cities face frequent weather events related to heavy precipitation resulting in flash floods. In recent years, cities like Mumbai, have witnessed unprecedented floods resulting in massive losses of life and property, heavy damages to built infrastructure, economic losses and disruption of economic and social services. More than half of the population living in this megacity are poor and more vulnerable to these impacts. Yet they do not have adequate insurance or social security cover to protect them from the losses inflicted by floods. It is now widely accepted that impacts of future climate change will often be observed through changes in the magnitude and frequency of existing climate hazards in the form of weather events. Further, climate-related hazards are recurring not just in the form of low-probability high-consequence events but also exist as high-probability low-consequence events. In light of this, it is critical to assess the vulnerabilities and devise adaptation strategies for Mumbai to cope with future risks from weather events.

The frequent weather events, mainly heavy precipitation resulting in floods, have made the civic administration undertake a number of short to medium-term adaptation measures. However, the effectiveness of such measures and their contribution to long-term city resilience needs to be evaluated. The city residents – households and commercial establishments – also take steps at the micro level to protect themselves from flash floods associated with heavy precipitation. However, there are recurrent impacts and recurrent costs of adaptation. There is, thus, a need to characterize adaptation undertaken by both public and private stakeholders, understand the costs, their burden on the stakeholders and effectiveness in enhancing adaptive capacity in the long-term. This study aims to characterize public and private adaptation in Mumbai in response to heavy precipitation and floods and seeks to add to the existing typologies of adaptation by identifying certain unique characteristics about adaptation efforts in the city.

The case study on Mumbai is presented here as follows. The next section describes the vulnerability of the city due to heavy precipitation and recurrent floods across the identified chronic flood spots. Section 3 gives details of the methodology and data sources used in identifying and evaluating different short to medium-term adaptation measures. Public or institutional adaptation, i.e., the role played by various departments of the local government is described in Section 4 followed by the measures undertaken by the private stakeholders, namely, cooperative housing societies and commercial establishments, as discussed in Section 5. There are certain unique features of adaptation activities in the city that are important while characterizing adaptation in a developing country context. We discuss, in Section 6, these features including inter-linkages between public and private adaptation as well as shortcomings of all the current measures. Section 7 draws conclusions based on the main findings of the study.

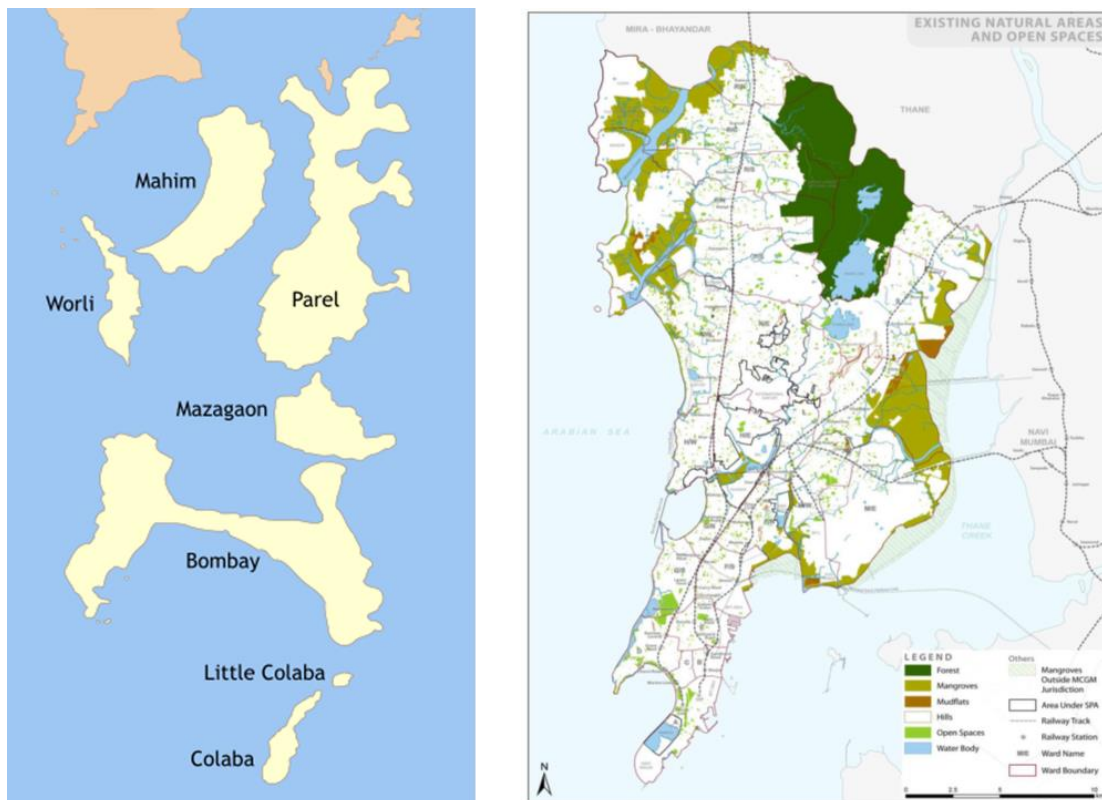
2. Vulnerability to recurrent floods

Mumbai is a coastal city in the Indian state of Maharashtra covering an area of 415.05 sq. km, and is also the state's capital. With a population of over 12 million, it is one of the largest mega cities in the world. The coastline of Mumbai is about 167 km long and has estuaries bays, creeks and beaches and is built on the central low-lying part of the island. The city is

the financial capital of India with a large commercial and trading base. With per capita income thrice that of the national average, Mumbai makes huge contribution to the total tax revenues of the country. The city is an important international sea port and strategic from defense perspective.

Mumbai, or formerly known as Bombay, constitutes the reclaimed land into the sea comprising seven islands, as seen in Figure 1 below. These seven islands were fishing villages and the reclamation activity was undertaken during the British rule in India. Since then, the city has transformed itself into a bustling megapolis. As per the current Development Plan of Greater Mumbai (2014-2034)¹⁵, the total developed area is 271.17 sq. km, which is about 65.34 % of the total area. Of this, the maximum area is under Residential (24.88%) followed by Transportation and Communication Facilities (12.79%) and Industrial (5.40%). The green cover of Mumbai is 128.42 sq. km, covering 30.94% of the total area. Extensive physical and economic development of the city had a major negative impact on the extent of green cover. It is evident that there has been a major shift in the land use pattern of the city and that has implications for the local weather patterns as well as creation of localized flooding spots. The Development Plan of Greater Mumbai (2014-2034), also reveals that 26.32% of the total area of Greater Mumbai has been affected by Coastal Regulation Zone (CRZ).

Figure 1: Mumbai: In 1900s and Now

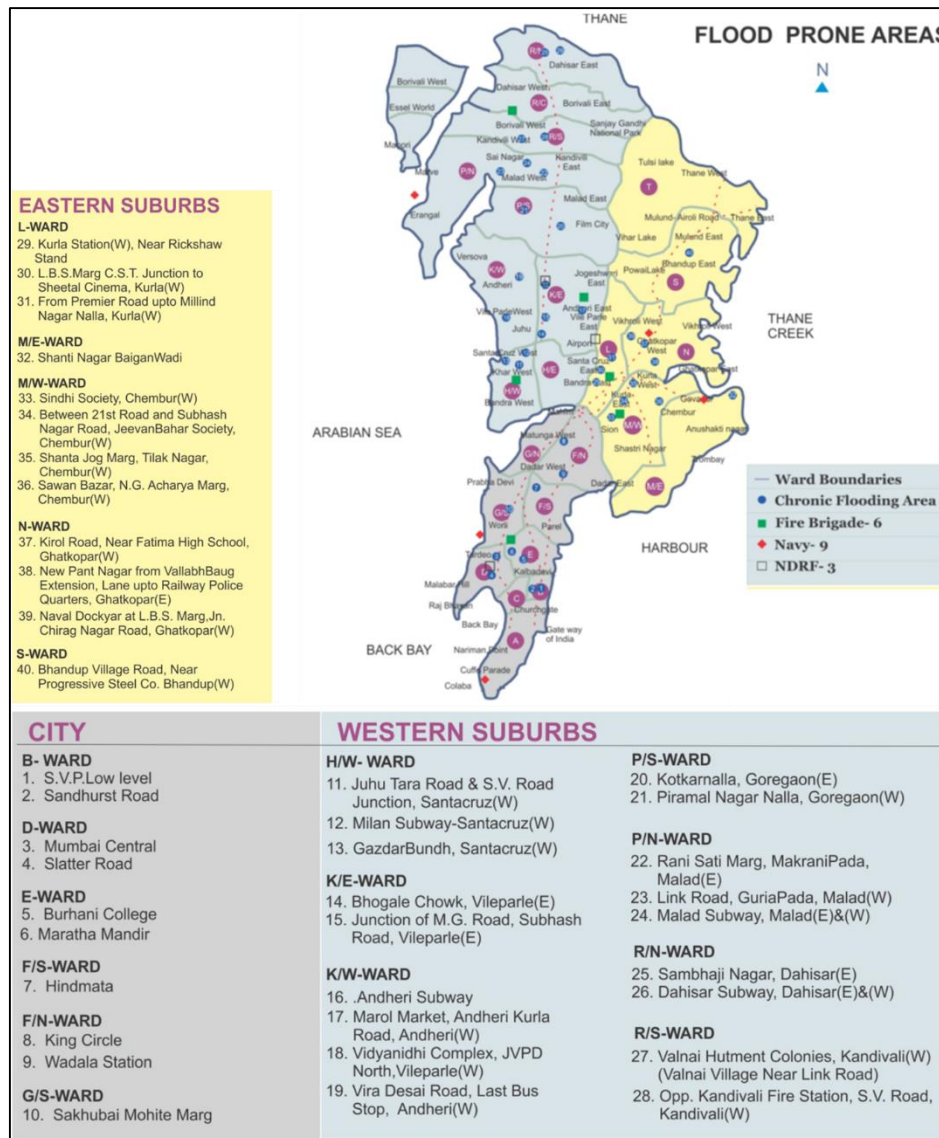


Source: Development Plan of Greater Mumbai (2014-2034), MCGM, 2014

¹⁵ Development Plan of Greater Mumbai (2014-2034), Available at: <http://www.mcgm.gov.in/irj/go/km/docs/documents/Draft%20Development%20Plan/5.%20Draft%20DP%20Report/DRAFT%20DP%20REPORT%20-%20202034%20Final.pdf>

The topography of the city also has a gentle tilt toward the west. Due to the location on the sea coast, river flood plain, flood prone topography and the landmass composed largely of reclaimed areas, the city is acutely vulnerable to climate risks. In this regard, the Greater Mumbai Disaster Management Action Plan (DMAP) has identified 40 chronic flooding locations as seen in Figure 2 below that are spread over the island city, eastern and western suburbs. The chronic flood spots are found in three types of areas - low-lying areas, river flood plain (Mithi River which flows through the middle of the city) and reclaimed areas. Besides the chronic flooding spots, changing land use patterns have also created localized flooding spots. The chronic and localized flooding spots lead to recurrent floods in the city.

Figure 2: Chronic flooding spots identified under the Disaster Management Action Plan



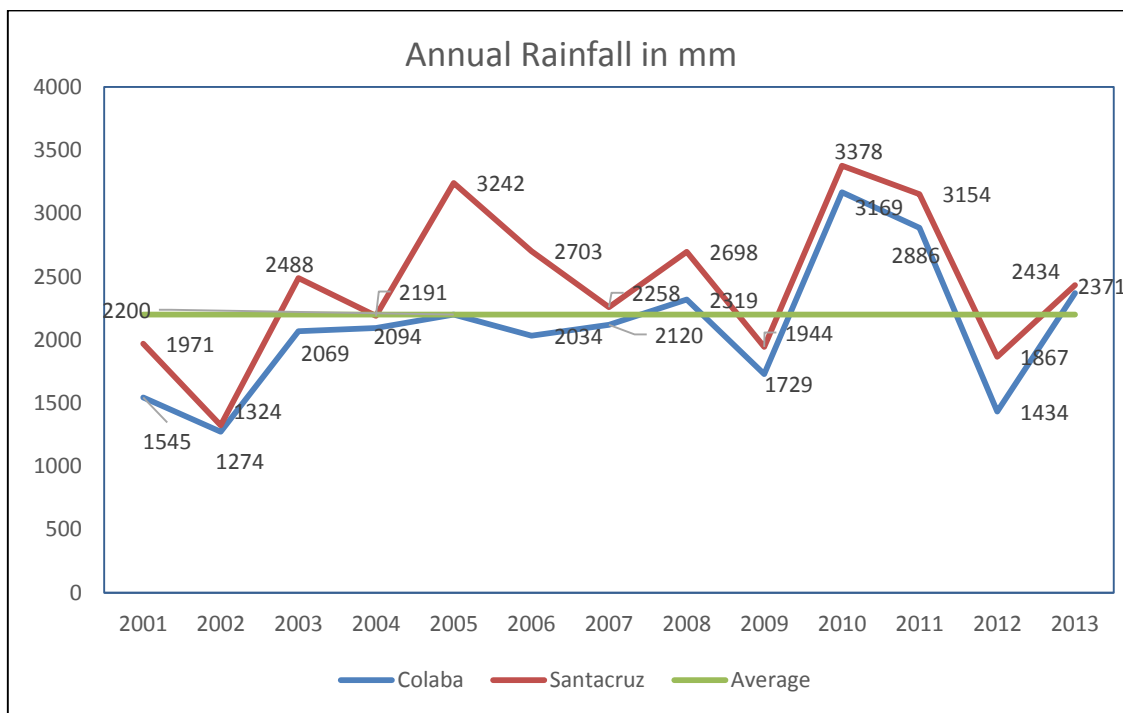
Source: Greater Mumbai Disaster Management Action Plan (DMAP)

Mumbai records an annual average rainfall of 2129 mm per year during the monsoon season between June and September¹⁶. Between year 2001 and 2013, almost every year, barring a few, the city has recorded the annual rainfall greater than the average as per the

¹⁶ Zope P. E., Eldho T. I. and Jothiprakash V, Study of Spatio - Temporal Variations of Rainfall Pattern in Mumbai city, India, Journal of Environmental Research And Development, Vol. 6 No. 3, Jan-March 2012

Figure 3 below. Looking at the average distribution of rainfall in the city, as much as 31 inches of rainfall is generally recorded in the month of July alone, which is also the wettest month. Typically, the monsoon stretches from June till September and one of the most challenging times of the year for the city. A direct result of the rainfall is noticed on the public transport system, primarily the local trains which are the backbone of the city. The rampant urbanization and population explosion has meant that the available infrastructure becomes highly ineffective in case of an emergency.

Figure 3: Annual recorded rainfall (mm) in 2001-2013 in Mumbai



Source: India Meteorological Department, www.imd.gov.in

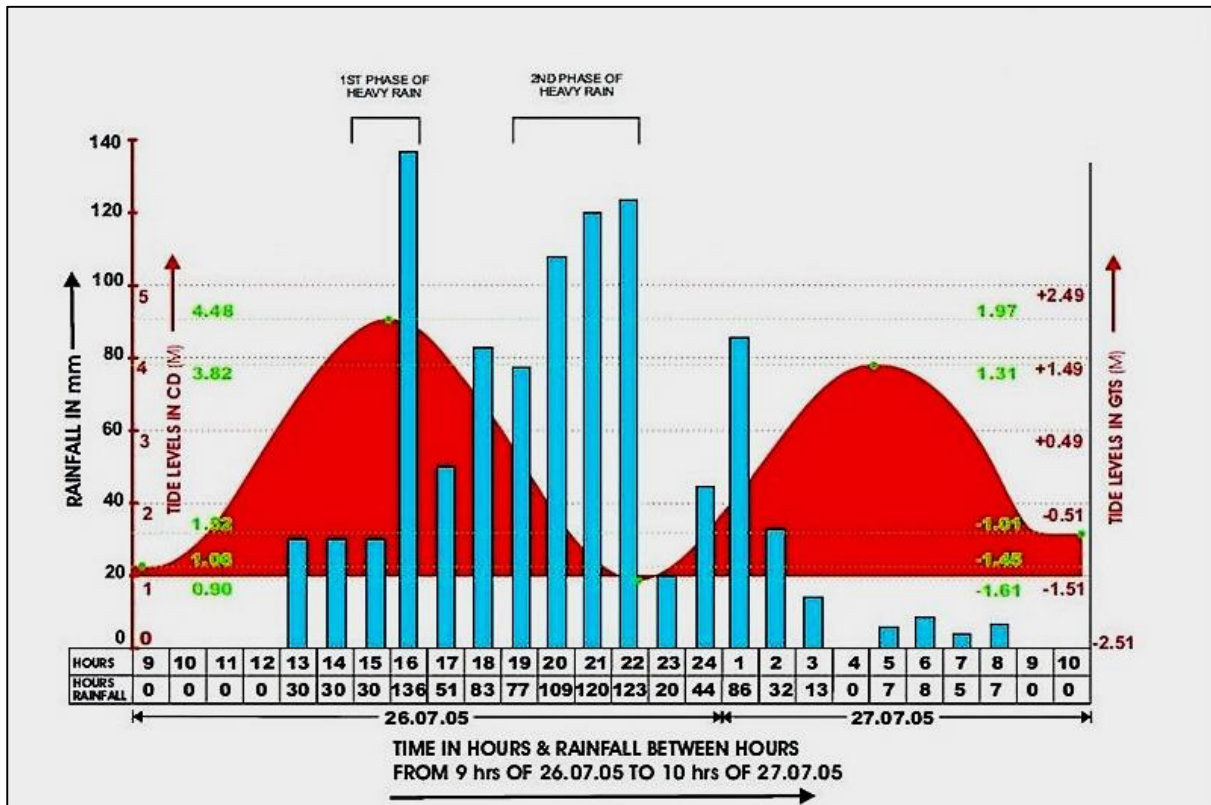
The India Meteorological Department (IMD) defines rainfall as ‘heavy’ if the precipitation is more than 65 mm in a day and it is termed as ‘very heavy’ if the daily precipitation exceeds 135 mm. Very high precipitation greater than 200 mm per day is also not uncommon in the city. The days when the daily rainfall is above 65 mm are critical for the city from the point of view of flooding. The Disaster Management Cell (DMC) working under the civic authority Municipal Corporation of Greater Mumbai (MCGM) now maintains a database of 15-minute interval rainfall for the administrative wards in the city. When the rainfall exceeds 40 mm in an hour, the flood alert is issued to the ward office control rooms.

In recent years, Mumbai has been experiencing many weather events, including the extreme weather event in July 2005 that led to unprecedented floods, massive damages, loss of life and property and affected the economic and social activities adversely¹⁷. On July 26, 2005, Mumbai was struck with a heavy storm. India Meteorological Department (IMD) weather station recorded **944 mm rainfall** (45% of the annual average rainfall in Mumbai) over a 24-hour period, with very high precipitation (exceeding 120 mm per hour) for a few hours between 4.30 pm and 6.30 pm and again between 8.30 pm and 10.30 pm. This

¹⁷ MCGM (2006), Fact Finding Committee on Mumbai Floods, Final Report, Volume I, March 2006

unprecedented rainfall coinciding with the high tide brought the city to a standstill. 22% of the city was submerged that day with very heavy flooding in the suburbs. The following graph explains the hourly rainfall received on 26th July 2005 along with the tide levels. Figure 5 depicts some of the pictures of the devastation.

Figure 4: Hourly rainfall on July 26, 2005 in Mumbai



Source: MCGM

Figure 5: Devastation in the aftermath of July 2005 extreme floods



Source: MCGM

Extreme weather events tend to have long term consequences for economic development and poverty alleviation in the city where majority of the residents (60% in case of Mumbai) live in slums and squatter settlements. Climate-related hazards are evident not just in case of low-probability high-consequence events but also exist in high-probability low-consequence events, which lead to recurrent impacts and recurrent costs of adaptation in urban areas. There is a need to characterize adaptation undertaken by public and private stakeholders and understand the costs, their burden on the stakeholders and effectiveness in enhancing adaptive capacity of the cities in the long-term.

In order to characterize adaptation measures undertaken by public and private stakeholders and analyse the response strategies, the study has used both primary data collected from communities and secondary data collected from government institutions. The response strategies are identified at both the institutional and community level.

3. Methodology and data sources

The underlying objective of the study conducted in Mumbai is to characterize and document public and private adaptation measures in response to the heavy precipitation and recurrent floods in the city. The characterization of adaptation measures would involve identifying adaptation measures undertaken by government authorities and private sector including households and commercial establishments, costs involved therein, short to medium-term benefits and their effectiveness in enhancing adaptive capacity in the long-term. The following methodology has been used to identify and classify the adaptation measures and understand their overall effectiveness:

- Characterization of adaptation using existing typologies identified through extensive literature review
- Identifying adaptation measures undertaken by public and private stakeholders through primary and secondary data and bringing out different aspects related to these measures, in particular, the private adaptation practices and linkages between public benefits and private adaptation
- Classify the types of adaptation measures implemented in the city using the existing typologies and accommodating unique features that do not conform to these typologies.
- Evaluation of public and private adaptation using parameters such as who initiates/undertakes the measures, who bears the costs, who is benefitted and how effective are they over short and medium to long-term

The existing typologies in the literature (as given in Table 1(a) and 1(b) of the main report) classify adaptation measures depending on the types of measures or actions undertaken by the stakeholders. The different typologies identified by various authors overlap in certain categories or actions. They attempt to bring in synergy between adaptation theory and practice to some extent. This is important given the implementation of various adaptation measures throughout the world and the need to understand the 'lessons learned' and the 'best practices' in the field¹⁸. Adaptation measures are generally reactive and anticipatory or proactive¹⁹ with local, regional and national scope²⁰ and taking the form of technological,

¹⁸ Biagini et al (2014), A typology of adaptation actions: A global look at climate adaptation actions financed through the Global Environment Facility, *Global Environmental Change*, 25, pp 97-108

¹⁹ Berrang-Ford et al (2011), Are we adapting to climate change?, *Global Environmental Change*, 21, pp 25-33 and Smit et al (2000), An anatomy of adaptation to climate change and variability, *Climate Change*, 45, pp 223-251

financial, behavioural or institutional interventions²¹. The primary drivers of action can be disaster or extreme event, climate variability or climate change²². Approach to adaptation can also target the social vulnerability, enhance system resilience or address specific risks²³ such as heavy precipitation and recurrent floods. Similarly, adaptation actions can be classified in the form of recognition or awareness, groundwork action to prepare stakeholders and actual adaptation action targeting policies, programmes, built environments and institutions²⁴. Different funded projects carried out over the last decade have initiated actions related to capacity building, policy, planning and management, practice and behavior, physical infrastructure, warning systems, financing and so on²⁵. Our study uses these typologies to characterize the adaptation measures undertaken by different stakeholders in Mumbai.

