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PREFACE

The present publication is the 3rd issue of the APN Science Bulletin series to be published in the APN's Third 5-year Strategic Phase, which runs until March 2015. Issue 3 (2013) is a peer-reviewed publication that has become a main source, next to the APN website, for up-to-the-minute information on activities undertaken by the APN. As a landmark publication written by the global environmental community, supported by the APN, and focussing on issues of underpinning science that is policy-relevant, the 2013 Science Bulletin aims to satisfy readers in both the science and non-science communities with a keen interest in Global Environmental Change in the Asia-Pacific region.

The 2013 APN Science Bulletin highlights those APN projects either funded and/or completed in the year of publication (the present year runs from April 2012 – March 2013). The Science Bulletin has three main sections: 1) Featured Articles; 2) Regional Research Projects funded under the Annual Regional Call for Research Proposals (ARCP) Programme; and 3) Scientific Capacity Development Projects funded under the CAPaBLE Programme. A supplement to the Bulletin will be published in early summer 2013 and will include a number of important activities supported by the APN outside its core programmes, for example, the development of Future Earth in Asia and the Pacific, Focussed activities under Ecosystems, Biodiversity and Land-Use, a series of Hyogo-funded workshops on the New Commons, among others.

Under featured articles, nine scientific papers have been written and cover a number of major themes in the APN's science agenda. These include issues from the tracking of endangered tree species in the forests of Borneo to observing the impacts of extreme weather events and adaptation plans in major coastal cities. Other issues focus on the impacts of climate on the hydrological cycle, and on smallholder farms.

The core regional research programme is supporting twenty-four regional-based research activities this year, two of which are seed grants for further proposal development, and includes a wide array of biodiversity, ecosystems and land-use themes from looking at Seagrass-Mangrove ecosystems, terrace farming practices, marine ecosystems in Northwest Pacific, among others. The APN continues its underpinning and policy-relevant research by looking at impact assessment tools for urban policy makers.

The APN's capacity development programme, CAPaBLE, is the 2nd core programme of the network and reports fourteen capacity development activities and their impacts for the region. Activities extend from supporting young and early-career scientists to attend major global change programme events such as the PAGES and Earth System Governance Conferences, to providing regional climate modelling training programmes and looking at the impacts of global environmental change on human health.

On behalf of the Scientific Planning Group (SPG), who advises the scientific programme of the APN to the APN's governing body, the Inter-Governmental Meeting; and of the SPG Co-Chairs, the executive editors of the present publication; we hope that you find the information contained in the third issue of the APN Science Bulletin both interesting and useful in your work.

Linda Stevenson (Managing Editor)

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ARCP2010-09NSY-PATANKAR

Impacts of Extreme Weather Events and Implications for Adaptation Planning for Coastal Cities

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ABSTRACT: This paper describes a study undertaken in three coastal cities of Asia — Mumbai, Bangkok and Manila — to assess the impacts of extreme weather events and measure the physical, economic and social impacts of the resultant massive floods in these cities. The focus of this paper is on estimating the uninsured losses resulting from extreme precipitation events, which normally do not get accounted for in the absence of data. The study has analysed primary data collected from households, farms and small commercial and industrial establishments located in flood-affected areas in the three cities. The information collected through the surveys has been supplemented with secondary data to identify and measure impacts such as damage to property and infrastructure, damage to stocks like physical capital, inventory and indirect impacts on flows like income, investment, employment and disruption of essential services. The findings have significant policy implications for integrating adaptation strategies with long-term development plans for the coastal cities.

KEYWORDS: *coastal cities, extreme weather events, uninsured losses, adaptation planning*

Introduction

Extreme weather events affect vulnerable urban areas (cities) adversely, with substantial damage and disruption of normal economic and social activities. The loss of physical, economic and financial resource base is also augmented by the loss of economic and social services. This combination of stock and flow effects can potentially alter the medium- to long-term development trajectory of the city. Since it is now widely accepted that impacts of future climate change will often be observed through changes in the magnitude and frequency of existing hazards such as extreme weather events, disaster management is an important context for integrating adaptation into decision-making for the cities at risk.

