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Cities at Risk: Asia's Coastal Cities in an Age of Climate Change

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SUMMARY Asia's coastal megacities are increasingly vulnerable to flooding disasters resulting from the combined effects of climate change (manifested as sea level rise, intensified storms, and storm surges), land subsidence, and rapid urban growth. Development of risk-management strategies, such as improved infrastructure, early warning systems and evacuation plans, and disaster response and relief aid, is urgently needed in all these cities. But substantial barriers to implementing these measures must first be overcome: lack of awareness, the distracting immediacy of other problems, budgetary constraints, and governance issues. Despite the absence of precise climate change predictions, recent studies suggest that climate change, sea level rise, and sinking deltas are occurring at much faster rates than were projected only a few years ago. Implementation of climate risk management in planning and policy must be given high priority if there is hope of meeting the twin challenges posed by climate change and urban growth.

The risks posed by climate change and sea level rise will continue to grow into the next century, even if a dramatic reduction in greenhouse gas emissions is achieved

Climate change will have profound impacts on Asia. Some rural and agricultural regions (e.g., the Indo-Gangetic Plain, the breadbasket of South Asia) face severe water shortages brought about by a drier climate and a diminished flow from the shrinking Himalayan glaciers, while others face the prospect of increased floods. Intensified heat waves will increase mortality, especially among the elderly and in large cities that are already affected by a significant rise in temperatures caused by the effects of urban "heat islands." For example, in the case of Ho Chi Minh City, it is estimated that there is as much as 10°C difference between the city and vegetated surroundings. Climate change will also likely increase the occurrence of vector-borne and diarrheal diseases.[1]

Most vulnerable to the impacts of climate change are Asia's low-lying coastal regions and especially its large river deltas—including the Ganges-Brahmaputra, Yangtze, and Mekong deltas. Identified by the Intergovernmental Panel on Climate Change (IPCC) as "hot spots" of vulnerability,[2] they are also the sites of some of the world's largest megacities (large urban regions variously defined as having more than 8 or 10 million people), significant not only from the standpoint of their large populations, but also their economic infrastructures and dominant roles in national and regional economies.

Growing Risks from Climate Change, Sea Level Rise, and Land Subsidence

The growing physical risks to Asian coastal regions result from a combination of factors related to climate change, including a rise in sea level and a likely increase in intensity of tropical cyclones, bringing higher winds and heavier precipitation, stronger storm surges, and increased coastal flooding. It should be noted that these "natural hazards" are largely anthropogenic in origin, related to climate change that is caused by greenhouse gas emissions, sea level rise resulting from climate change, and land subsidence caused by withdrawal of groundwater. (Urbanization also contributes to the rise in risk of flooding through the processes of building over natural waterways and creating impermeable surfaces.)

Because of the built-in momentum in the climate system resulting from past emissions and the slow response of oceans, the physical risks posed by climate change and sea level rise will continue to grow into the next century, even if a dramatic reduction in greenhouse gas emissions is achieved. However, as things stand, rather than slowing, climate change may be accelerating as emissions continue to grow: recent modeling results suggest a possible warming of 5.2°C by 2100, more than double the estimate the IPCC made several years ago.[3] A growth in mean temperature is only part of the story. Climate change may also be causing a change in the paths of tropical cyclones, bringing destructive storms to places previously spared and perhaps even shifts in the Asian monsoon system, with potentially dire socioeconomic consequences.[4]

Risks posed by cyclonic storms and storm surges will be compounded by a rising sea level resulting from the thermal expansion of ocean water and the melting of glaciers and ice sheets. Sea level is projected to rise at an increasing rate during the twenty-first century and will continue to rise for centuries after global temperatures have stabilized. Earlier IPCC projections of an 18–59 cm rise in global sea level by 2055 omitted possible effects of Greenland's ice sheet melting and are now considered far too low. One study suggests sea level could rise between 0.75 to 1.9 m by 2100, two or three times the IPCC estimate.[5]