While many actions or measures do fit into the existing categories or types, there are certain unique characteristics of adaptation measures that we find in practice through the information collected from public and private stakeholders in Mumbai. This knowledge base is used to suggest useful additions to the existing typology to cover different aspects of adaptation measures in practice. The existing typologies invariably focus on public adaptation measures given the types of measures, nature of decision-making and financing options for them. However, in the developing world, we come across private stakeholders like citizens, households and businesses initiating adaptation measures. The decision-making, financing and implementation is entirely in the private hands in such cases. The costs and benefits and sources of finance and implementation of privately initiated measures see cross-linkages between public and private domains, in particular, private provision of public adaptation goods. Similarly, there are recurring costs of adaptation given the recurring nature of the flood hazard. The present study, therefore, focuses on both public and private adaptation measures and examines aspects such as who initiates the actions, the decision-making process involved in the initiation, costs of the actions, benefits accrued and effectiveness in terms of addition to the coping capacity in future.

In case of public adaptation measures, various departments of the local government and public utilities undertake short to medium and long-term measures depending on the specific functions/roles assigned to them. The decision-making hierarchy and process for undertaking these measures is also well set. The costs of such measures are borne by the government and benefits accrue to the citizens at large. However, in case of private adaptation, we find that the individual houses have limited capacity to decide upon the coping measures and decision-making is largely in the purview of the cooperative housing societies. A cooperative housing society, as per the Maharashtra Co-operative Societies Act,

²⁰ Smit et al (2000), An anatomy of adaptation to climate change and variability, *Climate Change*, 45, pp 223-251

²¹ *Ibid*

²² Smit et al (2000), An anatomy of adaptation to climate change and variability, *Climate Change*, 45, pp 223-251 and Cutter et al (2008), A place-based model for understanding community resilience to natural disasters, *Global Environmental Change*, 18(4), pp 589-606

²³ Eakin et al (2009), Hidden costs and disparate uncertainties: trade-offs involved in approaches to climate policy, Adger et al eds., *Adapting to climate change: Limits to adaptation*, Cambridge University Press, Cambridge

²⁴ Lesnikowski et al (2011), Adapting to health impacts of climate change: A study of UNFCCC Annex I Parties, *Environmental Research Letters*, 6(4) and Lesnikowski et al (2013), National-level factors affecting planned, public adaptation to health impacts of climate change, *Global Environmental Change*, 23(5), pp 1153-1163

²⁵ Biagini et al (2014), A typology of adaptation actions: A global look at climate adaptation actions financed through the Global Environment Facility, *Global Environmental Change*, 25, pp 97-108

1960²⁶, is a society (group of housing units) whose object is to provide its members with the open plots of land, dwelling units or apartments and common amenities and services. Members also elect representatives who take decisions on behalf of the individual household members and look after the common services and their maintenance. For the maintenance of these services, the households have to contribute to the common pool of resources of the housing society. Cities like Mumbai, given the limited land mass and very high property prices, have seen vertical development in residential and commercial space. As a result, housing societies are the most common feature of residential areas across the city. Ability to respond and adaptation and coping measures are, thus, decided by the housing society with collective consent from the member households rather than individual households taking such decisions on their own. Hence, we have focused on a random sample of housing societies to identify measures undertaken by them for coping with floods.

The study has relied on the following important sources of data to obtain useful information on different aspects of adaptation measures:

- Primary data from the civic authority MCGM: Detailed personal interviews of civic officials using open-ended questionnaires – departments of the MCGM covered under this study include disaster management cell, storm water drains, development planning, water supply, sanitation, solid waste, roads and gardens and public spaces.
- Secondary data from MCGM: Reports obtained from different departments of the MCGM
- Primary data from questionnaire-based surveys: Primary surveys carried out among 30 cooperative housing societies and 22 commercial establishments in the flood affected areas of the city
- Detailed questionnaires administered to the housing societies and commercial establishments consisting of questions on physical characteristics, issues related to floods, measures undertaken during pre-monsoon and monsoon period to cope with floods and long term or structural measures to reduce flooding.

The adaptation measures undertaken by both institutional or public entities and private stakeholders are discussed in detail in the next two sections.

4. Institutional or public adaptation

The devastating floods of July 2005 became a real eye opener for the local administration and led to the formulation of the Disaster Management Plan for the city and other short to medium term measures to improve the coping capacity of the city to floods in future. Adaptation to climate risks mainly focuses on public provision of adaptation measures which primarily deals with improvements in public infrastructure goods and services to enhance the coping capacity.

In case of Mumbai, governance is a major challenge as it has multiple land owners including Mumbai Metropolitan Region Development Authority (MMRDA)²⁷, MCGM (local government) Urban Development and Housing Departments, District Administration, Special Planning Authority and other Para-statals. However, the key local government agency departments focus on public response or adaptation measures. MCGM is the Urban Local Body and

²⁶https://www.maharashtra.gov.in/site/Upload/Acts%20Rules/Marathi/1.Maharashtra_Co-operative_Societies_Act_1960%20%28XXIV%20of%201961%29.pdf

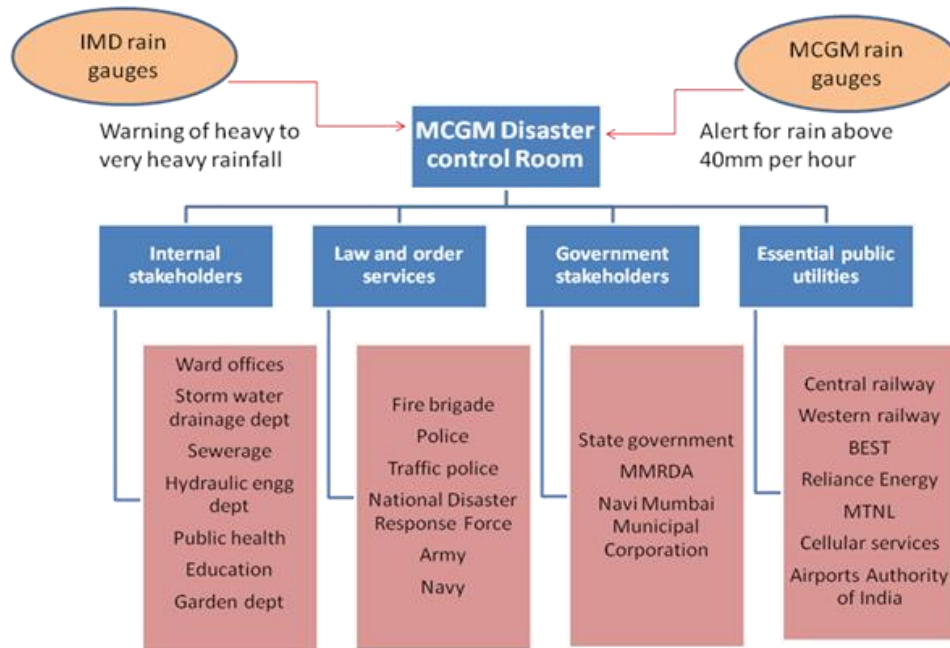
²⁷ MMRDA is responsible for planning and coordination of development activities in Mumbai and surrounding metropolitan region.

therefore the primary agency responsible for city governance and provides civic amenities including education and public health. The civic body is the first and primary responder to recurrent floods and building storm water infrastructure to reduce the extent of flooding in the city. The DMC working under the MCGM is responsible for rescue and relief operations during floods. The other core departments responsible are Storm Water Drainage department, Solid Waste Management department and the Roads department.

4.1 Disaster Management Cell (DMC):

In the immediate aftermath of the July 2005 floods, a Fact Finding Committee was appointed to look into the causes and to recommend activities to reduce the future risks of flooding in Mumbai. The committee came up with several recommendations, such as, upgradation of storm water drainage system, disaster management, river development and so on to improve the existing environment and upgrade and improve the governance and management to achieve sustainable development of Mumbai²⁸. Accordingly, a fully-equipped Disaster Management Cell (DMC) was made operational at MCGM headquarters in Mumbai after 2005. This cell has been given the responsibility of coordinating with different stakeholders and agencies for the rescue and relief operations in the event of floods during monsoon. 60 rain gauges have been installed and they feed rainfall data of 15-minute interval to the disaster control room. Alert is issued to the control rooms in each ward whenever the hourly rainfall exceeds 40 mm.

Figure 6: Hierarchy of immediate response to flood alert²⁹



Source: Based on the information in MCGM (2010), Flood preparedness guidelines 2010, www.mumbaimonsoon.com

Greater Mumbai Disaster Management Action Plan (DMAP) also came into existence in 2007. Under this plan, the risks and vulnerabilities associated with floods, earthquakes,

²⁸ MCGM (2006), Fact Finding Committee on Mumbai Floods, Final Report, Volume I, March 2006

²⁹ Patankar et al (2012), Enhancing Adaptation to Climate Change by Integrating Climate Risk into Long-Term Development Plans and Disaster Management," APN E-Lib, accessed March 7, 2015, <http://www.apn-gcr.org/resources/items/show/1572>

landslides, cyclones, etc., have been identified. The plan envisages specific roles for different stakeholders including government agencies and community organizations. Based on this plan, the DMC coordinates with different entities and departments during floods and other emergencies as depicted in Figure 6 above. The response measures undertaken by the DMC since the extreme event of July 2005 are outlined in Table 1 below. It must be noted that most of these measures have short-term impacts on dealing with floods. Disaster risk management rather than disaster risk reduction is the focus of these measures. There are no early warning systems in place, awareness and capacity building is limited and the measures focus on rescue and relief in the immediate aftermath of floods. The measures need to be upgraded, augmented and implemented on larger scale to enhance their effectiveness in building future coping capacity.

Table 1: Measures undertaken by the DMC

Measure	Effectiveness
<ul style="list-style-type: none"> • Public awareness and education: Launched a website and mobile application for regular updates on rainfall. 	<p>This will have a good short to medium-term impact if there is greater awareness among the citizens about this website and how the information on it can be used for traffic management.</p>
<ul style="list-style-type: none"> • Disaster risk management: <ul style="list-style-type: none"> - Prepare a Disaster Management Action Plan - Prepare a Disaster Management Monsoon Plan 	<p>The action plan focuses on immediate responses in case of an emergency. Same is the true with monsoon plan. These measures only help to cope with floods in the short-term.</p>
<ul style="list-style-type: none"> • Monitoring the weather predictions for a period of 8 days to 1 week through sources such as IMD, Skymet etc. 	<p>This will potentially lead to an early-warning system which currently does not exist in Mumbai. More technical and scientific infrastructure and knowledgebase will be required to create such a warning system.</p>
<ul style="list-style-type: none"> • Training and workshops: In the process of establishing an academic and research organization - CIDM: City Initiatives of Disaster Management 	<p>DMC has initiated training and capacity building workshops among the community for disaster response and management. However, the scope of this has been extremely limited till now.</p>
<ul style="list-style-type: none"> • Information disseminated to different stakeholders: Constant updates to various departments such as traffic (Road, Rail and Air); Fire, Police and other required control rooms 	<p>This is an important measure implemented in the aftermath of July 2005 extreme event which has addressed the communication gap between various stakeholders. The constant updates are an important step which will help the other agencies to respond to floods.</p>
<ul style="list-style-type: none"> • Information and communication tools: Communication equipment installed for regular monitoring and to mobilize resources during emergency 	<p>DMC can communicate with all the ward offices on a continuous basis to give them constant updates and get information in case of emergencies. This is also an important step implemented after July 2005 deluge, which is expected to improve communication across different ward offices within the city and improve the response of government agencies.</p>
<ul style="list-style-type: none"> • Creating and maintaining databases: Capturing data from 54 rain gauges installed across the city at every 15 minutes interval 	<p>The 15-minute interval databases can potentially be used very effectively to understand rainfall pattern across different wards in the city and create an effective early warning system, which does not exist currently.</p>
<p>Source: Based on the information obtained from the DMC through personal interviews with the Chief Officer and other officers reporting to him.</p>	

4.2 Storm Water Drainage (SWD) department:

As per the Fact Finding Committee, the Brihanmumbai Stormwater Disposal System (BRIMSTOWAD) is now being implementing at the cost of INR 1200 crore (approx. US\$ 266 million). It is a major policy initiative that is expected to improve the existing and age-old storm water drainage system in Mumbai and replace it with the one that will be much more effective in dealing with greater intensity rainfall. Once the project is implemented completely, it is expected to improve the flood situation in Mumbai as the new system is being designed for 50 mm rainfall per hour instead of 25 mm per hour design currently in place. Also, the project has been designed for the runoff coefficient of 1 instead of 0.5 due to the land use changes that have occurred in the city in past few decades. Thus, BRIMSTOWAD is expected to increase the adaptation capacity of the city for flash floods caused by heavy intensity rainfall in future. Under this project, a GIS data base of Mumbai using LiDAR and digital mapping camera, which contains contours at 0.2m interval, 3D and 2D map of Mumbai showing satellite images is being mapped.

The scope of BRIMSTOWAD Project work includes rehabilitation and augmentation of underground drains in city, construction of new drains, training of nullahs, widening and deepening of nullahs and construction of access road, construction of Storm Water Pumping Stations. The project is divided into two phases as detailed in Table 2 below and a total of 58 works are undertaken under this. Of which 20 works were done under Phase I and 38 under Phase II. Total expenditure incurred as of 30.05.2013 is Rs.1386.89 Crores. The project is expected to be completed by 2015-16. The specific tasks under this project are given in Table 3.

Table 2: Details of BRIMSTOWAD

Details	Phase I	Phase II
Total no. of works undertaken	20	38
Works completed	13	2
Works in progress	7	32
Works to be reviewed after preparation of Master Plan	0	1
Tenders under process for invitation	0	3
Source: Storm Water Department, MCGM, 2014		

Table 3: Measures undertaken by the SWD Department

Measure	Effectiveness
<ul style="list-style-type: none">Regular de-silting (cleaning) of nullahs (narrow waterways) to reduce the tendency of flooding or choking during heavy precipitationAll flood gates manned to operate them during high and low tidesChronic flooding spots management by deploying special squads.Dewatering at localized flooding spots by means of dewatering pumps.Augmenting the capacity of the present storm water drains.Desilting, deepening and construction of retaining walls along the Mithi River stretch.	The first four measures are recurring measures undertaken as short-term response when floods happen regularly at different chronic flooding spots. Augmenting the capacity of the storm water drains and deepening Mithi River stretch are the two important measures that will have medium to long-term impact on dealing with chronic floods in the city. However, these measures may still not be very effective for a July 2005 type of weather event, but the extent and depth of floods will definitely reduce once the BRIMSTOWAD is completed.
Source: Personal interviews with SWD department officials and reports obtained from them	

For implementing a large scale project like BRIMSTOWARD, there are many challenges. These challenges have a direct implication for the duration and cost of the project. These delays are majorly due to administrative and procedural reasons, as given below:

- Ministry of Environment and Forests (MoEF) clearance as regards removal of mangroves and construction of SWD works in CRZ affected area.
- NOC from various departments, i.e. Railway, Airport, Traffic Police and Mumbai Port Trust
- Diversion and protection of utilities such as Mahanagar Telephone Nigam Ltd. cables, High tension Electrical Cables, water mains sewer lines, Petrol pipe line etc. from the alignment of SWD works.
- Lack of access road in the sites due to slum on the both side of the nullah
- Cofferdams required to be built to carry out the works
- Difficulties for undertaking the work under tidal condition
- Continuous pumping require for dewatering at Sites
- Change in the scope of the work due to actual site conditions
- Detail Engineering Survey carried out after DPR approval
- Delay in land acquisition, removal of encroachment, shifting of project affected people after deciding their eligibility
- Suggested new methodology for foundation of the drain to expedite execution in marshy land / tidal zone etc.
- Impediments due to other outgoing development works and traffic congestion
- Change in grade of the concrete (M-25 to M-40) as suggested by Indian Institute of Technology Bombay
- Additional widening and deepening of nullah as per FFC recommendation
- Cost estimate presented in DPR based on 2004-05 schedule of rate, whereas tenders called were based on schedule of rate of year 2007/08/09
- Cost escalation due to inflation

4.3 Other departments in MCGM:

Table 4 lists the measures undertaken by other departments of the MCGM, which deal with floods directly or indirectly. As can be seen in the table, most are recurrent measures undertaken every year with little or no focus on long term solutions for dealing with floods and reducing the extent and depth of flooding. To undertake such measures by the different departments, huge costs are involved. Usually, these costs are borne by the agency and are reflected in their annual budget.

Table 4: Measures undertaken by other departments within MCGM

Department within MCGM	Other Response/ Measure	Effectiveness
Solid Waste Management	<ul style="list-style-type: none"> • Removal of fallen trees or branches of trees due to heavy rain or gusty Winds • Garbage is collected and transported to dumping grounds. • Zone wise contracts for transportation of garbage collected at bins. 	The role of this department is extremely critical in flood management as dumped garbage is one of the most important factors responsible for chronic and localized floods. However, the focus of this department is only on collection and transportation of garbage; not its disposal. This function is also not efficient as per the responses obtained from the households and businesses.

<p>Roads</p>	<ul style="list-style-type: none"> • Improvement of existing roads; • Construction of new Development Plan roads; • Existing roads convergence into concrete, RCC. • Repairs to bad patches / potholes 	<p>This department focuses on short-term and recurrent measure of repairing roads in the pre-monsoon and post-monsoon period. The bad patches and potholes usually lead to localized flooding spots. There is a need to have long-term solution based on better technology and design to construct better roads that would not cave in during heavy rains to prevent flooding.</p>
<p>Water Supply (Hydraulic Engineering Department)</p>	<ul style="list-style-type: none"> • Mobilize large number of water tankers during disaster for emergency supplies of water and cooked food; 	<p>During floods, people experience difficulties in accessing clean drinking water and water and sewage often gets mixed up. This department, however, has reported that they do not have any specific role during floods as per their assigned functions.</p>
<p>Sewerage & Operations</p>	<ul style="list-style-type: none"> • Collection of sewage at treatment • Checking of sewer lines and chronic spots • Monitoring and Handling Pumping Operations • Systematic Preventive Maintenance Programme (1st October- 31st May, every year) • To prepare shift schedule for staff of pumping stations & treatment plants for round the clock operation. • To carry out maintenance of dewatering pump sets of pumping stations and keep them in operating condition. • To carry out maintenance of all HT / LT breakers, transformers & other electrical equipment and keep them in operating condition. • To construct temporary bunds wherever necessary to protect the pumping stations from flooding and to repair existing bund walls in case they are defective. • To make arrangement of ropes by tightening them to existing trees and poles for easy walking during flooding 	<p>Mixing of fresh water and sewage is a common issue in flood-prone areas. Working of the pumping stations for dewatering during heavy rains is also undertaken by this department. Therefore, the recurrent maintenance work undertaken by this department annually is very important. However, the preventive maintenance work and other functions have not proved to be very effective in the face of recurrent floods that happen in the city every year. But the extent and depth of flooding has reduced due to some of these measures coupled with the BRIMSTOWAD activities.</p>
<p>Public Health Department</p>	<ul style="list-style-type: none"> • Organize emergency supplies of medicines and blood; • Organize provision of ambulances, including heli-ambulances; • Organize on-site treatment of injured with tagging and triage and their transport to hospitals; • Provide treatment to the injured at hospitals; • Organize post-mortem examination and corpse disposal; • Undertake epidemic prevention measures; • Involve and coordinate with Government and private hospitals and medical entities in the discharge of above functions; • Pre-contract arrangements with private hospitals; • Public awareness and education: Set up information centre for sharing of information with the media and the public. • To take up adequate measures for containment of communicable diseases during monsoon period. 	<p>In the monsoon period and in particular, after the flood waters recede, affected areas report vector-borne and water-borne diseases. Public health department, therefore, has an important role in offering facilities and services that will help in curing people of these illnesses. There are a few preventive measures that the department undertakes every year including fumigation and organizing awareness camps. However, these measures have not proved to be effective in the short-run as the incidence of these diseases is steadily going up. There are a number of factors like increase in the construction activity which are considered to be responsible for stagnant water and greater incidence of vector-borne diseases. For other diseases, the poor sewage disposal and garbage collection leads to unhygienic conditions. Hence, public health department mainly has a curative role but has not much of a role in preventing diseases. Long term effective solutions for</p>

	<ul style="list-style-type: none"> • ‘Standard Operative Procedures’ (SOP) have been prepared for Control room at Epidemiology cell & coordinating centre at EHO office. • Sensitization trainings and coordination meetings are being arranged for consultant’s associations, Indian Medical Associations (IMA) & Trust hospitals 	<p>disease prevention would require a coordinated effort of public health, solid waste, sanitation and water supply department.</p>
<p>Source: Personal interviews with department officials and reports obtained from them</p>		

5. Private adaptation

As discussed earlier in Section 3, the existing adaptation typologies invariably focus on the measures undertaken by the public or institutional entities in terms of reactive or proactive efforts, technological, financial or institutional forms of adaptation, measures undertaken to address vulnerability, build resilience or targeted actions for a specific risk and activities like planning, policy-making, information and communication, warning systems, green infrastructure, etc. For the cities of the developing world, government actions are often not adequate to cope with the present and future risks due to the limited technical, financial and human resources available at the disposal of the public entities. The governance structures, quality of governance, prioritization of government activities, absence of social security nets and negligible insurance coverage compel the private citizens and entities to undertake response and adaptation measures using the limited technical and financial capacity they have. This section discusses various aspects of private adaptation measures such as decision-making process, financing, benefits of such measures and their effectiveness over the long-term. We have covered two crucial private entities, as first responders in Mumbai – housing societies and commercial establishments – to better characterize private responses and distribution of costs and benefits. In addition to these important stakeholders, we have also explored the role played by Non-Governmental Organizations (NGOs) and Advanced Locality Management groups (ALMs) in the private response/adaptation sphere.

We have covered **52 entities (housing societies and commercial establishments)** under this study. The housing societies and commercial establishments (also referred to as businesses) interviewed under this study are located in the most flood-affected wards (administrative blocks) of the city as seen in Table 5 below. A number of chronic and localized flooding spots have been identified by the MCGM in these wards and the residents experience recurrent floods every year during the monsoon season. The residential density, number of households living near the flood spots and types of commercial activities and services, such as, shops, offices, markets, educational institutions and medical services, emphasize the critical role of private responses and adaptation to flood risk.