This paper describes the study undertaken in three coastal cities of Asia — Mumbai, Bangkok and Manila — to measure the physical, economic and social impacts, in particular the uninsured losses resulting from extreme precipitation events and massive floods. The study analysed primary data collected from households and commercial establishments and supplemented the findings with secondary data to identify and measure impacts such as loss of life, injuries, damage to property and infrastructure, damage to stocks like physical capital, inventory and indirect impacts on flows like income, investment, employment and disruption of essential services. The findings have significant policy implications for integrating disaster management and adaptation strategies with long-term development plans for the coastal cities.

HIGHLIGHTS

- The study focuses on extreme precipitation events and resultant floods in three coastal cities in Asia — Mumbai, Bangkok and Manila.
- Primary surveys were carried out among households and commercial establishments to identify and measure the physical and socioeconomic impacts and their costs.
- The cost estimates suggest substantial losses due to heavy floods resulting from the extreme weather events studied.
- These costs are borne by the residents themselves in the absence of insurance coverage and social security mechanisms.
- These costs can be avoided in future with effective adaptation planning.

Study Areas

The study selected extreme precipitation events in three cities, namely, Mumbai (India), Bangkok (Thailand) and Manila (Philippines). The selected cities fall under the densely populated low-lying coastal areas described by the IPCC Fourth Assessment report as “key societal hotspots of coastal vulnerability.” With millions of residents, the risk to life and property increases manifold with vulnerability to extreme weather events leading to floods.

Mumbai

Mumbai, the financial capital of India, is one of the largest megacities with a population of more than 12 million. The city is acutely vulnerable to climate risks due to its location on the sea coast, flood prone topography and landmass composed largely of reclaimed areas. The extreme precipitation event of July 2005 was selected in this study to examine the impacts and policy implications for long-term adaptation capacity. On 26 July 2005, Mumbai was struck with a heavy storm and recorded 944 mm rainfall (45% of the annual average rainfall in Mumbai) over a 24-hour period. This unprecedented rainfall, coinciding with high tide, brought the city to a standstill. The impacts of this event are discussed in this paper.

Bangkok

Bangkok, the capital of Thailand, is a sprawling urban agglomeration with a population of 5.7 million. Much of Thailand’s industrial and commercial capacity is concentrated within metropolitan Bangkok, as well as the bulk of its communications and transport infrastructure. When a major flood event affects Bangkok, it not only threatens the political and administrative functioning of the capital, but also puts much of the country’s factories and industrial parks at risk, and by extension, the homes and livelihoods of hundreds of thousands of the city’s residents. This study examines the impact of the 2006 floods, with a focus on four districts in the eastern region of Bangkok: Minburi, Nong Jork, Lat Krabang and Klong Samwa.

Manila

Metro Manila or the National Capital Region (NCR), with a population of more than 12 million, is the centre of political, economic, and sociocultural activities of the Philippines. Being near a river and a good harbour has made possible the development and expansion of the city of Manila to its suburbs in the last 30 years. This study was carried out in Metro Manila in the Pasig-Marikina flood basin. Both Marikina and Pasig suffered extreme flooding brought about by the tropical storm Ondoy in late September 2009 and Pepeng in early

October 2009. In this study, the impacts and responses to Ondoy in these cities were compared to another flooding event in 2011.

