Enhancing Adaptation to Climate Change by Impact Assessment of the Flood in Bangkok
การเสริมสร้างการปรับตัวจากการเปลี่ยนแปลงภูมิอากาศโดยการประเมินความเสียหายจากน้ำท่วมกรุงเทพมหานคร

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Abstract

Bangkok is not only Thailand's political, economic and administrative capital, but also a regional and global hub. In recent decades, it has transformed from a compact urban core into a sprawling megacity. Today, in addition to the original centre, the city also extends into its five neighboring provinces and forms a single agglomeration, the Bangkok Metropolitan Region: around 15% of the country's population resides here. However, alongside its economic and demographic vitality, Bangkok is highly vulnerable to climate change and other environmental issues. In particular, due to the 'three waters' of runoff, rain and sea rise, together with its low-lying topography of 1.0-2.0 meters, much of the capital is prone to inundation. This research draws analysis on the 2006 and 2010 flood and profiles the causes of the 2006 and 2010 flooding and presents four case study districts in the eastern suburbs of Bangkok: Min Buri, Nong Jork, Lat Krabang and Klong Samwa. Each of them has distinct physical, social and economic characteristics, yet all were impacted to varying degrees by the flooding and reflect Bangkok's rapid urbanization in their mix of agricultural, industrial and residential uses. The areas also illustrate the experience of residents living outside the inner city's established polder system.

The results highlight the importance of a localized analysis of the impacts of flooding, as both the intensity and the nature of its effects vary considerably from district to district. Of the four, Minburi was the worst affected, particularly as residents suffered loss of livelihood as a result of the economic disruption and health threats. As with the other districts, the indirect costs of the flooding at times exceeded the direct physical damage, though this is not generally recognized in official assessments. The research findings highlighted the significance of work absence as a major indirect cost: while the impact on individual households was relatively moderate, the agricultural sector was severely affected. Medical care was another indirect expense for inundated communities with the spread of diseases such as dengue fever and foot-and-mouth disease.

Keywords
Flood
Climate Change
Adaptation
Impact
Bangkok

บทคัดย่อ

กรุงเทพมหานครมิได้แต่เป็นเพียงเมืองหลวง ศูนย์กลางทางการเมืองและเศรษฐกิจของประเทศเท่านั้น แต่ยังเป็นศูนย์กลางของภูมิภาคและโลกด้วย ในช่วงศตวรรษที่ผ่านมา กรุงเทพฯ ได้เปลี่ยนผ่านจากศูนย์กลางเมืองที่มีความกระชับไปสู่การขยายตัวของเมืองอย่างไร้ทิศทางเป็นมหานคร ในปัจจุบันนั้นเมืองได้ขยายเข้าไปสู่จังหวัดปริมณฑลทั้งห้าและรวมเป็นศูนย์กลางขนาดใหญ่ โดยที่มีจำนวนประชากร 15% ของประเทศอาศัยอยู่ แต่ถึงแม้ว่ากรุงเทพฯ จะมีความมั่งคั่งทางเศรษฐกิจและประชากร แต่กรุงเทพฯ ก็ยังมีความเปราะบางที่สูงจากการเปลี่ยนแปลงภูมิอากาศและสิ่งแวดล้อมอื่นๆ โดยเฉพาะอย่างยิ่ง กรุงเทพฯ เป็นเมืองสามน้ำ กล่าวคือ น้ำท่า น้ำฝน และน้ำทะเลหนุน อีกทั้งยังมีภูมิศาสตร์เหนือระดับน้ำทะเลปานกลางเพียง 1 ถึง 2 เมตรเท่านั้น ทำให้พื้นที่ส่วนใหญ่เสี่ยงจากน้ำท่วม งานวิจัยชิ้นนี้เป็นการวิเคราะห์เหตุการณ์น้ำท่วมในปี คศ. 2006 และ 2010 โดยมีกรณีศึกษาในพื้นที่ชานเมือง 4 เขต คือ มีนบุรี หนองจอก ลาดกระบัง และคลองสามวา โดยทีแต่ละเขตมีลักษณะทางเศรษฐกิจและสังคมที่แตกต่างกัน แต่ล้วนได้รับผลกระทบจากน้ำท่วมในระดับที่แตกต่างกัน ซึ่งสะท้อนภาพการพัฒนาเมืองอย่างรวดเร็วที่มีความผสมผสานของการเกษตรกรรม อุตสาหกรรม และที่พักอาศัย และแสดงให้เห็นถึงประสบการณ์ของประชากรที่อยู่อาศัยนอกพื้นที่คันกั้นน้ำของเมืองชั้นใน