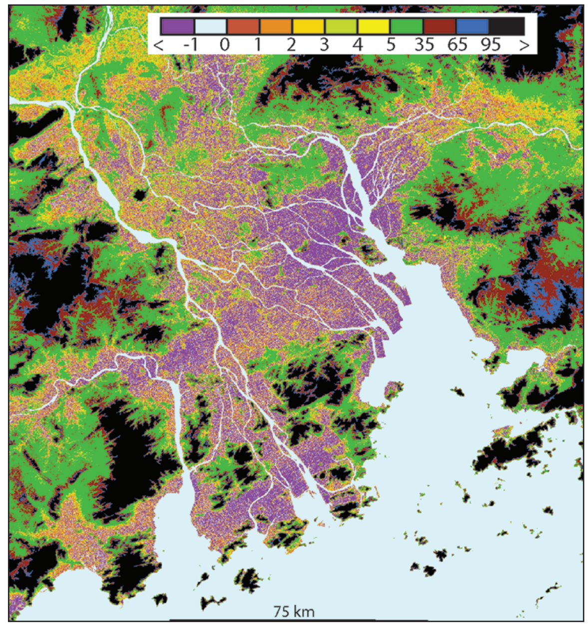
Land subsidence further adds to the growing risk of coastal flooding. Many coastal megacities in Asia are built on deltas where significant sinking is occurring due to soil compaction or groundwater withdrawal for household or industrial purposes. (Adding to the problem, withdrawl of groundwater that flows out to the sea also contributes to rising sea levels.) A recent global study of sinking deltas using historical maps and satellite images has identified the Pearl River Delta (China) and Mekong Delta (Vietnam) as particularly at risk, with much of their surface areas already below sea level and with only limited coastal barrier protection.[6]

In a number of Asian cities, the magnitude of land subsidence is greater than global or regional sea level rise. In Bangkok, the Gulf of Thailand is rising about 0.25 cm per year, but the city is sinking at a far faster rate, up to 4 cm per year.[7] In north Jakarta, subsidence has been measured at 6 cm per year, and sinking bridges have now become obstructions to water discharge.[8] Cumulative subsidence is about 3 m in the Yangtze Delta (Shanghai) and Tianjin City.[9] Floodwalls along the Suzhou River in Shanghai have already been raised three times since the 1960s to accommodate subsidence and a rise in relative local sea level. A floodwall that was built to withstand a 1 in 1,000-year surge was already nearly overtopped in a 1997 typhoon.[10]

Rising sea levels have many adverse impacts, including inundation of coastal plains, increased beach and coastal erosion, removal of protective sand dunes and vegetation, and intrusion of salt water into freshwater supplies, already a concern in many Asian coastal cities. However, the effects of sea level rise will be felt most severely in the form of amplified storm surges and flooding that can accompany tropical cyclones, which threaten much of the region annually. What in the past have been 1 in 100-year flood events may in the future become 1 in 10-year storms, with far-reaching implications for unprepared coastal populations and officials unaware of the dramatic changes in climate and flood regimes (frequency, magnitude, and extent) and the growing risk of major flood disasters.

In China, population growth in urban coastal locations from 1990 to 2000 was three times the national growth rate

Past surge and flood events have already been responsible for enormous human and economic tolls. For example, around the Bay of Bengal alone there have been an estimated 1.3 million cyclone-related deaths over the past 200 years.[11] More than 10 million people each year, most in Asia, experience some flooding due to storm surges.[12] Major recent coastal floods include Bangladesh's in 1991, which killed 140,000 people and made 10 million homeless, and Myanmar's in 2007, when 146,000 people were killed due to storm surges up to 6 m in height and that reached inland some 30 km, causing an estimated economic toll of US$17 billion. Storm-related floods in recent years have inundated 70–80 percent of both Jakarta and Manila. One estimate suggests that by the year 2100, even with a sea level rise of only 59 cm, a 100-year storm surge could inundate areas in Asia, affecting 362 million people, 10 percent of the total projected Asian population.[13] This estimate will need upward revision given the recent projections of more rapid sea level rise.



The Pearl Delta, China, with areas below sea level shown in purple.

Source: See note 6.