Methodology

The study carried out in Mumbai, Bangkok and Manila is based on the analysis of primary and secondary data on physical, economic and social impacts pertaining to extreme weather events and resultant flooding. The study also identified the immediate to medium-term post-disaster responses of the civic administration and citizens to cope with future floods. We describe the methodology used for the study here:

- Primary data were collected through random sampling from households, families engaged in agriculture (in Bangkok) and commercial and small industrial establishments in Mumbai, Bangkok and Manila by administering detailed questionnaires in flood-prone areas.
- The questionnaire focused on the stock and flow impacts of flooding due to extreme precipitation, costs of damage and repairs/replacements and response measures undertaken by the civic administration and citizens themselves.
- Primary surveys were supplemented with semi-structured interviews and discussions were carried out with residents, local government officials, civil society leaders and the private sector.
- In addition to the above, secondary data were collected from local government departments, published reports and previous studies on damage assessments.
- The primary and secondary data obtained through the above sources

	Mumbai	Bangkok	Manila
Population (in millions)	11.9 (Census 2001)	5.67 (official estimates for 2009)	12.10
Total area (km²)	437.71	1569	636
Population density (per km²)	27,209	3,617	15,617
Extreme weather event	26 July 2005	Oct 2006	Sept–Oct 2009
Affected regions	Eastern and Western suburbs	Bangkok Metropolitan Region	Metro Manila
Total estimated damages (official estimates of public infrastructure and insured losses)	US$ 68 million	US$ 117 million	US$ 590 million
Study areas for primary survey	Six wards of Mumbai worst affected by floods	Minburi, Nong Jork, Lat Krabang and Klong Samwa	Cities of Marikina and Pasig
Sample size	1,168 households; 792 commercial	300 households; 50 farms and 30 commercial	200 households; 87 commercial
Monthly average incomes of households	US$ 330	US$ 660	US$ 380
Estimated uninsured losses per entity	n/a	US$ 1,500 for households; US$ 1,000 for businesses; US$ 1,900 for farms	US$ 700
Total extrapolated losses	US$ 267 million for households; US$ 90 million for commercial establishments	n/a	n/a

Table 1. Summary of findings in study areas
Note: The exchange rates used in this table are:
US$1 = Indian Rupees 45; US$1 = Thai Baht 30; US$1 = Pesos 42

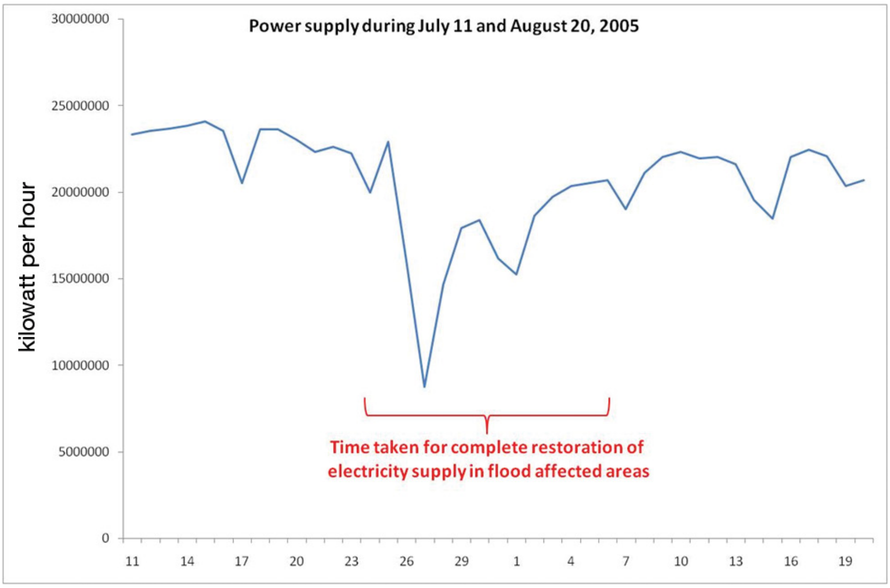

Figure 1. Daily power supply between 11 July and 20 August 2005 in Mumbai suburbs
Source: Reliance Energy Daily Drawal Data

were analysed using the appropriate statistical techniques.

Results and Discussion

The study examined the physical, economic and social impacts of extreme precipitation events and resultant flooding. Table 1 summarizes the study areas and the main findings of the primary survey. Based on the data gathered through questionnaires, we estimated the damages and costs of repairs/replacements on account of floods. The estimated costs are essentially uninsured losses suffered by households belonging to poor and middle-income strata and the private sector engaged in mostly informal activities (small commercial establishments).

