Chapter 4. Bangkok, Thailand

Chapter 4 examines the resilience of the Bangkok Metropolitan Region (BMR) to floods, which occur during the rainy season. It is critical to address this risk to ensure sustained and cost-effective urban green growth while adapting to the impacts of climate change, because precipitation and flooding affecting the region will likely increase in the future.

This chapter consists of three sections: 1) the natural disasters that pose the greatest risk in the BMR are identified; 2) the current state of DRM policy in the BMR is assessed; and 3) co-ordination and governance mechanisms between government entities and other stakeholders are discussed.

In particular, the chapter analyses four critical elements for enhancing DRM to floods:

1) Flood-resilient urban infrastructure in the BMR;

2) Flood-resilient land use in the BMR;

3) The BMR's economic resilience to floods; and

4) The BMR's social resilience to floods.

This chapter draws on the key findings of the OECD study "Green Growth in Bangkok, Thailand" (OECD, 2015). It also benefited from discussions at the Knowledge-Sharing Workshop on Urban Green Growth in Dynamic Asia, held in Bangkok on 6-7 August 2014, which was supported by the OECD Knowledge Sharing Alliance.

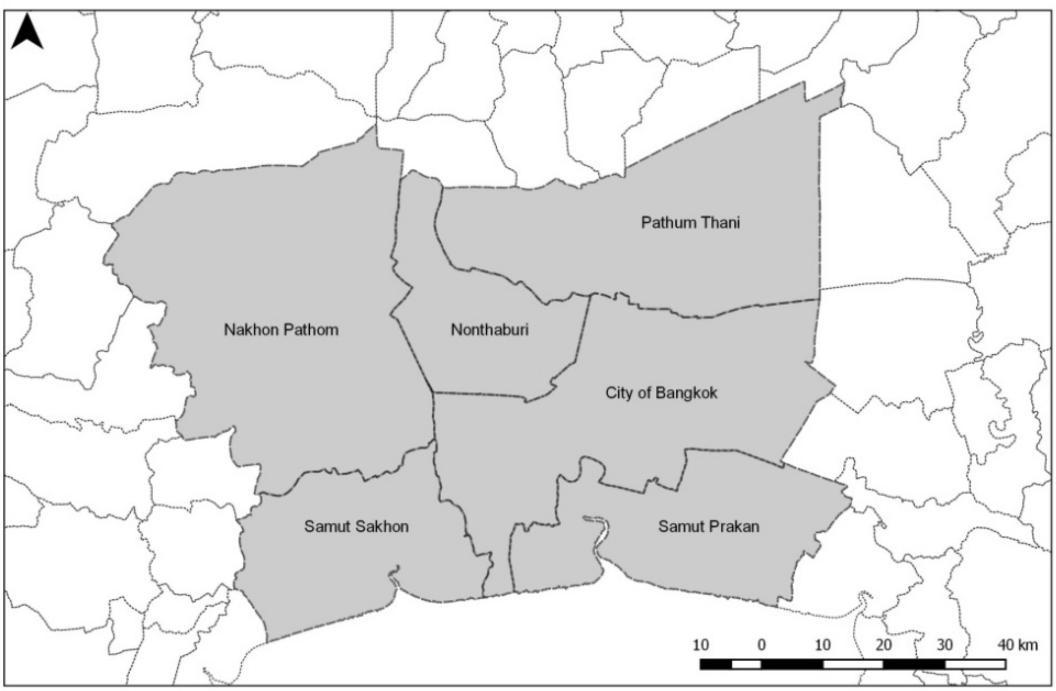
Main Points

- **The Bangkok Metropolitan Region (BMR) is highly exposed and vulnerable to floods** caused by seasonal storms between the months of July and October. It experienced major floods in 1942, 1978, 1980, 1983, 1995, 1996, 2002, 2006 and 2011. The BMR needs to find ways to become more resilient to floods – in other words, to better absorb and bounce back from such events to ensure green growth in the long-term and adapt to the impacts of climate change.
- To protect the city of Bangkok from floods, the Bangkok Metropolitan Administration (BMA) and the national government have made massive investments since the 1980s to develop large-scale polder and drainage systems. To avoid over-burdening the city's finances and escalating the need for such infrastructure in the future, public authorities need to consider complementing them with a variety of more adaptive infrastructure measures, such as **ecosystem-based adaptation or semi-permeable surfaces**. State-of-the-art information and communication technology (ICT) also offers many opportunities to optimise city functioning, better inform infrastructure decisions and improve emergency response services, to complement existing flood-control systems.
- The city of Bangkok and five surrounding provinces in the BMR have seen major changes in land use over the past 20 years, with significant loss of agricultural lands and conversion to residential, commercial and industrial uses. In particular, the city has lost natural water retention areas (swamps, wetlands, mangroves, etc.) and natural drainage systems that played a key role in managing excess water and limiting the damage done by floods. **An efficient region-wide strategy will require co-ordinating land-use strategies and assessing the climate-induced threats, exposure, adaptive capacity and the resulting vulnerability of urban areas**.
- The devastating flood of 2011 that affected the BMR and other parts of Thailand is reported to have ranked among the costliest natural disasters in the world since the 1980s. It caused damages in excess of USD 9.1 billion in the city of Bangkok alone. Among the economic activities affected, the manufacturing and business sectors were particularly hard hit, absorbing 58% and 18% of the total damages in the city of Bangkok, respectively. **As a consumer and supplier of climate adaptation measures and public infrastructure, the private sector must be targeted and engaged in strategies to increase the city's economic and physical resilience to floods**.
- The 2011 flood also had severe social costs. 42 of the 50 districts of the city of Bangkok were left underwater for weeks. The flood highlighted the vulnerability of the BMR's poorest residents to extreme weather events, affecting 73% of people living in low-income communities, often located in the most exposed areas near canals and rivers. **Local and national governments should involve local communities in raising public awareness** about the need to increase their resilience to floods and other threats. A more consistently integrated and comprehensive approach to this issue from governments at all levels would build their social capital, cohesion and on-the-ground preparedness during a crisis.

