AsianCitiesAdapt

Local governments championing adaptation to climate change

A PRIMER FOR DECISION-MAKERS IN ASIAN CITIES

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IMPRINT

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Introduction - Why to put climate change high on the local agenda

This primer deals with the challenge of governance and management in cities in times of climate change, thus addressing a key actor in climate adaptation - local governments.

We live in an urbanising world. In India, for example, more than 30 percent of the total population is agglomerated in cities and towns, a figure which is set to increase. In Malaysia, more than 70 percent of the population lives in urban areas, and the country is one of the most densely populated in Southeast Asia. Cities are centres of economic activity and consumption, contributing significantly to greenhouse gas (GHG) emissions. Due to the concentration of both population and economically and socially valuable assets and services, cities are highly vulnerable to stresses and shocks induced by climate change impacts such as:

- landslides
- urban flooding
- heat waves and increased heat island effects
- increased energy demand in the residential sector, for example for cooling
- increasing demand and reduced availability of fresh water
- decreasing air and water quality
- the degradation of eco-systems and their services
- sea-level rise and thus floods and coastal erosion, salt water infiltration to groundwater and drinking water bodies

At times, these impacts might become disasters with even more severe consequences leading to the loss of lives, the impairment of public health, and the destruction of personal property, infrastructure, and economic assets, all of which threatens a city's ability to be a source of livelihood for its residents.

Local governments in Asia and elsewhere have to acknowledge that climate change is happening and adds another layer of complex challenges to their local sustainable development agenda. Clearly, the impacts of climate change - in combination with population growth, rapid urbanisation, increasing informal settlements and high economic inequality - are stretching the limits of urban infrastructure and systems, and jeopardise the provision of basic services to all citizens, especially to the urban poor. In this way, already existing development challenges in resource management, service provision and infrastructure planning are intensified and can eventually make cities uninhabitable. Development gains can be quickly undone and investments from the past wasted, if local governments do not decide to act here and now.

Adaptation to climate change is no longer a matter of political choice. Even if increasing GHG emissions could be brought to a halt, ecological systems have already been disturbed and will take centuries to find a new balance. While ecosystems adapt, human societies have to review and gradually change the way they organise themselves.

It is clear that adaptation is indispensable to safeguard the current and future well-being of citizens and their social and economic activities, as these are based on a functioning urban infrastructure and the provision of basic services. But climate change adaptation also generates major opportunities for urban and regional development as synergies can be created and a basis for new, innovative fields of entrepreneurship developed. For example, disaster risk management as part of a climate adaptation plan will help to ensure that investments and progress in development are protected. Additionally, the accelerated introduction of innovative solutions such as smart monitoring tools or green infrastructure components will foster urban development and create new business opportunities.

For all of these reasons, it has become imperative for local governments to act. The way cities are governed, planned and organised defines the quality of life as well as the social and economic opportunities of their inhabitants to a large extent. With a high potential for increasing resource efficiency they can also contribute significantly to making the wider geographical area and eventually the country in which they are located more resilient.

To this end, politicians and practitioners in local governments need to make it a priority to improve their understanding of potential climate change risks and local vulnerabilities, find out about ways and means to reduce adverse climate change impacts, and recognise them in their city planning processes.

There is still a long way to go for cities to become more resilient to climate change, but as is true for any long-term undertakings: Even a long journey starts with the first small step.

Objectives

This primer has been produced to share the path to adaptation that was promoted in the AsianCitiesAdapt project with other local governments in the Asian region and encourage them to follow suit. The primer has two main objectives:

- Make basic information on climate change and its impacts in an urban context widely available.
- Provide an overview on the most important steps for developing and implementing a climate change adaptation plan at city level.

Target groups

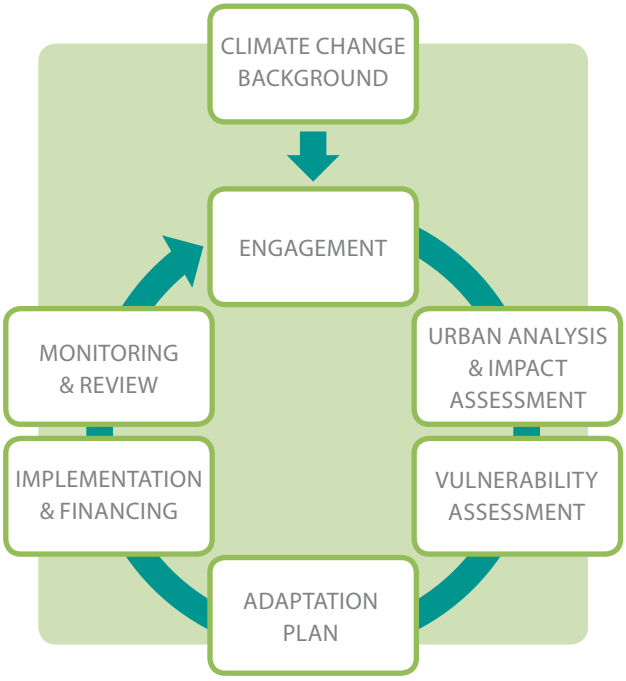
Main target group of this document are officials of local governments in the Asian region whose leadership in climate change adaptation is regarded as indispensable if their cities are to become more resilient. It will also be useful for supporting government agencies and other stakeholders and institutions with an interest in local adaptation to climate change, such as researchers, business people, members of civil society organizations, and representatives of communities.