Mumbai

For Mumbai, in the aftermath of the 26 July 2005 floods, the total cost of damage was estimated US$ 68 million by the government agencies. The Indian Merchants Chamber estimated these losses at US$ 1,100 million. However, most damages and costs for households and small commercial establishments were not accounted for in the absence of insurance coverage and unavailability of data. This study estimated these uninsured losses through the primary survey. The extrapolated costs or repair/replacement for the flood affected households and commercial establishments are shown in Tables 2 and 3. What is important here is that in the absence of insurance coverage, the extrapolated costs calculated here (US$ 267 million for households and US$ 90 million for commercial establishments) were the out-of-pocket expenses borne by city residents on account of unprecedented floods. In addition to these, there were a number of indirect impacts like the non-availability of essential supplies, price rise due to shortages, unavailability of transportation and disruption of essential services such as electricity and drinking water supply. The disruption of electricity supply is shown in Figure 1.

Bangkok

The extent of damage due to the 2006 floods was estimated by the government agencies for the four districts of the eastern region of Bangkok at US$ 117 million, which included damage to highways, rural roads, railways, waterways and dykes. These four districts have a mixed character of former agrarian regions now undergoing rapid suburbanization, with the damage extending to not only national infrastructure but

Item	Average cost of repairs/ replacement per household (in INR)	% of households reporting these costs in survey (N=1,168)	Estimated number of households affected by floods for Mumbai*	Estimated costs of damage in INR million for Mumbai*
Income loss	5,000	84	352,800	1,764
Reconstruction of house	15,000	86	361,200	5,418
Stove	1,500	57	239,400	359.1
Electric fans	1,000	35	147,000	147
TV	7,000	42	176,400	1,234.8
VCR/VCD	2,700	7	29,400	79.38
Music system	3,000	1	4,200	12.6
Motorcycle	8,000	13	54,600	436.8
Refrigerator	7,000	30	126,000	882
Washing machine	6,000	8	33,600	201.6
Furniture	5,000	31	130,200	651
Wardrobes	4,000	32	134,400	537.6
Utensils	3,000	38	159,600	478.8
			Total Estimated costs	**12,202.68 (US$ 267 million)**

Table 2. Cost of repairs/replacements in households in Mumbai for July 2005 floods

* 2001 census data show the total population of around 8.5 million in eastern and western suburbs of Mumbai. Assuming the average of 4 members per family, this translates to about 2.1 million households. We made a rough estimation that 20% of these households (about 420,000) were directly affected due to floods in July 2005 given the extent of flooding in suburbs and calculate the costs accordingly. It must be noted here that we are considering households that are located at the ground level and first storey of residential buildings. Hence 20% seems a reasonable estimate for directly affected households. This exercise provides at best only indicative estimates of the overall costs that households have had to bear in the absence of insurance coverage.

Item	Average cost of repairs/ replacement per establish-ment (in INR)	% of establishments reporting these costs in survey (N=792)	Estimated number of establishments affected**	Estimated costs in INR million**
Grounds and fences	40,000	48	46,080	1,843.2
Walls	11,000	26	24,960	274.56
Windows	5,000	4	3,840	19.2
Doors and mouldings	6,000	18	17,280	103.68
Electrical wiring and switches	10,000	28	26,880	268.8
Heating	10,000	1	960	9.6
Air conditioning	14,000	1	960	13.44
Machine tools	15,000	25	24,000	360
Finished products	24,000	28	26,880	645.12
Raw materials	20,000	13	12,480	249.6
Inventory	24,000	13	12,480	299.52
			Total Estimated costs	**4,086.72 (US$ 90 million)**

Table 3. Cost of repairs/replacements in small commercial and industrial establishments in Mumbai for July 2005 floods

**MCGM records show around 400,000 registered retail shops and other commercial establishments in the city out of which 60% or 240,000 are located in the suburbs. We make a rough estimation that 40% of these establishments were affected due to floods in July 2005 given the extent of flooding in suburbs and calculate the costs accordingly. This exercise provides at best only indicative estimates of the overall costs that such establishments have had to bear in the absence of insurance coverage.