Natural disaster risks

As a functional economy, defined by settlement patterns and human activity rather than by administrative frontiers, Bangkok extends far beyond the city of Bangkok, the capital city of Thailand, to the Bangkok Metropolitan Region (BMR) and beyond. The BMR consists of the city of Bangkok and five adjacent provinces (Nakhon Pathom, Nonthaburi, Pathum Thani, Samut Prakan and Samut Sakhon), encompassing 7 761.50 km^2 (Figure 4.1). The BMR is the unit of analysis in this study, although some analyses cover only the city of Bangkok due to limited data availability. There is no metropolitan government to administer the BMR. The city is governed by the Bangkok Metropolitan Administration (BMA), and does not belong to any province; it has a status of special local authority. It is subdivided into 50 districts, which are further subdivided into 169 sub-districts.

Figure 4.1. Map of the Bangkok Metropolitan Region



Source: OECD, based on Global Administrative Areas (n.d.), GADM database of global administrative areas, available at: www.gadm.org (retrieved in May 2015).

The Bangkok Metropolitan Region (BMR) faces high flood risk, in particular during the rainy season, between the months of July and October. It experienced major floods in 1942, 1978, 1980, 1983, 1995, 1996, 2002, 2006 and 2011 (Ahsan, 2013). The BMR also faces development challenges associated with environmental degradation, rapid and unplanned urbanisation in hazardous areas, and limited options of livelihoods for the poor. Since the BMR is projected to undergo rapid demographic, economic and urban changes, a concerted policy response to the high flood risk it faces can significantly increase its resilience.

Floods are only one of several possible risks that the BMR will face in the near future, both anticipated and unexpected. This chapter mainly discusses DRM policies to enhance urban resilience against floods, which can also be relevant for other types of risk.

Assessment of DRM policies

This section assesses two sets of policy challenges observed in the BMR. First, it looks at "hard" investments in flood-resilient urban infrastructure integrated with land-use planning and zoning policies. Urban infrastructure and land-use policies are at the core of flood resilience strategies. Physical capital and the urban form shape the built environment and are major factors exposing land and urban residents to floods. If properly managed, they can, however, be critical in containing such risks. It then looks at "soft" (i.e. non-structural) resilience measures to shift economic and social patterns and behaviour toward a greener, more sustainable development. Engineering solutions to flood risks have been the dominant paradigm for enhancing DRM, but in the BMR and elsewhere, economic and social policies can help mobilise resources and synergies from other groups in civil society, communities, the media and the private sector.

Vulnerability and risk assessment

Local governments in the BMR should develop instruments to assess which urban zones and residents are particularly vulnerable to floods and design land-use regulations accordingly. Flood-risk assessment and mapping is not used widely, especially to protect low-income communities at risk. This may be the result of a lack of local capacity to develop and use the necessary technology, or a lack of awareness among local governments about the benefits of such tools. USAID provides useful guidance and key policy recommendations that local, provincial and national authorities could follow to develop capacities to assess their vulnerability (USAID, 2014).

Flood-risk assessment tools should be used to assess both current and future threats. From this perspective, risk screening should be applied to areas where new development is likely to occur, and land-use regulations (e.g. zoning, building permits) could be used to create disincentives to develop such lands to avoid creating new zones at risk. In France, local prevention plans delineate areas at various levels of risk based on previous floods, but also according to predictions for the future. These measures should reinforce or complement economic interests (e.g. tourism) by taking flood risks into account.

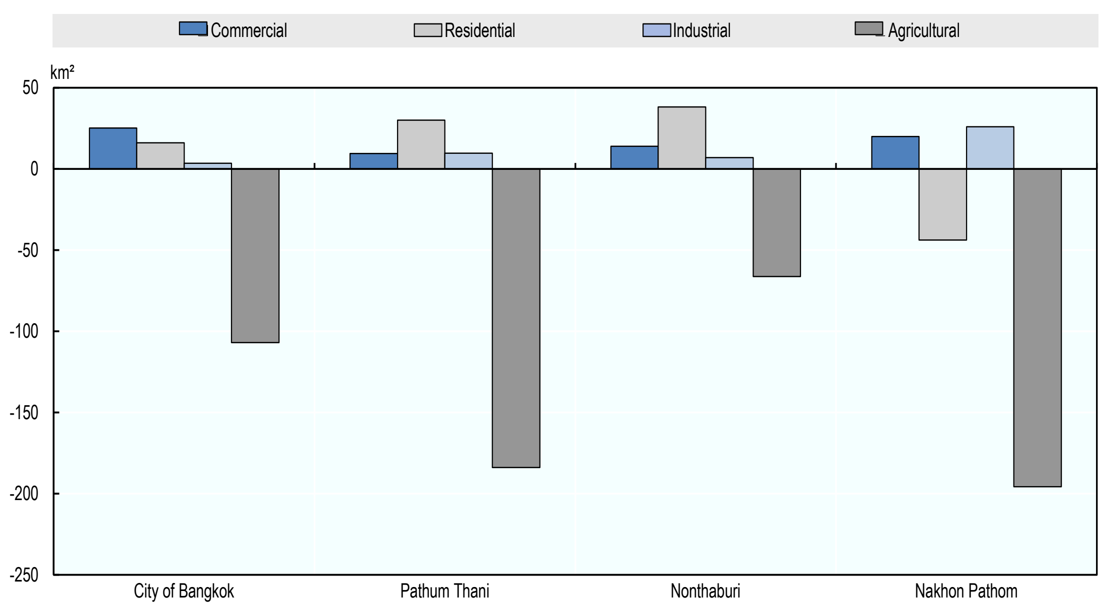
The BMR must develop a knowledge base of economic vulnerabilities in order to increase its resilience to floods. Experts and policy makers in the BMR could make use of the Aqueduct Global Flood Analyser,[1] which estimates the future economic and human consequences of floods under a variety of scenarios. For instance, in a scenario of severe climate change and continued current socio-economic development trends, it estimates that even with a 100-year flood protection system, the annualised gross domestic product (GDP) affected by inland floods in the BMR could currently reach USD 450 million (USD 272 million for the city of Bangkok alone) and USD 2.7 billion in 2030 (USD 1.7 billion for the city of Bangkok alone). Experts and policy makers must also integrate cost-benefit analyses of resilience policies and develop "soft" policies to properly tackle economic vulnerability to floods.

Local governments in the BMR should further develop information and mapping of the people, places and assets at risk. This will provide the basis for flood risk assessments so that corrective action can be taken. A database of businesses and industries could be built, with information on the type of enterprises by sector and area, employment size, access to roads and other basic services, etc. This would inform the risk assessment exercise and help create maps showing information on economically valuable areas and assets, as well as centres of employment for lower skilled people who live and work in the BMR.

