



# Flood Controls in Southeast Asia

## August 2017

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## Executive Summary

As the nations of Southeast Asia underwent rapid economic and population growth from the latter part of the last century, they also experienced rapid change to their traditional ways of life. Among these changes, people and their governments lost their traditional connection with, and understanding of water.

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**In recent years, studies from NGOs have started to highlight the impact of climate change on the economies and people of Southeast Asia as well as to point out the fragility of the tropical ecosystem and the vulnerability of low lying coastal zones on which many of the cities were built. The estimated economic fallout from just small rises in average temperatures is substantial.**  
 .....

In many cases, the priority was in expanding city infrastructure and building homes for new residents. Rivers were often channeled into concrete drainage channels which all too often also served as waste disposal systems.

In recent years, studies from NGOs have started to highlight the impact of climate change on the economies and people of Southeast Asia as well as to point out the fragility of the tropical ecosystem and the vulnerability of low lying coastal zones on which many of the cities were built. The estimated economic fallout from just small rises in average temperatures is substantial.

Although global examples of cross-border approaches to flood control exist, Asean countries are at very different stages in their domestic implementation of effective water management systems. There are many interesting case studies for how government agencies have approached their local flood control challenges, using both natural methods and new technologies. Each scenario requires a systematic way of thinking that addresses the different stakeholders, considers the local context and history, and takes into account the possible future fallout from climate change.

A consistent message that came across from the 417 Southeast Asia respondents surveyed and interviewed for this study was that not enough was being done at a local or regional level to prepare for the impact of climate change. In particular, the main concern seems to be that dry periods are getting longer and rainfall, when it occurs, is getting heavier. Nearly 70 per cent of respondents were expecting climate change to impact the region in the next decade. If Southeast Asia is to be able to cope with the impact of the effects of rising sea levels and heavier precipitation, a lot more dialogue and understanding of the nature of the problem needs to take place. As interviewees also pointed out, governments need to ensure adequate levels of funding to build more proactive programmes, institutes and water management systems for defending the region against the impact of climate change. Or at least, they need to better communicate the initiatives they are working on.





**Chapter 1**  
The impact of climate change  
on Southeast Asia

# Chapter 1. The impact of climate change on Southeast Asia

**Visitors to Southeast Asia are always impressed by the intensity of the monsoon rainfall. As the water courses through jungle interiors and makes its way through farmland, kampongs and cities to the sea, it leaves an imprint on the culture of the people. The waterways have defined many aspects of the region.**

The territorial waters of Asean occupy about three times as large an area as the land coverage. Its rivers pour out into the Pacific Ocean, the Indian Ocean and the South China Sea. Over the centuries, the rivers, coastlines and wetlands of the region have provided the highways, harbours and resources that have supported the region's growth. Nomadic sea gypsies sail around the coastlines of different countries in the region making livings from their boats to this day.

## *Southeast Asia's close affinity to water in earlier centuries*

For hundreds of years, the region has attracted traders from other parts of Asia, in search of new commodities and markets, refilling their barrels at the many different ports of call. These sea traders brought merchandise, customs, religions and different cultures to the hunter gatherers who populated the region. The predictable monsoon winds brought them from distant shores in regular seasons over the centuries, and with them came economic and population growth. The dense jungle that formed much of the interior of Southeast Asia meant that population settlements were concentrated along the shorelines and rivers of the region which formed the highways for trade. Ancient settlements expanded and new settlements were formed, often around the low-lying paddy fields close to the rivers.

## *Transformation during the 20th Century*

Over time, pressure on the region's flora and fauna began to show. The old traditions of taking only what was needed to feed the family were replaced by the hunger for natural resources and the need to accommodate the arrival of new residents. New harbours were cut out of the protective barriers of coral reefs and mangrove. Much of the ancient forests, particularly in lowland areas, were cut down for the timber trade and to clear the land for agriculture or new commodities such as tea and rubber. The latter part of the 20th century saw big rises in population growth and urbanisation, further concentrating people in the overcrowded cities as they moved away from the farms. By the early stages of the current century, most Southeast Asian people lived in cities rather than the rural settlements of their parents and grandparents.

*From rural to urban in a generation*

Factory jobs replaced farm labour as the main source of work. The need to house thousands of new urban migrants took precedence over planning for adequate water and sewage supplies. Unpredictable weather patterns brought simultaneous floods and droughts to areas in close proximity. Rising sea levels started to encroach on arable land and city streets. It suddenly became clear that the islands and archipelagoes of Southeast Asia would suffer disproportionately from the effects of population growth and climate change.

Country	1980 urban	2015 urban	2050 urban
Vietnam	19%	35%	55%
Thailand	25%	50%	72%
The Philippines	36%	45%	55%
Indonesia	22%	52%	72%
Malaysia	42%	75%	85%
Singapore	100%	100%	100%

Source: Kelly, P.F. & McGee, T.G., CIA, McKinsey, ASEANUP

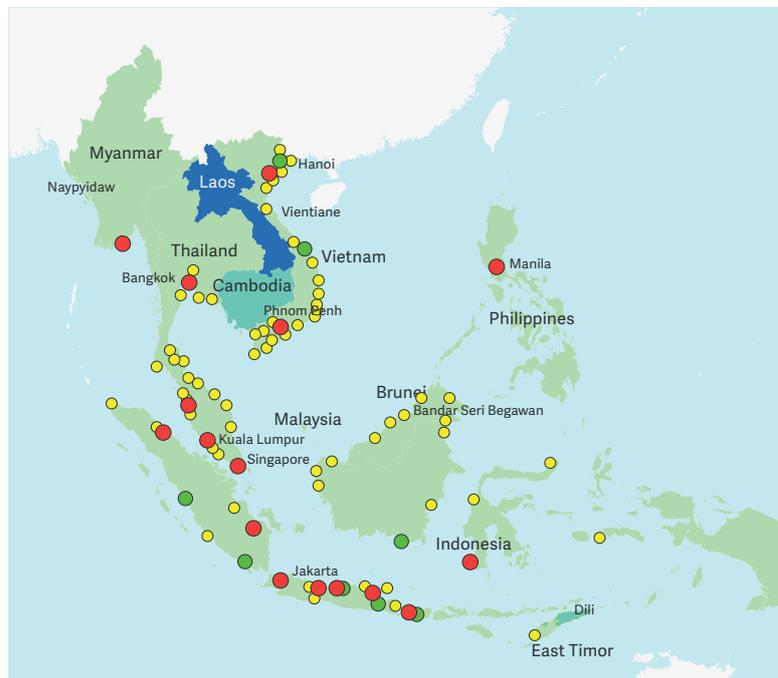
*Cities in low elevation coast zones in Southeast Asia*

**City size (population)**

- Small (100-500 thousand)
- Intermediate (500 thousand - 1 million)
- Big (More than 1 million)

**Percent of national urban population in low elevation coastal zones (LECZ) in Asia**

- Non LECZ
- 10.1-15.0
- >25.0



» Source: EastWest Centre

Compared with the rest of the region, Southeast Asia has a very large concentration of big cities located in low-elevation coast zones. This factor alone, without any change in the climate, has made it susceptible to regular damage and loss of life from flooding.

### *The evolution of society's interaction with water in Southeast Asia*

As the economies of Southeast Asia have grown, the interactions of their citizens with water has evolved. The more affluent cities of Singapore and Kuala Lumpur have reached the 'post industrialisation' phase in which they are now looking to re-establish their relationship with water and manage the impact of high tides and heavy precipitation in a more sustainable and proactive way. Some of the less affluent countries and lower-tier cities are still struggling in the initial industrialisation phase and are being forced into focusing on flood management as they grapple with the effects of climate change. And yet the region is still lacking in any overall system for addressing the water challenges that lie ahead.