ผลการศึกษาแสดงให้เห็นถึงความสำคัญของการวิเคราะห์ผลกระทบของน้ำท่วมในระดับท้องถิ่น โดยรวมถึงความเข้มข้นและลักษณะของผลกระทบที่แตกต่างกันระหว่างเขตต่าง ๆ จากเขตทั้งสี่นั้น เขตมีนบุรีได้รับผลกระทบสูงสุด โดยเฉพาะที่เกิดขึ้นกับประชากรที่สูญเสียความกินดีอยู่ดี อันสืบเนื่องมาจากความเดือดร้อนทางเศรษฐกิจและภาวะคุกคามด้านสุขภาพ โดยที่ทั้งสี่เขตนั้น ความสูญเสียทางอ้อมจากน้ำท่วมนั้นมีมากกว่าความเสียหายทางกายภาพโดยตรง และความสูญเสียทางอ้อมนี้มักมิได้รับการประเมินจากหน่วยงานของรัฐ โดยที่ผลการศึกษาได้แสดงให้เห็นว่า การขาดงานเป็นปัจจัยสำคัญของความสูญเสียทางอ้อม ซึ่งในระดับบุคคลอยู่ในระดับปานกลาง แต่ภาคการเกษตรได้รับความสูญเสียทางอ้อมมากที่สุด ค่าใช้จ่ายด้านสุขภาพยังเป็นอีกปัจจัยหนึ่งที่สำคัญของการสูญเสียทางอ้อม เนื่องมาจากการแพร่ระบาดของโรคไข้เลือดออกและโรคมือเท้าเปื่อยภายในชุมชน

คำสำคัญ
น้ำท่วม
การเปลี่ยนแปลงภูมิอากาศ
การปรับตัว
ผลกระทบ
กรุงเทพมหานคร

Introduction

Bangkok's vulnerability to flooding and other environmental challenges, such as heat waves, is projected to increase substantially in the coming decades. Some of the likely impacts, such as shifts in sea, temperature and precipitation levels, will result from climate change. There are other significant environmental issues beyond this, however, including the spatial pattern of future urban development and the accumulating effects of land subsidence. In terms of climate change, Bangkok is already one of the most vulnerable areas in Southeast Asia and has been identified by the IPCC as a future 'hotspot' due to the destabilizing effects projected on the city's hydrometeorology. Much of Thailand's 2,615 km coastline is at risk, including Bangkok. Global warming has already resulted in Thailand's rivers becoming increasingly unpredictable: flows are already becoming lower in the dry season and higher in the rainy season (ADB/JICA/World Bank, 2010; Chantavanich & Vungsiriphisal, 2005). Moreover, Bangkok's rapid urbanization is expected to continue, with a larger population and a more developed city fabric, the city's exposure is therefore forecast to be substantially higher even without climate change, land subsidence or other major environmental issues. The combined effect of these various factors is that not only will Bangkok be increasingly flood-prone in the future, due to climate change and other environmental issues, but it will also have more to lose as the city continues to develop and expand. A global assessment of port cities, conducted by the OECD, estimated that by 2070 Bangkok would be the seventh most vulnerable city in the world to coastal flooding in terms of population, and the tenth most vulnerable in terms of assets (Nicholls et al., 2008; Bangkok Metropolitan Administration, 2009).

This paper presents the background to Bangkok's flooding in 2006 and 2010. The research was conducted in the beginning of 2011 and that was before the largest flood of about 70-year return period which inundated agricultural and urban land in Chao Phraya River Basin. However, the localized impact analysis of the past impacts of smaller flooding remains necessary because an assessment of losses suffered by residents is crucial to a better plan for and respond to future flood. Impact assessment of the flood in 2006 and 2010, begins with an overview of the available secondary data on the impact of the flooding. Damage assessments should be holistic, reflecting not only the economic costs but also the environmental, social, psychological and health effects. Yet the official data is generally technical in nature, concentrating on infrastructure damage and compensation disbursements, and national in focus with little disaggregation at the district or community level. As a result, the local and non-physical impacts of the flooding are largely overlooked. Consequently, the research team on this study selected a total of 380 sample households, businesses and industrial estate to develop a more comprehensive picture of the flood. Household and business samples were randomly selected from 9 flood-prone communities in the selected 4 districts. These samples are ranged from lower to middle income levels. Using semi-structured surveys in sample communities within the districts, the team employed a series of sub-proxies, including physical damage, health costs, transport and work absence, to assess the direct and indirect flood-related costs to communities, businesses and individuals in the 2006 and 2010 flood. This was with the aim of developing a more fine-grained understanding of the true costs of the flooding, particularly to socially vulnerable groups. The team also analyzed the flood protection measures of Bang Chan Industrial Estate, Minburi, and hosted a community workshop with stakeholders, researchers and a hydrological expert from the Ministry of Natural Resources and the Environment.