Contents

The primer is divided into seven main chapters. The first chapter provides the reader with some background information regarding climate change, including its drivers, impacts and the key issues.

The following chapters are then structured according to the management cycle for the development and implementation of a climate change adaptation plan at city level, reflected in the diagram below.

Figure 1: Management cycle



1. Climate Change Background

1.1 Current knowledge of climate change - the greenhouse effect

The Earth's atmosphere contains a mixture of gases that are essential for life. The short wave radiations of the sun enter the atmosphere, where they are partly absorbed by the Earth and partly reflected. The reflected radiation is mostly long wave radiation which is trapped by gases such as carbon dioxide via an effect known as the greenhouse effect. This helps to maintain the life-preserving temperature on the surface of the Earth. Figure 2 depicts the greenhouse effect in action.

The most common greenhouse gases (GHGs) are:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF_6)
- Ozone (O_3)

Water vapour has the same effect as the gases listed above.

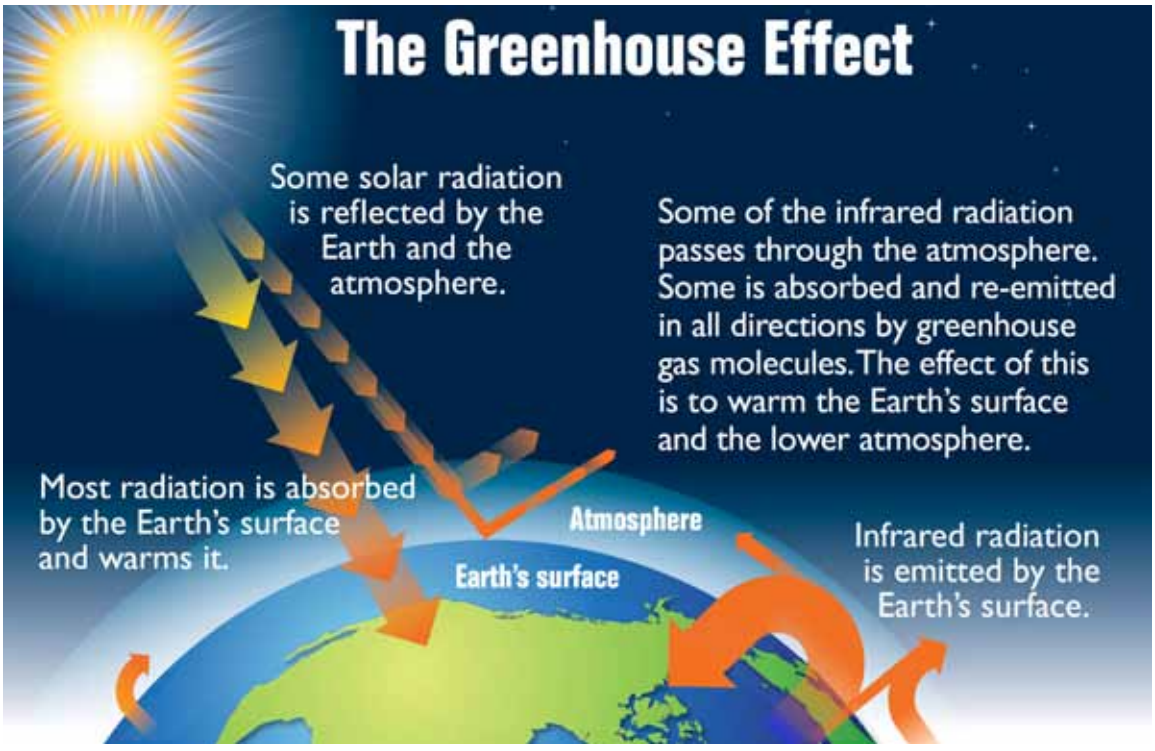
An excess of these gases in the atmosphere absorbs the long infrared radiation and traps the heat in the atmosphere resulting in a rise in temperature, triggering climate change.