Asian Urban Growth. Adding to the increase in vulnerability arising from physical hazards, and most likely of greater import, is the growing exposure to these hazards of population and economic assets due to the relentless spread of human settlements in flood-prone, low-lying coastal zones.[14] Asia is in the midst of unprecedented urban growth, with its urban population increasing by 140,000 per day and expected to nearly double from 1.25 billion in 2006 to 2.4 billion in 2030. Much of this growth, fueled by economic globalization and export-driven economies, will take place in coastal locations and especially Asia's port cities. The growth in some coastal urban regions has already been extraordinary. In China, population growth in coastal zones from 1990 to 2000 was nearly twice and in urban coastal locations three times the national growth rate. For example, Shenzhen, a city of only 300,000 in 1978, had a population of 8 million by 2006. Currently (2010), the Hong Kong-Shenzhen-Guangzhou corridor has a population of more than 60 million, and the Yangtze Delta, with Shanghai at its core, has a population of some 60 million.

Floods at high tide are already nearing the subway level in Mumbai

Vulnerability of Asian Megacities. Asia's coastal megacities are particularly at risk for disastrous floods: coastal, riverine, or combined. A recent Organisation for Economic Co-operation and Development (OECD) report examining the vulnerability to climate change and sea level rise of 130 port cities worldwide found that by 2070 approximately half of the total population threatened by coastal flooding will reside in just ten megacities, all but one located in Asia (see table).[15] The report warned of the increasing likelihood of "city-scale disasters" involving substantial losses of life and infrastructure and significant dislocation to national and regional economies. The vulnerability of selected Asian coastal megacities was also illustrated in other reports presented at the Asia-focused Cities at Risk workshop in February 2009.[16]

In Bangkok, existing flood protection is considered inadequate for even a 30-year flood event. Although 70 km of embankment have already been built along the Chao Phraya River, if nothing further is done, some 30–35 percent of Bangkok's land area could face inundation by 2050, leaving one million residents at risk of displacement, more than a million buildings flooded, and most slum dwellers without their livelihood.

Cities at risk of coastal flooding, ranked by exposed population in 2070

Coastal City	Exposed population estimate (millions)
Kolkata	14.0
Mumbai	11.4
Dhaka	11.1
Guangzhou	10.3
Ho Chi Minh City	9.2
Shanghai	5.5
Bangkok	5.1
Yangon (Rangoon)	5.0
Miami	4.8
Hai Phong	4.7

Source: See note 2.

Mumbai, the economic capital of India with 12 million inhabitants, is now the tenth-largest city in the world. Developed on a set of islands and reclaimed land and with a drainage system more than 150 years old, it is extremely vulnerable to coastal flooding. In July and August, floods at high tide already reach 4.8 m in height, nearing the subway level. While there is a system of gates that close at high tide to prevent sea intrusion, this also blocks outward drainage, resulting in a near panic situation during heavy rains. An earlier study put the cost to Mumbai of a one meter sea level rise at US$71 billion, indicative of the huge economic costs of climate change faced by Asia's coastal cities.[17]

Ho Chi Minh City is estimated to have a current population of nearly 8 million, and it is predicted to grow to 12–22 million by 2050. It accounts for 40 percent of Vietnam's national GDP; a climate-related disaster would therefore have enormous impacts on the national economy. A significant part of the city is already regularly flooded due to a combination of storm surge, rain, and riverine floods. In an extreme storm in 1997, some 48 percent of the population (3.2 million people) was affected by floods. In 2050, a similar 30-year flood event is expected to affect 12.5 million people and possibly create 2 million "climate refugees."

With 40 percent of its area below sea level and an outdated and poorly maintained drainage system, Jakarta is already subjected to extensive flooding during the rainy season, even in the absence of climate change. In 2007, some 70 percent of the city was flooded and 450,000 people were forced to flee their homes.[18]

Manila's susceptibility to flooding, even under the current climate regime, was forcefully illustrated by the 2009 Ketsena typhoon, which brought intense rainfall, inundated 80 percent of the city, and forced evacuation of many hundreds of thousands of inhabitants.[19]

What Can Be Done to Reduce Climate Change–Related Risks

While increased coastal flooding is inevitable, disasters involving large losses of life are not. However, averting or reducing the risks of such disasters is a severe challenge that will require action on a number of fronts, including the formation of comprehensive climate risk-reduction strategies, the development of the institutional capacity to implement and enforce adaptation measures, and the mobilization of necessary resources. The adaptation measures that can be taken to reduce climate-change flooding risks as part of a comprehensive risk-reduction strategy are well known.[20] They include risk and vulnerability assessments, construction of flood protection infrastructure (e.g., sea walls, dikes), appropriate spatial land use planning and building codes, early warning systems and evacuation plans, and disaster response and relief aid. However, in many Asian coastal cities, appropriate risk-reduction measures have not been implemented or even seriously considered. Some of the reasons for this include the following general barriers to urban adaptation to climate change for Asian coastal megacities:

While increased coastal flooding is inevitable, disasters involving large losses of life are not

The urban poor and climate change

Asian urbanization will be accompanied by a significant increase in the number of urban poor as rural-to-urban migration results in what has been termed the "urbanization of poverty."[a] The urban poor will bear a disproportionate burden of climate change risks because, from a lack of choice, they are likely to live in poorly served informal settlements or slum housing located in marginal, flood-prone lands and to lack the personal and communal resources to cope with disasters.[b] Protection of the urban poor and their neighborhoods will be a major challenge for many Asian cities in adapting to climate change.

[a] G. Piel, "The Urbanization of Poverty Worldwide," *Challenge* 40 (1997).

[b] D. Zoleta-Nantes, "Differential Impacts of Flood Hazards among the Street Children, the Urban Poor and Residents of Wealthy Neighborhoods in Metro Manila, Philippines," *Mitigation Adaptation Strategies for Global Change* 7 (2002): 239–66.

1. Urban officials' lack of awareness regarding the magnitude of the risk of coastal flooding and how vulnerability is rapidly increasing due to climate change and urban growth.
2. The need to cope with immediate problems of housing, transportation, and poverty.
3. Budgetary constraints, especially in the case of expensive engineering of flood protection works.
4. Governance issues, including the lack of institutional mechanisms to coordinate relevant activities over the range of agencies and territorial jurisdictions involved and the lack of necessary scientific, technical, and managerial capacity.

These barriers must be overcome first, and then the difficulties specific to individual adaptation measures can begin to be addressed.

Raising Awareness: Risk and Vulnerability Assessment Analysis. Identifying the risks and vulnerabilities posed by climate-change coastal flooding is the first step in developing a strategic plan for climate-change adaptation. It is also essential in helping motivate a policy response by urban officials who may have had experience with high-frequency, low-impact floods but not with flood disasters of a magnitude involving substantial loss of life.

However, in assessing the probability of climate change–related risks, there is a spatial mismatch between the current and foreseeable capabilities of science and the needs of policymakers. The global- and regional-level assessments provided by the IPCC and the scientific community must be supplemented by higher-resolution studies at the city level to be of practical use to urban planners and officials—a challenge that science cannot yet meet. There is also a mismatch in time horizons and capabilities. Climate models are not useful for predictions for less than a few decades hence, while planners have shorter time horizons in mind. These spatial and temporal mismatches are severe obstacles in assessing climate change risks.