Impact assessment of the flood in terms of direct and indirect costs

The research team on this study selected a total of 380 sample households, businesses and industrial estate to gauge the impact of the flood. In order to gauge the true effects of the flooding, the researchers designed a series of proxies to better measure the impacts, direct and indirect, on livelihoods and the local economy (Table 1). This involved synthesizing existing data at the national level, together with the primary research gathered through the fieldwork.

This allows us to develop a fuller picture of flood-related costs to individuals and the community. Table 2 below summarizes the average loss for each household, business and farm in the sample communities. While it includes repair costs to housing, vehicles and other equipment, it also extends to the intangible or indirect losses that result from illness or work absence caused by flooding. Revenue shortfalls or unpaid leave create an added burden that conventional measurements of costs and losses often fail to capture. While the difference in the sample households for these other costs only comes to around 1,400 baht, for businesses and farms the additional expense of worker compensation lost revenue represent much larger sums – 36,000 and 15,000 baht respectively. In the case of businesses, the indirect costs exceed the direct cost of the physical damage.

Table 2. Proxy measurements for flood-related costs of flooding, by sector.

COST OF TOTAL LOSS

HOUSEHOLD SECTOR

Proxy Variables	Sub Proxy			Total
1 Loss Occurred	House Repair	Motor Repair	Flood Protection	
	10,000	15,000	5,000	**30,000**
2 Work Absent	Daily Income	Day(s) Absent		
	300	3		**900**
3 Health	Medication			
	500			**500**
			Total	**31,400**

BUSINESS SECTOR

Proxy Variables	Sub Proxy			Total
1 Loss Occurred	Office Repair	Stock Damaged	Flood Protection	
	10,000	5,000	5,000	**20,000**
2 Work Absent	Compensation	Day(s) Absent		
	12,000	3		**36,000**
			Total	**56,000**

AGRICULTURAL SECTOR

Proxy Variables	Sub Proxy		Total
1 Loss Occurred	Field Damaged (1 Rai)	Flood Protection	
	30,000	12,000	**42,000**
2 Work Absent	Daily Income	Days	
	500	30	**15,000**
		Total	**57,000**

Table 3 is a detailed breakdown of the total costs, sorted by sector, month and district, of the flooding between August and November. For the sake of clarity, the effects on each sector and district is color coded according to its intensity, from 'no impact' (no color) to 'high' (blue), as the legend below the table explains. These measurements are used to assess the relative flooding levels, economic loss, physical damage, health effects and work absence resulting from the 2006 flood. Data is also presented for the less severe flood event of 2010 by way of comparison. The results highlight the importance of a localized analysis of the impacts of flooding, as both the intensity and the nature of its effects vary considerably from district to district. Of the four, Minburi was the worst affected in 2006 and 2010. The impact was particularly pronounced in September and October, as residents suffered loss of livelihood as a result of economic disruption and health risks.

Table 1. Proxies for gauging flooding effects, by sector.

Sector	Proxies
Household	Flood level / Flood duration / Cost of physical damage / Work absence / Health (physical and mental)
Agricultural	Flood level / Flood duration / Cost physical damage / Work absence / Product price
Business	Flood level / Flood duration / Cost of physical damage / Work absence /
Stock / Custom and trade	
Industrial	Household surveys. Flood prevention plan[1]

Table 3. Intensity of costs by month, district and sector, August-November 2006 and 2010.

MINBURI

Household Impact (2006)								
Month	Community			Home			Work	Health
	Level	No.	Loss	Level	No.	Loss		
August								
September								
October								
November								

Household Impact (2010)								
Month	Community			Home			Work	Health
	Level	No.	Loss	Level	No.	Loss		
August								
September								
October								
November								

NONG JORK

Household Impact (2006)								
Month	Community			Home			Work	Health
	Level	No.	Loss	Level	No.	Loss		
August								
September								
October								
November								

Household Impact (2010)								
Month	Community			Home			Work	Health
	Level	No.	Loss	Level	No.	Loss		
August								
September								
October								
November								

KLONG SAMWA

Household Impact (2006)								
Month	Community			Home			Work	Health
	Level	No.	Loss	Level	No.	Loss		
August								
September								
October								
November								

Household Impact (2010)								
Month	Community			Home			Work	Health
	Level	No.	Loss	Level	No.	Loss		
August								
September								
October								
November								