Table 5: Details of wards covered under the survey

Ward	Total population	Residential density (per sq.km.)*	Number of households near flood spots**	Shops, offices and markets near flood spots	Educational and medical services near flood spots	Chronic flood spots#	Localized flood spots\$
F/North	529034	131411	30703	58	56	2	9
F/South	360972	154380	21518	130	37	1	8
H/East	557239	197085	28827	66	18	0	14
H/West	307581	72935	18602	114	29	3	11
K/East	823885	120200	49848	136	49	2	7
L Ward	902225	165573	67986	245	61	3	13
M/West	411893	105094	48147	164	59	4	6

Source: Authors' calculations based on data obtained from the MCGM

Note: *Residential density is calculated as total number of people in the ward divided by the area covered by residential use in the ward

**Number of households calculated by authors from data on land use in each ward and average 4 persons per household

Chronic flood spots are low-lying areas which get flooded with combined effect of intense precipitation and high tide

\$ Localized flood spots are areas with inadequate drainage and obstacles created in the drain path due to informal settlements or other land uses

5.1 Cooperative housing societies

As described in the methodology section, our study has focused on cooperative housing societies to characterize the responses of households to recurrent floods in Mumbai. Just as the local government is the first responder to any hazard, households are the immediate and first responders when we consider private responses and adaptation practices. In cities like Mumbai, households organize themselves into housing societies, which take decisions on their behalf. To capture the responses and adaptation measures of these cooperative entities comprising households, **30 housing societies** have been randomly selected in the flood affected wards listed in Table 1 above. The surveyed societies are located near the identified chronic or localized flooding spots. The questionnaires were administered to either the secretary or the chairperson of the society committee elected by the member households. The decision-making on repairs and maintenance is taken by the elected committee members through the approved procedures by taking into account the majority opinions of households residing there.

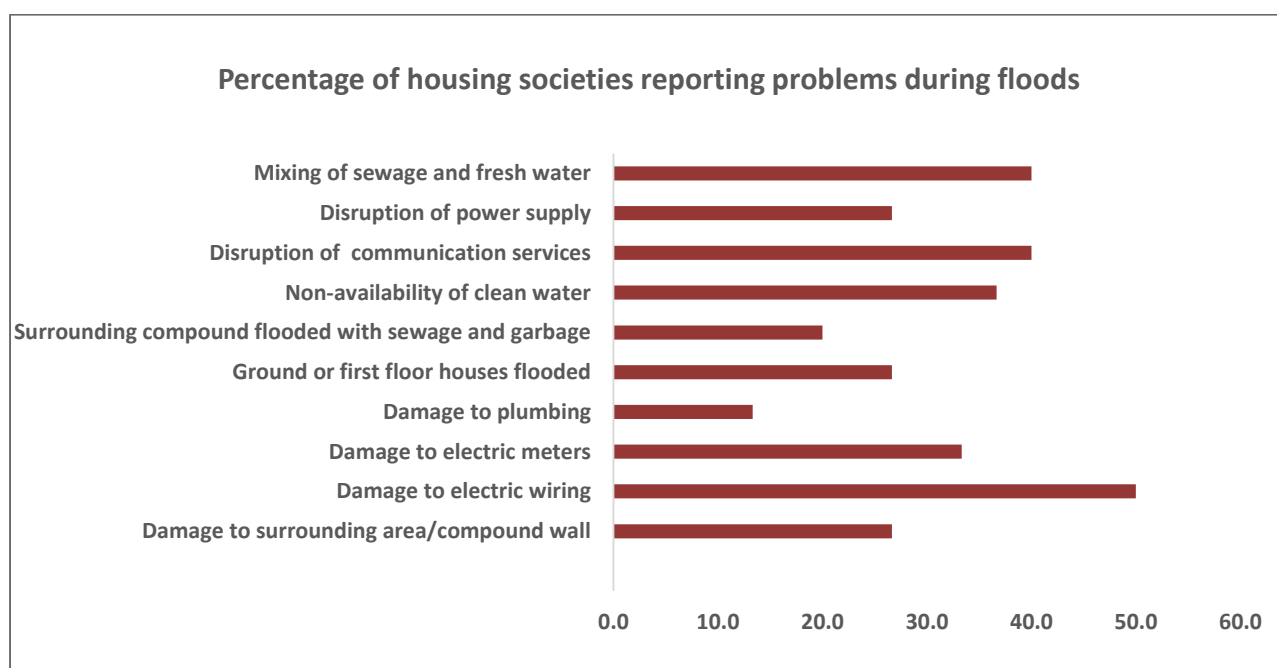
Most housing societies covered under the survey are multi-storeyed buildings with average 6-7 floors. We have also covered three skyscrapers (10 floors and above) and three single-

storey buildings (also known as chawls). Thus, the survey covers all types of residential buildings commonly found across the city. The year of construction varies from old buildings (mainly chawls) built in 1925 to newly constructed ones in 2012 (mainly skyscrapers). The newly constructed buildings are the redeveloped slums, where the Slum Rehabilitation Authority (SRA) has allotted tenements to slum dwellers at the same location where the slum was located. Most surveyed buildings (73%) undertake regular maintenance (once a year at least) followed by others who undertake maintenance work once in 2-3 years.

As mentioned, the wards, in which these housing societies are located, face recurrent floods. On an average, the housing societies have reported 4-5 days of flooding every year during the rainy season, with a few reporting 10-12 days of floods. For most societies, the compound remains flooded for about 6-7 hours. The average depth of flooding is 2-3 feet, with maximum depth of 4-5 feet experienced during the extreme floods of July 2005. All the housing societies interviewed by the survey team reported some or the other problems faced during recurrent floods as depicted in Figure 7 below. Prominent issues during floods have been damage to electrical wiring and electrical meters, disruption of communication services, non-availability of clean drinking water and mixing of sewage and fresh water. In addition to these issues, the respondents (society committee chairpersons or secretaries) have reported illnesses such as malaria, dengue and typhoid in the aftermath of floods. The society committees typically contact the municipal ward office to report on floods as stated by 50% of respondents. An important point to be noted here is that 84% of the respondents said that they do not receive any flood warning from the municipal ward office and the remaining rely on warnings issued through the television news channels.

Given the recurrent floods during the monsoon season, most housing societies have taken up the responsibility of undertaking measures in the pre-monsoon period to help them cope with the heavy precipitation and floods. These measures and their costs have been captured in the survey as reported in Table 6 below. The most common pre-monsoon measures are cleaning the surrounding compound and nearby gutters or nullahs. Some societies also repair the compound wall or fence before monsoon. These measures are undertaken every year by most societies covered under the survey. The costs associated with each of these measures are also given in Table 6. These costs are typically borne by the society committee through the monthly/annual contribution collected from the member households. In general, the average budget of the societies for pre-monsoon activities is Indian Rupees (Rs.) 20,000 per year.

Figure 7: Major problems faced by housing societies during floods



In addition to the pre-monsoon measures, housing societies also have to undertake some activities during the monsoon. Activities such as cleaning the compound of garbage/sewage and disinfecting the premises are undertaken soon after flood waters have entered the buildings during heavy rains. Most societies have to deal with flood waters in this way almost every year and the average budget set aside for this is Rs. 6000 as shown in the table below. The wide range of the budget for pre-monsoon and monsoon measures depends on the size of the society.

Table 6: Measures undertaken by housing societies during pre-monsoon and monsoon

Measure	% of HHs undertaking measure	% undertaking measure every year	Average budget (in Rs.) with range in bracket
Pre-monsoon			
Cleaning the surrounding ground / compound	86.7	84.6	20000 (2000-100,000)
Cleaning the nearby gutter or nullah	86.7	65.4	
Repairing the compound wall/fence	33.3	50.0	
Monsoon			
Cleaning the compound of garbage/sewage	83.3	88.0	6000 (500-12,000)
Disinfecting the premises	63.3	63.2	

After the unprecedented floods of July 2005, housing societies decided to undertake structural changes to achieve long-term solutions to the various problems faced by them year after year due to floods. Table 7 gives the list of these structural measures, their average costs and source of finance. Increasing the height of the surrounding plot has been the most used structural measure to prevent flood waters entering the society premises. Along with this, societies have relocated electrical meters, water pump rooms and elevated electrical meters to higher levels. Water supply networks or plumbing has also been repaired or modified inside premises to avoid the mixing of sewage with fresh water during floods. The costs for all the structural changes have been met with the members' contribution or society corpus. In addition to these measures, in some housing societies, the compounds have been fitted with paver blocks to raise the height and prevent rainwater from flooding the premises. This work has been done through the funds available to the elected representatives (corporators in Municipal Corporation) in the respective wards.

Table 7: Structural measures undertaken by housing societies to cope with floods

Measure	% of HHs undertaking measure	Average cost in Rs.	Source of finance
Increase the height of the surrounding plot	43.3	13000	Members' contribution/Society corpus
Reconstruction with stilt parking	13.3	50000	Members' contribution
Relocating electric meter room	26.7	9000	Members' contribution/Society corpus
Relocating/ Elevating water pump room	30.0	12000	Members' contribution
Elevating electric meters to a higher level	20.0	10000	Members' contribution
Modifying/repairing water supply network inside premises	30.0	5000	Members' contribution
Paver blocks	13.3	NA	Elected representative

There are some crucial points that need to be mentioned here. Despite one or the other structural measures implemented by the housing societies as long-term solutions to deal with specific problems related to floods, almost half of them do not believe that these measures will be effective enough if another extreme precipitation event like July 2005 strikes the city. In recent years, there is greater awareness about inspecting the overall structural strength of the old buildings and undertaking repairs or modifications accordingly. In case of the societies surveyed by us as well, 60% of them have done the structural audits in recent years. However, the decisions regarding measures to be undertaken for coping with floods have been taken by the member households and their elected committee and 63% of them have not taken any professional help to decide the technical specifications of the work undertaken. Except for elected representatives building paver blocks in the compound, there has been no help or technical and financial assistance from the local government or any other entity for the housing societies. Further, no training or capacity

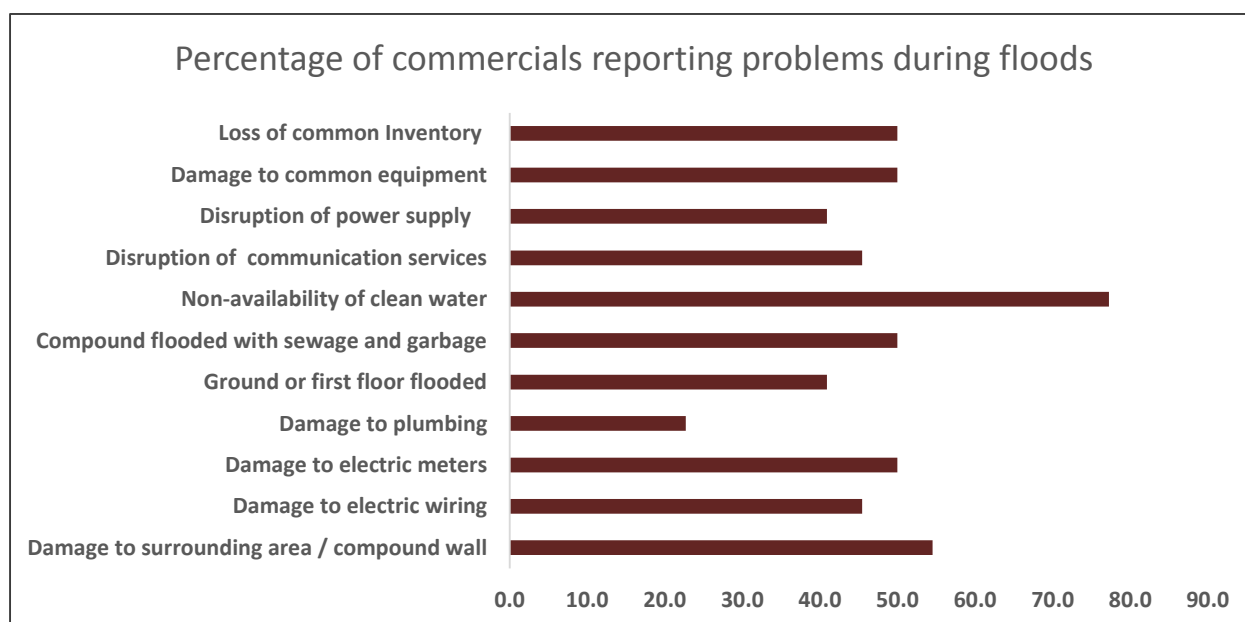
building activities have been carried out by the MCGM, NGOs or other community based organizations for the housing societies to help them deal with recurrent floods.

5.2 Commercial establishments

Along with the housing societies, 22 commercial establishments have been surveyed using detailed questionnaires in the flood-prone wards. The survey has tried to cover a wide variety of establishments from retail shops, trading entities, manufacturing units and workshops to flour mill, financial services, hospital and dairy. The nature of these businesses is such that majority of them (65%) are located in a single-storey building and others are multi-storey buildings. The year of construction, as in case of housing societies, varies from 1924 to 2007. Being located in old buildings, 55% of these businesses undertake regular maintenance work once a year followed by 18% who undertake maintenance once in 2-3 years. Average flood days reported by them are 4-5 per monsoon season. However, the range varies from minimum of 2 days to the maximum of 15 days of floods during the season every year. Further, flood waters remain in the premises for about 5-6 hours, with the maximum time reported as 48 hours. Depth of flooding is 2-3 feet on average with the maximum depth experienced during the 2005 extreme event of 5-6 feet.

Similar to the cooperative housing societies, commercial establishments have reported a number of major problems faced during floods as shown in Figure 8 below. The most critical problems reported by the majority of respondents are non-availability of clean water, damage to surrounding area and compound wall, damage to electrical meters and wiring, loss of common inventory and damage to common equipment. Other notable issues that businesses face similar to housing societies are the disruption of communication services and power supply and compound gets flooded with sewage and garbage along with flood waters.

Figure 8: Major problems faced by businesses during floods



Commercial establishments undertake regular measures in the pre-monsoon period to prepare to cope with the recurrent floods and reduce the depth of flooding if possible. The most common measures as listed in Table 8 are cleaning the surrounding ground/compound and cleaning the nearby gutter or nullah. The businesses who spend resources on these measures do so every year before monsoon. Another important measure is repairing of the compound wall or fence to prevent/reduce flood waters entering the premises. The average amount spent on the pre-monsoon measures is Rs. 18000. However the range varies from Rs. 4000 to Rs. 100,000 as the plot size of the businesses is considerably different. Similarly, during monsoon, especially in the immediate aftermath of floods, the business entities have to spend resources on cleaning the compound of sewage or garbage and disinfecting their premises. Similar to pre-monsoon activities, these measures are also undertaken almost every year and the budget for the same is around Rs. 13,000 with the maximum budget of Rs. 60,000 depending on the size of the establishment.

The commercial establishments have undertaken a number of structural measures after the experience of the deluge in July 2005 to protect their premises, equipment and inventory from recurrent floods. Some of these structural measures have been listed in Table 9 with the respective costs and source of finance. Important structural measures quoted by the respondents are increasing the height of the surrounding plot, reconstruction of the building with stilt parking, elevating electric meters and relocating electrical meter room. For the first two measures the source of finance is the developer or the owner of the establishment. Measures undertaken within the premises of the establishment have been financed by the owner as seen in the table.

Most of the measures undertaken by the developer and/or owner of the establishment are supposed to prevent flood waters from entering premises or reduce the depth of flooding. However, almost 50% of the respondents believe that these measures will not be effective for coping with a situation similar to the July 2005 floods. They firmly believe that the solution lies in the MCGM constructing an effective drainage system and cleaning the garbage on time.

Table 8: Measures undertaken by businesses during pre-monsoon and monsoon

Measure	% of businesses undertaking measure	% of businesses undertaking measure every year	Average budget (in Rs.) with range in bracket
Pre-monsoon			
Cleaning the surrounding ground / compound	59.1	100.0	18000 (4000-100,000)
Cleaning the nearby gutter or nullah	63.6	100.0	
Repairing the compound wall/fence	59.1	61.5	
Monsoon			
Cleaning the compound of garbage/sewage	77.3	100.0	13000 (1000-60,000)
Disinfecting the premises	63.6	82.4	

Table 9: Structural measures undertaken by businesses to cope with floods

Measure	% of businesses undertaking measure	Average cost in Rs.	Source of finance
Increase the height of the surrounding plot	41	30000	Developer/owner
Reconstruction of the building with stilt parking	41	50000	Developer/owner
Elevating electric meters to a higher level	27	8000	Owner
Relocating electrical meter room	27	6000	Owner
Relocating/ Elevating water pump room	14	5000	Developer/owner
Modifying plumbing system	9	5000	Owner
Modifying/repairing water supply network in the premises	9	10000	Developer/owner
Repairs inside premises to elevate furniture	5	5000	Owner
Repairs inside premises to elevate electronic gadgets	5	5000	Owner
Repairs to elevate equipment	5	5000	Owner

5.3 Role of NGOs and ALMs

Besides the cooperative housing societies and commercial establishments, groups of citizens organized into non-governmental organizations (NGOs) and advanced locality management committees (ALMs) have played a significant role in short-term responses to the extreme and recurrent floods in Mumbai. During the extreme floods of July 2005, the NGOs were actively involved in the rescue and relief work in several areas along with the MCGM team. Over 20 NGOs including Akanksha, Yuvak Pratishthan, Apnalaya and Dorabjee Tata Trust, volunteered their help³⁰ by creating temporary shelters for citizens stranded on the road and manoeuvring the solid waste by creating temporary dumping grounds. Based on the experience of this event, NGOs like Nirmala Niketan College of Social Work have actively been involved in imparting training to the city youth through the community based Disaster Risk Management Programme, supported by the Disaster Management Cell (DMC) of MCGM. The training programme covers various aspects related to dealing with the disasters/extreme events and aims to create capacity among communities to handle disasters effectively and save lives of maximum number of people by initiating support activities. In addition to this, many NGOs are actively involved in

³⁰ MCGM (2006), Fact Finding Committee on Mumbai Floods, Final Report, Volume I, March 2006

cleanliness initiatives, waste segregation and waste recycling in different areas of the city that helps in reducing the depth and intensity of localized floods.

The role of ALMs is also noteworthy here since they act as the support partners and coordinators between MCGM and citizens in housing societies. ALMs were set up in 1998 in all the 24 wards of Mumbai as a partnership between MCGM and citizens for the sustainable, environment friendly waste management programme for neighbourhood buildings³¹. ALMs are groups of housing societies or buildings located on the same street and are formed with voluntary participation of the citizens living there. Although the main focus of their work as per MCGM is to participate in activities related to waste management, they are known to take up many civic issues critical for their respective areas. ALMs get financial support from the member housing societies themselves and MCGM provides technical support required for waste management practices.

Figure 9: ALM members and residents conducting cleanliness drive in Mumbai



Source: <http://www.dnaindia.com/mumbai>

The main work of ALMs, as seen in Figure 9 above, revolves around maintaining clean, garbage-free areas with proper sanitation and hygiene. For this, they focus on cleaning nearby gutters and nullahs, which are critical for reducing the localized floods. In recent years, ALMs have also been roped in by the civic administration to seek cooperation of citizens for coping with water-borne and vector-borne diseases prevalent during the monsoon season. Thus, the work of the ALMs supports in coping with floods through effective solid waste management and health awareness campaigns for diseases related to water logging.

6. Assessment of the adaptation efforts

The response and adaptation measures by the public and private stakeholders as discussed in the preceding sections throw light on the types of adaptation measures or actions undertaken in Mumbai to deal with recurrent floods.

³¹ <http://www.mcgm.gov.in/irj/portal/anonymous/qlvarprg>

Table 10: Types of adaptation measures for Mumbai

Stimulus	Intent	Spatial scope	Degree of change	Driver of action	Form	Approach	Effectiveness	Frequency	Financing
Anticipatory	Autonomous	Local	Incremental	Disaster or extreme event	Technological	Resilience	Short term	Recurrent	Public
Concurrent	Planned	Regional	Transformational	Climate variability	Institutional	Targeted adaptation	Medium term	Permanent	Private
Reactive		National		Climate change	Behavioural	Social vulnerability	Long term		Insurance

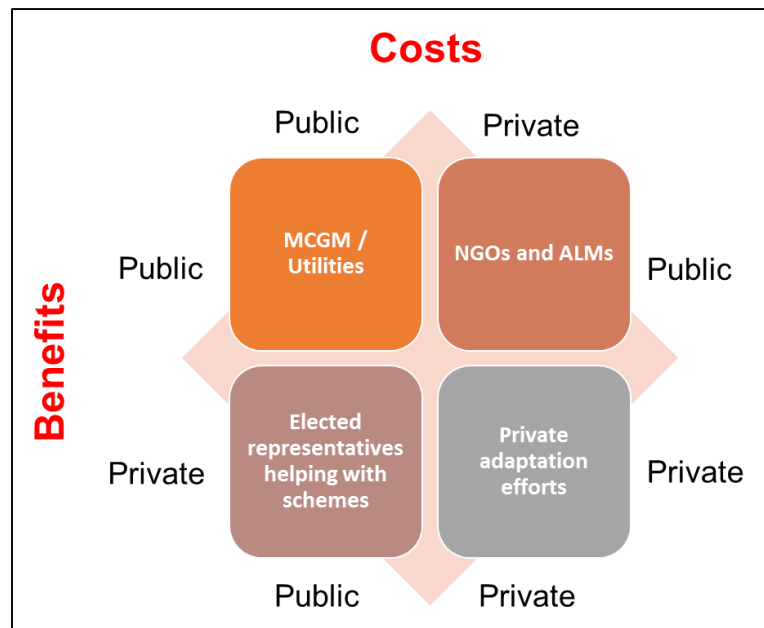
Table 10 above classifies these measures into the existing typologies found in the literature as well as adds new dimensions in the form of effectiveness, frequency and financing of the adaptation measures. Response and adaptation measures to cope with floods in Mumbai are essentially reactive and have been implemented in the aftermath of the extreme event of July 2005. They are planned interventions at the local level and initiated by the local government in its role as the civic administrator and first responder to weather events. The changes brought about by these measures are incremental and have been able to reduce the depth of floods, but the problem of recurrent floods remains around the chronic flood spots. The measures implemented by the local government have largely been institutional and not technological or behavioural that would have brought about transformational changes in the way the city dealt with floods. The new dimensions we are considering here in the form of effectiveness, frequency with which measures are implemented and the source of decision-making and financing give unique insights into adaptation options exercised in cities like Mumbai within a developing country context. The decisions here are driven by both public and private stakeholders and the focus is largely short to medium term. Such measures, therefore, are recurrent in nature and are undertaken annually or once every 2-3 years. Private stakeholders, with limited resources and technical capability, are not in the position to visualize and implement measures which would have long-term effect on the capacity to cope with floods. However, the local government also has taken a short to medium-term view while implementing the coping strategies, as discussed in Section 4. Hence, long-term enhancement of the coping capacity for the city against floods may not be achievable with the current set of measures.