Land-use policies

The city of Bangkok and the surrounding provinces of the BMR in particular have undergone major changes in land use over the past 20 years, with significant loss of agricultural lands and an increase in residential, commercial and industrial land use. More than 30 km^2 of residential areas were created in the province of Pathum Thani between 2001 and 2010, while around 184 km^2 of agricultural land was lost (Figure 4.2). According to international research,[2] private construction and real estate driven by speculation and short-term economic gain has been a critical component of the BMR's rapid urban growth (Marome, 2013). Such development has had a detrimental effect on the city's flood resilience, whereby industrial firms located in Pathum Thani and Samut Prakarn are highly exposed to floods because of their proximity to the Chao Phraya River. In the last 20 years, urbanisation in the vicinities of the BMR has been responsible for the disappearance of natural areas of water retention (swamps, wetlands, etc.) and natural flood ways (Snidvongs, 2012) that play a key role in managing excess water and limiting the damage from flooding. Mangroves, a critical natural feature in the metropolitan region that buffers the effect of storm surges, are also being cut down at a rapid rate, and are affected by coastal erosion (WWF, 2009). Land subsidence has also affected the city's exposure to floods, but it is no longer proceeding as rapidly in the city of Bangkok, unlike in industrial areas in the east of the city.

Figure 4.2. Land-use change in Bangkok and three surrounding provinces of the Bangkok Metropolitan Region 2001-10



Source: Marome, W. (2013), "Urban risk and vulnerabilities of coastal megacity of Bangkok, Thailand", proceedings of the 4th Global Forum on Urban Resilience and Adaptation, 31 May-2 June, Bonn, Germany.

Local governments in the BMR lack instruments to assess which urban zones and residents are particularly vulnerable to floods which would allow them to develop land use regulations accordingly (OECD, 2015b). Local governments could enhance land-use control tools so that they can effectively promote DRM. The FAR Bonus System, for instance, encourages developers to provide green space and rainwater storage areas (OECD, 2015a). However, it is not mandatory for developers and its effectiveness is questionable. Incentives to increase its impact (e.g. financial incentives for implementing the bonus) or the imposition of more binding rules could be considered. The potential for the local land improvement tax to reshape land use for flood resilience is underutilised in the BMR. The BMA and other BMR local governments could target specific locations where the rate of the land improvement tax could be raised, or alternatively, introduce development fees as disincentives to build and settle in areas of the city exposed to floods. Part of the revenues collected by local authorities from such taxes could be earmarked for flood resilience projects, to ensure that financial resources for this purpose are scaled up. Authority for implementing these taxes and development fees lies in the central government, which would need to closely co-ordinate these proposed measures with local governments.

Local governments should also improve the enforcement of land-use controls. Financial instruments could promote flood-resilient land use and strengthen the enforcement of land-use regulations. Penalties should be imposed on developers that do not comply, for example building in flood-sensitive areas in violation of zoning codes. In the BMA, the Financial Department and the City Planning Department are key stakeholders for achieving this objective, but financial and technical capacities need to be built up with the support of the central government.

Adaptive infrastructure

Flood-resilient urban infrastructure is a crucial element in the flood risk the BMR faces. The local climate, high exposure to water runoff from the north and the east, and the numerous possible flood ways make monitoring and maintaining infrastructure extremely demanding. Flood protection infrastructure in the BMR is developed and maintained by different authorities since 1983, including the BMA (Department of Drainage and Sewerage) and the central government (Royal Irrigation Department, and also, the Water Resources Department and Electricity Generating Authority of Thailand in the vicinities of the BMR), which has created some co-ordination challenges, as discussed below.

The first type of infrastructure in place is a polder system, consisting of numerous dykes to prevent water discharge from the north, the east and from high tides, and to prevent overflow from urban waterways. This is particularly important, considering that some areas of the city, mainly in the eastern districts, are found below these waterways. The second type of infrastructure is a drainage system that supplements the polder system and whose aim is to protect urban areas that are already inundated. It consists of: 1 682 canals (*klongs*) totalling approximately 2 600 kilometres, whose objective is to drive water to the Chao Phraya River and the sea through pumping stations and water gates; 6 400 kilometres of drainage pipes along major and secondary roads, and 7 drainage tunnels to evacuate excess water from the surface to the Chao Phraya River and the sea; and 25 stormwater retention ponds scattered across the city to capture early rainfall and decrease peak runoff in low-lying areas and in areas where the drainage capacity is too low to bring stormwater to the river and canals. The city of Bangkok's flood protection and drainage infrastructure was primarily developed to cope with localised flooding, more precisely water overflow from the river and canals from exceptional heavy rainfall. A substantial amount of water runoff originated upstream, north of the Chao Phraya Basin, and was carried by the Chao Phraya River down the Gulf of Thailand through the BMR during the 2011 floods. Since the overflow could not be contained by the current infrastructure, the BMA is trying to expand its capacity to avoid a similar disaster in the future. The current project consists of the construction of six new diversion tunnels, including three large drainage tunnels, five additional retention ponds and water expressways to drive overflow to the sea or to diversion tunnels.

The BMR is making good progress in developing polder and drainage infrastructure. However, these tools (new diversion tunnels, waterways, etc.) are a burden on the city's finances, and the 2011 floods illustrated that they alone may not be able to protect the city from exceptional and unanticipated water runoff caused by extreme weather. One alternative is to develop more "adaptive" infrastructure, such as ecosystem-based measures. Such an example can be found in the city of Portland, Oregon (United States). One of its key policies, in the city's 2005 Watershed Management Plan (PWMP), is the use of plants and soil in order to slow, filter and infiltrate runoff close to its source, in a way that strengthens and mimics natural functions/processes (OECD, 2012). Such adaptive measures are important complementary resilience strategies and present three main benefits:

- These strategies are often more cost-effective than polder and drainage infrastructure. It is estimated, for example, that Atlanta's tree cover has saved more than USD 883 million by precluding the need for stormwater retention "grey" facilities (US EPA, 2007). Chicago's experience with its Green Alleys programmes has shown that investing in permeable pavements, downspout disconnections, rain barrels and tree planting are an estimated three to six times more effective in managing stormwater per USD 1 000 invested than conventional methods (American Rivers, *et al.*, 2012).
- These alternatives can be put in place more quickly and are more flexible than polders and drainage systems. This is especially important given that projections of future changes in precipitation (due to climate change) and socio-economic trends are subject to considerable uncertainty. Ecosystem-based adaptation measures to counter flood risk can therefore contribute to an "adaptive" management of the BMR.
- These measures, in particular ecosystem-based adaptation measures, can simultaneously address other green growth policy goals. Green curbs, for example, offer increased absorptive capacity in heavy rainfall, increase natural vegetation in cities, create pedestrian space and dis-incentivise private car use.

