

EXECUTIVE SUMMARY

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This report is the primary output from the Climate Change Impact and Adaptation Study for the Bangkok Metropolitan Region (BMR) produced for the Bangkok Metropolitan Administration (BMA) with financial support provided by the World Bank. The views expressed in this report are those of the authors, and do not necessarily reflect the views of the World Bank.

The report concerns climate change, and provides an analysis of climate change impacts and adaptation options for the Bangkok Metropolitan Region. It is produced by a group of multi-disciplinary experts working under the company Panya Consultants Co. Ltd, based in Bangkok, Thailand. In addition to the more general matters on the physical setting and socioeconomics of BMR addressed herein, the report considers a number of issues related to climate change in detail. These are: changes in the inundation pattern, and impact on the population and socioeconomics, and coping mechanisms to deal with the changed situation.

A number of conclusions have been drawn from the analysis presented in this report. These are discussed below in categories that relate to specific objectives in the Terms of Reference for the current study.

Climate Forcing and Bangkok

Warming of the global climate system will have a multitude of impacts on the monsoon-driven climate of Bangkok. Based on analysis of a subset of models used for the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC), researchers at the Integrated Research System for Sustainability Science (IRS3) of the University of Tokyo estimate that by 2050 the local mean temperature will rise by 1.9°C and 1.2°C, and the basin mean precipitation will rise by 3 and 2% corresponding to IPCC A1FI and B1 climate scenarios (SRES - Special Reports on Emissions Scenarios) respectively. Furthermore, the sea level in the Gulf of Thailand will rise by 0.29 and 0.19 meters corresponding to IPCC A1FI and B1 climate scenarios. We adopted the climate forcing for the study.

Furthermore, we acknowledge that impacts on the hydrology of the city will be exacerbated by land subsidence (accumulated land subsidence would spatially vary from 0.05 to 0.30 meters depending on location in 2050), affecting storm surge (maximum 0.61 meters at the Chao Phraya River mouth) and urban infrastructural development. These were also included in the hydrological simulation for the study.

To aid informed decision-making based on likely impacts and costs of adaptation to climate variability and change, we looked at a number of climate scenarios for 2050. These were: Future with land subsidence; Future with land subsidence and A1FI or B1 scenario on a 1/10, 1/30 and 1/100 years occurrence basis; and with or without affecting storm surge. For purposes of comparison, the base year flood corresponds to probable flood in 2008.

Nevertheless, all of the discussion in the subsequent sections of the Executive Summary relates to the situation under Future climate in 2050 with land subsidence and A1FI climate scenario on a 1/30 year occurrence basis together with affecting storm surge. This circumstance is most likely to occur in the future.

Critical Characteristics of Climate Change Consequences on the Hydrology of the BMR

Certain characteristics of climate change consequences on the hydrology are of particular importance in determining the preferred approaches to reduce unfavorable impact in the future. A comprehensive modeling of the future hydrology of the city, and more importantly, its upper catchment areas has shown that:

- **Flood-prone area will expand in the future.** We estimate that an additional 180 km² of Bangkok and Samut Prakarn may be inundated under varying depths and to varying number of days under the A1FI climate change condition in 2050. The change marks about a 30% increase in the flood-prone area between 2008 and 2050. Furthermore, 7% of these provinces may remain inundated for over one month. Much of the increase in flood-prone area will be in the western part where the existing and planned flood protection infrastructures (dikes and pumps) may be inadequate to save the area from higher depths of flood in the future.
- **Flood volume will increase by the same percentage as precipitation, but flood peak discharge will increase more.** We observed a linear relationship between future precipitation and flood volume in the Chao Phraya River. Nevertheless, flood peak discharge in the Chao Phraya River will increase by a larger percentage than precipitation. This observation corresponds to unequal travel times of floods from upstream catchments.
- **Storm surges are important, but will have less effect on flooding.** Storm surges are not uncommon in the Gulf of Thailand. They are also responsible for flooding the BMR area. However, we estimate that the flood-prone area in Bangkok and Samut Prakarn will increase by about 2% due to affecting storm surge striking western coast of the Gulf of Thailand.