#### *Early 20th Century*

##### **TRADING FARMING AND FISHING ECONOMIC PHASE**

- River and coastal highways as transport links to interiors
- Source of food and fresh water
- Hubs for settlement and trade
- Connection between cultures, water and the forces of nature

#### *Latter 20th Century*

##### **INITIAL INDUSTRIALISATION CHANNELING PHASE**

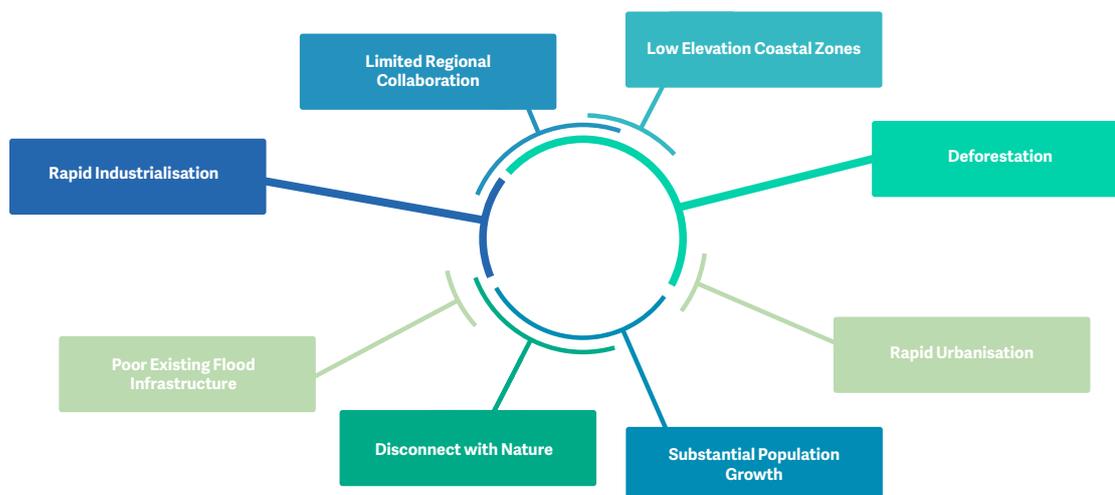
- Rapid urbanisation and population growth contain, control and channel the path of waterways
- Waterways as human and industrial waste extractors
- Frequent floods recognised as a part of life in many areas
- Disconnect between cultures, water and the forces of nature

#### *Latter 20th Century*

##### **POST INDUSTRIALISATION RETROFITTING PHASE**

- Water as a centre for leisure or social interaction
- Waterways re-designed and 'beautified' with vegetation artificially re-introduced
- Flood controls retrofitted into urban areas
- Urban reconnection with water as a social catalyst

» Source: *Eco-Business Research, interviews*



» Source: Eco-Business Research, ASEANUP, Butler, R., CIA, EastWest Centre, Kelly, P.F. & McGee, T.G., McKinsey, Szudy, M.,

Area	Impact
<b>Low elevation coastal zones</b>	Over 80 Asean cities and more than 25% of the population of most member states are in low-elevation coastal zones
<b>Deforestation</b>	The Asean 5 countries (Indonesia, Malaysia, Singapore, Thailand, The Philippines), have lost an average of 8% of their forests from 2005-2014 <sup>1</sup>
<b>Urbanisation and industrialisation</b>	The average Asean country (except Singapore) went from 29% urbanisation rate to 51% from 1980 to 2015
<b>Population growth</b>	Southeast Asia's population more than tripled in size from 197m in 1957 to 647m in 2017 <sup>2</sup>
<b>Disconnect with nature and industrialisation</b>	Once a major employer, the agriculture sector has dropped significantly to account for an average of only 33% of jobs in Asean countries less Singapore in 2012 <sup>3</sup>

Source: Eco-Business Research, ASEANUP, Butler, R., CIA, EastWest Centre, Kelly, P.F. & McGee, T.G., McKinsey, Szudy, M.

### Core factors that put Southeast Asia at risk from climate change

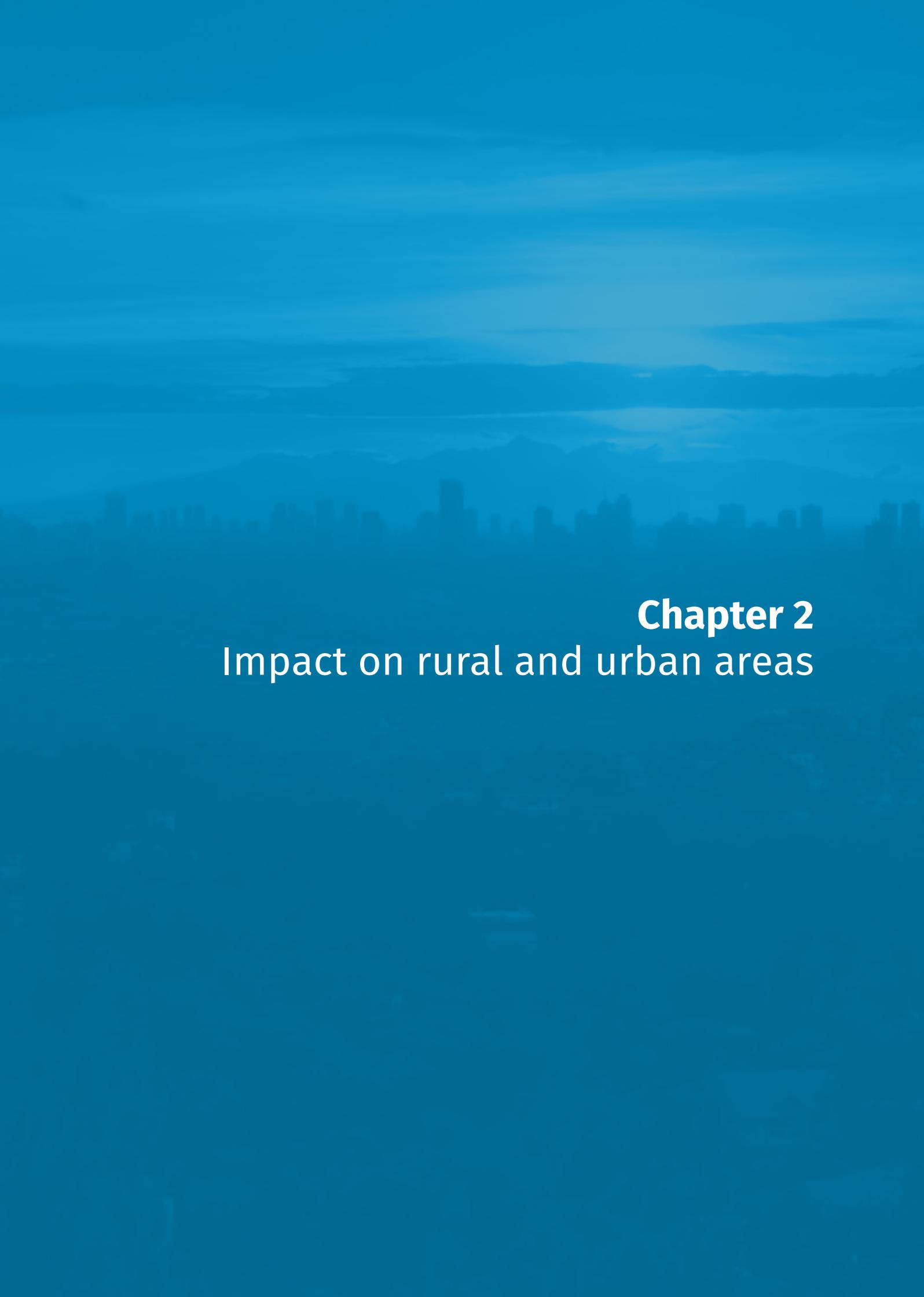
Different parts of the world are facing a different impact of climate change. The people of Southeast Asia are particularly susceptible to the effects of flooding due to the geography of the region and the rapid growth of their economies and populations in recent decades.

» <sup>1</sup>Butler, R., Deforestation rates., [http://rainforests.mongabay.com/deforestation\\_alpha.html](http://rainforests.mongabay.com/deforestation_alpha.html)

» <sup>2</sup>Worldometer: <http://www.worldometers.info/world-population/south-eastern-asia-population/>

» <sup>3</sup>Szudy, M., "Agriculture in the Southeast Asian countries under Globalization"





**Chapter 2**  
Impact on rural and urban areas

# Chapter 2. Impact on rural and urban areas

**Climate change and in particular rising global temperatures are estimated to impact both sea levels and precipitation intensity. A climate model study by the Massachusetts Institute of Technology (MIT) and researchers from the Swiss Federal Institute of Technology found that with every 1°C rise in temperature, the moisture-carrying capacity of the air rises by 7 per cent. This means that rainfall becomes heavier and potentially more damaging.**

.....  
**“There’s a huge mismatch or gap between decision makers’ belief in sustainability projects and their level of commitment and investment. Green entrepreneurial education, training, and action are needed at an individual, organisational, national, and global level.”**  
.....