The Bangkok and Vicinities Development Structure Plan 2013 and the Bangkok Comprehensive Master Plan (2014-2018) already incorporate some principles of adaptive management to floods, through land-use strategies such as the creation of environmental conservation areas and flood diversion channels (OECD, 2015a). Agricultural land is also used, to some extent, to drain water runoff. The following "adaptive" infrastructure strategies could be developed to enhance the BMR's flood resilience:

- Local governments in the BMR should assess how more flexible infrastructures can complement the existing polder and drainage systems, not only in the plains of the BMR but also in denser areas of the city of Bangkok. Cost-benefit and cost-effectiveness analyses could be carried out to compare their performance with conventional flood-protection infrastructure;
- Peri-urban ecosystem-based infrastructures could be developed: in the vicinities of the BMR, the creation or restoration of lost natural habitat (coastal and upstream wetlands, mangroves, forests) and retention ponds can play a critical role in draining and retaining water runoff. This is particularly relevant in the northern suburban upstream areas, where this strategy is more economically feasible;

- Canals need to be preserved and well maintained. Many have been buried and replaced by roads as a result of sprawling urban development. Those that remain are also losing their function as waterways, partly because they are not well maintained. Dredging canals and removing waste as well as contaminated soils would recover their functions and improve water quality; and
- Smaller scale infrastructure could also be developed in urban centres. There is considerable unused land in the downtown areas of the city of Bangkok that might serve as retention ponds, such as old parking lots or railroads used as dumps for old trains. Instead of buying the land outright, which is prohibitively expensive in these areas, the BMA could simply purchase the right of usufruct for these areas in times of flooding and build dykes around them, while connecting them to the city's water supply and sewerage system. Installing semi-permeable surfaces on secondary roads (*soi*) and small sidewalk rain-absorbing planter boxes could also yield high retention rates. Amendment of building codes, branding of office buildings, compensation mechanisms for water storage capacity and green roof subsidies are some instruments local authorities could use to implement these strategies.

Many of these actions could contribute not only to adaptation but also mitigation and create other co-benefits. Green roofs, trees and green corridors could reduce the "heat island" effect and lower energy needs, and provide social benefits by preserving livelihoods in local communities and providing recreational green spaces. Local authorities could start out with some pilot projects in the city to assess how to adapt existing best practices (from the Netherlands, Sweden and the United States, for example) in the context of the BMR, while raising public awareness among local communities about their benefits.

Disaster risk financing

The 2011 mega-floods that hit the BMR and other parts of Thailand is reported to have been among the costliest natural disasters since the 1980s. It resulted in losses in the global supply chain of USD 44.2 billion and significantly slowed Thailand's economic growth in the months that followed the floods (OECD, 2013). The flood revealed that most manufacturing industries were not prepared for floods, which increased the magnitude of the damages. The manufacturing sector suffered a loss of USD 32 billion (i.e. 70% of total losses) at the country level. Forty-five percent of the world's manufacturing capacity of computer hard disk drives are produced in the affected area, and due to the flood disaster, it is estimated that global supply of hard drives fell 30% that year (OECD, 2013). The tourism, financing and banking sectors were also significantly affected (Ahsan, 2013). In the city of Bangkok, total damages reached THB 296 billion (USD 9.3 billion at 2014 prices), and 58% of the damage went to the industrial sector (Table 4.1). More than 1 000 factories were affected in the Bangkok region and Bangkok's secondary airport, Don Mueang, was closed for six months (OECD, 2013).

Table 4.1. Damages sustained by different economic sectors in the city of Bangkok from the 2011 flood disaster

Sector	Damage (THB billion)	Damage (% of total damage)
Industries	171.9	58
Business and infrastructure	54	18.3
Agriculture	37.1	12.5
Services and others	33	11.2

Source: BMA (2014), "Bangkok flood control", Department of Drainage and Sewerage, presentation made at the Bangkok Knowledge Sharing Workshop on Urban Green Growth in Dynamic Asia, 6-7 August, Bangkok.

Economic resilience does not only imply being prepared for and withstanding shocks, but also being able to bounce back and emerge stronger than before (Matsumoto and Daudey, 2014). Insuring disaster-related losses is a critical instrument of flood resilience, complementing infrastructure protection. In Thailand, the insurance sector provides property insurance for losses due to the interruption of commerce by natural disasters. It also offers natural disaster coverage under life insurance policies, for automobile and personal accident insurance and for crop-failure insurance (OECD, 2013).

The affordability of flood insurance policies, however, can be a significant barrier, especially considering the frequency of such disasters, which increase premiums on the instruments. After the 2011 floods, many businesses and individuals struggled to find affordable insurance policies to cover flood damages and losses. Of the total losses in 2011, only about USD 10 billion were insured. In response, the national government set up the National Catastrophe Insurance Fund (NCIF) in 2012, which is used as a reinsurance reserve, and regularly raises awareness about it and other insurance products at seminars and events (OECD, 2013). Local insurance companies that issue policies carry part of the risk and transfer the rest to the NCIF, which passes on a portion of that risk to international carriers operating on the global reinsurance markets (OECD, 2013).

Properly evaluating the impact of disasters is crucial to prepare for post-recovery and reconstruction plans. The Ministry of Interior, with the help of the World Bank and other development partners, undertook an assessment of the impact of the 2011 floods in 26 of the 66 provinces affected by the disaster. This offered recommendations for recovery in several economic sectors (OECD, 2013). Thailand's Office of Insurance Commission (OIC) collects data from insurance companies, which keep track of insured losses. These data are then transmitted to the NCIF. The OIC also reviews the capital adequacy of companies' exposure to disaster risks, so that they can be adequately covered in risk-based capital reserve calculations (OECD, 2013).

Insurance systems could be further developed to provide further protection against floods for the BMR's economy. Crucially, the private sector should be encouraged to participate in the system though tax incentives, especially for small and medium-sized enterprises. Certain industries could also be required to participate. Such risk-financing mechanisms could be combined with risk reduction: more incentives could be given to developers and builders to "build back better" (e.g. by increasing access to public transport, nearby shopping centres, restaurants and recreational opportunities, and providing green public spaces), to avoid simply rebuilding and exposing housing to the same risks.