6.1 Public and private adaptation: costs and benefits

Adaptation efforts that we come across in different parts of the world seek to bring about improvements in existing infrastructure, change the existing technologies, introduce early warning systems, create greater public awareness and capacity building and thus enhance the coping capacity for the future climate risks. Technological or institutional adaptation is planned or autonomous and is financed through public resources. Local or provincial governments, who are the first responders to weather events and other risks use their resources to finance measures that would be effective over short to medium-term and sometimes enhance the long-term adaptive capacity. In case of Mumbai as well, a number of measures as discussed in Section 4 are identified, designed, financed and implemented

by the various departments of the local government MCGM. These measures are shown in Figure 10 below as measures where costs and benefits are both by and for the citizens. Storm water drainage system upgradation is a good example of this.

Figure 10: Link between public and private adaptation in terms of costs and benefits



However, there are other types of recurrent as well as structural measures that are financed and implemented by the private stakeholders. Such measures, as discussed in the preceding section, are identified, designed, financed and implemented by the private stakeholders, the benefits of which are also restricted to these stakeholders. Examples of these are the measures implemented by housing societies and businesses, such as, raising the height of the surrounding plot, elevating electrical meters, etc.

Beyond these public and private adaptation efforts, we also come across some unique efforts where the costs may be financed through public money, yet the benefits may accrue to only select private stakeholders. A good example of this type of a measure is elected representatives using public funds allotted to them for developmental works to fit paver blocks in private housing societies. These paver blocks help raise the plot level and may reduce or keep the flood waters out. The benefits in this case are only restricted to the private stakeholders residing in the housing societies. Similarly, there are efforts by private stakeholders in different parts of the city, where the benefits might be enjoyed by all the people living and passing through the area. This is a typical case of private stakeholders financing public adaptation goods. An example of this is the role that NGOs and ALMs play by helping solid waste management of their areas and keeping the nearby nullahs clean to reduce the extent and depth of flooding in the area. The role of private stakeholders in providing public adaptation goods can be enhanced in future if the local governments build the right partnerships with them to create awareness, capacity building and behavioural changes among people that would effectively deal with floods.

6.2 Critical observations on the current adaptation measures

We have outlined a number of public and private adaptation measures, in the preceding sections, that deal with recurrent floods. The following are the critical observations about these measures, which have important policy implications:

- Most public and private adaptation measures are recurrent in nature and have only short-term impacts and hence would not enhance the resilience in the long run. Even the structural measures like the BRIMSTOWAD would only reduce the extent and depth of flooding in the city. Hence, recurrent floods will be a threat for the city over a long time given the low effectiveness of current adaptation efforts.
- Not only are the floods recurrent but the costs are also recurrent. Most measures are only short-term and recurrent measures which involve spending resources on a regular and recurring basis. Every year, before the monsoon season, public and private stakeholders undertake measures that are barely effective for that season. The focus is on cleaning and repairing that involves recurring costs. If measures are devised for medium to long-term effectiveness in dealing with floods, resources spent on recurring measures can be saved and used elsewhere.
- There is a total lack of an integrated approach and various departments of the local government work in silos. Departments like solid waste, water and sanitation and public health do not have a common agenda for dealing with floods. What is needed is a well-coordinated effort in MCGM that will bring all the departments together to chalk out a common programme for dealing with recurrent floods.
- Recurrent floods are the result of not just the failure of the current storm water drainage system to carry the rainwater out to sea but also the failure of the solid waste machinery to keep the roads and nullahs free of garbage. This is apparent from the feedback received from the housing societies and businesses. Therefore, effective solid waste management should become an urgent actionable agenda for the civic authorities to bring about medium to long term improvement in floods situation.
- Although future climate risks cannot be predicted with absolute certainty, it has been accepted widely that future climate change will be manifested through the increase in the frequency and intensity of current hazards. If Mumbai experiences higher precipitation in future and if extreme events like July 2005 return much earlier than anticipated, the current measures do not equip the city to deal with the ensuing floods. Extreme precipitation may still lead to intense floods and cause heavy damages to public and private assets. Thus, current adaptation efforts would not create effective resilience for future.
- The focus of all the adaptation efforts is recurrent floods caused by heavy precipitation during the monsoon season. However, future climate change may also bring about sea level rise, which might inundate some areas in the city. The civic administration is not focusing on this risk while designing the storm water system or building infrastructure along the coast. This puts a question mark on the future resilience of the city to flood risks.
- The development planning process in the city and the surrounding metropolitan region is largely silent on the future climate risks. For future resilience, it is important that development planning mainstreams adaptation into its processes.
- While dealing with future climate risks, the role of ecosystem services like mangroves is very important. They provide the first level of protection against inundation of the coasts

from rising sea water. Their role in building future resilience has largely been ignored so far. There is a need to pay more attention to such ecosystem services and take steps to conserve them.

- In case of private adaptation measures, the decision-making is driven by individual needs with little guidance on what is appropriate, cost effective and beneficial in the long-term. The measures undertaken by housing societies or businesses may not be technically and financially the best possible solutions as professional help is often not sought.
- As private adaptation measures are designed and financed by private stakeholders with the limited focus on their individual premises, there is a strong possibility of mal-adaptation. This has been experienced in many parts of the city where individual housing societies or businesses have increased the heights of their plots, thus flooding the road in front or nearby premises. As there is no regulation on the measures undertaken by private stakeholders, resilience in these areas to future risks may suffer.
- Adaptation done by private stakeholders is financed through out-of-pocket expenses, i.e., their own resources. This puts burden on the households and small businesses. There is as yet no mechanism to finance private efforts. Insurance can play an important role in financing such efforts. But it is not explored yet in developing countries due to very low insurance penetration levels.
- Although citizens are making efforts to protect themselves against recurrent floods, there is very low awareness about future climate risks. There is a greater need for more awareness and capacity building to prepare citizens for future risks and the best ways to deal with them. Behavioural changes can bring in lot of benefits by improving the solid waste management, cleanliness of the surroundings and hygiene.

7. Conclusions

To conclude, cities like Mumbai face frequent weather events resulting in recurrent floods in the low lying parts of the city. Floods involve costs in terms of damage to physical infrastructure and assets and losses due to disruption in normal economic activities. Therefore, adaptation measures are important to reduce the intensity and depth of flooding and prevent the damages and losses. Generally, public stakeholders, i.e., local governments undertake measures that bring about changes in the existing infrastructure, use better technologies and create awareness and capacity building. However, in developing countries, local governments may not have the technical, financial and human resources to undertake adaptation measures on a large scale and make them effective over the long-term. Hence, private stakeholders like households and commercial establishments also design and finance the measures suitable for their needs. The present study has identified and characterized the public and private adaptation measures in Mumbai. These measures are essentially reactive, planned and in response to the extreme precipitation and floods of July 2005. The efforts are concentrated on dealing with recurrent floods in the short-term and hence may not enhance the city resilience to more intense flood risks. Public adaptation efforts would require greater coordination among various civic entities to work towards an integrated approach to reduce the impacts of recurrent floods. The focus will have to shift from short-term recurrent measures to long-term solutions that would save on the existing and future resources. In case of private adaptation, there is a serious concern of mal-adaptation, unless local governments provide some guidance on what measures would be

suitable for different areas within the city. The role of citizen groups is critical here. These entities can work closely with the public stakeholders to engage in effective adaptation measures and ensure greater success of the measures to enhance city resilience in future.

Acknowledgement

We would like to thank the entire team in the APN Secretariat for providing us with adequate funding and timely and prompt support in all our activities. We would specially like to thank Dr. Linda Stevenson who has supported so many of our requests and changes during the tenure of this project. The research team is also grateful to Mr. Mahesh Narvekar, Chief Officer, Disaster Management Cell, MCGM and his entire team for sharing all the relevant databases with us from time to time and giving us valuable inputs while planning the primary survey in flood affected areas in Mumbai. Our special thanks to Ms. Champaka Rajagopal, AGM and Head, Urban Development, Egis-Geoplan for giving us a comprehensive view of the planning process and the priorities of development planning for Mumbai. The Centre for the Study of Social Change (CSSC) needs a special mention here. We would like to thank them for successfully carrying out the primary surveys for us. We also want to thank Mr. L. S. Vhatkar, Chief Engineer, Storm Water Drainage Department, Mr. P. H. Mhatre, assistant Engineer, Sewerage and Operations Department, Mr. Ashok Pawar, Chief Engineer, Roads and Traffic Department, and Mrs. Medha M. Gogate, Assistant Supdt of Gardens, Gardens Department. We would also thank Mr. Rajkumar Sharma, ALM from Chembur and Mr. Abram, Nirmala Niketan. Finally, we would like to appreciate the research associates who worked with us and put in lot of efforts to compile the information, analyse data and complete the report on time.

b. Bangkok

Characterizing Public and Private Adaptation to Climate Risks and Implications for Long-Term Adaptive Capacity in Asian Megacities

BANGKOK

ARCP2013-26NSY-Patankar
Asia Pacific Network for Global Change Research (APN)
2015

Researcher: Assistant Professor Dr. Wjitbusaba Ann Marome
Faculty of Architecture and Planning, Thammasat University

Research Assistant: Ms. Patchraphan Pimbanjong
Mr. Khunnawud Aungkarattanapichai
Mr. Naim Leani
Ms. Lalita Intasean

Language editor: Ms. Gorawan Guntawong



1. Institutional and Public adaptation

In the plan or development policies of the country to cope and adapt to climate change, including the climate change master plan, the environmental plan, the vision statement, strategic plan, government action plan, studies, and reports from the various ministries, departments all have differing roles from each other. The plans utilized within this study will follow the main plans for the country by relevant departments which have a direct responsibility in mitigating the possible impact of climate change in Thailand, such as the Office of Natural Resources and Environmental Policy and Planning (ONEP). The study will also look at the role of each department that are associated with the plans to further illustrate policy planning and mechanism in urban areas, such as plans by the Office of Transport and Traffic Policy and Planning (OTP) with the Ministry of Transport, the Bangkok Metropolitan plans, plans from the Community Organizations Development Institute (CODI), plans by the Department of Public Works and Town and City planning (DPT), and plans from the Ministry of Interior.

Based on the plans, the plans to cope with climate change can be separated into 7 main subject categories:

8. Urban planning – the development of cities to mitigate the impact of climate change.
9. Water management – in response to the flood in 2011, plans to manage water in Thailand has been given priority in comparison to incidences arising from disaster event
10. Finance – the fiscal system which plays an important role in gearing flood management
11. Insurance – a sector that illustrate the importance to consider coping mechanisms to deal with future risks.
12. Governance – good governance, for instance participation, accountable resource management, decentralization of power to local governments for instance.
13. Infrastructure
14. Transportation

2. An Analysis of Short to Long Term Plans Related to Climate Change Adaptation

Within the plans or the country's development policies that allows the ability to cope and adapt to climate change; in the climate change master plan, the environmental plan, the vision statement, strategic plan, government action plan, studies, and reports from within the different ministries, departments, or agencies all have differing roles from one another. It was found that key points within the plans were city development, water management, basic infrastructure, budget, finances and economic mechanisms, insurance, communications, including energy consumption. There can be subsequently separated in short-term plans (5 years), medium term (10 years), and long term (more than 10 years):

According to the plan's intervals there have mention of climate change such as –

Short-term plan: the short-term plans often mention of water management. The effects of the flood in 2011, has resulted in agencies prioritizing water management. Similar has been

found on short-term plans for city development, which details short-term plans on river bank corrosion protection, green land use planning, reforms of urban planning laws or building laws, or increasing awareness for those who invest in high-risk zones, as well as the development of infrastructure for flood protection and increase drainage capacity.

Medium-term plan: in general covers plans for communication and transport, particular on the use of clean energy, incorporating congestion charge in urban areas, and limiting land usage by zoning ordinance. Other sectors mentioned in the medium-term plan often stated the implementation of taxation, such as carbon tax, or the development of carbon labeling, or on aspects of insurance relative to the development of agricultural insurance.

Long-term plan: the most important points mentioned in the long-term plan for Thailand is the aspects of participation, such as the establishment of an environmental fund or to develop fiscal mechanisms to deal with the issues and the effects of climate change. This may result in decentralization of local governments that will have its own financial system in order to deal with this problem in their context and in the long-term as well. Another long-term planning aspect is infrastructure because it requires a period of study and construction, for instance the development of energy creation through waste.

3. An Analysis of Short to Medium-Term Plans related to Climate Change Adaptation from Public Sectors

3.1) Since the public sector maintains the authority to use the rule of law, the mechanism used by the public sector is to enforce the law to drive implementation relevant to adaptation towards climate change. Such as the enforcement of the Section 31 of the 2007 Disaster Prevention and Mitigation act.

As the scope and extremity of the flood disaster multiplies, and has an increasing likelihood to enter the surrounding areas of Bangkok where there are several industrial estates, the government has issued a statement warning of serious disasters and to provide unified solutions to flood problems. However, it cannot be fully implemented because such laws still exist under the provisions of other laws and the customary bureaucratic mechanisms. Simultaneously after the 2011 flood, the Prime Minister's office established the Flood Relief Operations Command (FROC) as a single command system. The single command system directs the management of flood problems towards the same direction by appointing the "Committee for water management and flood". It was specified in the Regulations of the Prime Minister's Office that the committee has the authority to carry out the management of water and flood according to the committee's regulations and the nation's water management policy. The committee also has the authority to direct and evaluate the progress to ensure that the execution plan is uniformly followed by the relevant state agencies. This was seen as a means to integrate the authority to analyze, command, and manage with a "central point", which is the Flood Relief Operations Command, in order to create a center that is able to tackle flood problems well, efficiency and directly.

However it found that the establishment of the committee, or a command center for flood disaster relief was only an ad-hoc establishment or was set up only in times of need. If the government had policies to establish command centers, network or agencies which had clear responsibilities even during normal instances, this will enhance the speed of disaster

relief, more concrete coping measures, applied past case-studies to help plan for the future or finally, a disaster coping plan among capable ministries or agencies.

3.2) A systematic water management plan is crucial during flood disasters

The devastating effects of the 2011 flood has illustrated lessons that can be learnt which are “the lack of systematic management” and “the lack of clear communication” amongst both public and private sectors, since there has never been a disaster of this scale before in one lifetime. The plans relevant to disaster management incorporate the following 1) protection mechanism plan 2) disaster management plan and 3) relief to citizens affected by disaster. Nevertheless, there is a limitation of long-term climate change adaptation plans or policies in both public and private sectors.

If there were disaster management plans where both the public and private sector can adhere to, and understand its responsibilities, this will increase the efficiency to work within disaster situations and lead to future adaptation.

4. An Analysis of Long-Term Plans related to Climate Change Adaptation from Public Sectors

4.1) Climate change adaptation – does not only rely on studies of water management but includes the planning for long-term urban development to allow cities to adapt (adaptation), recover, and persist (resilience) rapidly and more efficiently within all sectors in the long-term.

Carmin (2013)³² highlights the aspects of city and climate change adaptation. The “city’s” need to respond to climate change is inevitable. At the same time, cities must grow in conjunction with the uncertainty of climate change. The scientific evidence show that there is a need to support the planning of cities in order to define guidelines for decision making and the city’s implementation of activities in coping with climate change. Decision making within situations of uncertainty, including how to approach adaptation that suits the situation of the whole city in both concrete and abstract ways, will help set the adjustment to an uncertain future. Local authorities need to have guidelines and concrete action in order to mitigate the risk. These refer to the constructed environment (built environment), the preparation of information regarding building conditions (building code), requirements on the utilization of land (land use regulations), and city plans (Urban Planning) in order to contribute to infrastructure adaptation strategies of the public services; such as the sewer system, the healthcare system health, health services, and disaster management.

4.2) The limitation of plan and policy integration where agencies and organizations can concretely implement climate change adaptation

It is commonly acknowledged that state operational plan or the strategic plan with each ministry adhere to the country’s 11th economic and social development plan, and details the functions listed within this plan to form the authority and role of each agency. Although there is the master plan to cope with climate change between 2009 to 2050 by the Office of Natural Resources and Environmental Policy and Planning (ONEP), it is not the main plan

³²Carmin, J. et al, 2013, “Urban Climate Adaptation and Leadership: From Conceptual Understanding to Practical Action”, OECD Regional Development working Papers, 2013/26.

that ministries follow. There are limitations for organizations or agencies to use this plan operationally since there are numerous national plans and the need for agencies to acknowledge the importance and use. Furthermore, due to the perception that climate change is a distant matter, results in a lack of seriousness and inadequate implementation of the master plan.

Despite the nation's economic and social development strategy being integrated into the climate adaptation plan, and ministries or agencies forthwith integrating it into their operation, the adaptation to climate change cannot be mentioned within a short time or within 4 years. Therefore, there needs to be a plan that foresees into the future where all ministries abide to, or as a provincial level plan that has been integrated separately from the state's 4 year operational plan. It must illustrate the need to map continuity within plans and policies, so it can result in allocated budgets being used to adapt to climate change in a clear and concrete manner.

"...The roles and responsibilities of policy makers are to do everything at once, as a plan for the national level to lead the implementation... with the limited budget to invest more in the social society rather than the economic or environment... The local climate adaptation plans need to mainstream into the management of public goods policy in order to ensure that the authority will use the budget to cope with climate risks... Currently, the fiscal mechanism has not been concretely developed to truly help as it is difficult... there must be a push to change climate change to a KPI that is important create a fluid environment for the province's finances and management..."

Dr. Thuttai Keeratipongpaiboon

Policy and plan analyst, NESDB

4.3) Plans or policies must rely on the consistency of each sector, and most importantly, collaboration.

One important development aspect that must proceed is participation; the same applies to the development for climate change adaptation, where development cannot proceed if there is a lack of participation. This can be clearly seen within the city development sector, no distinction have been made between the development of basic infrastructure or transport and communications. In the present time in Thailand there is a ministry to monitor these distinctive themes, such as land utilization relating to the use of automobiles as land use determines the activities on the land. However in Thailand the plans for the land utilization have been associated more to logistics but the agency, which should have a large overview within cities, has no mention of this. Therefore the participation within agencies or organizations will facilitate the perception of the larger view and enhance the ability to bring plans into proper implementation.

Another point that is an important aspect is the people and local participation. It is important to the aspect of adaptation to climate change that must also consider the society as well. One coping mechanism which will reduce people's risks is that the citizens or the locality must be involved in the access to information, or in creating awareness within communities for climate change mindfulness. It would seem this is an aspect that is distant to the community or people within cities but the situation in 2011 has illustrated that disaster is not a distant matter and can happen at any time. Particularly when situations are beyond the

power and capabilities, the societal group that received the most impact is people. Accordingly, there must be measures or networks to assist in their ability to protect themselves.

4.4) When referring to the adaptation to climate change in the longer term, the city development must incorporate the concept of adaptation to climate change into the planning or policies of both the short and long term. In looking to solving the problems of water management systems (water management) as the sole approach, without the consideration that risks are not only caused by climate change, but risk can also be caused by people.

The planning strategies or strategic improvement of the city and every sector in the city, can be done in accordance with the climate in the future by studying and understanding the future risks that has a likelihood to change a city's risk profile. This can be done through the consideration of changes occurring in other aspects, and also incorporating this understanding. For instance changes in socio-economic factors and environmental change as a result to urbanization, which acts similar to an acceleration factor that causes coastal areas to remain in situations of risk and uncertainty. The main and important element of the study of adaptation to climate change, under the concept of adaptation and development of cities under climate change, is to achieve and create a view point that is whole (holistic view).

5. An Analysis of Urban Services Plans provided by the Public Sector

Adaptation to climate change should be integrated into the strategic development of the city. Hence, this part will focus an analysis on three key urban services of the housing sector, infrastructure, and transportation sector which are the key drivers in shifting forward the development of the city, in particular the city development strategy under the risk of climate change and adaptation to climate change. The analysis will also focus on action plans of those three urban service sectors in order to trace back of the extent to which the national policy can translate adaption plan into local action.

Adaptation to climate change, under the risks stemming from climate, may vary depending on various conditions that occurs over a variable time, such as the increased occurrences of floods that are already frequent and has an increased likelihood to become more severe. These changes may result in the society and various sectors to encounter risks in a format that differs from the original. Defining the development strategy, therefore, requires a broader vision. As the plans or policies in the present that are being implemented, in both the levels of ministries and agencies, look just to reduce the environmental impact, and does not incorporate (mainstreaming) climate change adaptation within the urban development policy and plan. In order to manage future risks sufficiently, there must be planning and adaptation for the society and the various sectors in the city to meet the least risks caused by climate change.

The decision making on the various topics from the state departments or public (public policy analysis), has a huge impact on the adaptation ability towards climate change. The policies or strategies in various areas from the crucial sectors with city development, for example residential, infrastructure, and transportation, can facilitate or hinder climate change adaptation. The integration of climate change aspects must consider how the policies or strategies can help enhance adaptation capabilities to changes from the environment at the national or provincial level. It must also consider that each sector's projects, roles, authority

(structure and role), and operational mechanisms or instruments are varied, and whether the sectors has its opportunity to facilitate the implementation of adaptation activities towards climate change in the short or long term. In order to be able to manage the future risks adequately, there is the need to plan and adjust so the society and the different sectors can have the least risk from climate change.

Sector	Organisation	Structure and Role	Mechanism	Instrument
Housing	Community organization and development institute ³³ (CODI) (country level)	Community-based rehabilitation issue after the disaster event, focusing on informal settlement (Post-Disaster Relief and Recovery) 1. Development of an area-based community organization which is set up to encourage local communities to manage themselves. 2. Coordinating with local government and the parties involved. 3. Encouraging the flood victims to have the opportunity as a backbone for the community rehabilitation and create change. 4 The establishment of community networks to manage disaster ³⁴ and their network of communities ³⁵ 5 To contribute to the disaster response and adaptation to climate change plan with sustainable	1. Working with "structure of city committee" (Town and Network committee) 2. "The local community self-management" The strengthening of society from the base (Bottom-up) where the power of community organizations and civil society is the core, the participation and the decentralization of decision making power is important for the institution to coordinate the authority of all sectors. The organization of infrastructure and operational mechanisms of the institute proceeds accordingly as witnessed in the Royal decree establishing the institute in 2000.	1. Communication. ³⁶ Communication links with other communities that are experiencing the same problem, to create a community-based rehabilitation and build lives and rehabilitate the community in a short time 2. Finance ³⁷ includes the following: - Community-based welfare system. The system is linked to social welfare. - Revolving funds (Community level) - District level disaster solutions Fund/city (City level) Can be part of a community benefit fund. Such as public sector Welfare Fund 1 baht per day. ³⁸ - Risk insurance fund

³³ CODI, 201-Lessons from disaster management of community organization in mid1, 2011.