Soroush Moeinzadeh,  
Supply Chain Sustainability  
Consultant, Kuala Lumpur,  
interviewed for this paper

Sea levels are also likely to rise with global temperatures further compounding the issue. UN-Habitat, a United Nations programme promoting sustainable human settlements, describes the direct effects of a sea-level rise to include storm flooding and damage, coastal erosion, increased salinity in estuaries and coastal aquifers, rising coastal water tables and obstructed drainage. It also points out a number of indirect impacts such as changes to coastal eco-systems and the distribution of bottom sediment on the sea bed.

The studies indicate that increases in temperature would create severe problems for tropical regions such as Southeast Asia. The expectation is for as much as a 25 per cent increase in the rate of catastrophic precipitation. As the table below shows, the region already suffers very high rates of rainfall and flooding, and so an increase of this size would have devastating consequences if governments do not take early defensive measures.

In a report entitled, “Southeast Asia and the Economics of Global Climate Stabilisation”, the Asian Development Bank (ADB) concluded that Southeast Asia is particularly vulnerable if no action is taken to address climate change, and may lose up to 11 per cent of gross domestic product (GDP) by 2100. OECD estimates that some of Asean’s most exposed cities stand to lose up to US\$2,847 billion in combined assets by the 2070s, mostly through floods and rising sea levels.

*Future exposed assets and populations in Southeast Asia cities*

Country	City	Future exposed population by the 2070's (000)	Future exposed assets by the 2070s (US\$b)
Indonesia	Jakarta	2,248	321
Indonesia	Palembang	561	80
Indonesia	Surabaya	327	47
Indonesia	Ujung Pandang	34	5
Malaysia	Kuala Lumpur	295	84
The Philippines	Manila	545	130
The Philippines	Davao	11	56
Singapore	Singapore	29	21
Thailand	Bangkok	5,138	1,118
Vietnam	Hanoi	4,711	334
Vietnam	Ho Chi Minh	9,216	653
<b>Total</b>		<b>23,115</b>	<b>2,847</b>

» Source: OECD, Nicholls R et al

Considering the weather patterns and impact of flooding in the current decade, these figures actually seem conservative. Asean countries have been badly affected by flooding either through monsoon rains or through typhoons every year of the decade. The more severe floods have impacted multiple countries at the same time, causing problems for relief work.

*Future exposed assets and populations in Southeast Asia cities*

Country	2010	2011	2012	2013	2014	2015	2016
Indonesia	1	1	2	2	1	1	1
Malaysia	1	1	0	0	1	0	1
Thailand	1	3	0	2	2	0	1
The Philippines	2	4	6	6	6	3	3
Vietnam	2	2	3	4	2	0	2
<b>Total</b>	<b>7</b>	<b>11</b>	<b>11</b>	<b>14</b>	<b>12</b>	<b>4</b>	<b>8</b>

» Source: Relief web, Eco-Business

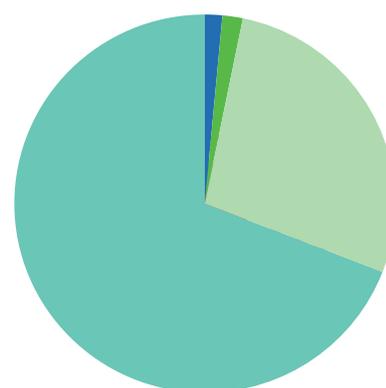
To assess the likelihood in a rise of temperatures and climate change, Eco-Business Research undertook a survey of regional opinion leaders in June 2017. The results show a high level of awareness of the potential catastrophic effects of climate change on the region as well as a high level of concern about whether governments have the full resources to tackle the problems.

The full results are in the appendix to this report. Some of the key points include:

- 84 per cent of respondents agreed that there had been “significant changes to the weather and climate in recent years”,
- 80 per cent of respondents agreed that average temperatures had become hotter
- 51 per cent of respondents indicated that storms or typhoons had become more severe.
- 43 per cent agreed that rainfall had become higher
- 69 per cent of respondents agreed with the statement “we will encounter significantly more extreme weather or climate conditions in the next decade”.

**Do you believe the weather or climate in your country of residence will show more extreme patterns in the next decade?**

- Don't know (1.7%)
- No (2.2%)
- Maybe (27.3%)
- Yes (68.8%)

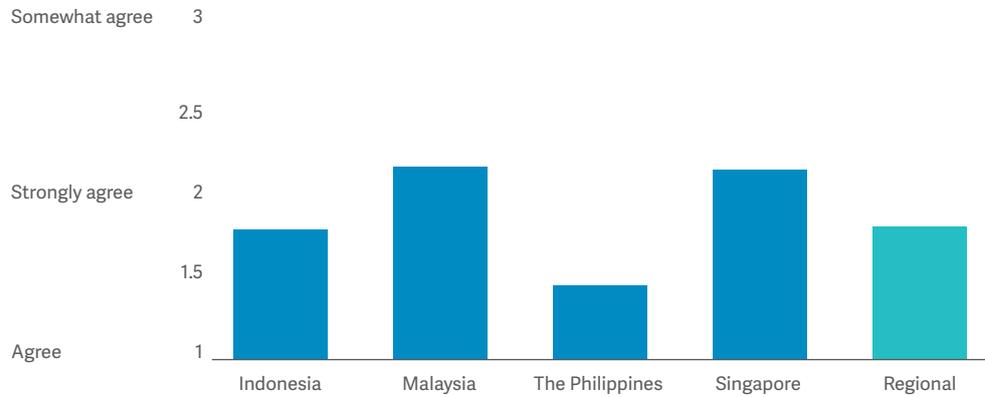


» Source: Eco-Business Research, interviews

This is a particular cause for concern given the high levels of flooding brought about through current weather patterns and the struggle that most Southeast Asian nations have in dealing with them. Most respondents in all countries also indicated concerns as to whether their country was adequately prepared to deal with the effects of climate change in terms of expertise, budget allocation and Asean level collaboration.

All respondents from Southeast Asia were worried about the impact of climate change on their local economies with respondents from The Philippines, a veteran sufferer from the typhoon season, showing the biggest concerns.

**The Philippines fears it has the most to lose from extreme weather events and climate change**

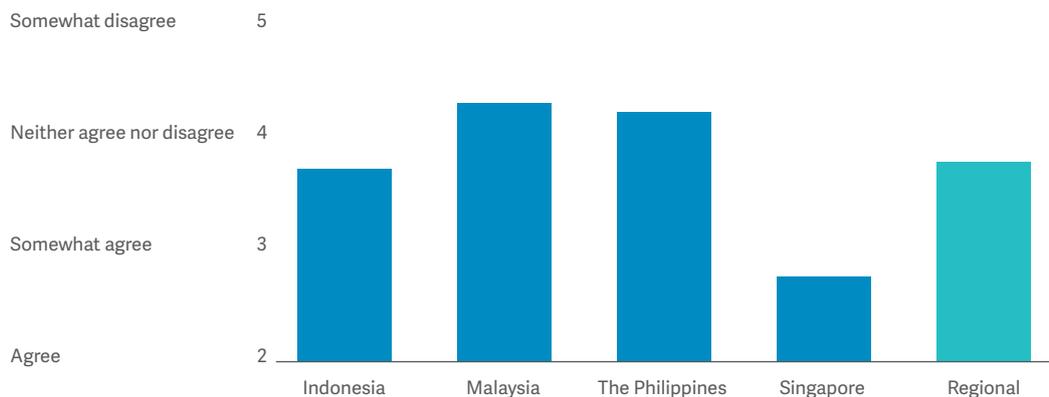


Weighted responses to the question "Extreme weather events and climate change could have a significant impact on our local economy"

» *Eco-Business Research survey of 417 respondents in Southeast Asia*

Regionally, the average respondents were concerned about whether urban planning in their country had adequately factored in the impact of extreme weather and climate conditions. Respondents from Malaysia and the Philippines showed the most and for other questions that asked whether their countries had sufficient in-house expertise and a good strategy in place. Respondents from Indonesia showed the highest level of concern for the statement "My government has allocated sufficient resources and funding to plan for extreme weather events and climate conditions". As one respondent from Indonesia, a director of a forestry government agency said: "Working with related stakeholders, the government has developed plans to deal with climate change impacts, but (lacks) adequate funding for communities to mitigate the impact. Climate change is a very complicated matter which needs integration (at) almost every step"