The national government could subsidise insurance compensations or provide matching funds based on such efforts (OECD, 2014). The national and local governments could also consider investing in *ex ante* parametric risk-financing instruments or disaster reserve funds. The objective is to avoid having to mobilise and shift budgets from other competing demands in the aftermath of a flood disaster. In Austria, for instance, the Catastrophe Fund (*Katastrophenfonds*) is used to finance damages from disruptive shocks sustained by public bodies, households and businesses, which also require *ex ante* prevention investments and actions taken before the fact. It is financed by a mix of income, capital and corporate taxes (OECD, 2014). International development partners and donors could also participate in such schemes, given that Thailand may have lower financing capacities than a developed country. Finally, more research needs to be conducted on how to optimise such safety-net mechanisms. A clearer evaluation of potential damages across sectors and jurisdictions would be useful to raise awareness on the need for safety nets and insurance policies.

Private sector engagement

National and local governments should also encourage the private sector to take voluntary infrastructure measures to protect their businesses. After the 2011 floods, the Industrial Estate Authority, a public company run by the national government, provided financial assistance for the construction of flood protection infrastructure around industrial facilities. In the city of Bangkok, and the provinces of Pathum Thani, Samut Sakhon and Samut Prakarn, a total of around THB 6.8 billion (USD 211 million at 2015 market prices) was invested in the construction of concrete walls, dykes and sheet piles (Thampanishvong, 2013). One option would be to develop such initiatives, especially for small and medium-sized (manufacturing) enterprises with relatively weak financial reserves and limited management capabilities. It is critical, however, that such investment does not result in mal-adaptation measures. An “individualised” approach to protect one business (e.g. building a single dyke) could put neighbourhood or downstream properties and assets at greater risk, and it is in the financial interests of businesses to invest in flood resilience measures consistent with regional plans and strategies, to guard against this.

National and local authorities should assist the private sector in making comprehensive investments to prepare for large-scale floods in the BMR. Standing committees or councils involving major stakeholders from the public and private sector could be created at the BMR level to organise defences against floods. They should be chaired by the Thai government, which plays a prominent role in building resilience to floods in the BMR, and should also be supported by specific funds allocated by the Thai government to support these strategies (OECD, 2015a). Decisions should be based on the information of the database on businesses and industries and their vulnerabilities, as mentioned previously.

Such infrastructure efforts by the private sector can contribute to the resilience of the communities in which they are located, their workforce and its ability to get to work, and the ability of supply chains to continue functioning or return to normal functioning as quickly as possible. Moreover, resilience measures also generate significant co-benefits, such as improved green spaces, healthier environments in which workers live, a more attractive and safer community to attract a better labour pool, and a better quality of life. For example, the financial support provided by the Industrial Estate Authority could expand such a comprehensive approach in its efforts to create pocket parks in neighbourhoods.

Use of ICT

The BMA and other relevant agencies operating infrastructure in the BMR should develop technology to help policy makers rethink systems. The objective is to obtain a comprehensive understanding of how water flow and infrastructure interact, and how different types of infrastructure are connected. This will help to inform policies to increase the BMR's capacity to withstand floods. Simulation and monitoring tools are critical instruments that can also encourage green growth.

The BMA has a Flood Control Centre (FCC) that was established in 1990. It uses computer technology to systematically manage flood protection. The FCC monitors and collects hydrological data (rainfall and water level), data on the condition of operation facilities, on flood damage and water quality, using an online system. This is very helpful for city staff to remotely monitor water gates and pumps of the main canals and the river of the city, and act quickly and efficiently in case of flood. Improvement of this flood technology system could also help inform decisions on infrastructure that can boost the BMA's resilience to floods. The Public Utilities Board of Singapore, for instance, is using a cutting-edge simulation software called 3Di.[3] This not only measures real-time water levels in different places in the city, but analyses, models and forecasts potential water flows in the city in case of flash floods. Such a system can help to identify catchment-wide solutions to reduce the speed of surface runoff in urban areas, to identify which areas to monitor and to decide proactively on appropriate infrastructure and land-use strategies (Public Utilities Board of Singapore, 2013). Such technology would be a good complement to the existing FCC for the BMA.

The FCC and other types of technology-based assessment such as 3Di could be scaled up to other local authorities in the BMR and integrated into the metropolitan-wide monitoring framework, in order to harmonise the analytical capacities across the entire metropolitan region, thereby encouraging a comprehensive regional approach. This is critical, because most of the infrastructure is in the city of Bangkok, and the software may help to identify needs in other provinces of the BMR that are also risk factors for the city. It is equally important to ensure that the data collected and monitored by the FCC are available to other DRM-related departments and agencies in the city when needed. From the study it was not clear if such a well-functioning horizontal network exists or not.

A city's flood resilience does not only depend on flood-protection infrastructure. Improvements to the wastewater treatment system, in particular, will be critical in avoiding public health issues. Biochemical oxygen demand (BOD) and dissolved oxygen (DO) are at critical levels in many canals, and pollution created by untreated water can create public health issues when a flood occurs. Similarly, uncollected solid waste in slums and informal settlements along the river and canals can be a source of concern, as floods can spread them throughout the city, causing severe environmental degradation and public health hazards. After the 2011 floods, in the month of December, the amount of solid waste generated dramatically increased to around 12 000 tonnes per day, from around 7 000 tonnes per day in November. This was mainly due to the damages to household furniture and materials (BMA, 2012). In addition, waste sometimes obstructs drainage pipes, compromising the efficiency of flood protection infrastructure. Improving the performance of wastewater and solid waste treatment performance will be a crucial part of increasing the BMR's resilience to floods while fostering green growth.

Transport also presents major infrastructure challenges that can affect the BMR's resilience to floods. Mass transit and non-motorised transport modes can help offset the road-centric development of the BMR. This has increased its vulnerability to floods, by destroying natural habitats and encouraging urban sprawl. Few wide roads are connected to the main arteries of the city in low-income communities, which exposes the urban poor to risk during floods and obstructs relief operations (Marome, 2014).