³⁴ http://www.openbase.in.th/files/pdf_.111pdf

³⁵ <http://chumchonhai.or.th/data-disaster>

³⁶ Seeing s disaster as an opportunity-harnessing the energy of disaster survivors for change, Environment &Urbanization, Vol. from (2)23International Institute for Environment and Development.(IIED)

³⁷ <http://www.codi.or.th/index.php/samples/-185landresolve-case-study/36-32-07-16-06-2013-2665>

³⁸ http://www.codi.or.th/downloads/exlearn/group_exlearn

		development		
	National Housing Authority ³⁹ (NHA) (Country level)	<p>National Housing Authority is a state enterprise under the jurisdiction of the Ministry of social development and human security, where the Ministry of Finance is a shareholder in the role a representatives of the state</p> <p>(Post-Disaster Relief and Recovery)</p> <ol style="list-style-type: none"> 1. To provide housing for the people who rent or lease 2. Find loans to build housing for the leasing or to financially assist the person to build housing, business, or land allocation 3. Community-based rehabilitation issue after the disaster event. 4. The development of housing for those affected by the flood protection plan. By the National Housing Authority to resolve building issues, residential encroachment by canals, and building retraction (6 meters) 3,046 canals in Bangkok and its vicinity (95,335 households). The project has been formed to support the preparation of new housing development project to accommodate those affected by the flood prevention plans of the 	<p>The community rehabilitation after the disaster (Post-Disaster Relief and Recovery)</p> <ol style="list-style-type: none"> 1. Residential development by bringing assets currently waiting development (sunk cost) and the original land (Land Bank) to develop new projects in the form of a sales project 	<ol style="list-style-type: none"> 1. The housing policy of the government as a tool to drive the organization according to the Government's policy on social welfare policy and human security 2. In accordance with the development of social welfare & human security. 3. Rely on law enforcement

³⁹ http://intranet.nha.co.th/download/article/article_20140630140556.pdf

		Strategic Committee to place the water resources management system ⁴⁰ (this project is currently in the GIS database development process provided under the government's plan and the policy year 2013-2016 ⁴¹ .		
Infrastructure	City planning department, Bangkok Metropolitan Administration (BMA) (City level)	<p>1. The most important role for the department of city planning is to prepare a comprehensive city plan, set land use regulations, and zoning ordinances. This includes the department's main role in controlling the land utilization activities, monitoring of building mass density and space (FAR, OSR, Minimum lot size, height, set back), and incentives with bonuses.⁴²</p> <p>2. Plans include transportation plan, infrastructure plan, open space plan and land use plan.</p>	<p>The use of tools in land utilization⁴³</p> <p>1. Measures of control (negative measure)</p> <p>As the different state departments use legal tools (legal instrument) to control the development of the private sector which could be done through regulations that law officials have set. Overall this incorporates:</p> <p>16. 1.1 use control land (Land use control) according to the city planning act 1975 (1992 revision, No. 3)</p> <p>1.2 building control (Building Control) according to the building control act 1979 (2000 revision, No. 3)</p> <p>1.3 control allocation of land (Land Subdivision Control) the land allocation act 2000</p> <p>17. 2. Incentive measures (positive measure) in order to support and guide the</p>	<p>The urban planning tool</p> <p>1. Comprehensive city plan of Bangkok, Thailand.</p> <p>Define measures to provide tools to be able to continue to meet the objectives of comprehensive city plan. As follows:</p> <p>1.1 land utilization activities control.</p> <p>1.2 building density control and vacant lots (Minimum lot size, OSR, FAR, Height, Set back)</p> <p>1.3 with incentives bonuses.</p>

⁴⁰ http://m.banteedin108.com/news_detailm.php?q_id=1690

⁴¹ <http://www.manager.co.th/iBizChannel/ViewNews.aspx?NewsID=9560000058796>

⁴² Report on a preliminary study. The project cost to hire a consultant to measure the mechanism and city development in the urban metropolis, department of town and country planning, Bangkok, 2013.

⁴³ Report on a preliminary study. The project cost to hire a consultant to measure the mechanism and city development in the urban metropolis, department of town and country planning, Bangkok, 2013.

			<p>development of the private sector (Infrastructure Led Development) to be in the direction as defined in the Comprehensive Plan</p> <p>2.1 Measures were developed from the application of negative measures</p> <ul style="list-style-type: none"> - Measures to promote (Incentive Measure) is to be carried out according to urban development policies by increasing the building to land area ratio (FAR Bonus) - Compensation (Corrective Measure, yet regulated in the current comprehensive plan of BMA) for those who have been affected by the negative measures, which resulted in a lower land use potential such as transfer of development rights (Transfer of Development Right or TDR). This is in order for the land owners, who were subjected to regulations of the conservation of works of art, architecture, history and archaeology, or conservation of natural resources and environment, to receive compensation from the transfer of development rights to areas that are being promoted for development through the city development policies. Such as promoting the development of the area for traffic interchange and the mass transit rail traffic. <p>2.2 Measures for the beneficiaries of positive measures pay (Beneficiary pay principle)</p> <ul style="list-style-type: none"> - Use of financial tools such as the land owner must have joint responsibility towards basic infrastructure, for instance city development through land reform according to the Land Reform Act in 2004. - Fair compensation payment given to asset owners that have been impacted by land seizures, in cases where infrastructures are according to positive measures, it is necessary for the 	
--	--	--	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--

			acquisition of land through expropriation.	
Transportation	Office of Transport and Traffic Policy and Planning (OTP) ⁴⁴ (National-local level)	1. Responsible for the development of the traffic and transportation of Bangkok. ⁴⁵ (with the Bureau of traffic and transportation, Bangkok) 2. Measures to control the traffic volume	1. Strategic Plan on logistics development Collaboration between the public sector (work, traffic, and transportation) with the social sector. 2. Travel management in disaster situations is an important process to evacuated the public evacuation quickly and securely with 3 stages: - Before disaster (Pre-disaster Phase) - Interval between disaster (disaster During Phase) - After disaster (Post-disaster Phase)	Setting up seminar participation forum. The project defines the guidelines for the management of transportation routes in a disaster in Bangkok and vicinity.

⁴⁴ .Office of transportation and traffic policy and planning, Strategic plan for the development of sectoral transport system 2020 -2011 , OTP, Master plan for the development of traffic and transport systems 2011 – 2020, Ministry of transport 2011-2015 strategic plan.

⁴⁵ <http://www.otp.go.th/index.php/introduce-otp/mission.html>

6. An Interview of Public and Private Response and Adaptation Plan

The short term coping and the long-term adaptation of the various, important sectors of both private and public sectors in this study by evaluating:

1. Response and limitation of the public and private sector
2. The preparedness for the future
3. The funding source
4. The preparation of the plan and participation of the public and private sector

These points are investigated through in-depth interviews, in order to analyze the coping and adapting abilities and private and public sector policies after the disaster in 2011.

6.1) Response from sectors and their limitations

Disaster and climate change adaptation issues	THAIGIA ⁴⁶ (Thai General Insurance Association)	Urban Planning and Specific Planning Bureau DPT ⁴⁷ (Department of Public Works and Town & Country Planning)	ONEP Climate Change Management and Coordination Division ⁴⁸ (Office of Natural Resources and Environmental Policy and Planning)
Response and Limitation	<p>The problem solving from insurance companies (Bangkok Insurance) in that time is to use SMS systems to help manage and facilitate contact with people who received damage. Such as the use of photos of example appliances or furniture that is damaged or to document damages. During that time, cost of damages averages at about 100,000 Thai baht per household. After the 2011 event, there were sales occurrences in the form of "sub-limits" or what called "zoning". Through collaboration with GISTDA to manage zoning and distribution of information to insurance companies in the assembly.</p> <p>Limitation is the unclear responsibility of who or which government sector</p>	<p>Since the department is more a practical agency than a policy based agency, there are frequently tasks that have to be performed.</p> <p>Urgent tasks or tasks under their responsibility within each financial year causes tasks which require long amounts of time, such as tasks related to climate change awareness, are often not considered.</p>	<p>Climate change committee schedules every 6-month or yearly meeting, which causes limitations to the operation or the implementation of plans into other agencies. However if there is a climate change master plan in the future, it can improve the efficiency even more. The development of a road map to prepare a detailed plan towards an action plan, it could also enhance the cooperation between agencies even more.</p>

⁴⁶ Anon Vangvasu. President, THAI General Insurance Association. Interview, 22 December 2014

⁴⁷ Chutthatip Achavasamit. Urban Planning Specialist, Department of Public Works and Town & Country Planning. Interview, 28 January 2015

⁴⁸ Prasert Sirinapaporn. Director, Climate Change Management and Coordination Division, Office of Natural Resources and Environmental Policy and Planning. Interview, 23 January 2014

	has the executive authority or who should be asked for assistance		
--	-------------------------------------------------------------------	--	--

6.2) Funding source for future responses

Disaster and climate change adaptation issues	THAIGIA (Thai General Insurance Association)	Urban Planning Comprehensive and Specific Planning Bureau DPT (Department of Public Works and Town & Country Planning)	ONEP Climate Management Change Coordination Division (Office of Natural Resources and Environmental Policy and Planning)
Funding Source	To set up a fund to the state's promote disaster insurance (National Catastrophe Insurance Fund) that facilitates supply to support cases where the foreign investors (Reinsurance companies) lost their confidence, and be able to guarantee security in the highest amount (capacity) and the interest rate is the same in all insurance areas.		The environmental fund under the ONEP, and another fund within the provincial planning which supports waste management, will have focuses on coping with climate change. The funding source is with the local government administration (ONEP will help oversee on the technical aspects)

6.3) Preparation/ evaluation of the plan and participation between government /private agencies

Disaster and climate change adaptation issues	THAIGIA (Thai General Insurance Association)	Urban Planning Comprehensive and Specific Planning Bureau DPT (Department of Public Works and Town & Country Planning)	ONEP Climate Management Change Coordination Division (Office of Natural Resources and Environmental Policy and Planning)
Preparation and evaluation of the plan	Who has jurisdiction over which area must be clear. In the future, the state could introduce taxation systems to help, for instance premiums, etc. The plan, or the establishment of management structures during disasters is highly crucial, each sector must know its roles within disaster situations.	If agencies within the operational level, like the department of public works and town and country planning, or the provincial level can disclose what they are currently doing and the higher levels can look back at what the operation level is doing (meaning to view and reflect back is to have a top-down process for plans to be implemented properly, and also a bottom-up process so local authorities can disclose what they are currently doing), this will also mainstream the subject of	The ONEP has considered the city into the plan or strategy by looking at settlements as a sector and focuses on two main points: 1. The reduction of risks, such as utilizing city planning mechanisms or tools to cope with climate change; such as usage of building codes, organizing of specific plans. 2. To prepare readiness such as enhancing knowledge for communities, reliance on cooperation in developing plans, where literature review and reviews of relevant plans are primarily used.

		climate change into the operational level.	
Disaster and climate change adaptation issues	THAIGIA (Thai General Insurance Association)	Urban Planning Comprehensive and Specific Planning Bureau DPT (Department of Public Works and Town & Country Planning)	ONEP Climate Management Change Coordination Division (Office of Natural Resources and Environmental Policy and Planning)
Participation between government /Private agencies	A clearer picture of the government policies will help the private sector to trust the management more. Dialogue between the government, private sector, industrial sector, and insurance sector will improve the situation.	The lack of continuity and connectivity between the agencies at the policy and operational level makes work difficult because the agencies within the operational level have their usual work and it is difficult to further include it into this usual system.	The mechanism or dimension that the private sector will cooperate on is during the consultation process of the plan, which includes both private and NGOs. Within the Environmental policy committee, it also includes participation of the private sector, which is to invite the private sector as an expert.

7. Cost and benefit analysis of Public and Private Adaptation

7.1) Structural and non-structural measures⁴⁹

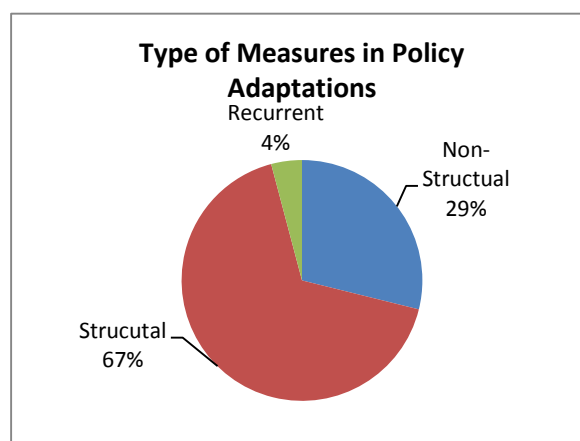
Structural measures: Any physical construction to reduce or avoid possible impacts of hazards, or application of engineering techniques to achieve hazard-resistance and resilience in structures or systems; Non-structural measures: Any measures not involving physical construction that uses knowledge, practice or agreement to reduce risks and impacts, in particular through policies and laws, public awareness raising, training and education.

Common structural measures for disaster risk reduction include dams, flood levies, ocean wave barriers, earthquake-resistant construction, and evacuation shelters. Common non-structural measures include building codes, land use planning laws and their enforcement, research and assessment, information resources, and public awareness programs. Note that in civil and structural engineering, the term “structural” is used in a more restricted sense to mean a load-bearing structure, with other parts such as wall cladding and interior fittings are termed as non-structural.

⁴⁹ UNISDR.(2007), TERMINOLOGY ON DISASTER RISK REDUCTION. [Online], Available: <http://www.unisdr.org/we/inform/terminology> [2 January 2015].

BMA and some of BMR Urban Development and Climate Change Adaptation Policies: classification by type of measures: Structural and Non-Structural⁵⁰

Type of Measures	Number of Projects
Non-Structural Measure	28
Structural Measure	65
Recurrent Adaptation	4
Total	97



The BMA Climate Policy options and urban development policies in risk reduction are classified as Structural measures, non-structural measures and recurrent adaptation measures. The structural measures highlighted construction policy and engineering techniques in mitigation and adaptation. The policies include roads construction, building dykes, building flood ways and increasing the capacity of waste management. The constructions of engineering approach in risk mitigation are planned in many parts of Bangkok. Most of the structural measures are implemented in transportation sectors apart from infrastructure planning in building dykes and increase capacities of flood way and canals. The non-structural measures are non-engineering approaches in mitigating the risk through policy and planning. The climate change adaptations in Bangkok are strategic policies in environmental planning, green city campaigns, community capacity building, insurance policy and development of information system. There are 28 totals of non-structural measures which are less compared to 65 structural measures. There are 4 projects identified as recurrent adaptation of short term benefit measures that occurred as a routine response measure.

7.2) Type of Measures by Sectors⁵¹

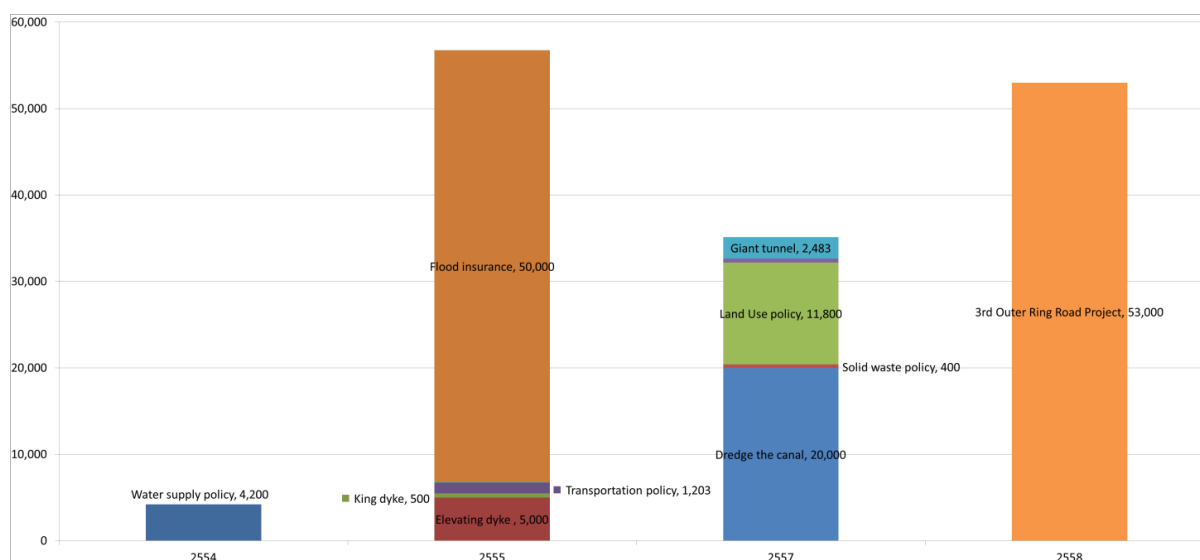
Measures	Sectors	Number
Non-Structural	Production	3
	Urban	8
	Infrastructure	2
	Financial	3
	Transportation	4
	Service	1

⁵⁰ All programs are published on the Bangkok Public Relations division, are projects within Bangkok and its vicinities (outer ring 2 and some projects along the coast) since the year 2011-2012 (the post 2011 flood operations) and in the year 2014-2015 (the preparedness of flood coping mechanisms).

⁵¹ All programs are published on the Bangkok Public Relations division, are projects within Bangkok and its vicinities (outer ring 2 and some projects along the coast) since the year 2011-2012 (the post 2011 flood operations) and in the year 2014-2015 (the preparedness of flood coping mechanisms).

Recurrent	Infrastructure	3
	Urban	1
Structural	Infrastructure	37
	Urban	2
	Transportation	26

Millions



The policy planning in 2011-2012 (post 2011 flood operations) and 2014-2014 (the preparedness of flood coping mechanisms) ⁵²

Analysis in type of measures, the government intervention were implemented in the highest portion in structural measures with 67% of adaptation measures, with 29% of non-structural and 4% of recurrent adaptation which is account as response measures.

Non-structural measures are policies summarized as follows:

Production: Agriculture zoning, water management for flood prevention in industrial zones

Urban: Low carbon city campaign, Coastal runoff land use planning

Transportation: Planning for low carbon transportation development

Financial: Disaster insurance, Community Fund

Service: Eco-Industrial town

Structural measures are policies summarized as follows:

Infrastructure: Flood way, dyke, water tunnel, landfill, Incineration

Transportation: roads and bridges elevation, roads expansion

Urban: Land use policy, Hydro Station Land use development

⁵² All programs are published on the Bangkok Public Relations division, are projects within Bangkok and its vicinities (outer ring 2 and some projects along the coast) since the year 2011-2012 (the post 2011 flood operations) and in the year 2014-2015 (the preparedness of flood coping mechanisms).

Recurrent Adaptation Measures:

Flood response; clearing the flood way, water drainage system, improve canal drainage capacity

7.3) Robustness decision making⁵³

Disaster and Climate change operates under the principle of non-linear and uncertainty, which means the current data, might be valid for adaptation effectiveness in application.

Two key points:

- The decision needs to be robust in term of diversifying measures in a wider strategy by prioritizing the cost benefits as well as the robustness to uncertainty. This would lead to more flexibility for government investments rather than spending heavily on structural measures.
- Heavily spending on structural measures might yield higher benefits relative to the cost, but it is not sufficient to meet the robustness to uncertainty in current conditions of climate change in policy adaptation. Therefore, the policy decision must be able to cope with long term uncertainties.

7.4) Heavily Structural measures can transfer risk and it is impossible to eliminate risk from flooding

The structural measures could reduce floods in one location but would transfer to other location, urban flood management should consider wider interest in flood risk reduction in order to avoid conflicts which could happen. Moreover, the structural engineers measure are designed to eliminate the floods in pre-determined levels which could fail in uncertainties, therefore it is the best solution to combine with non-structure which are designed to minimize the risk. The balance strategy would help the cities for resilient adaption.

7.5) Climate Change Adaptation measures needs to take consideration of cost benefits and robustness to climate change uncertainties.⁵⁴

Robustness of policy includes combining strategies in non-structural and structural measures. Over reliance on structural measures such as dyke, flood defense, drainage system and road construction requires high costs compared to non-structural measures such as reduced social vulnerable and raise awareness in risk reduction due to high cost of investment and would not adapt into changes to climate change. The flood risk cannot solely be prevented by structural measures where it will transfer the risk to other; therefore it needs to require consideration of wider stakeholders for robustness decision making. High robustness to uncertainties policy takes wider consideration of stakeholders such as early warning and urban development control, and also regards as more sustainable and adaptive to changing conditions. Moreover, climate change adaptation decision making policy need to take account the long term benefits in robustness to climate change uncertainties. The logic of climate change that the data is uncertain, the robustness measure would enable urban development for resilience capacity over the long run.

⁵³ Abhas K Jha, Robin Bloch, Jessica Lamond, 2012, A Guide to Integrated Urban Flood Risk Management for the 21st Century, Cities and Flooding, THE WORLD BANK, Washington, D.C.

⁵⁴ Robert L. Wilby and Suraje Dessai. [2010], Robust adaptation to climate change. [Online]. Available: <http://www.hps.cam.ac.uk/research/webref.html> [2 January 2015].

7.6) Relative cost and benefits and robustness (temporal aspects) of public and private policy measures

The histogram illustrates above show the government's budget during 2011-2012, and 2014 – 2015. It is apparent that the majority of the budget is to develop the infrastructure for water management. The highest budget has been allocated to the development of the third outer ring which is a large project by the Ministry of Transportation. Not only will it be an increase in transportation routes, it is also relied on as channels for water management since it where the long haul routes from the east and west side of the Chao Phraya River converges. Subsequently, the second highest budget was allocated to the setting up the National catastrophe insurance fund which requires large amounts of money to show the financial security to support during disaster times. The expansion of the canal also requires a large budget, which also becomes one of the largest budgets in 2011, in order to open up paths for quicker water drainage as a disaster coping measure for the future. Nevertheless, the plans does not consider the societal aspects or people as much which can make coping mechanisms and risks from climate change not as robust (robustness) if only infrastructure is prioritized.

The 2011 flood, when the flood has lessened, the various sectors have increasingly begun to consider coping mechanism for disasters. The government and the private sector should find a way to cope with or communicate more, and bring about quick term policies. This can be clearly seen with the Dam building policy around the six industrial parks or estates built in Ayutthaya and Pathumthani. Due to the flood damage to the industrial sector, however only the seven industrial estates suffered damages as high as 237,410 million baht. This does not include the factories outside of the estate that had a loss of up to 239 million baht. The extensive damages within land, buildings, equipment and machinery, raw materials, and products have had considerable impact on every sector. The insurance sector is also affected because the industrial estates have a total insurance limit of 600,000 million baht, where insurance companies within Thailand guarantee 15% and forward to insurance companies for the other 85% of the insurance premiums. Many sectors are affected successively, especially regarding employment, when industrial factory's hiring or the employees are also impacted. According to evaluations, only the industrial factories within the industrial estates have impacted the hiring of up 192,000 people. Base on this, the policies or protective measures must focus towards the industrial estates in order to reduce the damage or economic impact of the country.