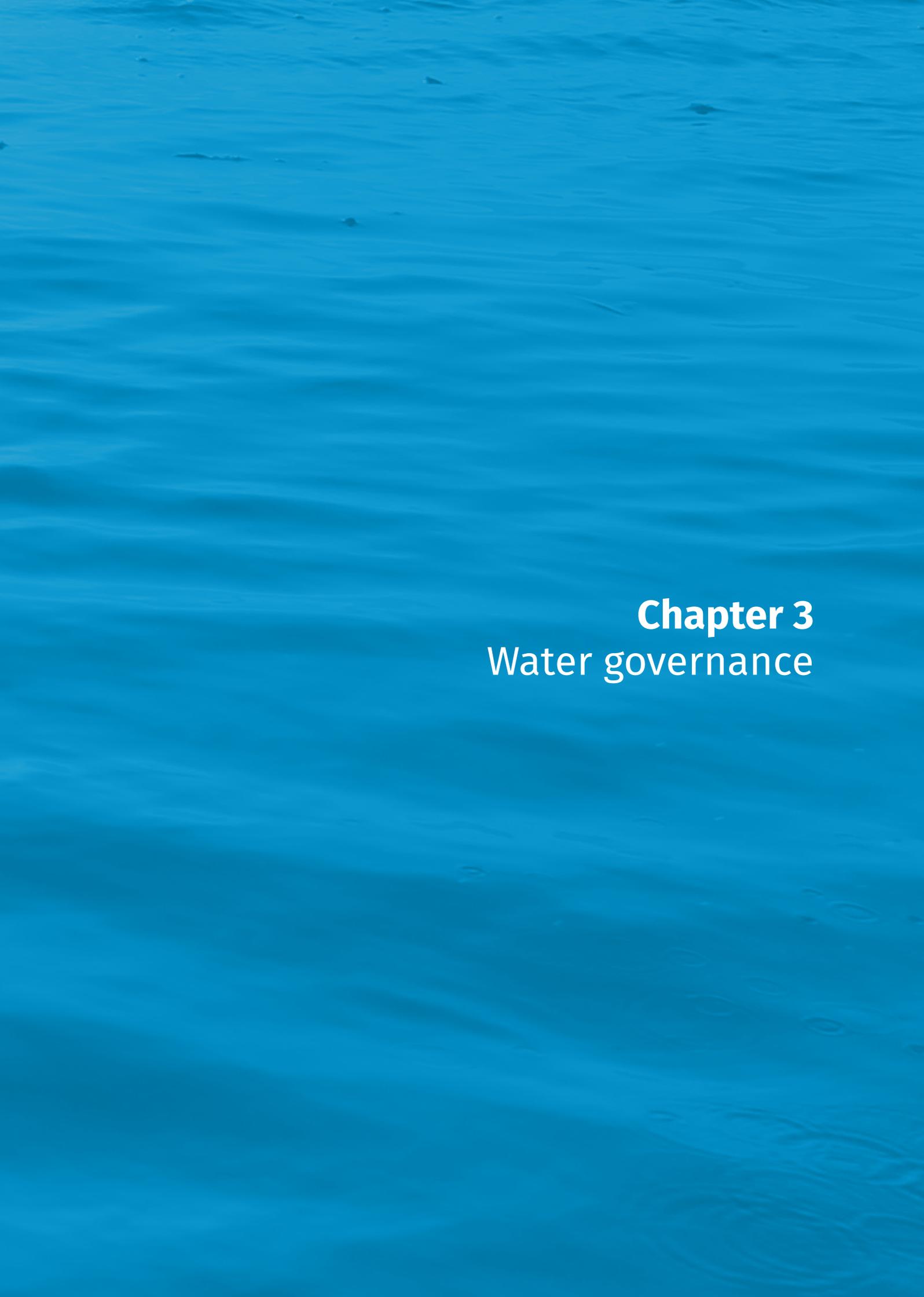
**Most respondents are not entirely confident that their countries have got the right plans in place**



Weighted responses to the question: "Urban planning in my country adequately factors in the impact of extreme weather events and climate conditions"

» *Eco-Business Research survey of 416 respondents in Southeast Asia*



The background of the entire page is a vibrant blue color with a subtle, natural texture of water ripples. The ripples are soft and organic, creating a sense of movement and depth. The color is a consistent, bright blue throughout.

## **Chapter 3**

### Water governance

# Chapter 3. Water governance

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**“The issues that we face have become increasingly complex, a number of them are even trans-national... And many of them require inter-agency, whole-of-government responses in terms of integrated planning right from the start and effective implementation subsequently... We’ve also had to build connections and networks across geographical boundaries with neighbouring countries (and) strengthen collaboration across ministries and agencies so we can work towards an integrated outcome”**

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Desmond Kuek, former Permanent Secretary MEWR 2010-2012

*Most governments around the world have a natural focus on the promises of their political manifestos, which often include short term plans. Of course, political leaders also face limited funding as well as conflicting and changing priorities. One of the common comments from respondents to the survey was that in many countries there was a lack of coordination between government officials, for instance from ministers to local government officials and between different agencies. It was felt that each different layer or department of government had its own agenda and goals, and there would often be a lack of coordination as a result.*

As UN-Habitat has suggested, land planning for areas such as residential zones and highways is usually done using historic climate data rather than projected conditions. The cost of land and the political risk of changing the designation of use often means that infrastructure such as ports, airports, water sanitation facilities and power plants are sited in vulnerable locations.

*Asean studies on flood management by other multilateral institute*

The East-West Centre, a US-funded institute for public diplomacy in Asia Pacific, mentions that the World Bank, the Asian Development Bank and the Japan Bank for International Cooperation have collaborated on a series of studies to evaluate the impact of climate change in Southeast Asia, looking particularly at cities that are likely to suffer flooding such as Ho Chi Minh, Jakarta, Bangkok and Manila. These studies have considered the risk assessment and economic impact of climate change-related events such

as flooding and rising sea level with a view to highlighting these issues to local governments and businesses. Unfortunately, studies of this nature seem to be primarily undertaken by global NGOs. There does not seem to be much interest, awareness or funding for similar assessments at a local level or indeed for a regional approach to something like flood management.

This is perhaps due to the complexity for governments in dealing with weather-related issues even at just the national level. Plus Asean models itself as more of an advisory than a regulatory institute, so its effectiveness at tackling regional weather-related challenges is limited.

*Asean’s Integrated Water Resources Management provides country guidelines*

Asean has established the Asean Working Group on Water Resources Management to enhance regional cooperation on freshwater management. This group has developed some useful initiatives and frameworks for member states. For instance, the Asean Integrated Water Resources Management (IWRM) country strategy guidelines. Each Asean country has a self-appraised performance report on the website which looks at various indicators such as flood, stormwater, irrigation, pollution and sanitation management and considers progress for each parameter. As with any data looking at the performance levels of different Asean countries, what is immediately obvious from these reports is the different types of challenges that each of the countries face and their very different stages of managing those challenges. Across the region are examples of internationally recognised best-in-class solutions located close to neighbouring ‘works in progress’.

Although Asean lacks the funding and regulatory systems of the longer established European Union (EU), it is interesting to consider the frameworks put together by the latter institute for member states.

#### *Using the EU experience for developing framework for flood management*

For instance the EU Flood Directive requires member states to establish flood risk management plans focused on prevention, protection and preparedness. This applies to inland waters as well as all coastal waters across the whole territory of the EU with all assessments, maps and plans available to the public for independent scrutiny. Cross-border considerations were incorporated into the directive to ensure that defensive measures did not increase flood risk in neighbouring countries. Member states were required to take into consideration long term developments, including climate change, as well as sustainable land use practices.

The framework thinking behind the EU directive could equally be used in Southeast Asia. In particular the concept of prevention, protection, preparedness, emergency response and recovery and lessons learned, which the EU elaborates as:

Prevention: preventing damage caused by floods by avoiding the construction of houses and industries in present and future flood-prone areas; by adapting future developments to the risk of flooding; and by promoting appropriate land-use, agricultural and forestry practices;

- Protection: taking measures, both structural and non-structural, to reduce the likelihood of floods and/or the impact of floods in a specific location;
- Preparedness: informing the population about flood risks and what to do in the event of a flood;
- Emergency response: developing emergency response plans in the case of a flood;
- Recovery and lessons learned: returning to normal conditions as soon as possible and mitigat-

ing both the social and economic impacts on the affected population.