Past experience is no longer an adequate guide to the future

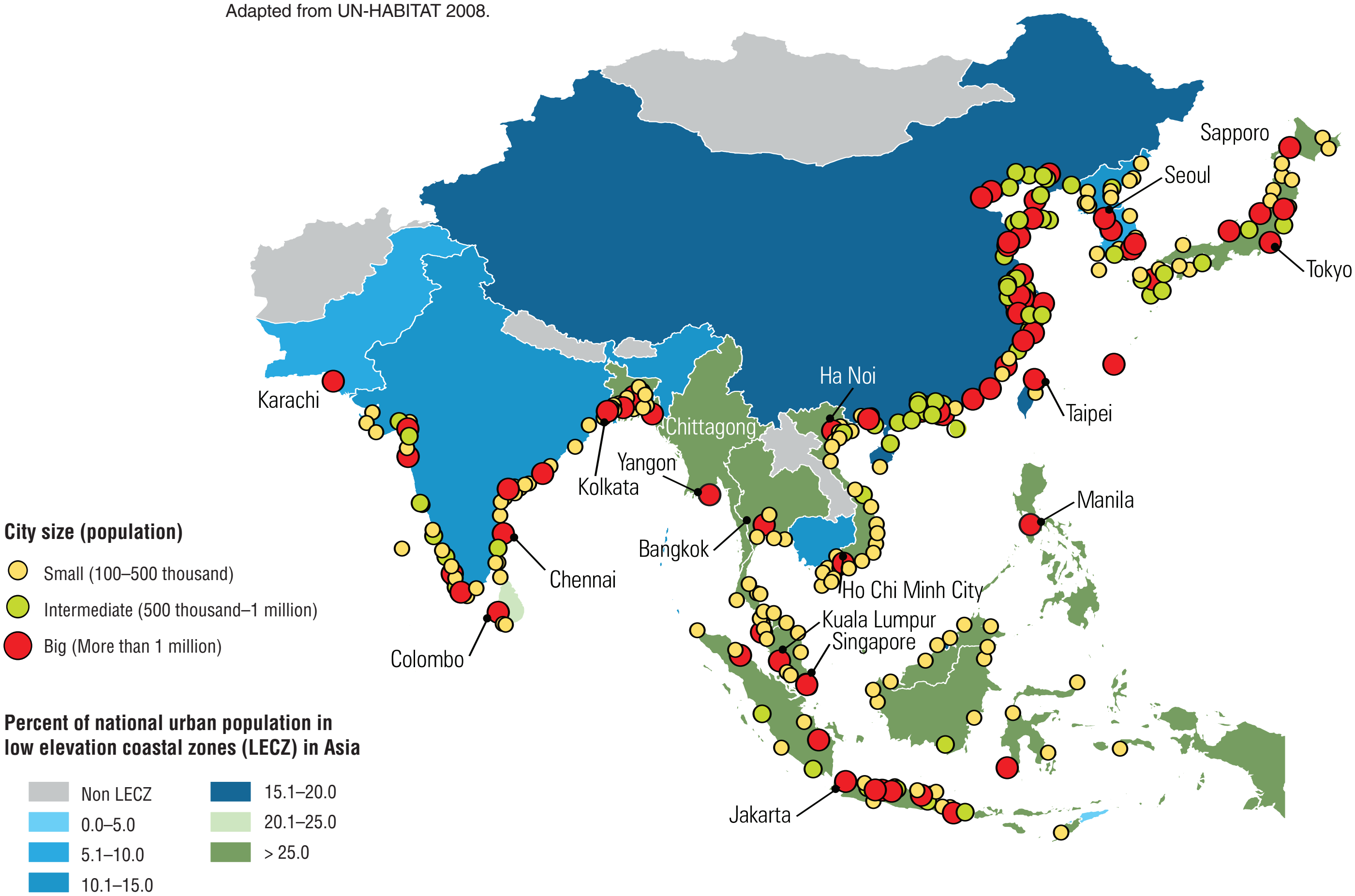
Coastal Flooding Risk Prediction and Mapping. A city-level flood risk/vulnerability assessment should incorporate: (1) information on past extreme events and disasters; (2) the preparation of hazard maps for possible future extreme events; and (3) preparation of vulnerability maps of populations and infrastructures at risk.

Predicting probability of future coastal flooding events, even in the absence of climate change, is inherently difficult because of the many variables that must be considered, the relative rarity of extreme events, and sparse historical records. The range of uncertainties involved is dramatically illustrated by the different probabilities of a Katrina-like storm and flood provided by the U.S. Army Corps of Engineers prior to the event, which put the probability as a 1 in 396-year event, and that of a private company, which assessed the probability as a 1 in 40-year event.[21] The difficulties in assessing risk probabilities are compounded by the need to now also incorporate the effects of future climate change and as a result to view risk probabilities as “transient” rather than “fixed.” In short, past experience is no longer an adequate guide to the future.

The most common approach to projecting climate change at subregional levels is a complex top-down process that involves downscaling, that is, deriving local-level data from global and regional climate models under various global CO_2 emission scenarios. The results can be difficult for nonscientists to interpret and of limited use to planners. An additional problem is that such models are more suited for predicting average temperature change as opposed to extreme precipitation, the occurrence of which is the major

Asian cities at risk from sea level rise.