LAD KRABANG

Household Impact (2006)								
Month	Community			Home			Work	Health
	Level	No.	Loss	Level	No.	Loss		
August								
September								
October								
November								

Household Impact (2010)								
Month	Community			Home			Work	Health
	Level	No.	Loss	Level	No.	Loss		
August								
September								
October								
November								

Remark: color coding for Table 3 and 4:

	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

The results also illustrate the significance of absence from work as an indirect cost in the flooding. In Klongsamwa and Ladkrabang, the two most densely populated districts, many residents were unable to travel to work, especially in October when the inundation was at its peak. Ladkrabang in particular is a major agglomeration economy, with an industrial estate and the then recently constructed Suvarnabhumi Airport, opened in September just before the 2006 flooding hit. The composition of the work force, and consequently the nature of their economic loss, is different to a largely agricultural district such as Nong Jork, where the labor is primarily self-employed. As much of the area is farmland, the district is less exposed when inundated. Nevertheless, it experienced protracted flooding, with some areas submerged in over a foot of water for more than a month. As a result, its generally low income population were faced with a variety of health issues, such as dengue fever and foot-and-mouth disease. The survey results also illustrate that the costs of the flooding, through lost income and damaged infrastructure, is generally more severe for the community as a whole than its individual residents. This is also the case for the analysis of flood levels and numbers of flood days where major access in and main areas of the communities were submerged. This suggests a different perspective on the effects of flooding and the value of viewing its

impacts at a community level: the conventional measurements used in official data, besides national aggregations, is typically the unit of the individual household. If the impacts at a community level are more severe, as these results suggest, then this would reinforce the importance of collective adaptation and mitigation strategies at a community level. Currently, preparedness in the event of extreme flooding is generally undertaken privately by individual households, with government encouragement focusing on self-reliance and personal initiative. But to minimize the very substantial community-wide costs of the flooding, there needs to be a platform for collective action.

It is also interesting to rank the impacts according to different income levels, as in table 4. This helps identify the social vulnerability dimensions within the community and the varying challenges that households experience, depending on their income. The results are illuminating. While the general consensus is that the poor people are the worst affected by flooding, the study findings suggest that this only holds true if general non-flood-related issues such as poor health, lack of sanitation and income insecurity are included in the calculation. These are the chronic afflictions of poverty that cause widespread misery on a daily basis, but are not necessarily flood-specific. The differences between the work absence levels of poor and affluent households, for example, while not statistically significant, are in fact more favorable for the lowest income (<10,000 Baht/month) households (80.4%) than the highest income (>50,000 baht/month) households (84.3%). Of course, the true costs at an individual or national level may be open to interpretation. While a low income household is likely to experience the effects of work absence more sharply, especially if employed in a non-salaried position, the net loss may be higher for the work absence of more affluent households as the cost in lost earnings in their case is higher.

The results also show that work attendance remained relatively unaffected through the flooding, suggesting a comparatively high level of adaptation. Nevertheless, within the agricultural sector work absence was a major problem as fields and land were inundated, in the worst cases potentially extending into weeks. Within the agricultural sector, farmland was the worst affected by flooding in both 2006 and 2010, with levels in excess of a foot lasting over a month. Therefore, from one perspective, farmland is arguably the most vulnerable to flooding. Nevertheless, it is important to note fisheries were the most affected by the increasing cost of production. As for small businesses, the impact is less straightforward and depends in particular on the product of the enterprise. For instance, while the service sector is likely to be weakened by flood-related disruption, demand for basic consumer goods could actually rise among residents who rely more on local shops to provide them with food and other provisions.

The survey also illustrated some interesting dimensions to flood preparedness at a household level. The results highlighted poor levels of preparedness in 2006: for instance, only 26% of households had stocked food and only 31% drinking water before the flood. However, this proportion rose substantially for the 2010 flood (to 37% and 41% respectively), suggesting that many households had learnt important lessons from the previous event and prepared more effectively. And when respondents were asked whether in future they would be willing to stock up on food and water supplies before flooding, for both goods around 75% of households stated that they were willing to do so. This suggests that local communities have the capacity to develop better preparation strategies and that there is still further potential to improve on these responses. This is where a well-coordinated strategic partnerships could be very effective.

Table 4. Intensity of flood impact by sector and income level, 2006 and 2010.