In the building of the dam around the 6 industrial park or estate (Bang Pa-in industrial estate, Bang Wa industrial estate (hi-tech), Rattana Nakorn real estate, Bang Kadee industrial park, Rojana industrial zone, and Nawanakorn industrial zone). The government has financially assisted on 2 out of 3 of the building costs or in the about of 3,256, 694 baht, which was government approved to maintain the industrial estate in case another flood happens. Some industrial factories have built their own dams as a protective layer due to uncertainty. However in considering a different perspective, in using measures in the form of building infrastructure is only the transferal of risks onto other sectors (transfer risk). If a flood occurs again, the communities within the surrounding areas of the industrial estate will be the areas receiving water, and then the production line will not be able to proceed as workers are unable to travel to work as logistics also becomes more difficult. In the end, although the machinery has been protected, the community or workers are still faced with risks during disasters.

As mentioned above, it has been illustrated that the government has allocated large amounts of money to protect the industrial sector like factories, materials and equipment, or stock in order to subsist from floods, and it is most certain that the allocated funds will be used in this matter. This brings the most benefits to the operation personnel for when floods occur again in the area. Building dams reassure the operation personnel to a certain extent that the machinery, products, or the factory is protected. The sector receiving the most benefit from the reduction of industrial factory damages, are the insurance sector as it means assistance is not in the form of a large payment like what was being claimed by many and simultaneously in 2011. However, the benefits come with two major sectors, such as the industrial sector and the insurance sector. Even though it can help assist in forms of payment or reduce the impact on the economy but the public sectors, labor sector, agricultural sector, etc., cannot not benefit from subsidies to build dams that the government has allocated a large amount in this time.

7.7) Recurrent Adaptation

Coping occurs repeatedly every year in Thailand, in the characteristics of coping along the canals in Bangkok, which is mainly to dredge the canals, open waterways, installing water pumps during the flood and rainy season. The adaptation projects within Bangkok are implemented repeatedly per year. This can be illustrated as follows:

Project	Year of Budget	Budget amount
"dredge drainage systems of roads, lanes, alleys with areas of Bangkok" from the original an MOU agreement was made between the department of corrections and Bangkok in the year 2012 in a total of 50 districts in Bangkok ⁵⁵	2012	271 million baht
"dredging of draining systems to cope with rain water" Department of Drainage has accelerate the cleaning of drainage pipes, where in Bangkok has approximately 277 lines and is 964,842 meters long (50 million baht) ⁵⁶	2011	130 million baht
Dredge the outer canals to cope with floods from the eastern bank, with 16 canals, with 13 canals on the Eastern bank (67 million baht)		
The project to dredge canals in Bangkok districts, in total of 677 kilometers, in the agreement of the Department of Drainage and the Thai army. ⁵⁷	2010	380 million baht

The table above illustrates the policies or measures for adaptation in Bangkok during the flood and rainy season and is repeatedly implemented each year to open the water ways. Other than dredging the canals, there is also the removal of water weeds along the river and canals, or waste collection. Each of the projects is often in cooperation with the different sectors such as the public sector, the army, or the department of corrections because of the need to use large quantities of personnel and limited period of time.

55 <http://www.manager.co.th/home/viewnews.aspx?NewsID=9550000113874>

56 ASTVith The Manager Online (1 February 2012), Bangkok invests 130 million to dredge canals, pipes to cope w floods, from <http://www.manager.co.th/qol/viewnews.aspx?NewsID=9550000014605>

57 Sanook.com (30 June .2013), Bangkok mayor orders dredging of 677 kilometers of canals to protect against floods, from <http://news.sanook.com//947549>

If the budget that is allocated repeatedly each year is adjusted or towards the planning or construction of permanent buildings, it will save much more of the budget and allow usage of the funds to support other protection measures.

7.8) Private and Public adaptation: cost and cost sharing and benefit & co-benefits of funding and agent of implementation

In a survey of the public sector, it was found that during instances of disasters, it took approximately 2 weeks for people to return to normal life. It was also found that a majority of households were not prepared for poor situations or conditions when a flood occurs. Moreover, in cases of power outages, it was found that issues of electricity can be solved in the short to medium term period. Even if people in Bangkok have been more aware of the future disaster risks from the 2011 flood, the majority of people are still insists on taking out insurances, in addition to not being as adequately prepared to cope for the future. On the whole, this is because people do not have the resources to assist the management of coping measures. Additionally, there are also perceptions that a flood of this magnitude will not occur as frequently. Therefore the preparation for the societal sector to cope or adapt to climate change is to wait for assistance rather actually preparing because budget towards this is small and perceptions that this flood incidence will not be regular.

The joint venture between the government and the private sector are predominantly as financial aid where the state assists with 2 out of 3 of the total construction cost, such as the construction of dams around the industrial estate. As previously mentioned is in the nature of contributions of the private sector but this highlight that there is some cooperation or agreements between the government and the private sector, such as the industrial policy to borrow money from banks at interest rates of 0.01% and extended repayment terms up to 15 years, or the policy which was formed from after-flood issues which is finding a vendor that can fix machinery as the majority of store are also affected. This lead to the restoration of the manufacturing sector after the flood situation, under the cooperation of department of industrial works, department of industrial promotion, the board of investment, and in coordination with the company Reeds Tradex, to mobilize stakeholders in the industrial sector. A one stop service has been established to comprehensively assist the industrial sector that were affected by the flood, this includes providing knowledge on how to restore, fix, finances, credit insurance and find personnel to temporarily take over the production line. This assists in the mobilization of stakeholders to facilitate arrangements of meetings, including best practices or the process to restore the factories.

Even though the government has provided help towards the construction of dams that surround the industrial park, the industrial sector remain active in providing their own investment and managing on their own (self-organization). Within the industrial estate or park, there are coping measures in the event of future situations of floods such as the preparation of water pumps, sand bags, or the use of mobile dams or dike that can be quickly installed within one day. The dams or water protection matters have already been tested. The operation personnel also have coping measures for unexpected events and has an action plan for every step because if they make mistakes like in 2011, it will cause detrimental loss for the entrepreneurs. ⁵⁸

⁵⁸ Daily News newspaper, Private sector ready to cope with flood disaster, struggle to survive before repetition from the year 2011, Monday October 14, 2013, from <http://www.dailynews.co.th/Content/economic>

For the small and medium enterprise (SMEs) the majority of agencies that came and assisted the sector were banks, in order to help the businesses continue their operations or enhance their efficiency. An example of programs that help in this manner is the Thailand Military Bank's SME Revitalizing credit program that supports SMEs to recover in the form of long-term loans of the Thai military Bank. This is another policy by the government to provide assistance to SMEs sector. Another government effort is to provide financial assistance to the societal sector that have been affected by the flood in the amount of 5000 to 20,000 baht, or mobilize funds from various sectors including the private sector, people, or the media to provide financial assistance to help flood victims in the form of various funds.⁵⁹

It can be witnessed that during disaster events, the cooperation from the various sectors within the country is a crucial aspect⁶⁰. Every sector endeavors to help or mobilize funds with maximum effort. For instance the societal sector, such as people or households which is the smallest sector to be impacted by the flood, has received assistance from funds or financial support by the state or donations to renovate their homes. Whereas the SME sector, the main forms of assistance primarily falls with commercial banks to assist the business efficiency. The largest sector, regarding the largest sector to require large amounts of funding, is the industrial sector where assistance falls primarily on to the government and money from the treasury of the Government's savings bank. However, it would be better if the government has created plans for future financing, where all sectors cooperate in order to cope with future risks, and to improve the structure to manage the fiscal system better so the government funds or funds from taxes of the citizens will not benefit a sector more than the other. Thus developing financial plans during disaster incidences should be reasonable and maximized to receive or in the amount that is suitable for every sector.

This research also complimented by a small set of samples of household survey, to understand community in housing sector recovering time after 2011 flood. A survey of the public sector (30 households) found that the societal sector do not have the readiness to adapt to the effects of climate change due to the perception that the risks are within their scope. There are no plans for such risks, where coping measures are still found in a more ad-hoc manner, among both in the household and the community level. This can be seen by observing the time for people to restore their lives back to normal, where the recovery time after the flood took too long (37.93% on average 2 weeks). Those who are affected the majority are prepared to cope with problems in the immediate, face-value approach, there is no long term planning such as, those affected will not invest the time and money to manage future risks.

⁵⁹ ASTV ผู้จัดการรายวัน. [16 มีนาคม 2555]. *TMBอัดฉีดSMEน้ำท่วม ปลดปล่อย30ล.ตบ.3%5ปี*. [Online]. Available: <http://www.manager.co.th/Daily/ViewNews.aspx?NewsID=955000033820> [2 January 2015]

⁶⁰ Matichon online. [30 มีนาคม 2554]. *รวบรวมหน่วยงาน-องค์กร-ภาครัฐ-เอกชน รับบริจาคเงิน-สิ่งของช่วยเหลือน้ำท่วมภาคใต้*. [Online]. Available: http://www.matichon.co.th/news_detail.php?newsid=1301473147

Sector	A: How many days did you take to get back to the normal life?					B: How do your preparation for bad weather and floods?				C: In case of electricity disruption, How long of the response of the electricity office?		
	<1wk	2wk	3wk	4wk	5wk	1	2	3	4	Fast	Moderate	Slow
Household	9	11	2	8	3	7	2	8	10	8	17	2
35. %	17.24	37.93	6.90	27.59	10.34	25.93	7.41	29.63	37.04	29.63	62.96	7.41

B: How do your preparation for bad weather and floods

1. Prepared or stocked on food like rice and groceries, water and medicines.
2. Stocked on candles, flashlights and other emergency supplies.
3. Prepared ready packed clothes/toiletries and secured emergency evacuation place with relatives/friends
4. No

Sector	D: In case of water services disruption, How long of the response of the water services office?			E: Are you interested in flood insurance scheme, if not possess one already?			F: Are you willing to invest your resources (time, money, etc.) to minimize future flood impact?							
	Yes	Not sure	No	Yes	Not sure	No	Yes	Not sure	No...because					
Household	1	2	3	4	5	6	1	2	3	4	5	6		
62.	7	18	2	7	36	8	9	6	78. 30 (66.67%)					
	25.93	66.67	7.41	13.73	70.59	15.69	20	13.33	-	8.7	26.09	-	65.22	-

F: Are you willing to invest your resources (time, money, etc.) to minimize future flood impact

1. Yes
2. not sure
3. no because
 1. I'd rather rely on the government to do that.
 2. I don't believe in my ability to prevent such strong flood, I d prefer to recover from whatever impact it may give.
 3. I don't think such severe flood would occur so often.
 4. I hope be to living somewhere else before the next flood.

5. I don't have the resources.

6. Other reason

8. Critique of the adaptation efforts

- The measure most important to the distribution of power, which includes the management of the financial system towards the local level, in order for the local authority to have concrete plans and management for climate change adaptation. This is seen as long-term should be started because participation and planning from local authorities is important.
- As mentioned above, there should be an agency plan at the Ministry-level to the local level that will be upheld or followed concretely. Additionally, the adherence to the national economic and social development plan that has a duration of 4 years (from the comparison to IPCC, it was found that Thailand has a plan but there are still limitations within the practical stage) or should have a KPI (key performance indicator).
- Some reforms that are more than the economic and social development plan based on the national stage did that just 4 years (from compared to the IPCC, it found that the Thai national plans, but there are also limitations in the process of being implemented) or should it be a KPI (Key performance Indicator).
- The lack of continuity within the plans such as is the long-term plan without returning to consider the short-term plans.
- The climate change convention officer (CCCO) of the different agencies include:
 - Head of CCCO which is a fixed term officer, in instances of ministries.
 - The assistant CCCO, at least one person

The establishment of the CCCO within relevant agencies of 30 agencies, that consists of 19 ministry-level agencies (every ministry), and 11 non-ministry level agencies. It can be observed that this project will create consistency and direct within the ministries towards the same direction on the topic of climate change adaptation. If the coordination occurred from departments directly responsible for topics of climate change, like the Office of Natural Resources and Environmental Policy and Planning, and bring the climate change adaptation plan to be implemented according to the roles and responsibilities of the ministries. However, the current plans that were formed within the ministries have gaps and inconsistencies. Thus, to push for a coordinating structure that has more roles is one way to assist the formed plan to be implemented and consistent among the different agencies and become more wholesome.

9. Policy implications and way forward

The point derived from the IPCC AR5 Chapter 12, about human settlement, infrastructure, and spatial planning, and the comparison of urban development policies and plans in Thailand from study reports and strategic planning for climate change adaptation, such as the plan to improve the environment, the vision report, strategic points on natural resources and environment management over the time frame of 20 years, and in many other plans within the ministry, agencies, and Bangkok found that:

- Thailand had studies on the vision regarding policies, distribution of power, or finances towards local areas can be compared to the international level. However on practical

term, or when looking more in-depth to the agency responsible for the implementation, it was found that the plans only focus on the short-term measures of coping with disaster rather than the long-term measures of adapting to climate change. Thus it can be observed that good governance, or finances of the government, will only appear within plans at the policy level or long-term level more than at the organizational level, like the 4 year governmental operational plan. This makes the practical implementation of the plan limited and difficult. The community organizations that promote disaster funds for the community or promote local administrative organization is one way to help people or communities cope and adapt in situations of disaster, even though it is not in the policy level.

- There are currently many city development plans, but the policies towards city planning that focuses on the climate change coping measures are still unclear, such as the building code bonus, the vehicle parking policy, or the compact city project. There are several urban development concepts but do not go within the same direction. The ambiguity of the plan, therefore, becomes a constraint on the development of cities to cope with climate change.
- Policies that use economic tools as a tool to control is still a broad concept or within the study period, so it does not indicate which ministries are responsible.

On the issue of the development of transport and communications to support the climate change, it was found that within Thailand there is a lack of transportation planning that is necessary to join to other planning measures, such as urban planning, because transportation plays a role within the infrastructure of the city. If city development does not facilitate the development of transportation systems towards the adaptation of climate change, then implementation cannot be concretely achieved. For example, since the city has to be conducive to the changes in types of transportation that leads to convenience, or city policies like Smart Growth or Compact City will reduce the usage of cars or lessened travel distances which can then lead to the reduction of gas emissions from vehicles. Additionally, the enforcement of vehicle tax or defining vehicle use in ways to improve efficiency, including the usage of economic measures in tax is still limited in Thailand.

c. Manila

**Characterizing Public and Private Adaptation to Climate Risks and
Implications for Long-Term Adaptive Capacity in Asian Megacities:
The Case of Metro Manila**

By Emma Porio

With the Assistance of Cora Milana Bolong, Justin See and John Paolo Dalupang
Ateneo de Manila University

1. Introduction

This study characterizes and measures climate and disaster adaptation interventions in response to heavy precipitation events and flooding impacts in Metro Manila. By developing a typology of adaptation measures that cities and communities undertook, this study also attempts to estimate the costs and damages of flooding and its implications for short- and long-term implications for urban development and resilience.

Coastal cities in Asia have a high exposure to climate-related hazards such as heavy to extreme precipitation, sea-level rise, cyclones and storms. Being a coastal megacity, Metro Manila is highly vulnerable to climate change impacts such as heavy monsoon rains, floods, sea level rise (SLR), and tropical storms/typhoons. Compounding the effects of these climate-related stresses is the high subsidence levels in some of the cities in the metropolis like Manila, Navotas, Malabon, etc. Like other countries in Asia, where 18 percent of the urban population live in low coastal elevation zone (LECZ)⁶¹, most Philippine cities like Metro Manila are at risk to hazards like storm surges and sea level rise. As seen in the map (see figure 1, below), Manila Bay fronts the capital city with the Laguna de Bay Lake and the Sierra Madre Mountains at the back framing the whole metropolis.

Manila was once governed by a central local authority, alongside other surrounding cities and municipalities. But in 1975, President Ferdinand Marcos created the Metro Manila Commission (MMC) and installed Imelda Marcos as governor to coordinate the cities and municipalities comprising the metropolis. With the assumption of President Corazon Aquino after the EDSA Revolution in 1986, most of its functions were returned to the local authorities of the agglomeration of cities and towns comprising the metropolis. This left the MMC only with the tasks of traffic management, solid waste management and flood control. In 1992, the Local Government Code and the Urban Development and Housing Act (UDHA) further strengthened the power of local governments and increased the weakening of the MMC (later reorganized as Metro Manila Development Authority) of its potential metropolitan control/management. Thus, functions with direct implications to climate adaptation and disaster risk reduction and management like planning, land use, social housing, resettlement, and delivery of basic services got devolved to the local governments. But hazards like floods, earthquakes, tidal/storm surges and soil subsidence cuts across political-administrative boundaries, causing gaps and “disconnects” across systems and layers of decision-making frameworks of action. In 2010, after the flood devastations of Tropical Storm Ketsana in 2009, the Philippine Government climate adaptation and disaster risk reduction policies and programs. In subsequent years (2011-2014), the 17 cities and municipality in the national capital region (NCR), each crafted an integrated climate adaptation and disaster risk reduction and management councils and plans. Later, this report will discuss in detail these plans in relation to how it was implemented in the cities of Marikina and Pasig, two major cities in the NCR located along the Pasig-Marikina River system and continually at high risk to flooding.

Recent extreme events like the Ketsana floods (2009) and the monsoon rains of 2012/2013 have demonstrated the vulnerability of the metropolis to flooding and how local governments fall short of the functions expected of them. During Ketsana, 70 percent of both Marikina City

⁶¹ Low elevation coastal zones are contiguous areas along the coast that is less than 10 meters above sea level (McGranahan et al. 2007).

and Pasig City were flooded, with some urban poor communities under water for a few days or weeks. The floods paralyzed the city and compromised the delivery of basic services and other related urban functions. Rescue and rehabilitation operations were largely done with support from the MMDA and the national government. The severe limitations of a decentralized and/or devolved governance system seem not to be recognized in the two laws enacted in 2010 (The Disaster Risk Reduction and Management Act; The Climate Change Act). These laws largely lodged the responsibilities of climate adaptation and disaster risk reduction in the local governments. The disastrous consequences of this institutional arrangement was also seen in the aftermath of Typhoon Haiyan in Tacloban City when the whole city was paralyzed and the Secretary of the Department of Interior and Local Government (DILG) had to pry a letter of authorization from the mayor in order to intervene and provide rescue, relief and rehabilitation services.

The research findings here are crucial in formulating evidence-based policies and programs more appropriate and effective for climate adaptation/resilience and disaster risk reduction (DRR) strategies for key actors/stakeholders. More importantly, this will pave the way for mainstreaming climate mitigation and adaptation strategies into the intertwined DRR management and climate change adaptation policies in the Philippines. Thus, it will facilitate the crafting of a more effective monitoring and measurement system of vulnerability and adaptation measures implemented by local governments -- the key implementing body of the national climate change and DRR policies and programs in the Philippines.

2. Exposure and vulnerability of the city

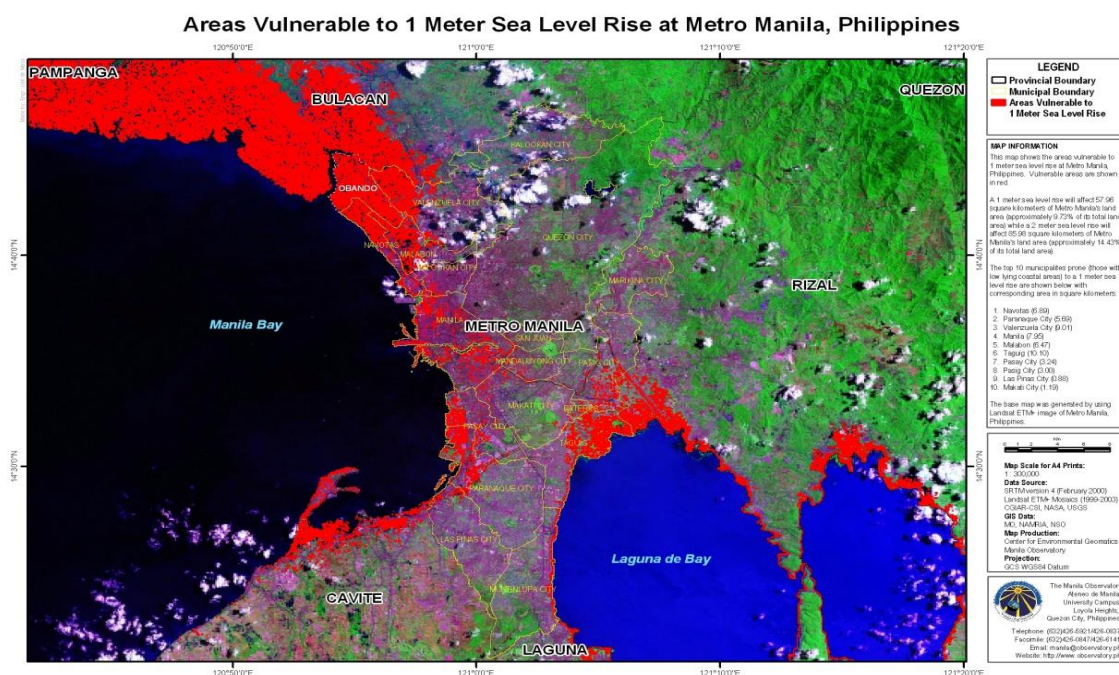
This section elaborates on the geophysical, economic and social characteristics of Metro Manila that render the city vulnerable to climate hazards, risks and disasters..

In third world cities like Metro Manila where urban growth and sprawl remains largely unregulated, the vulnerability to climate change-related effects like floods is quite high, especially among the urban poor communities, reducing their potential for adaptation and resilience. The devastating Ketsana floods of 2009 brought to the surface how the social, demographic and political-ecological landscapes of the metropolis have been largely transformed in the last few decades. At the turn of the century, Manila had a population of 300,000 under one central authority. A century later, it had absorbed some of the surrounding towns and consolidated itself as a metropolitan area comprised of 17 cities and 1 municipality and with a population of 13.9 million (UNCHS 2014). It has a daytime population of 16-18 million and a population density of 18,000-20,000 per square kilometer (see Appendix Map 1). The national capital region (as Metro Manila is also known) is highly important for its economic, political and cultural functions. It contributes 38 percent to the national gross domestic product (GDP). In 2013, the annual GDP growth was 7.5 percent, second to highest in the region after China. But about 40-60 percent of Metro Manila's population does not have security of tenure in their housing nor access to adequate basic services such as potable water, sanitation and sewage services. Most of the urban poor reside in informal settlements along riverbanks, coastal areas, sloping areas and degraded environments which are not safe for human habitation and very prone to flooding and other hazards.