Adapted from UN-HABITAT 2008.



concern in assessing flood risk. Thus the uncertainties associated with such projections, as with all climate futures models, are necessarily quite large. In the last analysis, there will always be limits to predictability, so societies must make effective adaptation decisions in the absence of accurate and precise climate predictions.[22]

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As an alternative to this traditional scenario-driven "impacts" approach, vulnerability assessments focus instead on socioeconomic vulnerability and determine "critical thresholds" of flooding—for housing, industry, utilities, and other key infrastructures—and estimate the likelihood of the extreme events that would pass these thresholds based on downscaling forecasts or historical extreme events, that is, a bottom-up as opposed to the prevailing top-down approach and one that focuses on vulnerabilities as opposed to risks.[23] While the uncertainties will be as high with this approach as with scenario-driven approaches, they will also be more transparent, and the findings regarding vulnerabilities more directly applicable for planning.[24]

Stakeholder Involvement. For any risk and vulnerability assessment to be politically credible, it is important that local scientific researchers, urban planners or officials, and major stakeholders be involved in their preparation and that assessment not be solely or largely a product of external consultants, as is often the case at present. Moreover, any assessment will require ongoing revision, taking into account new findings on climate change by the scientific community and the change in exposure to risk resulting from ongoing urban development, including the growth of informal settlements. This further demands development of indigenous capacity for monitoring and reassessing changes in risk and vulnerability over time.

Communication of Risk and Vulnerability. Effective communication of the assessment results, beyond a simple dissemination of risk and vulnerability maps, will be critical in raising the awareness of both the general populace and urban officials. Promising in this respect are animated visualization techniques, which can dramatically illustrate the impacts of potential flooding on neighborhoods, housing, and other infrastructures in terms that are meaningful and convincing to both nonspecialist and specialist audiences.[25] However, this requires prior development of an urban spatial database and computer mapping capabilities, skills, and equipment, all more likely to be found in local universities than in urban government agencies. This provides a strong argument for development of partnerships between local universities and planning officials and "local communities of knowledge," as has already occurred, for example, in Thailand, Taiwan, and Vietnam in order to create the necessary sustainable knowledge base.[26]

Flood Protection Works. As one component of adaptation to the risk posed by climate change–related flooding, most Asian cities will construct engineering works such as sea walls, dikes, diversion channels,

Bank studies of climate change impact and adaptation in Asian coastal cities

The World Bank, ADB, and JBIC have undertaken a set of coordinated studies of climate-change impact and adaptation in several Asian coastal megacities considered at high risk of flooding, including Bangkok, Kolkata, Ho Chi Minh City, Jakarta, and Manila. These comprehensive studies include projections of magnitude of risk and vulnerabilities as consequences of climate change, and variability, potential adaptation measures, and key policy priorities for adapting to climate change. Conducted by multidisciplinary teams of consultants conferring with local stakeholders, these studies are intended to facilitate informed decision making on the part of the government and private sector on measures needed to address climate change and its consequences. These studies are an indication of the growing concern regarding the developmental consequences of climate change and may lead to loans and grants by the sponsoring agencies. However, they also suggest that even in these very large Asian megacities, local capacity to conduct such essential studies may be absent or limited, a situation that almost certainly prevails in many smaller but still quite populous Asian coastal cities at high risk of flood disasters.

and reservoirs. Such adaptation measures will be expensive and may require substantial foreign assistance, as was well as long lead times (up to 30 years) for implementation. The cost of adaptation to climate change required by developing countries, mostly in Asia, is estimated by the World Bank at US$75–100 billion per annum. However, the United Nations (UN) adaptation fund (established to help developing countries fund this adaptation) remains pitifully under-resourced at US$18 million. Fortunately, other multilateral and donor agencies such as the World Bank, Asian Development Bank (ADB), and Japan Bank of International Cooperation (JBIC) have initiated major projects in select Asian coastal cities, and new mechanisms for international funding arrangements for adaptation are being discussed.[27]

Evacuation is not easily executed, in part because of the reluctance of governments to order mandatory evacuations, and unwillingness of residents to leave their unprotected property

In general, cities should begin by repairing and strengthening existing defenses, completing already planned works, and executing "no regrets" measures that also contribute directly to development goals (e.g., improved sewage, water supply, and drainage works). Flood proofing by raising and reinforcing critical but vulnerable infrastructure (e.g., power, water, and medical facilities) should also be given high priority.