Impacts to be Considered

Climate change impact analysis of major infrastructural sectors (buildings and housing, transportation, water supply and sanitation, energy, and public health) has shown that several factors with potential contributions to the future development of the city are of importance and ought to receive prioritized attention from city planners and policy makers.

- **Large population will live in flooded area.** About one million inhabitants of Bangkok and Samut Prakarn will be affected by the A1FI climate change condition in 2050. One in eight of the affected inhabitants will be from the condensed housing areas where most live below the poverty level. One-third of the total affected people may be subjected to more than a half-meter inundation for at least one week. This marks a two-fold increase of that vulnerable population. The impact will be critical for the people living in the Bang Khun Thian district of Bangkok and the Phra Samut Chedi district of Samut Prakarn.
- **The economic damage of flooding will rise four-fold in 2050.** We found that under current climate and infrastructure conditions, economic damage from flooding (at current prices) would be 35 billion baht (about one billion U.S. dollars), which might rise to 148 billion baht (about 4.22 billion U.S. dollars) in 2050. However, 70% of the cost in 2050 would be attributed to land subsidence alone.
- **Buildings and houses are the most affected infrastructure.** More than a million buildings and housing (residential, commercial and industrial) units in Bangkok and Samut Prakarn might be impacted by flooding in 2050. These impacted buildings will include about 300,000 units in the western areas such as Bang Khun Thian, Bang Bon, Bang Khae, and Phra Samut Chedi districts. The total partial damage (to buildings and assets) may exceed 110 billion baht (3.14 billion U.S. dollars) at current prices. Nevertheless, half of the cost will be due to probable partial damage caused to the large number of new buildings that will be subjected to land subsidence in the flood-prone areas.
- **Commercial and industrial sectors will suffer substantially.** The commercial and industrial sectors will lose considerable income due to business suspension during flooding. We estimate that value-added income losses will be 22 and 10 billion baht (0.63 and 0.29 billion U.S. dollars) in commercial and industrial sectors respectively.

Now is the Time to Act

The causes and impacts of the climate change peril are so diverse that it is difficult to formulate a blueprint solution to the problems faced by the BMR. Thus, the options available for sustainable development of the city must rely on the implementation of a unique mix of structural and non-structural adaptation measures.

- **Mainstreaming climate change in national and sector development planning.** Lack of awareness of climate change within the government and insufficient relevance of available climate information to development-related decisions poses considerable difficulties in mainstreaming adaptation in the city's development planning. We propose mainstreaming climate concerns at both policy and operational levels. At the policy level, projected impacts of climate change should be embedded in all development planning. Operational level mainstreaming or climate proofing, on the other hand, will involve critical analysis of adaptation options for actual implementation of activities.
- **Implications for financing organizations.** We believe there is an urgent need for international financing and donor organizations to reconsider their policies pertaining to climate change impacts and adaptation options. While we acknowledge that climate change provides a considerable challenge to the development of coastal mega-cities such as Bangkok, it also stands as a common entry-point for much of the sectoral development works. Therefore, financing provided in different socioeconomic and infrastructure sectors must be hinged specifically on adaptation to climate impacts.
- **The business-as-usual measures may be inadequate to save the coasts from erosion.** The problem of coastal erosion along the shoreline in the Upper Gulf of Thailand is already a critical deterrent to the sustainable development of the BMR. The situation will only get worse when the sea level rises in the future. We propose initiation of an urgent research study to identify suitable solutions to protect the shoreline taking sea level rise and land subsidence into account.
- **Some issues must be addressed as a matter of urgency.** We found that the existing and planned flood protection dikes and drainage system will be largely inadequate to protect the western part of the BMR from any flood exceeding a 10-year return period in the future. We propose that some of the existing dikes be raised and the pumping capacity of three western pumps be increased. Our initial economic viability analysis of the proposed structural interventions indicates a favorable investment portfolio. Feasibility of these propositions, including rigorous appraisal of their environmental consequences, should be undertaken as a matter of urgency.

Finally, we applaud current initiatives of Bangkok city administrators and international financial institutions to 'unpack' impacts of climate change faced by Bangkok, reflecting trends toward climate mainstreaming in the development agenda, and call for a continued policy to specifically direct funds towards implementation of adaptation measures for truly sustainable development of Bangkok.