FLOOD 2006

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 Good	Service
Level of Flood	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%
Number of flood day	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 Occurred	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 Absent	*	*	*	*	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 2010

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 Good	Service
Level of Flood	39.29%	31.85%	39.00%	42.11%	32.14%	31.11%	31.00%	36.84%	51.52%	50.00%	60.00%	56.25%	50.00%
Number of flood day	32.14%	30.37%	31.00%	31.58%	32.14%	34.07%	34.00%	31.58%	72.73%	58.33%	60.00%	43.75%	42.86%
Loss Occurred	42.86%	41.48%	41.00%	36.84%	33.83%	35.56%	36.00%	31.58%	39.39%	58.33%	40.00%	31.25%	35.71%
Work Absent	*	*	*	*	87.50%	85.93%	85.56%	89.47%	81.82%	75.00%	60.00%	56.25%	50.00%
Health	*	*	*	*	66.07%	65.93%	67.78%	52.63%	*	*	*	*	*
Production Price	*	*	*	*	*	*	*	*	90.91%	66.67%	60.00%	*	*
Stock	*	*	*	*	*	*	*	*	*	*	*	18.75%	*
Customer	*	*	*	*	*	*	*	*	*	*	*	50.00%	78.57%

Conclusion

The results highlight the importance of a localized analysis of the impacts of flooding in 2006 and 2010, as both the intensity and the nature of its effects vary considerably from district to district. Of the four, Minburi was the worst affected, particularly as residents suffered loss of livelihood as a result of the economic disruption and health threats. As with the other districts, the indirect costs of the flooding at times exceeded the direct physical damage, though this is not generally recognized in official assessments. The research findings highlighted the significance of work absence as a major indirect cost: while the impact on individual households was relatively moderate, the agricultural sector was severely affected. Medical care was another indirect expense for inundated communities with the spread of diseases such as dengue fever and foot-and-mouth disease.

Another important finding was that that the costs of the flooding, through lost income and damaged infrastructure, was generally more severe for the community as a whole than individual households. If the impacts at a community level are more severe, as these results suggest, then this would reinforce the importance of collective adaptation and mitigation strategies at a community level. Currently, preparedness in the event of extreme flooding is generally undertaken privately by individual households, with government encouragement focusing on self-reliance and personal initiative. But to minimize the very substantial community-wide costs of the flooding, there needs to be a platform for collective action.

The research also disaggregated its findings by income group and occupation to develop a clearer picture of the effects of the flooding on different groups. One significant finding was that the work absence levels of the poorest households were, as for more affluent households, relatively low. This suggests that, contrary to what might be expected, the poorest households demonstrated a relatively strong adaptive capacity. Economic insecurity may be a significant element in this, however, and further research is required to ascertain the nature of their adaptation strategies.

The results also highlight the varying impacts on different business and occupational sectors. Farming, according to the survey results, was the worst affected within the agricultural sector, with levels in excess of a foot lasting over a month. Fisheries, on the other hand, though less vulnerable to direct physical damage was most exposed to the rising production costs as a result of the flooding. As for small businesses, the impact was less straightforward and depended in particular on the product of the enterprise. While the service sector was weakened by flood-related disruption, demand for basic consumer goods actually rose among residents who were more dependent on local shops to provide them with food and other provisions. Again, these nuances potentially have important implications for how post-disaster economic recovery strategies should be targeted.

What is clear is that, if Bangkok fails to adapt successfully in the future, flood disasters could become a regular and recurrent problem for large areas of the city. The costs will not only be the substantial direct effects of damaged housing and lost livelihoods, but also the longer term implications for Bangkok as a national centre and regional hub. In the wake of the 2011 flooding, some parliamentary lawmakers have even proposed that the capital be moved to the higher land elevation of Nakhon Nayok. While Bangkok has successfully overcome the challenges of its natural setting in the past, as its economic and demographic vitality testifies, it needs to develop a sustained and meaningful strategic response to a future of climate change and environmental instability if its strength as a global city is to be maintained. It is not clear that infrastructure alone will be able to provide residents of suburban areas like the districts in this case study protection from future flooding. It was clear during the 2011 flooding that some local communities considered that the infrastructure protecting inner Bangkok was making their own situation worse. Flood adaptation approach must be underpinned by a strategy of collective adaptation. One of the key findings of this study was that the damage caused by the 2006 flooding was typically higher at a community level than for the average household. This suggests that a platform for meaningful communal cooperation, drawing on the middle ground between highly centralized public interventions and the 'privatized' approach of household preparedness and self-reliance, would be extremely valuable.

Remark

[1] It was not possible to access information in this sector, either at the employer or factory worker level, and so the impact could not be measured. However, as most of the factory labor force resides close to the industrial estate, the information acquired through the household surveys was an acceptable substitute. In addition, the researchers were able to access information regarding the flood prevention plan of both industrial estates to analyze the gap in their adaptation strategies.

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