Past experience demonstrates a temptation to over-rely on technological fixes in the form of major engineering works. As recognized in Vietnam, it is possible that engineering works may serve only to displace flooding to areas outside protective dikes and to increase the risk of a major catastrophe in the event of a dike failure.[28] In order to avoid the inadvertent promotion of risk taking in flood-prone regions by creating a false sense of security (as has occurred on a large scale over the years in the United States, leading to ever-rising flood loss despite increasing investment in flood control) such measures should be only one part of more comprehensive programs that include spatial planning and land use regulation.[29]

Warning Systems and Evacuation Planning. Providing protection by engineering work against the entire range of possible flooding events is not feasible because of the prohibitive costs that would be involved. Most municipalities in Asia and elsewhere can aim only at protection against more frequent, lower-intensity events. In regard to possible but rarer high-impact events, adaptation measures as a rule must focus on protection of lives as well as key infrastructure (e.g., power, utilities, medical) essential to disaster management and reconstruction efforts.

Warning systems and evacuation plans will be critical in coping with large-scale disasters (e.g., major storm surges accompanying typhoons) and especially for preventing associated loss of life. However, as the 2005 Hurricane Katrina in the United States demonstrated, evacuation is not easily executed, in part because of the reluctance of governments to order mandatory evacuations, as well as the unwillingness of many residents to leave their unprotected property. Evacuation will be an even greater challenge in many developing countries with poorly developed communications and public transportation systems. However, it can be done, as shown in Bangladesh, by successfully coupling early warning systems with mass evacuations to protective shelters, a measure that has already helped save many lives[30] (in sharp contrast to the inept response of the Myanmar government to the 2007 Cyclone Nargis[31] and in the United States to Katrina).

Land Use and Spatial Planning. The need to regulate land use and channel future growth to reduce exposure to flooding risk is self-evident. However, many Asian coastal cities at high risk either lack updated master or land use plans, or have produced them for only part of an urban area, much of which may be occupied by informal or unregulated settlements. Even if land use plans exist, they may have been prepared without consideration of the growing risks and vulnerabilities related to climate change, and as a result may actually be maladaptive and inadvertently promote exposure to climate risk.

While Asian urban governments differ among themselves in their regulatory powers and resources, most megacity governments in theory already have the necessary instruments to regulate land use through zoning, building codes, and ordinances. Unfortunately, implementation of land use plans often fails: the plans are too static for rapidly expanding cities in which much of the growth may be in the form of unregulated settlements; mixed land uses are the rule, not the exception; land registration lags; and land speculation is rampant. As one observer has concluded, "What the tools all have in common, with rare exception, is limited implementation."[32] Rather than enforcing existing land use regulation, urban governments may actually contribute to their violation: one critic has charged that in Jakarta, for example, 80 percent of building permits issued by government agencies for development of open spaces that were reserved to reduce flooding did not meet the official environmental standards.[33]

Instead of attempting conventional, detailed land use zoning, which has proven to be both expensive and ineffective, a "more appropriate and dynamic tool for developing countries" would be to focus on the location of major new infrastructure investments as the key to guiding private sector growth.[34] Given the acute shortage of infrastructure in most developing cities and the anticipated future surge in expenditure for urban infrastructure, it is imperative to locate any new infrastructure in low-hazard zones.[35] Unfortunately, it is likely that only after major disasters, if then, and in the face of opposition from vested interests will most cities confront the need to go even further in the form of "strategic retreat": relocating substantial parts of existing key infrastructure and settlements to safe ground, perhaps the only solution for long-term protection.

How to best 'mainstream' climate risk reduction into overall urban management and development remains a question

Controlling Land Subsidence. In many Asian coastal cities, control of groundwater withdrawal should be given high priority in order to reduce land subsidence and related flood risks. Bangkok has already banned groundwater pumping in the central city to help control subsidence, although legal and illegal pumping still occur on a large scale.[36] Jakarta has recently dramatically raised fees for groundwater extraction, especially for commercial usage and for wealthier residents, to help control subsidence, but with results as yet unknown.