» Source: European Union

A regional framework is being planned for Asean, and in many instances governments have, at a local level, implemented some creative methods for prevention and protection as well as established informal dialogues with counterparts from other member states to share best practices. As some of the examples in the next chapter show, the earlier large infrastructure methods are now also being refined with natural methods as well as new technologies. The case studies also show the complexity of managing floods at the national level.

As well as budget constraints, there are lots of new technologies or systems available, each requiring a customised application. In most cases, a large number of diverse stakeholders are impacted by the necessity to retrofit cities or rural areas to cope with changing circumstances. This also requires the enactment of new laws and regulations for businesses and citizens. And this is just at the local level. Ideally Asean member states should be considering cross-border initiatives and regional standards. And once this has all been addressed, regional and national government agencies have an ongoing task of educating stakeholders about what has been done, why it was done and how people and businesses can contribute through behavioural and operational changes.



The background image is a blue-tinted photograph of an industrial facility. On the left, a tall, slender white chimney rises from a multi-story building. The building has several windows and a flat roof. In the foreground, there is a large, circular structure with a glass facade, possibly a water treatment tank or a large storage tank, situated near a body of water. The water is calm, and the sky is a clear, light blue with some faint clouds. The overall scene is industrial and modern.

## **Chapter 4**

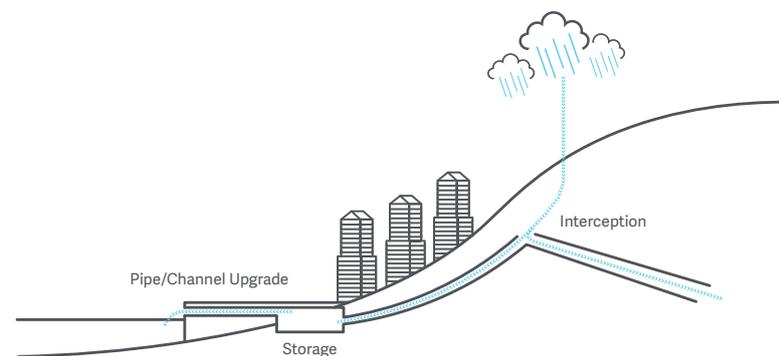
# Technologies and systems to manage water

# Chapter 4. Technologies and systems to manage water

**Using the EU Flood Directive framework, the idea of prevention and protection is an obvious task for governments. There are many examples from the region that show how government planners have adapted their local situation to prevent floods and protect their citizens.**

## *Intercepting heavy rain in Hong Kong*

For instance, the first approach to manage heavy precipitation is to use natural methods of diverting, storing or channeling the water supply. The illustration below from the Drainage Services Department from Hong Kong shows the strategy of interception, storage and pipe or channel systems that was put in place after heavy rainfall in the 1990s caused flooding in the central business district. This has been attributed to reducing the number of flooding blackspots in the Special Administrative Region from 90 in 1995 to seven today.



» *Hong Kong's 3-pronged approach to flood prevention*

## *Singapore's "source-pathway-receptor" model for managing stormwater*

Singapore received a similar wake-up call when its legacy stormwater infrastructure was overwhelmed by a short period of intense rain on one day in 2011 that flooded its central shopping precinct, Orchard Road. The solution that was put in place was somewhat similar to the Hong Kong format. Ng Joo Hee, the Chief Executive Officer of the Public Utilities Board, now known as PUB, referred to it as the "source-pathway-receptor" approach. Hence upstream areas would have built in 'run-off' areas (the source) which might include detention tanks or rain gardens and bioretention swales, which are landscape systems designed to partially treat water quality. The pathways were the drains and canals which were enlarged to accommodate increased water intensity. The receptor areas might be built higher to withstand rising stormwater levels, or have flood barriers designed in. Much of the stormwater is then harvested for freshwater consumption.

### *Retrofitting cities to cope with new demands for stormwater*

Both the Singapore and Hong Kong examples showed how a rethink was urgently needed in order to change how stormwater is managed. In both city-states, the existing infrastructure and regulatory system had become redundant due to population and building growth (which prevented upstream rainfall from being absorbed by the land) as well as incidences of higher intensity rainfall. In order to fully understand the impact on various stakeholders, both cities put together expert panels of advisors consisting of members from academia, professional bodies, private and public sectors, with fields of expertise in civil and hydraulic engineering, flood control and climate. The stakeholder engagement process, to educate businesses, the construction sector and the general public about the new hard and soft systems in place to address flooding is an ongoing task that both city states have allocated resources for.

### *Society's changing relationship with waterways*

One of the main problems that has led to flooding, apart from shifts in weather patterns, is the changing interaction that Southeast Asian has with natural waterways as it evolves. This point was raised in Chapter 1 of this paper in the diagram "The evolution of society's interaction with water," and has also been the subject of academic research. For instance a recent study by Augusta Hermida from the University of Cuenca has shown how different generations related differently to the River Tomebamba in Cuenca, Ecuador. The study found that perceptions have evolved over the generations primarily through the changing uses and demands that society has placed on the river. Earlier generations enjoyed a more direct interaction with the river for commerce and swimming, whereas the current generation seems to restrict itself largely to social meetings on the banks of the river.

### *Bringing the Klang River back into the life of Kuala Lumpur*

Much the same change in human interaction with waterways has been taking place in Southeast Asia, although the social interaction phase seems in some cases to have been neglected. Kuala Lumpur means 'muddy confluence' in English as it was founded on the meeting point of the Klang and Gombak Rivers. As the city grew, the Klang River was diverted into a series of concrete channels to manage the erosion force of monsoon rains. The backs of buildings were positioned to face the river, making it a dumping ground that was disconnected from people's daily lives. Pollution

and flooding followed. To rebuild the lost connection between the city, river and the people, Kuala Lumpur City Hall launched the US\$1.3 billion River of Life project in 2012, which involved cleaning and beautifying the waterways. As monsoon surges still need to be controlled, water levels have been managed through the construction of inflatable rubber dams and by adding storage capacity through flood mitigation ponds.

### *Rebuilding mangrove and bamboo to protect a freshwater lake in The Philippines*

The Philippine government is also looking to use more natural methods to manage water supplies and control floods by replanting mangrove and bamboo on the shoreline of the Laguna de Bay, a freshwater lake to the east of Metro Manila. Regional officers of the Philippine Department of Environment and Natural Resources (DENR) started the process with a large public engagement meeting to better understand the needs of the farmers, fishermen and residents surrounding the lake. The event quickly reached capacity with latecomers listening through open windows outside. Eusebio Jacinto, an officer from DENR) explained: "Our plan is to plant 1.6 million hectares of bamboo, and 600,000 hectares of mangrove. We've got to find better ways to keep pollution and sediments from getting into the lake and rivers." By slowing erosion and absorbing nutrient pollution, Jacinto says, siltation should diminish, Laguna de Bay's water will get cleaner, and its capacity to store floodwater should improve. Bamboo and mangroves are native to the Philippines and well regarded as soil stabilisers and nutrient sponges. As with the Klang River, earlier infrastructure installations with drainage canals, pumping stations, treatment plants, and other hard fixes made of concrete and steel were struggling to keep up with the growth in population and storm intensity.



» Eusebio Jacinto of the Philippine Department of Environment and Natural Resources displays a bamboo planting intended to help fix Laguna de Bay's problems with erosion and sedimentation. Image: Keith Schneider via Citiscope

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**“Flooding is the main problem in many areas in Jakarta, and one of them is Poglar, where flooding is a common issue because of high tides. It is not easily overcome due to geographical conditions. Therefore, one of the strategic programmes of the Government of Indonesia is to minimise flood damage through integrated water resource management.”**

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Toni Sudarsono, Field Supervisor, Water Resources Management, Public Works Department, Jakarta.