The land use pattern within and around the metropolis have changed so much. For example, the loss of forestlands within and around the metropolis has been remarkable. For example,

the loss of forestlands within the Marikina and Montalban watershed areas had led to the loss of up to 50 percent of the watershed topsoil which had flowed to into riverbeds resulting in the decline of the “loading capacity” of rivers to absorb flood waters (Zoleta-Nantes, 2009, cited in Tuano and Sescon 2012).

On the average, the Philippines get about 20 typhoons a year, with about 10 of them making landfall in Central Luzon and affecting Metro Manila. Thus, flooding occurs almost every year especially in the low-lying areas of the Pasig-Markina Flood Basin, West Manggahan and the KAMANAVA (cities of Kaloocan, Malabon, Navotas and Valenzuela) Flood Basin. After Ketsana in 2009, most local governments (where DRRM resides) reformulated their “Disaster Risk Reduction and Management Plan” supported by key policies and programs.



Source: Coastal Cities at Risk Project, Manila Observatory.

As mentioned earlier, the large losses and damages of Tropical Storm Ketsana and the 2012-2013 monsoon floods made national and local officials recognized the urgent need to have a policy and program framework for reducing risk and vulnerability, especially for communities located in high risk areas. The urgency for a coherent and consistent policy framework was highly recognized by officials and community leaders alike after the disaster but seems to dim as time passes. But local officials do not want to focus on the hazard vulnerabilities of their cities (floods, earthquakes) as it might harm their investment and development plans for the city.⁶²

Cities in the Pasig-Marikina Flood Basin. The focus of this study are Marikina City and Pasig City because their geo-physical and environmental characteristics make these cities highly exposed and vulnerable to the impacts of flooding.

Located in the headwaters of the Pasig-Marikina Flood Basin, Marikina City and Pasig City is 16 kilometers and 12 kilometers, respectively, east of the old colonial city of Manila and part

⁶² Cutter et al. (2008). A Place-Based Model for Understanding Community Resilience to Disasters, *Global Environmental Change* 18: 598-606. Elsevier Ltd.

of the Laguna de Bay Basin. Both cities are situated at the bottom area of the basin and sprawled along the rivers of Pasig and Marikina alongside the Manggahan floodway. The latter was constructed in the 1970s to provide alternative spillway from the two rivers. The diversion dam at the head of the Manggahan Floodway pushes the flood waters to Laguna de Bay and reduces the flooding in Metro Manila. But the process contributes to the flooding of the coastal areas in nearby Taguig city (where the newest urban development center, Global City or The Fort, is located), Taytay and other lakeside towns in the provinces of Laguna and Rizal. Furthermore, pollution and sediments carried by the floodway have also compromised the lake's ecosystem services. Because of the deforestation of the Marikina watershed, the Marikina River is the major contributor of silt to the lake through the Manggahan Floodway. The sedimentation rate of the lake is about 1.5 million m³/year with additional pollution and waste coming from inland and shoreline settlers, the latter living in informal settlements up to 5 rows deep, with no access to sanitation and sewage services (see Figure 2 below).

Figure 2. Manggahan floodway during the 2009 Ketsana floods



Source: Manila Observatory.

Meandering through Pasig city is the famous intestine-shaped stream *Bitukang Manok* (in Pilipino, chicken intestine), which used to be inhabited by informal settler families (ISF) until its rehabilitation in 2007-2009 by the Pasig City local government. The city views this place very significant in Philippine history as revolutionaries at the turn of the century hid here and held rendezvous meetings with their provincial revolutionaries.

Both cities are members of Alliance of 7 cities and municipalities (hereinafter, The Alliance) located at the foot of the Marikina watershed area, largely feel by the Sierra Madre Mountains. The Alliance was formed after Ketsana in 2009 to find a common space for the local chief executives to discuss and find solutions to the flooding and other ecological-environmental problems of their cities. This was an important step because local chief executives started recognizing that environmentally-linked problems have to be addressed collectively, beyond the political-administrative boundaries of their own respective cities.

3. Methodology and data sources

The methodologies employed here identify the flood adaptation measures of both the public (local governments) and private sector (commercial-industrial and residential households) as

well as characterizing the costs and benefits, where possible, and the short- and long-term effectiveness of these responses.

Heavy losses and damages have resulted from extreme climate events but the methodologies to assess them systematically need more work and refinement. The previous study carried out by the team employed mixed methodologies (quantitative and qualitative) to assess the economic and non-economic losses resulting from both rapid and slow-onset climate events in three cities of Metro Manila, namely, Marikina, Pasig and Quezon City. But as will be mentioned later, much more needs to be done in order to achieve more precision in measuring the impacts as well as the costs of adaptation, both short- and long-term adaptation.

The current study investigates the public and private adaptation measures of local governments, commercial-industrial establishments, communities and households in flood prone areas in the Metro Manila cities of Marikina and Pasig. From these characteristics and patterns of flood responses and adaptation measures adapted by different stakeholders, we can glean the policy and program implications for resilience planning and governance.

Methodology and Data sources. This study utilized both primary and secondary sources. For primary sources, the research team conducted household surveys, key informant interviews (KII), and focus group discussions (FGDs) among housing associations and residents in flood prone communities, local government officials and commercial-industrial establishment owners/managers. The research team interviewed a total of 50 households representing 15 housing associations and 20 commercial-industrial managers/owners from the cities of Marikina and Pasig in Metro Manila. While the respondents have been long-time residents of the Marikina-Pasig Flood Basin and regularly experience flooding and other hazard impacts (see map below), an overwhelming majority of them (80 percent) were born in other parts of the metropolis or outside of Metro Manila. Secondary data sources, focus group discussion (FGDs) and key informant interviews supplemented the household and commercial-industrial surveys.

The research team shared both primary and secondary data regarding the social vulnerability of local governments and riverside/coastal communities to flood impacts with government officials/community leaders and its possible applications to the local climate and disaster risk reduction strategies.

4. Institutional or public adaptation

This section identifies the flood responses and adaptation measures, both short and long term, adopted by the local governments of Marikina City and Pasig City in Metro Manila. As mentioned earlier, the overarching policy framework of climate adaptation and disaster risk reduction in the Philippines are: 1) The Climate Change Act of 2010, and 2) The Disaster Risk Reduction and Management Act of 2010. But the main responsibility of implementing these laws lies in the 1, 430 local governments of cities/municipalities as in the case of Marikina City and Pasig City.

This study found that most of the adaptation measures initiated by national, metropolitan and local government agencies largely addressed the building of institutional, physical and/or infrastructural resilience. These really constitute the *hardware* of risk reduction and climate adaptation. But the *software* -- human resource capability building-- while acknowledged as having a central role by national and local policies role in building a “culture of safety and

disaster preparedness” among local governments and citizens, the budgetary allocation for this component in adaptation investments is quite miniscule. This pattern is evident in the following sections.

Institutional Framework for Climate Adaptation and Disaster Risk Reduction. The following adaptation measures, both structural and non-structural, have been formulated from an overall comprehensive and strategic planning framework made by the local governments of Pasig City and Marikina City. The making of this plan is under the leadership of the mayor, planning department and the local risk reduction and management unit, in coordination with the legislative branch, other sub-units of the local government (see Appendix Figure 1) and the *barangay*/village DRRM units. This plan starts with the making of the local disaster risk reduction and climate adaptation plan at the *barangay* (community/village), the lowest political-administrative unit of the government. Participated by barangay officials, sectoral and community leaders, these plans are elevated and consolidated at the municipal/city level. Before the integrated plan is approved, it undergoes a series of public consultations, debates and revisions. Then the plan is submitted to the National Disaster Risk Reduction and Management Council (NDRRMC).

The key instrument, then, for climate adaptation and resilience building is the city’s crafting of a strategic, integrated and collaborative framework for climate adaptation and disaster risk reduction. The central aim is to reduce the vulnerability and increase capacity building of local governments in dealing with climate change and disaster impacts. In doing so, local governments are investing in transforming their bureaucracies and service units so it can support the adaptation and resilience building initiatives of their constituent communities.

Local Governments’ Adaptation Measures. Local governments are the frontline actors/stakeholders in the implantation of climate adaptation and disaster risk reduction and management strategies. Below is an enumeration of the structural and non-structural measures adopted by the local governments of Pasig City and Marikina City:

Structural Measures:

10. Installation of the state-of-the-art early warning system (EWS) connected to an integrated weather/climate assessment and monitoring system (e.g., CCTVs, GPS vehicle tracking, radio links to the national weather bureau, wide area alarm siren systems, etc.). This system also includes the installation of automatic weather station (AWS) in critical urban areas, increasing the efficiency of information gathering regarding rainfall levels in different parts of the city, which have potential but variable contribution to flooding. This integrated system increased the efficiency and effectiveness of flood warnings, especially to the informal settler communities and commercial-industrial establishments along the riverbanks and floodways, including those flood prone areas in other parts of the city.
11. Installed a more sophisticated fiber optic connectivity to increase the local government’s capacity to monitor and share information with the key units and stakeholders in different districts and communities (e.g., real time video streams transmitted to key decision-makers).
12. Acquired a sophisticated software for damage assessment and monitoring (e.g., REDAS in Pasig City’s Emergency, Rescue and Recovery Division), supported with a vehicle tracking system and weather bureau radio links. This is to increase the efficiency and effectiveness of the city’s early warning system of the city.

13. Construction and/or improvement of infrastructure: a) road/road dike construction/improvement along rivelines and water channels; b) DRRM office, c) pumping stations for flood water including portable pumping stations which is more effective for floodwaters in critical waterways, d) flood control gates, e) evacuation centers. This is to promote overall infrastructure resiliency of the city against floods and other climate-linked risks/dangers.
14. Dredging of rivers, creeks, canals and other waterways to improve efficiency of flood flow.
15. Strict implementation of the anti-pollution device law for commercial and industrial establishments. This is part of the clean air campaign of the city so as to decrease the air pollutants emitted by industries/commercial establishments.
16. Heightened implementation of “clean and green” programs including rehabilitation of parks, playgrounds, urban gardening/farm, buffer zones, green building, rainwater harvesting facilities, massive tree planting, regular waterways cleaning and/or upgrading and other water diversion techniques. This is one set of “green” interventions supporting the climate resilience drive of the city.
17. Relocation and upgrading of informal settlements along rivers and water channels to facilitate flood flow and reduce risk for the people residing in these areas. This also include other resettlement components like the “balik sa probinsya” (back to the province or countryside) schemes.
18. Social housing programs (limited) for flood-displaced residents. This is to reduce the clogging of riverbanks/water channels with informal settler families (ISF).

The financing of the above structural measures of adaptation initiated by the local governments of Marikina and Pasig mostly come from the city budget. The latter is supported from the internal revenue allotment (IRA) of local governments from the national government, locally generated taxes, and grants/loans from multi-/bi-lateral institutions and private sector. Moreover, the implementation of these adaptation measures require counterpart financing from the concerned sectors. For example, residents (i.e., social housing tax) and beneficiaries pay for the social housing projects while commercial-industrial establishment owners pay for the installation of anti-pollution devices (costing about P123,000-P250,000), just to give a few examples. While this counter-parting scheme may slow down the implementation, it promises to be sustainable because the co-sharing or co-financing leads to the “ownership” of the adaptation measures.

Non-structural Measures

10. In view of the flood impacts of Ketsana in 2009, the local government revised its comprehensive land use and development plans, including but not limited to the following:
 - d. Revision of building codes (i.e., new building standards and designs like an ordinance mandating that habitation happens in the second floor and leaving the ground floor free for unimpeded floodwater passage);
 - e. Designation and better design for new and safe resettlement sites;
 - f. Revised city investment plan including incentives for relocation of industries to less flood prone areas.
11. Conduct of emergency community planning for effective disaster response by DRRM officials with key stakeholders, especially in vulnerable communities along the river, lake and coasts.

12. Continuous training and employment of “green police/aides” in partnership with local DRRM units (i.e., community- or *barangay*-based).
13. Public advocacy activities for “clean and green city” measures like solid waste management, clean air drive (carless Sundays, bike movement, e-jeep/trike, anti-pollution mechanisms, carbon-sink initiatives like tree planting), etc.
14. Capability building and training programs for disaster response, preparedness and resilience building for DRRM officials/staff and related units of the local government, including those in the communities or *barangays* (e.g., rescue, emergency and disaster training; community hazard mapping).
15. Multi-sectoral consultations/dialogues, community participation and other regular feed-backing mechanisms are key to the formulation and implementation of climate and DRRM-related ordinances and policies (e.g., the formulation of a climate and flood resilient framework for the city). This is to facilitate communication and delivery of support services across sectors.
16. Building livelihood resilience initiatives among informal settlers, women and youth: a) Eco-savers cooperative programs in partnership with schools and communities, b) crafts from recycled products and water hyacinths in the floodways, c) organizing women and youth into livelihood groups which are linked to a foundation, d) training informal settlers for “clean and green” jobs.
17. Building identity, pride and commitment to the environment and place. After the great floods in 2009, “The Pasigueno Spirit” in Pasig City or the “Marikit Na” (Beautiful Marikina) movement has been a concerted effort by residents and city/community leaders alike. This strategy is designed to strengthen community spirit and solidarity to support the climate and disaster adaptation initiatives of their city government.
18. Disaster Preparedness and Resilience. The focus here was on improving access and standards of infrastructure related to delivery of basic services for distribution of potable water, electricity and health care. Investments in improving the distribution of emergency drinking water supplies, sanitation facilities—efficient networks of distribution

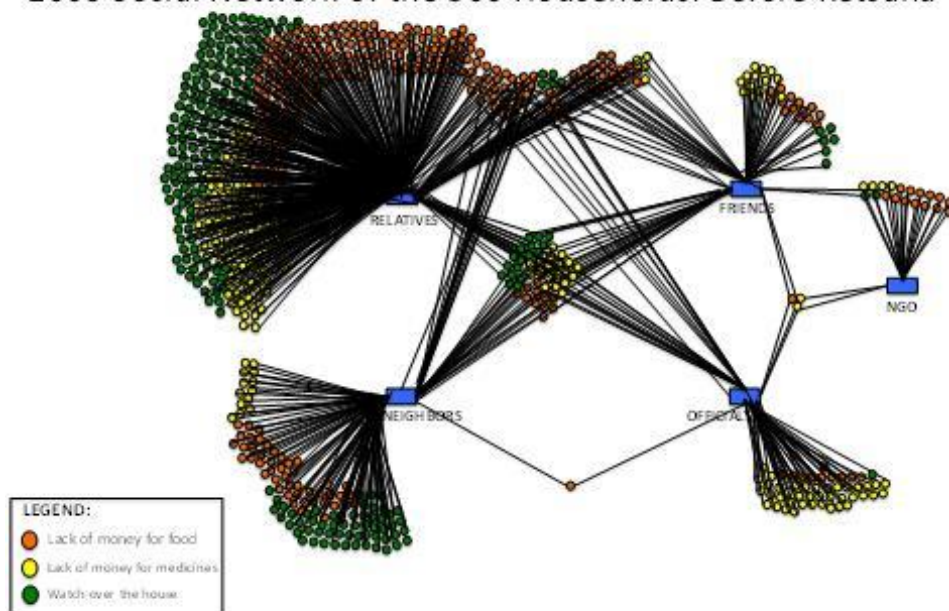
Local governments financed most of the non-structural/structural measures from their internal revenue allotment (IRA) and/or in partnership with national government agencies, multi-lateral agencies and in public-private partnerships. The crafting and implementation of adaptation measures by the city also reveal the pol-economic cracks “cracks” among local governments, national governments, urban poor communities and private sector. Among local governments, those who have high revenues (e.g., Pasig City which has a large commercial-industrial sector) are able to invest in expensive structural and infrastructural measures while those with lower revenues struggle to make do with their meager resources and largely dependent on the national government. After the floods in 2009, Marikina City gave several “recovery” incentives to business establishments and real property owners. But these incentives decreased their tax collection compromising their intention to invest in medium- to long-term adaptation measures.

Social capital, social insurance and resilience. The study also found that successful adaptation and resilience-building initiatives at the city bureaucracy level are associated with communities possessing high levels of social capital across (bridging capital) and within (bonding capital) their localities. This translates to stronger systems of social support such as better access to flood information, evacuation support, relief goods and distribution, health care services. Stronger socio-cultural systems of support are also linked to more

secure bases of housing and community tenure, more economic assets and also correlated with other aspects of quality of life like savings, better house structures and ownership. All of these factors are highly correlated with climate-proofing initiatives (strengthening house structures, greening the environment) in the local government unities and communities.

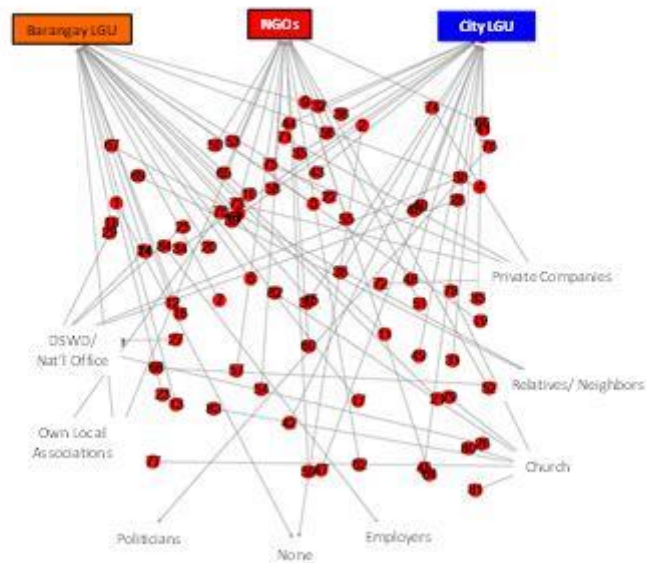
Social capital and trust networks within bureaucracies and across communities are crucial in creating institutional arrangements (with MMDA, other LGUs, private sector) for emergency electricity power systems, deploying public transportation systems during typhoons, heavy rains and flooding season. Before the great floods of 2009, as illustrated in figure 3 below, our community surveys showed that they possess strong bonding capital within their own trusted networks of kin, neighbours and friends but very weak bridging capital with local government officials and civil society organizations (CSOs). Not surprisingly, our 2014 survey showed that the communities' trust of local government officials, DRRM officers and NGOs have greatly increased (see figure 4 below) because of the services they got during and long after the Ketsana floods.

2009 Social Network of the 300 Households: Before Ketsana



Source: Pofo and See, 2014

During typhoons and floods, from whom do you ask for
FOOD and BASIC necessities (2014)?



Source: Porio and See, 2015

Contact with local officials. Unlike our earlier community surveys where a quarter only contacted their institutional actors (e.g., local officials, DRRM officers, community security force), the current survey revealed that residents have increased their contacts/relationships with them.

Flood warnings. A great number of the residents obtained information about floods from the local governments' early warning system (EWS) such as alarm/siren, house-to-house announcement through mega-phones. This reinforced by radio, tv and text-blast from the DRRM office. About 80 percent of the residents said that they received training and flood drills from their community DRRM officials.

Social Insurance: Social capital and mistrust networks before and after Ketsana. Before the big floods of 2009, community surveys⁶³ in the flood basins of Metro Manila showed that very few (less than one-fourth/25 percent or less) asked help or received help from local governments and non-government organizations (NGO) but results from the 2014 study survey showed that those who received help/assistance from local officials and NGOs have doubled (about 40 percent). In the earlier periods, they asked help mostly from family members, relatives, and friends (see Appendix Table 1). Notably, there has been increasing reliance on institutional sources of help or assistance for housing associations and households at the community level. But this can also be reflective of an increasing dependency on institutional resources for rescue and relief operations during flooding and evacuation. In a sense, the coming in of humanitarian agencies to help the flood displaced residents, have in a sense, also created another kind of displacement of social and institutional relationships within the community. For example, post-disaster recovery initiatives like cash-for-work for the urban poor have created both intended and unintended consequences to the social fabric of the community. Oftentimes, the CSOs are instructed by

⁶³ Porio, Emma (2011). Vulnerability, Adaptation and Resilience to Floods and Climate-Related Risks among Marginal, Riverine Communities in Metro Manila. *Asian Journal of Social Science* 39: 425–445. Netherlands: Brill Publishers.

the LGUs to prioritize the poorest of the poor in the community; thus, they will go to the community leader for the list of the 100 indigent families, which make the list so highly politicized and causing divisions between those include and not included in the beneficiary list.

5. Private adaptation: Structural and Non-Structural Measures

Commercial-Industrial Adaptations (Short and Long-Term). Based on a survey of 20 commercial-industrial establishments along the Pasig-Marikina River System, the following are the adaptation measures of the private sector:

5. Structural measures include but not limited building and design adaptation of roof, walls, floor to the intensity of monsoon rains and winds; strengthening/reinforcing of building structures; escape/evacuation routes clearly delineated; length of ground floor and storage raised/increased above the highest flood length during Ketsana. Other adaptations include:
 - d. Transport—structural adaptation of transport vehicles like elevated wheels so the flood waters will not damage the machine or the passengers; buying insurance for damages from flood (learning from the *Ondoy* (Ketsana) where insurers refuse to compensate for “acts of God” like natural calamities like floods;
 - e. Infrastructure—elevating the roads, building bigger culverts, water channels, flood resilient roads, bridges;
 - f. Services—relocating, elongating and reinforcing their electricity connections/posts and water pipes.
6. Non-structural measures adapted include early warning system in place for the employees (flood level warning displayed in front of the factory post), information/communication materials displayed in the bulletin boards of each floor, multi-graded evacuation sites for different levels of flood length
7. In general, commercial-industrial establishments along the flood lines concentrated in “fortifying” their structures and surroundings in preparation for the next flood.
8. Linking and coordinating the establishments’ disaster preparedness to that of government bodies like the local government and the Metro Manila Development Authority.

Residents’/Households’ measures to cope with flooding. As shown in Table 1 below, an overwhelming majority (95 percent) took measures in preparing for the floods such as cleaning their surrounding areas or compound; cleaning the gutter or canal; clean compound of garbage/sewage and repair of compound wall or fence (55 percent). In general, the residents did these preparatory tasks several times a year. But slightly over half of them (55 percent) participated every year in the repair of a common structure like the compound wall/fence. But only 40 percent reported that they set aside a budget ranging from P200-P2000 (US\$5-50) to contribute to the repair of these structures before and during the monsoon period.