	Proxy variables	Sub-proxies				Total
Household sector	*Loss incurred*	Food and utilities	Transportation	Repairs	Flood prevention	
		15,000	600	25,000	5,000	44,400
	Work absence	Daily income	Day(s) absent			
		300	3			900
	Health	Medication				
		300				300
						45,600
Business sector	*Loss incurred*	Lost customers	Stock damage	Repairs	Flood prevention	
		15,000	5,000	5,000	5,000	30,000
	Work absence	Daily income	Day(s) absent			
		300	3			900
						30,900
Agricultural sector	*Loss incurred*		Field damage		Flood prevention	
			30,000		12,000	42,000
	Work absence	Daily income	Day(s) absent			
		500	30			15,000
						57,000

Table 4. Flood related costs calculated based on primary survey in Bangkok

PROXY PARAMETERS	Household Sector (300HH)								Agricultural Sector(50)			Business Sector(30)	
	Community				Home								
	<10,000	10,000-30,000	30,000-50,000	>50,000	<10,000	10,000-30,000	30,000-50,000	>50,000	Farm	Livestock	Fishery	Consumer Goods	Services
Flood Level	57.14%	54.07%	52.22%	63.16%	32.14%	41.48%	47.78%	42.11%	45.45%	66.67%	60.00%	68.75%	57.14%
No. of Days Flooded	62.50%	47.41%	52.00%	52.63%	57.14%	38.52%	44.44%	42.11%	78.79%	75.00%	80.00%	56.25%	57.14%
Loss Incurred	44.64%	43.70%	45.56%	31.58%	30.36%	28.15%	28.89%	36.84%	42.42%	50.00%	40.00%	43.75%	50.00%
Work Absence	*	*	*	*	80.36%	87.41%	85.33%	84.31%	90.91%	91.67%	80.00%	56.25%	42.86%
Health	*	*	*	*	66.07%	59.26%	74.44%	68.42%	*	*	*	*	*
Production Price	*	*	*	*	*	*	*	*	75.76%	58.33%	100.00%	*	*
Stock	*	*	*	*	*	*	*	*	*	*	*	31.25%	*
Customer	*	*	*	*	*	*	*	*	*	*	*	43.75%	64.29%

	Flood Level	No.of flood days	Loss Incurred	Work Absence	Health
High	30 cm	> month	>10,000	> week	Admission
Medium	15 cm	1-4 week	5,000-10,000	3-5 days	District Officer
Low	5 cm	< week	<5,000	1-2 days	Store Purchases
No Impact	No impact	No impact	No impact	No impact	No impact

Table 5. Intensity of flood impact by sector and income level in Bangkok

community buildings, fisheries and farms. Thus, this study estimated the average loss for each individual household, farm and business through the primary survey, the results of which are given in Table 4. The losses include repair costs for housing, vehicles and other equipment and also indirect costs resulting from illness and work absence. As is evident from the table, these costs are substantial for individual households, farms and businesses, where average monthly incomes of households are Thai Baht 20,000 (US$ 660). These findings are further reinforced in Table 5 when we examine the intensity of flood impact by sector as reported by the respondents.