#### *Using technology for low lying coastal areas in Indonesia*

As the example from Manila shows, coastal towns in low-lying areas face multiple challenges in managing high tides, preserving freshwater supplies and reducing collateral damage after heavy rainfall. In West Jakarta, high tides combined with the outfall from the Angke river frequently flood the area of Poglar. To minimise the damage from this, the Public Works Department of Jakarta has installed a pump gate which consists of a floodgate on an existing waterway equipped with pumps. This removes the need for a separate floodgate, pumping station and reservoir, all of which consume land and resources. The floodgate and screen can be opened to discharge the retained water by gravity flow. If the water level outside the floodgate gets higher, the pump gate can be closed to block back flow. Once the retained water reaches a certain level, the pump starts operating to forcibly discharge the retained water. <sup>4</sup>

#### *Smart uses of technology for managing water*

A recent study of rainfall incidence around the Sungai Selangor Dam and Sungai Tinggi Dam in Malaysia using rain animation software showed that much of the rainfall was missing the dam catchment areas. According to Mansor Ghani from the Malaysian Water Association, a far higher rate of rainfall incidences has been achieved further downstream in the form of stormwater that can be stored in lakes, ponds or off-river storage systems. Hence this is causing a re-think for water resources infrastructure to ensure adequate funding for downstream storage mechanisms.

#### *Customised and integrated solutions*

Perhaps the key takeaway from these examples is that each scenario for flood control and water management comes with its own contextual issues and usually requires a tailored approach. This could come purely from natural methods such as rebuilding defensive mangroves or constructing storage ponds. Alternatively, pump technology is going to be an important component for low-lying tidal estuaries to manage water flows. Again, a customised solution is needed for every installation. Waters from muddy, perhaps polluted confluences such as the ones described in the Kuala Lumpur case study above, will require different pump capabilities to those operating in sea water barrages or freshwater lakes. Government agencies then need to consider the ongoing operations and maintenance

of this equipment and the power that it consumes. The process should preferably start early (before the issue becomes a problem) and consider the future impact of water levels that are higher than current historic records.

#### *Real-time data on stormwater*

At the 2016 Eco-Business Smart Water Roundtable in Singapore, one of the discussion topics was how to better manage and integrate existing technologies such as sensors, rainfall measurements, automation technologies, data analytics and the industrial internet of things to create a smart water grid. These technologies are currently being used to provide real time data accessible through the website of the PUB, concerned office workers can check on the stormwater level of drains near their residence during storms, and even subscribe to SMS alerts in case of rising waters. The vision was to have a system that operates with minimal power consumption to proactively manage the supply and demand of water in a way that transforms the habits of the consumer and industrial user. The consensus from the delegates, which included representatives from PUB and Economic Development Board of Singapore as well as private sector executives from co-hosts ABB and other organisations, was that there were many opportunities to more efficiently manage and control water.

#### *Software modelling to assess river systems*

The private sector already offers a number of technologies aimed at reducing the impact of floods. For instance, DHI, an engineering consultancy headquartered in Denmark, offers a software-based approach for modelling water solutions that considers the effect of rainfall, groundwater, surface water and seawater, as well as health risks in connection with flooding or contamination when designing an urban approach to water management. Terry Van Kalken, Head of Water Resources Department for DHI Water & Environment said that this type of modelling software was being used to assess several river systems in Southeast Asia in order to plan for flood controls, particularly for incidences of high intensity rainfall, which seem to be getting more prevalent according to survey respondents.

Perhaps part of the problem in the roll out and adoption of these technologies at both a national and regional level is that the management of water and flood controls is seen as the responsibility of government, similar to defence or building roads. So the general public are

looking to the government to provide the solutions rather than drive change from the ground up. Further to this, most of the case studies outlined above were implemented as a reaction to an existing problem, rather than as part of a longer term strategy to manage the impact of climate change. Several respondents commented that despite higher levels of public awareness on the impact of climate change, there was insufficient action taken at the consumer level.

This is particularly the case for controlling floods that occur occasionally in areas that have been developed without due consideration for the environment or adequate risk assessment. Some respondents complained that not enough was being done at the initial design phase of urban planning to factor in natural methods for cooling and managing water.

It would seem prudent to incorporate a more robust flood and water management appraisal system into all forms of land use in the region. This would look at the problem from different perspectives and consider the impact of higher levels of precipitation and sea levels in the not too distant future. A basic example below looks at the historical context of the situation as well as the upstream and downstream impact and the scenario of increased flooding through climate change before software modelling systems are implemented.



» Flood modeling software

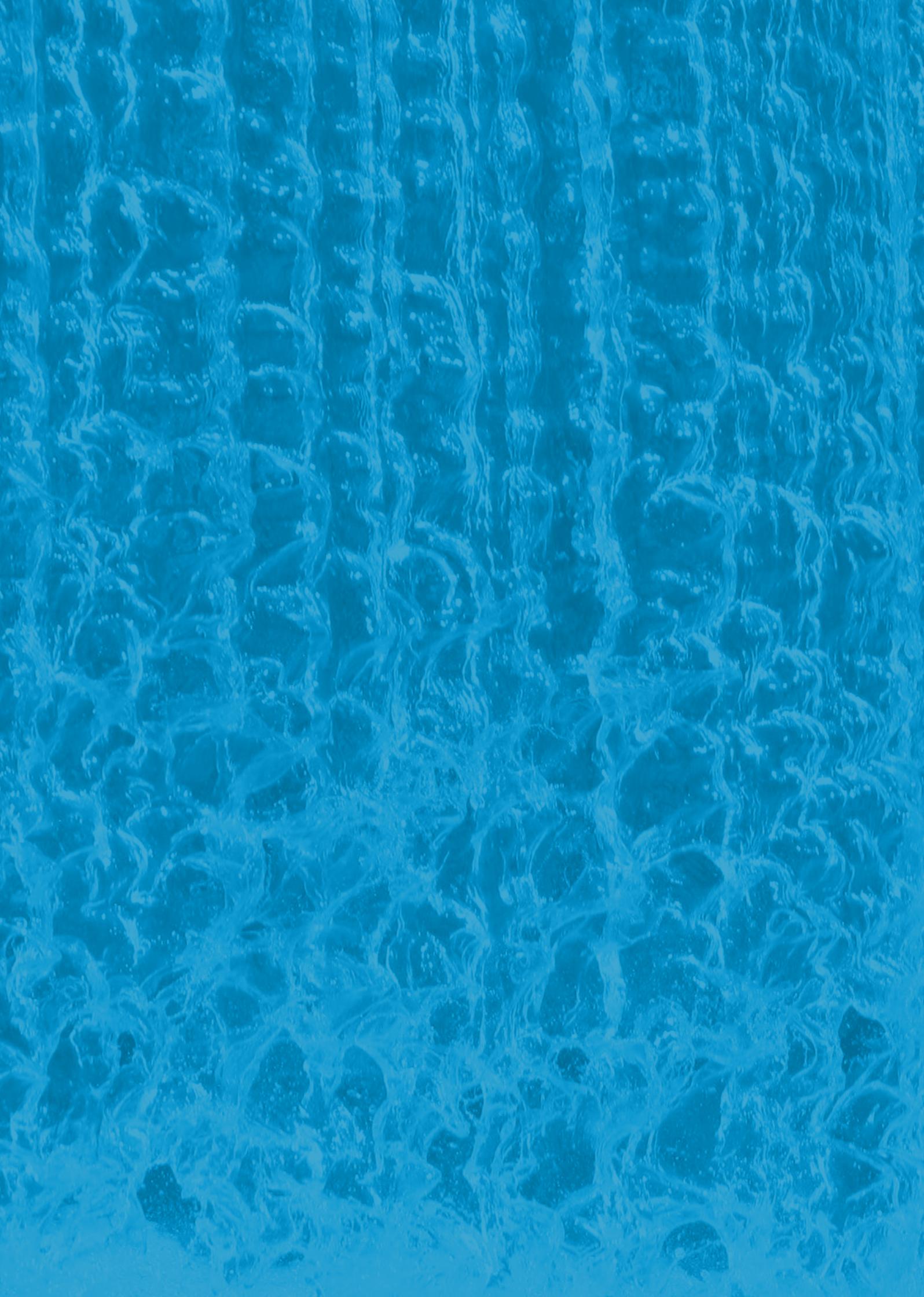
**Framework for assessing options for flood control in rural area**