Table 1. Percent of Households/Residents Undertook Measures **prior** to the Monsoon Period (N= 50 Households)

Measures	% of residents	Frequency
Cleaning surrounding areas or compound	95 percent	Several times a year
Cleaning gutter or canal	95 percent	Ditto
Participated in the repair of compound wall or fence	55 percent	Ditto
Set aside budget for repair of compound wall or fence	40 percent	Irregular; when budget permits
Clean compound of garbage/sewage	95 percent	Several times a year
Disinfecting premises	75 percent	Several times a year

Table 2. Percent of Households/Residents Undertook Measures **during** the Monsoon Period (N=50 Households)

Measures	% of residents	Frequency
Cleaning of surrounding areas or compound	95 percent	Several times a year
Cleaning gutter or canal	95 percent	Ditto
Participated in the repair of compound wall or fence	55 percent	Ditto
Set aside budget for repair of compound wall or fence	40 percent	Irregular; when budget permits
Clean compound of garbage/sewage	95 percent	Several times a year
Disinfecting premises	75 percent	Several times a year

Comparing the above two tables, there is hardly any difference in the number of people doing preparations before and during the monsoon period. It seems that consistently, the range of recalcitrant (i.e., do not follow preparatory norms) ranged from 5-60 percent of the population depending on the task. The highest reticence is in the area of setting aside a regular budget for repairs of common structures. Understandably, setting aside a calamity or disaster savings fund at the household level is a challenge, especially among the vulnerable urban poor communities living along Pasig-Marikina river banks and Manggahan floodway.

Structural and non-structural measures to cope with flooding. At the household and community level, the structural measures that the residents employ to cope with floods include adding additional floor to their house, reinforcing the posts/foundations and strengthening the roof/walls. They also helped in reinforcing the perimeter walls of the housing complex/compound.

The above structural measures were supplemented with non-structural measures like cleaning the surrounding areas/compound, canals/water channels, and observing proper solid waste management practices inside the household and in the community.

Table3. Percent of Households/Residents Undertaking Long-term Measures

Measures	% of residents	Cost and source of financing
Increase height of the surrounding plot	30 percent	P5,000-P15,000 private financing
Reconstruction w/ stilt parking	20 percent	No data
Relocating Electric meter	20 percent	P550-P3000 private financing
Relocating/Elevating Water Pump room	10 percent	P3000, members' contribution
Elevating electric meter to higher level	30 percent	P600-P2200, members contribution
Modify plumbing system	30 percent	P200-P5,000, members' contribution
Modify/repair water supply network	15 percent	P2,00-P3000, members' contribution
Covering terrace w/ permanent roof	10 percent	P2,000-P16,000, private financing

(US\$ 1 dollar = P43.00)

Long-term measures. From Table 3 below, only a small percentage of the population, ranging from 10-30 percent, undertook long-term measures, largely because of the lack of financing sources. Those who were able to undertake long-term measures were the better-off in the community and could raise their own money for these adaptation measures.

When queried about the effectiveness of the long-term measures undertaken, only 45 percent said that these will be effective when faced again with an extreme event like that of Ketsana in 2009. A large proportion of the residents are actually aware of the inadequacies of their preparation for a future extreme event like Ketsana. Based on their previous experiences, they know that floods could rise fast above their perimeter wall or of the river dykes nearby and that they could not do much but to evacuate from their dwellings.

Insurance (formal/social). When asked about insurance, only a small portion (20 percent) of the housing complex have insurance for their property. Thus, about 85 percent of the buildings have not undergone any structural audit nor were professionals (engineers or architects) were hired/consulted regarding the construction or repair of the structures. Surprisingly, about 35 percent of the resident said they received assistance form elected officials in terms of repairing their housing structures such as construction materials (e.g., zinc, plywood, nails, coco-lumber). After the Ketsana floods, most insurance companies refused to compensate flood damage as these “acts of God/acts of nature” and beyond their control. Also, insurers refuse to insure houses that are in flood prone areas.

In terms of preparing for floods, only about 20 percent said they set aside an amount ranging from P5000-P100,0000 for the repair or reconstruction of their structures. In general, the decision to undertake the repair is done by the officers and owners of the structures. In general, costs of adaptation at the household and community level are largely shouldered by the owners of the structures.

Flood responses and adaptations done by middle-upper income households. Compared to the urban poor communities along the Marikina-Pasig Riverline, those from better off areas (e.g., gated community) in the same area displayed a different pattern of response and adaptation. Better-off households have the following range of flood responses and adaptations: 1) moved out of the house temporarily by checking into hotels, moved to

their condominium across town or to their relatives/friends; 2) moved out of the area permanently; 3) renovated their house to become more adaptable to floods (e.g., raising the house, changing floor plans, adding upper floors); 4) buying insurance for their homes/cars; 5) replace/repair their cars; 6) replace/dispose furniture and appliances. The different economic capacity of these households definitely allowed them to move or invest in these adaptation measures. Interestingly, this study found that only a few of those who could afford moved out or relocated. Those who remained despite their place being flood prone, asserted that they were born in this community and so were their parents/grandparents. Moreover, a lot of their friends and neighbours also remained. Thus, their commitment to the place was reinforced; this is also the main reason why they invested heavily in “flood-proofing” their homes.

6. Critique of the adaptation efforts

The study found that both public and private sectors displayed a combination of recurrent and revised patterns of reactive adaptation.

Recurrent and Revised Patterns of Reactive Adaptation. In the past 2012-14 floods, our data show that local governments through their DRRM units still practice/demonstrate recurrent reactive adaptation patterns. In some cases, however, they introduced some minor improvement in the organization and implementing mechanisms of these reactive responses. For example, the practice of evacuating flood victims to schools, displaces teachers/students as construction of permanent evacuation centers have not been done, have been modified by allowing resumption of classes with the evacuees confined to a couple of buildings or classrooms. But both cities have constructed and/or improved their flood-response infrastructure like DRRM centers (e.g., reinforced and widened areas for relief packing/distribution and community participation and mobilization).

Clean-up and clearing of debris after floods have also become a combined public and private efforts with the barangay DRRM spearheading the efforts.

At the household level, most urban poor households that we surveyed still need to build and increase their preparedness that is already embedded in their everyday routines like having ready-to-go emergency packs/bags, organizing household appliances, utensils, clothing and other basic needs in a very systematic manner (e.g., storing household things in boxes connected to pulleys for raising it during floods). In this way, efficiency of storage reduce damage/losses to household appliances, clothing, etc. In like manner, movement of people and resources during/after floods and the rehabilitation efforts afterwards are facilitated. It is interesting to note that some of the households have instituted adaptive “systematic” routines into their household management strategies like storing supplies, sourcing information regarding emergency services, food supplies, and livelihood/employment opportunities.

But the most notable adaptation (20 percent) is the building of additional floor/storey to their housing structure. The remainder who could not afford to build this very important adaptation, evacuate to the temporary shelters (i.e., schools and multi-purpose community halls located in higher grounds) or to their neighbours with multi-storey housing structures. To do the latter, involve building “trust” networks with better-off neighbours who could afford to build additional floors. This is quite a problem for migrants who have not built enough “bridging” capital with their better-off long-time residents of the place. For example,

knowledge of hazards in the immediate environment and practices to reduce risks like regular evacuation drills is very important for vulnerable groups in the community.

While majority of the recurrent re-active responses or mal-adaptive programs like evacuation and relief distribution still continue, there has been some notable improvements in the organization of the evacuation process, improved facilities at the evacuation center by engaging the private sector, civil society organizations and community-based organizations in the implementation of these processes.

7. Summary and Conclusions

Comparing the patterns of responses and adaptation measures of government, commercial and industrial establishments and urban poor communities show the increasing emphasis of non-structural measures alongside structural/engineering-based solutions or initiatives. This is a significant change after the great Ketsana floods in 2009. Our earlier studies (e.g., Porio, 2011) showed heavy emphasis by city governments on structural and/or engineering measures such as infrastructure resilience-building/construction or improvement of roads, bridges, pumping stations, river dredging and the like.

Among local governments there is also an increasing consciousness regarding the importance of building non-structural measures like increasing community awareness and participation through training and other capability-building programs in building towards community and city resilience.

Urban services resilience. As seen in the previous sections, some of the major adaptation measures by public and private institutions focused on investments in improving the urban basic services, social services and social safety nets by government and government sectors (civil society organizations like NGOs and CBOs, private sector). These investments are very critical in low-lying areas along the Pasig-Marikina River and other flood prone areas of the city where most of the urban poor communities are located.

Improvement of early warning systems. Through collaborative mechanisms, local governments have partnered with national government agencies, civil society organizations and the private sector in improving early warning systems for floods and other hazards. Wide reaching alert sirens to warn residents of critical flood levels were improved after the 2009 Ketsana floods. This was supported with localized flood level alert systems (includes flood levels painted on major street/electric posts) adapted by major commercial-industrial establishments and residential buildings.

Crafting a strategic, integrative and collaborative climate adaptation and DRRM plans and programs. Urban resilience frameworks regarding land use, planning, and development investments are key determinants that shape climate adaptation and disaster risk reduction policies and programs.

Resilience building demands the revision or re-examination of these frameworks. In this study, local governments revised their land use, building standards and/or codes, and environmental policies and programs to mention a few so as to adapt their governance institutions to the new climate regime.

Multi-sited, integrated and collaborative resilience initiatives. Adaptation measures that has been mainstreamed successfully have been mutually constituted across several institutional levels, i.e., formulated in collaboration with the key stakeholders like the national

and local government agencies, CSOs, private sector and the “concerned sectors” of the community. In this way, the ownership of the program is quite broad and its long-term support is assured.

Institutional memory and data bases. Local government officials and other decision-makers strongly articulated that institutional memory and data bases must be collected, formatted and stored in ways that is accessible, understandable, and “consumable” information that can be used in planning and making critical decisions in day-to-day operations as well as during extreme conditions.

Local stakeholders, especially key decision-makers like the local chief executive and DRRM officials/staff must **increase their skills in interpreting/applying climate-and flood vulnerability-related data/information** in developing resilience-building strategies that are sensitive to the different stakeholders’ political-economic, cultural and geo-physical locations.

Local governments must **develop incentive structures that will make people follow policies and program norms and/or change their behavior.** LGUs should give incentives to the private sector and vulnerable communities to coordinate/integrate their planning and development actions with the climate/DRR preparedness and resilience building of smaller units of government, communities and households. This is illustrated in Pasig City’s Environmental Programs and Marikina City’s integrated solid waste management program.

Institutional Coordination. While local governments are at the forefront of climate and DRR action, they must always coordinate with metropolitan, national governments, private sector and community-level actions, especially those of vulnerable sectors.

Public-Private integration of horizontal and vertical initiatives in planning and investment decisions is critically needed. In like manner, local governments from the lowest administrative unit of the *barangay* up to city level must integrate their planning and development decisions as well.

Coordinated Installation of City and Community infrastructure. In some urban poor communities, *barangay* councils have constructed concrete walls along rivers and canals while residents have installed sandbags in entrances and doorways to contain flood waters and lessen damages to their homes. Overall, both *barangay*/local government DRRM units have made efforts to improve community and home drainage systems to the nearby river to protect from extensive flood damages.

Community organizing in partnership with their local governments. Communities with active organizations collaborating with government and non-government organizations seem to be better equipped in preparing their residents for flood evacuation, evacuation center support for water, food, medicines, rehabilitation and recovery. Often this leads to the development of micro-meso level networks of institutions and resident groups working together in providing evacuation/transport support and both immediate and long-term support.

Local health services system. Building resilience in health, nutrition/food, is a long-term process involving education, training, creative of alternatives or incentives to change their behavior and lifestyles of people.

But more can be done in terms of building the capacities of communities, especially the vulnerable urban poor communities along the flood lines.

1. Crafting of a strategic, integrative and collaborative climate change adaptation disaster risk reduction plans and programs.
 - a. Revision of land use and building codes to make it flood-proofed/resilient and or adaptive.
 - b. Revision of environmental codes to promote/support the greening and clean air movement of the city, ranging from systematic and integrated solid waste management programs and environmental programs that compel stakeholders (government, private sector, community) to contribute to the overall greening and cleaning of the city.
 - c. Revising and supporting the in-city relocation, outside resettlement and other housing solutions for the poor (e.g., return to the provinces or *balik probinsya schemes of the government*).
 - d. Creating alternative livelihood programs for women and other vulnerable sectors.
2. Engaging and building partnerships with the vulnerable communities like the urban poor communities.

8. Policy implications and way forward

This section provides a summary of findings and policy/program implications of the study in support of the city administration's efforts to improve the adaptation responses.

Adaptation Patterns and Resilience Building Initiatives. The study shows the importance of macro-level policies in crafting local adaptation and climate resilience plans and programs. In the Philippines, national policies frame and contextualize the crafting of local plans and programs. policies on climate change (Climate Change Act of 2010) and disaster risk reduction (Disaster Risk Reduction and Management Act of 2010) have to adapted by the local government units/ This adaptation was done by crafting an intertwined "Climate Change Adaptation and Disaster Risk Reduction Management Plans: for the city.

1. Crafting of a strategic, integrative and collaborative climate change adaptation disaster risk reduction plans and programs.
 - a. Revision of land use and building codes to make it flood-proofed/resilient and or adaptive.
 - b. Revision of environmental codes to promote/support the greening and clean air movement of the city, ranging from systematic and integrated solid waste management programs and environmental programs that compel stakeholders (government, private sector, community) to contribute to the overall greening and cleaning of the city.
 - c. Revising and supporting the in-city relocation, outside resettlement and other housing solutions for the poor (e.g., return to their home province (*balik probinsya*) schemes of the government).
 - d. Supporting the creation of alternative livelihood programs for women and other vulnerable sectors. These livelihood programs were linked to environment programs like solid waste management and savings scheme for the youth and poor families as well as to the health programs of women and persons with disabilities (PWs).

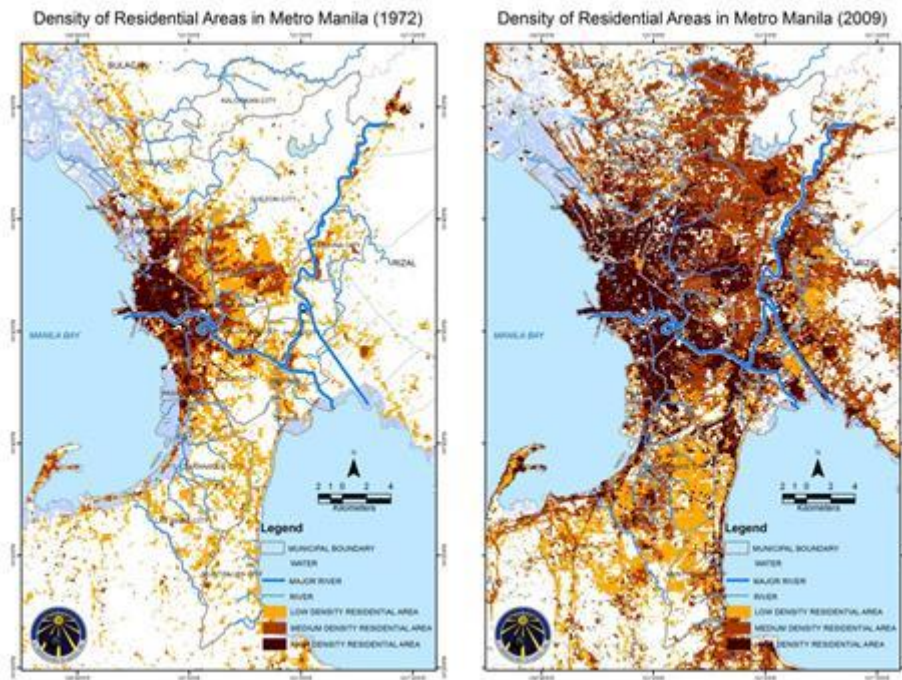
2. Engaging community leaders, especially those from vulnerable, urban poor communities, to be part of the community planning and disaster preparedness programs of the local government.
3. The short-medium and long-term adaptation plans of the city must be historically (over time), horizontally and vertically connected/linked to each other, especially from one political-administrative regime to another.

Social Inclusion and Building Urban Resilience: Some Fundamental Issues

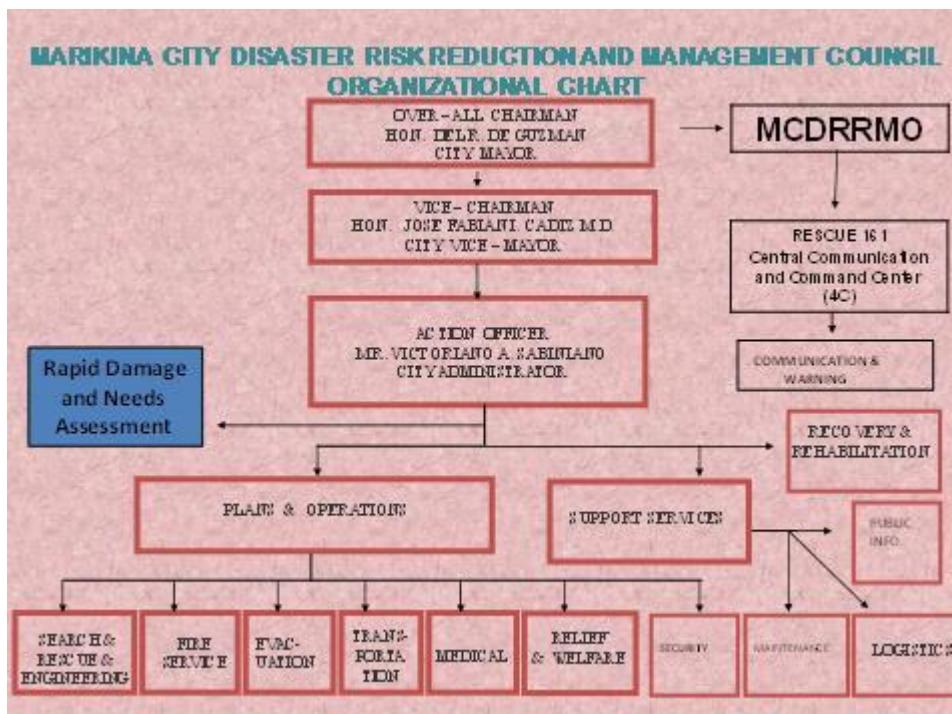
Crafting local resilience strategies with the local governments, private sector and urban communities, especially the poor, demands that we also bear in mind larger macro-meso forces at the global, national, metropolitan levels that impinge on climate adaptation and disaster risk reduction initiatives. Crafting policies and programs that attempt to address and/or reconcile climate adaptation, disaster risk reduction, growth and equity/social inclusion issues is quite complex. More than ever, this is important because the current patterns of investment, development and growth among cities in Metro Manila is largely consumer- and services-driven (e.g., expansion of real estate and commercial, retail establishments, vertical housing, transport, etc.), which render the city highly vulnerable to climate risks and disasters (e.g., typhoons, flooding).

List of Appendix Tables and Figures

Appendix Figure 1. Density of Residential Areas (1972-2009).



Appendix Figure 2



Appendix Figure 3. Recurrent Pattern: Lining Up for Relief Goods in Tumana, Marikina City after the Floods



Appendix Figure 4. Recurring Pattern: Rescue Operations in Marikina City



References

- Brooks, N. et al. (2005). The determinants of vulnerability and adaptive capacity at the national and the implications for adaptation. *Global Environmental Change* 15: 151-163.
- Cutter, S, et al. (2008). A place-based model for understanding community resilience to natural disasters. *Global Environmental Change* 18: 598-606.
- Da Silva, Jo et al. (2012). A Systems Approach to Meeting the Challenges of Urban Climate Change *in International Journal of Urban Sustainable Development*. doi 17 September 2014, At: 20:08. Publisher: Taylor & Francis
- Measham, T. et al. (2011) Adapting to climate change through local municipal planning: barriers and challenges. *Mitig Adapt Strat Global Change* (2011) 16:889–909.DOI 10.1007/s11027-011-9301-2
- Patwardhan, A. (2014). Adaptation in the development context. PPT presentation in the NAP Expo, Bonn, Germany, August.
- Patankar, A, Patwardhan, A, Marome, W and Porio, E (2012). Enhancing Adaptation to Climate Change by Integrating Climate Risk into Long-Term Development and Disaster Management. Research report submitted to the Asia Pacific Network for Global Change Research. Tokyo, Japan.
- Porio, E (2014). Climate Change Vulnerability and Adaptation in Metro Manila: Challenging Governance and Human Security Needs of Urban Poor Communities. *Asian Journal of Social Science* 42: 75- 102. Netherlands: Brill Publishers.
- Porio, E. (2014). Climate Change Adaptation in Metro Manila: Community Risk Assessment and Power in Community Interventions *in Community Interventions*, Jan Fritz and Jacques Rheume (eds.), Springer Publications (Netherlands).
- Porio, E. (2013). Life Along Manila's Flooding Rivers *in The Environments of the Poor in Southeast Asia, South Asia and the Pacific*, Armin Bauer and Aris Ananta (eds.). Singapore: Institute of Southeast Asian Studies (ISEAS) Press.
- Porio, E. (2011). Vulnerability, Adaptation and Resilience to Climate-Related Effects Among Marginal, Riverine Communities in Metro Manila *in Asian Journal of Social Science*, 39: 425–445, Brill Publishers.
- Rodima-Taylor, D, et al. (2012). Adaptation as Innovation, Innovation as Adaptation: An institutional Approach to Climate Change *in Applied Geography* 33: 107-111. journal homepage: www.elsevier.com/locate/apgeog.

Glossary of Terms

ALM	:	Advanced Locality Management
AWS	:	Automatic Weather Station
BMA	:	Bangkok Metropolitan Administration
BRIMSTOWAD	:	Brihanmumbai Stormwater Disposal System
CCCO	:	Climate Change Convention Officer
CODI	:	Community Organizations Development Institute
CRZ	:	Coastal Regulation Zone
CSO	:	Civil Society Organization
DILG	:	Department of Interior and Local Government
DMAP	:	Disaster Management Action Plan
DMC	:	Disaster Management Cell
DRRM	:	Disaster Risk Reduction and Management
DTP	:	Department of Public Works and Town and City planning
EWS	:	Early Warning System
FDG	:	Focused Group Discussion
FROC	:	Flood Relief Operations Command
IMD	:	India Meteorological Department
KII	:	Key Informant Interviews
LECZ	:	Low Elevation Coastal Zone
MCGM	:	Municipal Corporation of Greater Mumbai
MMC	:	Metro Manila Commission
MMDA	:	Metro Manila Development Authority
MMRDA	:	Mumbai Metropolitan Region Development Authority
MoEF	:	Ministry of Environment and Forests
NGO	:	Non-Governmental Organization
NHA	:	National Housing Authority
ONEP	:	Office of Natural Resources and Environmental Policy and Planning
OTP	:	Office of Transport and Traffic Policy and Planning
THAIGIA	:	Thai General Insurance Association
UDHA	:	Urban Development and Housing Act