Such factors illustrate the need for infrastructure systems thinking. Assessing how different types of infrastructures interact with each other in case of disaster is a critical part of identifying needs and adapting infrastructure, economic and social policies accordingly. To achieve this difficult task, local authorities in the BMR and the central government could consider developing other types of ICT management tools, relying on high-technology sensor networks that monitor all critical infrastructures in the region (energy, water, solid waste, flood defences, transport, etc.). Collecting data will help to study their overall performance on a day-to-day basis and in case of disaster. The Operations Centre of the city of Rio de Janeiro is a good example of a citywide data system integrating information on different types of urban infrastructure. It was developed by IBM and collates all data, input online, to identify trends and complex impacts of potential disasters, such as floods, fires and landslides. This can help decision makers select the most appropriate action and identify which urban areas need support.[4] The BMA and the Thai government could consider developing such technology progressively in the BMR.

Assessment of DRM governance structure

Mainstreaming DRM

The Thai government used to be the central decision maker in most of green growth opportunity areas, and its strategies and decisions significantly affect development in the Bangkok Metropolitan Region (BMR), especially in terms of spatial planning, infrastructure development, financing and policy instruments. The 1997 Decentralisation Action Plan, however, delegated some of the responsibilities to local governments. The BMA now has discretion over some important policy levers, especially in the areas of land use, wastewater treatment and solid waste management (OECD, 2015).

A consequence of the decentralisation reform in Thailand is the need for stronger co-ordinated actions between different levels of government. In regard to flood resilience, the Thai government has established major disaster prevention and relief guidelines for action at lower levels of government through the National Disaster Prevention and Mitigation Plan (2010-2014). However, for example a BMA project to build a pumping station has been blocked because it was not well co-ordinated with the central government (Department of Rural Roads and the Marin Department) who controls these areas. Such co-ordination between the national and local governments tends to be regulatory: in regard to flood resilience, for instance, the Thai central government has established major disaster prevention and relief guidelines – in particular the National Disaster Prevention and Mitigation Plan (2010-2014) – to be adapted at the local level (e.g. Bangkok Disaster and Prevention Management Plan). The same mechanisms are in place for spatial planning. However, there is a lack of collaborative approach and capacity-building strategies, reflected in the incomplete translation of national spatial plans at the local level and management failures between the national government and BMA during the 2011 floods.

Horizontal co-ordination

One of the obstacles to DRM in the BMR is the lack of co-ordination mechanisms on land use across provinces and municipalities to promote flood resilience, especially in terms of the preservation of natural drainage habitats and the location of industries. This could negate the policies of one local government or the Thai government. The following efforts could be taken in the five provinces of the BMR:

- Implement regional land-use plans in all local plans. The 2014-2018 Bangkok and Vicinities Development Structure Plan defines some land-use and transport strategies at the scale of the BMR (OECD, 2015a), and some of them may help to improve the BMR's flood resilience. They include: 1) specific locations for industries; 2) low-density areas that can serve as flood channels or emergency water storage areas; 3) wetland conservation areas to protect coastal zones; and 4) extending the mass transit network. However, this is not legally binding. Public authorities should first make sure that other surrounding provinces in the BMR develop local spatial plans that are consistent with the 2014-2018 Bangkok and Vicinities Development Structure Plan. Metropolitan commissions on land use (OECD, 2015a) could assess to what extent the regional plan is translated into all local plans in the BMR and consider what action might be taken if not.

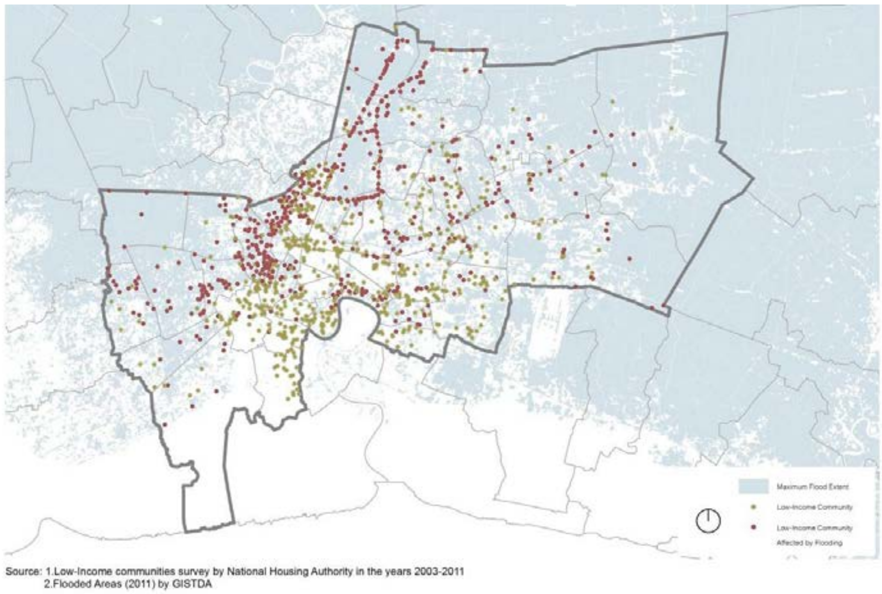
- Regulations for flood-resilient buildings in the BMR should be co-ordinated. Bangkok's Comprehensive Plan 2014-2018 provides tools that can be used to enhance flood resilience, such as the FAR Bonus System, minimum open space ratio (OSR), setback along rivers, canals and main roads, and control of building heights and sizes. However, these tools have only been adopted by the BMA, and all local governments in the BMR should be using them.
- Finally, zoning mechanisms should be used to restrict the location of firms in Pathum Thani and Samut Prakarn, where industries are highly exposed to floods because of their proximity to the Chao Phraya River. Local land-use controls should target the location of new industries, large commercial buildings and housing, in a consistent and coherent regional approach. Such land-use strategies would help mitigate losses and damages from flooding in the future.

The government, possibly with the assistance of metropolitan committees and advisory boards, could help municipalities achieve these goals, if they lack the requisite financial and technical capacity. They could also provide the political leadership necessary for this demanding enterprise (OECD, 2015a).