In a natural equilibrium, the amount of GHGs released in the atmosphere is in balance with the amount captured by forests and oceans, which act as sinks. These natural sinks counter the greenhouse effect and rising temperatures. However, with rapid urbanisation and industrialisation, coupled with widespread deforestation, the amount of carbon dioxide released by human activities can no longer be balanced by absorption in natural sinks. As a result a part of it remains in the atmosphere and traps heat, resulting in climate change (see Figure 3 for the example of Indonesia).

1.2 Sources of greenhouse gases

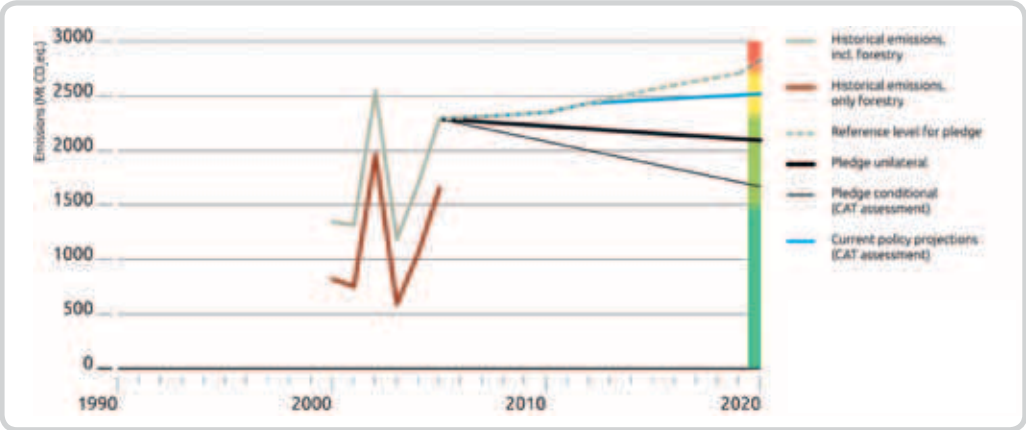
Some greenhouse gases originate from natural processes such as the respiration of people and animals, or volcano eruptions. Famously, the world's cow population contributes significantly to emissions of methane.

Figure 2: The greenhouse effect in action



Source: www.epa.gov/climatechange/science/indicators/download.html (second edition, 2012)

Figure 3: Indonesia's GHG Emission Trends and Projections (1990 - 2020)

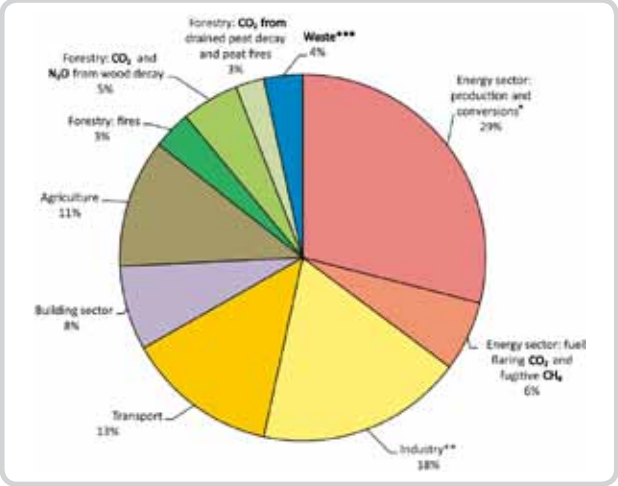


Source: http://climateactiontracker.org/countries/indonesia.html

However, a major increase in GHG concentration has been recorded since the beginning of 19th century with industrialisation in Europe. Drivers for this increase are economic activities, especially the excessive consumption of fossil fuels for industrial processes, energy production and transportation. Changes in land use also cause higher GHG concentrations in the atmosphere. As mentioned above, deforestation plays a major role due to their capacity to store CO2 - plants and trees function as carbon sinks.

Landfills can be a major source of GHG emissions since waste generates methane, a very aggressive GHG. Figure 4 depicts global GHG emission by sector for the year 2010.

Figure 4: Global annual GHG emission by sector (2010)



Source: http://www.unep.org/pdf/2012gapreport.pdf

Not all activities mentioned have the same impact on GHG concentration, because they have different emission intensities. Emission intensity refers to the amount of emissions released by a certain pollutant or source. Furthermore, different GHG have different global warming potentials. The global warming potential of a certain GHG depends on the atmospheric life of the gas (number of years it stays in the atmosphere) and its ability to trap heat.

The following table provides an overview of the most common GHGs, their main anthropogenic sources, their atmospheric life and their global warming potential.