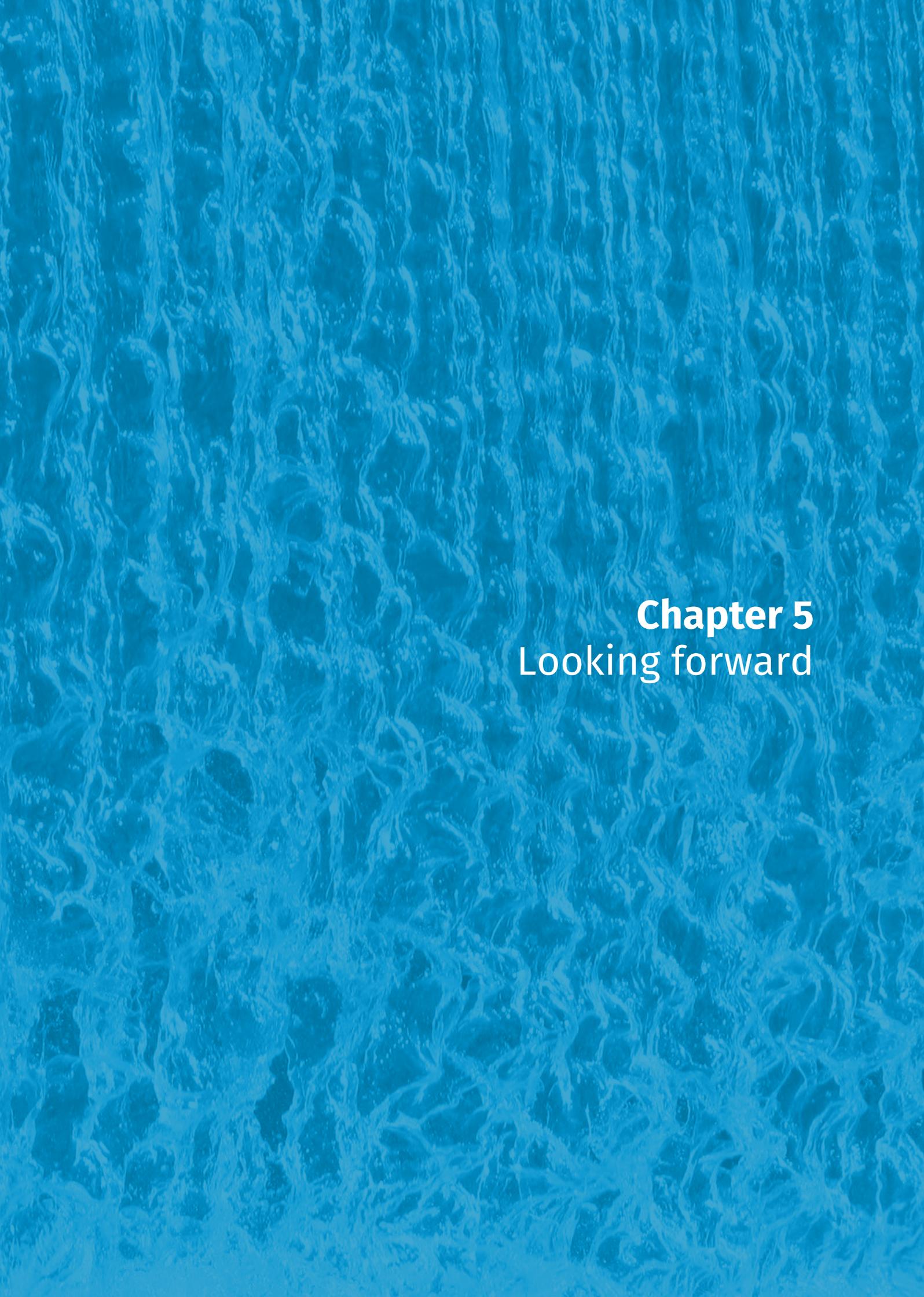
As the example above shows, a simple appraisal of a flood incident in a rural area has pinpointed some of the rectification work that can be done upstream. It also highlighted a potentially greater impact on town dwellers downstream if the situation intensifies. However, this is just an outline and can only be used for a quick appraisal of the many stakeholders involved for the first stage of the planning process.

	Define the issue	Historical context	Current economic impact	Future impact	Options and considerations
<b>Centre of interest</b>	e.g. river flooding a roadway during monsoon period	Former arable land upstream from a large coastal town	Seasonal inconvenience to traffic and occasional residential impact	15-25% heavier precipitation would destroy the road and surrounding houses	Building the road higher
<b>Stakeholders involves</b>	Road users linking coastal towns and nearby residents, suburban dwellers	Kampong built to withstand minor flooding, small number of residents	Currently minor residential flooding which residents have become accustomed to managing	Likely bigger suburban community	Town dwellers downstream will be most impacted
<b>Upstream considerations</b>	Arable and mixed residential, greater water run off	Previously forested, larger amounts of water retained	More waste refuse gets channeled down with monsoon rains	Likely more run off with greater upstream building density	Replanting trees. Building more was infrastructure. Education in waste disposal
<b>Downstream considerations</b>	Further downstream flooding	River moved into wider estuary	River constrained by bridge linking east and west sides of town with further pollution and waste dumping	Possible big structural damage to town	Catchment ponds, river widening. Pump system for high tides. Education in waste disposal

» Source: Eco-Business Research, interviews

» <http://www.grundfos.com/cases/fjnd-case/pump-gate-an-innovative-solution-to-flood-control-in-densely-populated-areas-poglar-indonesia.html>





**Chapter 5**  
Looking forward

# Chapter 5. Looking Forward

**Awareness of the likely impact of rising sea water levels and higher rainfall patterns seems to be gaining traction in Southeast Asia. The economic and human impact on the region's many cities that occupy low-elevation coastal zones has been estimated to be substantial. And yet the region as a whole still seems to be reactive, rather than proactive in its approach to flood control. Certainly the respondents to this survey were concerned about whether their countries had the right level of planning and investment needed to take on the climate of the future. Asean has put together some thinking, guidelines and a regional performance system to tackle the issue, but is unlikely to take on the role of a regional regulatory body at this stage simply because it does not have the mandate for this from member countries.**

There seems to be a general feeling that it is the responsibility of governments to manage water supplies. Many of the people surveyed for this study were concerned about whether their governments had adequate expertise, resources and plans in place to cope with the impact flooding in the future. And yet many interviewees also mentioned interesting case studies that showed high levels of planning and preparation for flooding from government agencies. Perhaps many of these initiatives are not getting communicated adequately to the general public. Respondents tended to agree that although in many cases disaster preparation programmes were often in place, the softer aspects of flood control infrastructure, such as skills development and financial systems were not always being planned adequately.

Governments in many cases are also keen to involve communities and re-establish their lost relationship with and respect for their water supplies and ecosystems. There do seem to be a number of effective outreach programmes initiated by various government agencies in the region, and yet the habits of citizens and businesses are not changing at a fast enough rate. One of the ways that all Asean member states can help to build greater water awareness from their citizens is by ensuring that schools are more actively involved. History classes can show how the region has evolved with its use of water. Geography and science classes could be revised to ensure a greater understanding of health of water systems and how the problems they face might be exacerbated through climate change. Mathematics and economics teachers can help children to understand the economic impact of climate change and poor water management.

As suggested by some of the people interviewed for this study, governments need to ensure that there is a unified national policy for flood control which permeates all agencies and different levels of hierarchy,

transcending different departmental agendas. As the case studies from Hong Kong and Singapore suggested, committees to look at issues of flood control then need to be drawn from multiple sectors such as the private sector, climate change experts, geography experts, trade associations and regulators in order to put together a cohesive and lasting approach.

At higher levels of education, academic institutes that study both the historical, human and scientific aspects of climate change and flood management need to ensure that they are engaged deeply with governments and solution providers.

Private sector companies that are users of water or developers of land or urban infrastructure need to ensure they are at the forefront of the dialogue on climate change and flood control in their areas of operation, rather than just reacting to government legislation.

.....  
**Clearly a lot more dialogue and exploration of options needs to be undertaken by government agencies, citizens and businesses, not just at a national level but at a regional level, to encourage Asean funding and institutional involvement and the sharing of best practices from other parts of the world.**  
 .....

Private sector companies that provide solutions to climate change and flooding also need to step up communication and dialogue to gain a greater understanding of the solutions on offer, and how they might complement each other and some of the natural systems available. For instance, organisations offering big data analysis might present their solutions alongside sensor companies that check stormwater levels, automation companies that deal with the flow control, and pump companies that provide extraction systems.