Stakeholder engagement

Floods in the BMR may entail both significant economic and social costs. In the 2011 floods, no fewer than 42 of the 50 districts of the city of Bangkok were under water, affecting around 1.8 million residents. Human damages are also likely to be high in case of future floods: in one scenario of severe climate change and continued current socio-economic development trends, and even with a 100-year flood protection system, the Aqueduct Global Flood Analyser estimates that around 54 600 people would be affected by inland floods in the BMR (around 35 500 in the city of Bangkok alone) and that around 144 500 people would be affected in 2030 (around 88 400 in the city of Bangkok alone). The 2011 flood also highlighted the vulnerability of the poor to extreme weather events: 73% of people within its communities of urban poor (i.e. 457 805 people) were affected by the disaster – a far higher share than for more affluent segments of the population (UN ESCAP, 2012). As explained earlier, low-income communities tend to settle in vulnerable areas such as canals and riverbanks (Figure 4.3). Floods disproportionately affect the urban poor in the BMR and deepen poverty and inequalities, resulting in weaker long-term economic growth. While such vulnerability can be explained by poor access to urban services, such as electricity, transport, and water supply and treatment, it also stems from a lack of efficient policies to directly protect these communities from floods. To increase the BMR's resilience to floods, it will be critical to enhance the preparedness and response capacity of local communities, especially the urban poor.

Figure 4.3. Low-income communities affected by the 2011 floods in the city of Bangkok



Source: National Housing Authority (2012), "GIS-assisted approach in housing development for low-income earners", GIS Section, Department of Housing Development Studies, presentation made to the delegation from SUDU, UN ESCAP, Bangkok.

One of the most important policy responses of the BMA is the Bangkok Disaster Prevention and Mitigation Plan 2010-2014 (BADPREMOP-2010-2014). This defines the actions of the Bangkok Fire and Rescue Department (BRRD), the lead BMA agency in charge of disaster relief in the city of Bangkok, and follows the guidelines of the National Disaster Prevention and Mitigation Plan 2010-2014. These plans particularly target pre-disaster preparation (e.g. improve public awareness, education and safety), incident management (e.g. evacuation to shelters) and post-disaster management (e.g. infrastructure reconstruction). These three types of actions are mostly top-down, while one of the most effective strategies to fight floods, which is not explicitly specified in the Disaster Prevention and Mitigation Operational Plan, is the direct involvement of these communities before, during and after a disaster. During the 2011 mega-floods, many residents volunteered to fight floods (Global Disaster Preparedness Centre, 2013). This encouraged the BMA to change its strategy and to co-operate more with the local residents, by going out into the field to the volunteers' camps, and discussing the flooding issues with local leaders in these camps. This co-operation provided remarkable help and human resources to fire fighters, for carrying supplies and helping the most vulnerable populations in the city (e.g. the elderly, the young and disabled).

The assistance provided by volunteers during the 2011 flood is a good example of the benefits offered by joint actions between local authorities and communities and individual citizens. Such contributions could have been used even more efficiently had their response been organised *ex ante* and their co-operation and collaboration been worked out in advance. Mechanisms to allow CSOs to participate in the design of disaster action plans should be reinforced, so that they can make contributions based on their knowledge and experience of practical and viable community-based responses to disasters. The important role that is played by communities and individuals acting as "first responders" was dramatically demonstrated in the Great Hanshin Earthquake of 1991 in Kobe, Japan, where more than 27 100 people were rescued by their neighbours, as compared with only 7 900 by the Kobe Fire Department (IFRC). The Netherlands and the United States also provide some innovative practices of stakeholder engagement that Bangkok could replicate (OECD, 2015a).

Mobilising urban residents to fight floods and making them agents of resilience to floods in the BMR can be more easily implemented through district administrations, schools, churches and media. Local governments in the BMR can encourage the involvement of these civil society institutions/entities in more decentralised preventive strategies. Local communities can be helped to build greater resilience to floods by increasing their "social capacities" to self-organise, prepare for and respond to stresses and shocks (crisis), which is reported to be lacking in some communities (Marome, 2014).

Each of the 50 districts in the city of Bangkok has an elected mayor. The BMA could leverage its human and financial resources by encouraging the establishment of community-based resilience committees at the district level and providing them with capacity-building training. With additional technical and logistical support, they could carry out simple vulnerability assessments and develop threat or risk maps, and establish some priorities among actions to enhance their resilience. These could then be proposed to the BMA and other provincial governments or BMR-wide resilience commissions for approval and funding.

A major threat to flood resilience is a lack of social capital on the ground, which can lead to inaction when a disaster occurs. In the BMR, lack of information and interest among residents – partly owing to lagging levels of education – has been identified as a key social obstacle (Institute of Development Studies, 2007). Schools and churches (Buddhist *wat* and Muslim temples in Bangkok's case) are natural community centres, possessing several critically important physical assets and attributes in times of crisis, such as large open areas that can act as emergency shelters, food preparation operations and eating facilities, medical attention units and staff. Their organisational lines of authority and responsibility are already operational, and they are also an integral part of a community's social capacity or capital. The following measures could be implemented in schools and churches:

- School programmes and religious centres can raise awareness of flood risks, and include practical workshops to build knowledge on how to manage floods at the household and community levels. School education and capacity-building programmes on the management of floods, as well as making information on flood risks publicly available should complement these community-based workgroups or committees. Schools and churches can serve as efficient communication channels assisting district administrations, provincial and national governments, as well as local communities (e.g. deployment of early warning systems). Likewise, they can be critical "first responders" and "safe havens" to complement local authorities' action to protect local communities and assets in case of disaster; and

- Flood risk maps should be made publicly available and widely disseminated in schools, churches, and through other means such as simple posters, local newspapers, and social media. School and church communities can review and refine base maps showing physical infrastructure assets, elevation or proximity to other "risk factors" such as rivers, canals and the coast. The BMA and the 50 district administrations should train schools and churches in how to conduct simple flood-risk assessment and can replicate the project in other provinces of the BMR.

Local authorities should encourage and support the media in raising awareness about disaster risks. Topical urban issues in the BMR focusing on urban resilience can be publicly debated in multiple media outlets, such as radio shows, news articles, social networks and other digital and physical platforms. Local authorities should work more systematically with the media in workshops, training sessions and forums as new strategies to build resilience to floods are announced. Involving the media in disaster risk planning will also enhance a sense of community, a key element in building social capital and resilience to floods.