Manila

In 2009, the typhoons Ondoy and

	Pre-Ondoy		Ondoy Period		Post-Ondoy	
	Men HH	Women HH	Men HH	Women HH	Men HH	Women HH
Absences from school	6	8	14	17	6	7
Number of workdays lost from sickness due to flood	5	7	9	10	5	8
Number of work days lost due to flood	6	8	20	22	6	9
Average income loss due to floods	P1,715	P3,250	P7,250	P6,450	P2,750	P3,400
Average amount of spent on medicine	P300	P400	P3,200	P3,000	P500	P450
Average losses (appliances, etc.)			P25,000	P20,000		
Average income	P6,250	P5,000	-	-	P6,500	P4,200

Table 6. Costs due to floods in Marikina and Pasig city during 2009 floods

		Pre-Ondoy		Ondoy Period		Post-Ondoy	
		Men HH	Women HH	Men HH	Women HH	Men HH	Women HH
Food		P6,000	P5,800	P2,500 + relief goods	P2,000 + relief goods	P6,500	P6,000
Water	Drinking	P50	P45	P240	P240	P60	P50
Water	Cooking/washing utensils	P80 (well) P500 (piped)	P80 (well) P550 (piped)	P80 (well, long lines) P1,500 (piped)	P80 (well, long lines) P1,500 (piped)	P80 (well) P740 (piped)	P80 (well) P700 (piped)
Energy/electricity		P2,000	P1,800	P5,000	P4,500	P2,000 (wet) P3,000 (dry)	P1,800 (wet) P2,500 (dry)
Sanitation/laundry (mud, waist deep; cleaning, two weeks – one month)		P300	P310	P2,000	P2,000	P360	P320
House repair				P1,500 – P15,000	P1,000 – P8,000		

Table 7. Costs of basic needs in Marikina and Pasig city during 2009 floods

Pepeng caused total damage in Pesos (P) of 28.6 billion, including reconstruction costs of P 200 billion or almost 3% of the national GDP as per the government estimates. The primary survey carried out in the two cities in Metro Manila focused on how residents with no insurance coverage had to bear the brunt of the typhoons. With the average income level of P16,000 per month, the residents of these cities had to spend large amounts on repairing and reconstructing their homes with Marikina residents spending P141,000 and Pasig city residents spending P12,000 for the same. This difference in spending is due to the fact that the extreme flood levels (average height of 20 ft) affected even the upper and middle-income households in Marikina city, whereas, mostly low-income households were affected in Pasig city. Other losses were in terms of lost workdays, absenteeism from school, income loss and damage to appliances. The comparative summary of these losses is indicated in Table 6. Similarly, in Table 7, summary of costs of basic requirements is indicated, which shows how the expenditure on basic necessities increased substantially for the residents during floods.

The physical and socioeconomic impacts

of extreme weather events and their costs calculated for the three cities as a part of this study, thus, highlight the importance of a localized analysis to assess the impacts of flooding, as the nature and intensity of the impact would vary from area to area and also for the households belonging to different income groups. An important finding is that these huge monetary costs are the uninsured losses borne by residents belonging to poor strata or engaged in informal commercial sectors. There are no insurance or social security mechanisms currently in place that would help them to deal with the adverse impacts of floods.

Conclusions

The study carried out for the three coastal cities in Asia — Mumbai, Bangkok and Manila — identifies and measures the physical and socioeconomic impacts of extreme precipitation events resulting in unprecedented floods. These impacts and the costs of damage and repairs/reconstruction have important policy implications for long-term adaptation planning for these cities. As the results of the empirical study show, the costs of damage are very high for the city residents. Most importantly, these costs are out-of-pocket expenses to be borne by them in the absence of insurance coverage and social security.

The study in a way highlights the cost of inaction if very little is done in future to enhance the coping capacity of the cities for future weather events and climate risks in general. The study puts forth a convincing argument that adaptation strategies need to become a part of mainstream planning while devising strategies of developing infrastructure, housing, transport network and other facilities and services in the city. Although adaptation is costly, the costs of inaction can prove to be costlier. Hence, there is a need for integrated and coordinated efforts from all agencies including local government, planners, public utilities and community at large to work towards greater adaptation to future climate risks for the city.

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PROJECT TITLE

Enhancing Adaptation to Climate Change by Integrating Climate Risk into Long-Term Development Plans and Disaster Management

COUNTRIES INVOLVED

India, Philippines, Thailand

PROJECT DURATION

1 year

APN FUNDING

US$ 65,000

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