Clearly a lot more dialogue and exploration of options needs to be undertaken by government agencies, citizens and businesses, not just at a national level but at a regional level, to encourage Asean funding and institutional involvement and the sharing of best practices from other parts of the world. 🌐



**Appendix 1**  
Key country findings from the survey

# Appendix 1. Key country findings from the survey

**A summary of how survey respondents from the core countries varied with the regional average in their response to question 8. (Full details of the question and detailed response by country is in Appendix 2 below).**

## Indonesian respondents

- Less likely to agree that government funding is good
- Less likely to agree that rural plans are good
- Less likely to agree that their government works with neighbours on the issue
- More likely to agree that they are prone to floods
- More likely to be concerned about the economic impact of floods

## Malaysia respondents

- Most likely to be concerned about the effectiveness of rural and urban planning for floods
- More likely to be concerned about whether they have sufficient government funding
- Less likely to agree that their country works well with neighbours on the issue
- Less concerned with the impact of climate change on their country
- More concerned than the regional average about their country's response

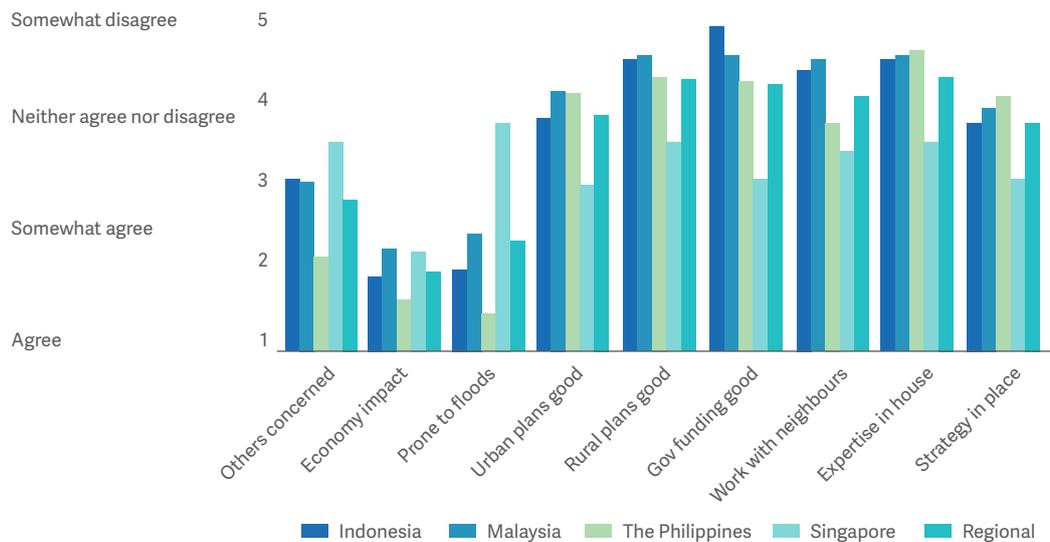
## Philippines respondents

- Most likely to agree that they are prone to flooding
- Most likely to be concerned about the economic impact of floods
- Most likely to agree that many others in the country are concerned about the impact of climate change
- Least likely to agree that their government has experts and a good strategy in place
- More likely to agree that their country works with neighbours on the issue

Singapore respondents

- Least likely to agree that they are flood prone
- Least likely to agree that others in the country are concerned about the impact of climate change
- Most likely to agree that their government has a better control on flood management with good planning and funding
- Slightly more likely to agree that their government works with neighbours on the issue

Regional and country overall weighted responses



Weighted responses to the question: "Urban planning in my country adequately factors in the impact of extreme weather events and climate conditions"

» Eco-Business Research survey of 416 respondents in Southeast Asia



## **Appendix 2**

### Detailed survey response

## Appendix 2. Detailed Survey Response

### 1. Which country are you based in? (Choose one)

Answer Options	Response Percent	Response Count
Indonesia	22.1%	92
Malaysia	20.6%	86
Singapore	22.1%	92
Thailand	9.4%	39
The Philippines	21.1%	88
Vietnam	4.8%	20

### 2. What is your job title? (Choose one)

Answer Options	Response Percent	Response Count
CEO, CFO, COO, CIO, President, Managing Director, Country Manager	20.9%	87
Vice President, General Manager	5.8%	24
Director	18.0%	75
Regional Manager	5.0%	21
Manager	25.4%	106
Technical, Engineer	6.0%	25
Consultant, Academic	18.9%	79
Other (please specify)	91	
Answered question	417	

### 3. Which industry are you in? (Choose the one that most closely matches your sector).

Answer Options	Response Percent	Response Count
Agriculture	8.6%	36
Automotive	0.2%	1
Banking, finance, insurance	2.9%	12

Construction, engineering, architecture, real estate	13.4%	56
Consumer goods	2.2%	9
Education	7.4%	31
Energy	8.9%	37
Government or other public sector	4.3%	18
Healthcare	1.0%	4
Information technology or telecommunications	3.1%	13
Manufacturing	6.5%	27
Non-profit or NGO	16.8%	70
Services	7.0%	29
Transport or logistics	1.2%	5
Utilities	2.4%	10
Other (please specify)	14.1%	59
Answered question	417	

4. What sort of organisation do you work for? (Choose one).

Answer Options	Response Percent	Response Count
Multinational corporation	28.5%	119
Small or medium enterprise	33.3%	139
Government agency	11.8%	49
Other (please specify)	26.4%	110
Answered question	417	

5. Based on your personal observations, do you feel there have been any changes in the climate conditions or weather patterns of your country of residence in recent years? (Choose one).

Answer Options	Response Percent	Response Count
No, I do not think the climate or weather have changed noticeably in recent years	1.5%	6
Maybe, I think there have been minor changes to the weather in recent years	14.0%	58
Yes, I think there have been significant changes to the weather and climate in recent years	84.0%	347
Don't know	0.5%	2
Other (please specify)	10	
Answered question	413	

6. If you answered 'maybe' or 'yes' to the previous question on climate or weather changes, please indicate which of the following you have noticed. (Check all that apply)

Answer Options	Response Percent	Response Count
Average temperatures have become higher	81.4%	328
Average temperatures have become lower	2.2%	9
Storms or typhoons have become more severe	50.9%	205
Sea or river levels have become higher	18.4%	74
Monsoons and seasons have become less predictable	72.0%	290
Rainfall has become higher	42.7%	172
Rainfall has become lower	12.9%	52
Reservoir water levels have become lower	28.0%	113
Other (please specify)	8.9%	36
Answered question	403	

7. Do you believe the weather or climate in your country of residence will show more extreme patterns in the next decade? (Choose one).

Answer Options	Response Percent	Response Count
No, I believe the weather or climate will not experience any significant changes	2.2%	9
Maybe, I suspect that the weather or climate might show some more extreme patterns	26.8%	111

Yes, I believe that we will encounter significantly more extreme weather or climate conditions in the next decade	69.3%	287
Don't know	1.7%	7
Answered question	414	

8. Please indicate the extent to which you agree or disagree with the following statements relating to your country of residence.

Answer Options	A.	B.	C.	D.	E.	F.	G.	H.	I.
a. Many other people in my country are concerned by the impact of extreme weather events and climate change	59	134	131	33	35	13	11	1	417
b. Extreme weather events and climate change could have a significant impact on our local economy	179	166	45	14	8	2	2	1	417
c. My country is particularly prone to flooding	148	139	66	26	14	17	4	3	417
d. Urban planning in my country adequately factors in the impact of extreme weather events and climate conditions	46	80	95	33	51	62	49	1	417
e. Rural planning in my country effectively helps guard against the impact of extreme weather events and climate conditions	27	49	54	59	54	74	54	46	417
f. My government has allocated sufficient resources and funding to plan for extreme weather events and climate conditions	18	39	96	84	55	74	46	5	417
g. My country works with neighbouring countries to produce solutions for extreme weather events and climate conditions	12	55	111	92	56	63	23	5	417
h. My country has developed adequate expertise in combating extreme weather events and climate conditions	17	44	92	77	74	69	40	4	417
i. My country has a strategy in place for addressing the factors that contribute towards climate change such as managing CO2 emissions	20	65	131	66	51	49	32	3	417
Answered question	417								

A. Strongly Agree, B. Agree, C. Somewhat Agree, D. Neither Agree nor Disagree, E. Somewhat Disagree, F. Disagree, G. Strongly Disagree, H. Not Applicable, I. Response Count.



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