Main policy recommendations

- Conduct flood-risk assessment and mapping at the BMR. Develop maps of urban flood risk zones that more accurately reflect changing flooding threats (in terms of exposure and vulnerability) to inform policy makers, residents and businesses of the potential future impacts and possible flood protection/adaptation policies.
- Promote risk-sensitive land use and flood-resilient building regulations by combining regulatory and fiscal measures, in a co-ordinated way for the entire BMR.
- Enhance the use of eco-system based adaptation measures (e.g., urban parks, wetlands) to reduce the investment need for flood protection infrastructure.
- Complement the Flood Control Centre with state-of-the-art flood simulation tools, early warning systems and integrated data collection systems to analyse and disseminate information in real-time on changing conditions during times of crisis or urgent need.
- Partner with the private sector to develop private and public flood insurance mechanisms. Promote evaluation of the impact of disasters, which could be used for better assessment of future disaster risks.
- Enhance the preparedness and response capacity of local communities, especially the urban poor, through providing them with capacity-building training. Use existing community entities, such as schools and religious centres to raise awareness of flood risks and how to prepare and respond to flood at the household and community levels.
- Engage the media in the coverage of disaster risks and broadcast public interest messages, community events and information about flood risks and other impending threats.

Notes

[1] The Aqueduct Global Flood Analyser is a tool developed by the World Resources Institute, Deltares, the Institute for Environmental Studies, Utrecht University and the Netherlands Environmental Assessment Agency. However, this tool should only be a basis for reflection, as infrastructure is the main variable taken into account to calculate economic and human damages.
See: http://floods.wri.org/#/state/4000/Bangkok%20Metropolis,%20Thailand (last accessed 29 August 2018).

[2] Coastal Cities at Risk (CCaR): Building Adaptive Capacity for Managing Climate Change of Coastal Megacities (Vancouver, Manila, Lagos and Bangkok) is funded by the International Development Research Centre (IDRC) and three Canadian research councils.

[3] The 3Di Water Management software was developed by Deltares, the Delft University of Technology and Nelen & Schuurmans, in the Netherlands.

[4] www.epa.gov/jius/projects/rio_de_janeiro/rio_operations_center.html.

References

Ahsan, S. (2013), "Resilient cities for the poor or by the poor? A case study from Bangkok", Technische Universität, Berlin.

American Rivers, American Society of Landscape Architects, ECONorthwest, and Water Environment Federation (2012), "Banking on green: A look at how green infrastructure can save municipalities money and provide economic benefits economy-wide", Portland, Oregon, available at: https://www.americanrivers.org/conservation-resource/banking-on-green/ ; and https://s3.amazonaws.com/american-rivers-website/wp-content/uploads/2017/03/06142720/banking-on-green-report.pdf.

BMA (2012), *Bangkok State of the Environment 2012*, Department of Environment, Bangkok.

BMA (2014), "Bangkok flood control", Department of Drainage and Sewerage, presentation made at the Bangkok Knowledge Sharing Workshop on Urban Green Growth in Dynamic Asia, 6-7 August, Bangkok.

Global Disaster Preparedness Centre (2013), "Building urban resilience", Workshop Results, Bangkok.

Institute of Development Studies (2007), "Governance screening for urban climate change resilience-building and adaptation strategies in Asia: Assessment of Bangkok City, Thailand".

Marome, W. (2013), "Urban risk and vulnerabilities of coastal megacity of Bangkok, Thailand", proceedings of the 4th Global Forum on Urban Resilience and Adaptation, 31 May-2 June, Bonn, Germany.

Marome, W. (2014), "Mapping and measuring social vulnerabilities of coastal areas of Bangkok and periphery", proceedings of the 5th Global Forum on Urban Resilience and Adaptation, 23-31 May, Bonn, Germany.

Matsumoto, T. and L. Daudey (2014), "Urban green growth in dynamic Asia: A conceptual framework", *OECD Regional Development Working Papers*, No. 2014/12, OECD Publishing, Paris, http://dx.doi.org/10.1787/5js7svlw8m0x-en.

National Housing Authority (2012), "GIS-assisted approach in housing development for low-income earners", GIS Section, Department of Housing Development Studies, presentation made to the delegation from SUDU, UN ESCAP, Bangkok.

OECD (2012), *Compact City Policies: A Comparative Assessment*, OECD Green Growth Studies, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264167865-en.

OECD (2013), "Disaster risk financing in APEC economies: Practices and challenges," OECD, Paris, available at:http://www.oecd.org/daf/fin/insurance/OECD_APEC_DisasterRiskFinancing.pdf.

OECD (2014), *Boosting Resilience through Innovative Risk Governance*, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264209114-en.

OECD (2015a), *Green Growth in Bangkok, Thailand*, OECD Green Growth Studies, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264237087-en.

OECD (2015b), *Stakeholder Engagement for Inclusive Water Governance*, OECD Studies on Water, OECD Publishing, Paris, http://dx.doi.org/10.1787/9789264231122-en.

Public Utilities Board of Singapore (2013), "Tapping into intelligent technology for floodcasting, New modelling software in development aims to forecast flood events", available at: www.3di.nu/wp/wp-content/uploads/2014/03/Tapping-into-intelligent-technology-for-flood-casting.pdf.

Snidvongs, A. (2012), "Flood and urban risk/vulnerability management", presentation made at the Science-policy Dialogue on Challenges of Global Environmental Change in Southeast Asia, 19-21 July, Bangkok.

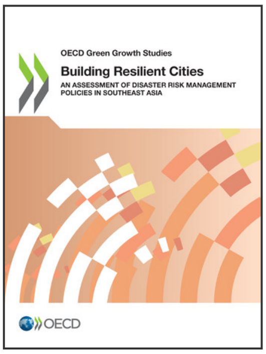
Thampanishvong, K. (2013), "Background paper for the *Global Assessment Report on Disaster Risk Reduction: the Case of Thailand*", Thailand Development Research Institute, Geneva.

UN ESCAP (2012), "The Thailand floods of 2011: While businesses lost millions, the urban poor lost out most in the floods", Sustainable Urban Development Section's internal working papers.

USAID (2014), "Spatial climate change vulnerability assessments: A review of data, methods, and issues", report produced by Tetra Tech ARD, Washington, DC.

US EPA (2007), "Reducing stormwater costs through low impact development (LID) strategies and practices", EPA 841-F-07-006, United States Environmental Protection Agency, Washington, DC, available at: http://water.epa.gov/polwaste/green/upload/2008_01_02_NPS_lid_costs07uments_reducingstormwatercosts-2.pdf.

WWF (2009), "Mega-stress for mega-cities, A climate vulnerability ranking of major coastal cities in Asia", World Wildlife Fund for Nature, Gland, Switzerland.



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