Disaster Response and Relief. In the absence of effective risk-reduction measures, disaster response and relief become default coping mechanisms. In the case of major disasters, a large proportion of the relief aid will necessarily come from foreign countries. Unfortunately, this can result in promoting "moral hazard" by allowing the target government to avoid its own responsibilities for implementing risk-reduction measures that could prevent a disaster. Donor governments might reflect on the evidence that disaster risk reduction is "often more effective and cheaper than post-disaster relief and reconstruction" and adjust their policies on aid accordingly: for example, by investing more in development of necessary human resource and institutional capacities.[37]

Governance Structures and Capacities. Climate change will create new demands on urban governance structures and capacities. It is widely agreed that action to address climate-change risks and risk reduction will need to be placed in the overall context of urban planning and development rather than treated as a stand-alone issue or activity. How to best "mainstream" climate risk reduction into overall urban management and development, however, remains a question that will have different answers in different contexts. Nevertheless, it will universally involve coordination across a large number of sectoral agencies, interactions among discrete territorial governments, and collaboration among agencies at various levels: national, regional, and local. Sharing of experiences among governments that are addressing this issue, including those gained in large coastal cities both within the region[38] and in the OECD countries (e.g., Japan, Netherlands, and the United Kingdom), would be a step forward.

New York City's approach to developing a strategic planning process for adaptation to climate change may be instructive. Institutional components include the formation of a scientific panel on climate change to advise on climate-change prediction and impacts; a broadly based climate-change adaptation task force responsible for overall strategic planning; a governmental interagency task force to coordinate measures to protect essential infrastructure; and development of community-specific climate adaptation strategies for especially vulnerable neighborhoods.[39]

Enhanced scientific and managerial capacity to deal with climate risks at the city level is critical to effective governance. Urban planners urgently need to be trained in climate risk management, including risk and vulnerability analysis and its applications to planning and development. This priority recommendation emanating from the Cities at Risk workshop is echoed in a recent report of the UN International Strategy for Disaster Reduction, which stated that "it is paramount that risk reduction becomes part and parcel of urban planning"—a challenge for urban planning schools, which ordinarily do not include this topic in their curriculum, and for development assistance programs in training or retraining current urban planners and officials.[40]

Reducing the risk of large disasters depends on political leadership recognizing the growing threats of climate change

The Outlook

Unfortunately, there is a high likelihood of future flood disasters in Asia's coastal cities—disasters that will involve large losses of life and infrastructure, as well as damage to national and regional economies. Given the uncertainties involved in assessing future flood risks, many disasters will be unavoidable. In too many cases, however, these disasters will fall into the category of "predictable surprises," in which governments react to foreseeable events with seeming surprise despite having the information necessary to act beforehand. (Manila, for example, had at its disposal well-prepared risks and vulernability studies; the failure to prepare for the 2009 flood was one of governance.) The reasons for the failure to act are numerous, but in addition to lack of access to required resources may include difficulties in understanding risk probabilities and therefore unreasonable optimism in an ongoing gamble with nature; the short time horizon of many, if not most, political leaders; an undervaluing of future benefits and overvaluing of near-term benefits in considering development options; and uncoordinated, ineffective institutional arrangements for addressing coastal flooding risks and vulnerabilities.[41]

Reducing the risk of large disasters is possible, but difficult. It will require the thorough incorporation of climate risk management into urban planning and governance. This will depend in part on the scientific community providing improved urban-scale predictions of the magnitude, incidence, and extent of climate change–related risks, but also, more importantly, on political leadership recognizing the growing threats of climate change, developing a coherent strategy including appropriate institutional structures, and mobilizing the necessary resources to deal with climate change–related issues.

Notes

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[15] R.J. Nicholls, S. Hanson, C. Herweijer, N. Patmore, S. Hallegatte, J. Corfee-Morlot, J. Chateau, and R. Muir-Wood, "Ranking of the World's Cities Most Exposed to Coastal Flooding Today and in the Future," *OECD Environment Working Paper,* no. 1 [ENV/WKP(2007)1] (Organisation for Economic Co-operation and Development, Paris, 2007). A focus on these large megacities should not mask the fact that many other very large cities are also at risk; China alone will have 20 cities with more than 1 million people in its exposed coastal regions.

[16] The East-West Center co-organized and sponsored the Cities at Risk workshop held in Bangkok, February 2009. Co-organizers included START, Chulalongkorn University, Thailand, and Ibaraki University, Japan. Sponsors included ADB, World Bank, and JBIC. Major financial support was provided by Asian Pacific Network for Global Change and the International Council for Science.

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