Table 1: Greenhouse gases, atmospheric life and global warming potential

Main Greenhouse Gases						
Greenhouse Gas	**Chemical Formula**	**Pre-Industrial Concentration**	**Concentration in 2005**	**Atmospheric Life (years)**	**Anthropogenic Sources**	**Grobal Warming Potential (GWP)**
Carbon-dioxide	CO_2	280 ppm	379 ppm	Variable	Fossil Fuel Combustion Land Use Conversion Cement Production	1
Methane	CH_4	700 ppb	1774 ppb	12	Fossil Fuel Rice Paddies Landfill Waste Livestock	21
Nitrous oxide	N_2O	275 ppb	319 ppb	114	Fertilisers Combustion Industrial Processes	310

Source: Ewing et al., 2007

1.3 Climate change impacts

As a consequence of increased GHG concentration and global warming, climate change leads to a variety of direct and indirect impacts.

Direct impacts include:
- surface and ocean temperature increase
- melting glaciers
- sea-level rise
- more droughts and more intense heat waves
- extended rainy seasons (i.e. monsoon periods)
- more frequent and severe storms (i.e. typhoons, cyclones, hurricanes)
- more frequent and extreme floods (fluvial, pluvial and sea-driven)

Indirect impacts include:
- loss of fresh water, (fertile) land, biodiversity and agricultural productivity
- stress on natural resources
- destruction of infrastructure
- increase in vector borne diseases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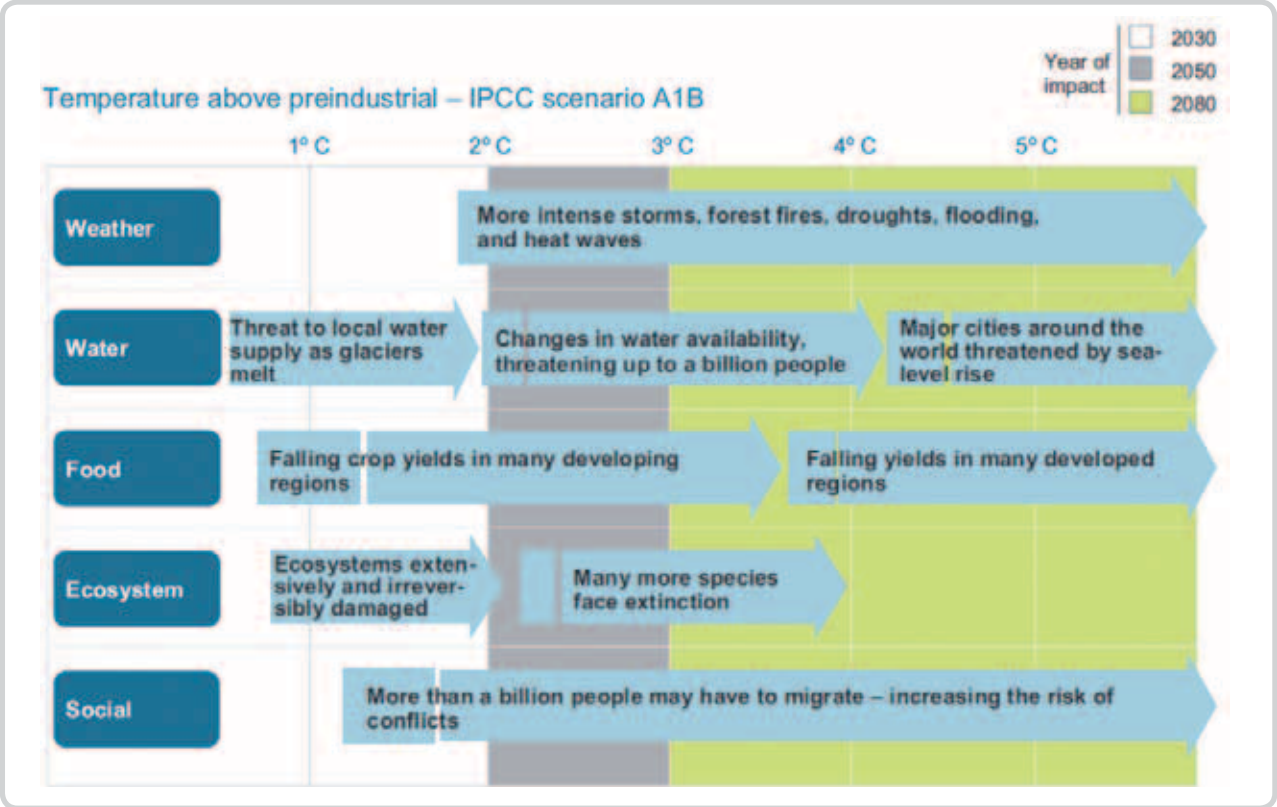
The scope of climate change and the severity of its impacts depend on the extent of temperature increase. This is depicted in Figure 5 that provides an overview of the climate characteristics susceptible to change and the possible major threats to humankind and ecosystems as temperatures rise over time.

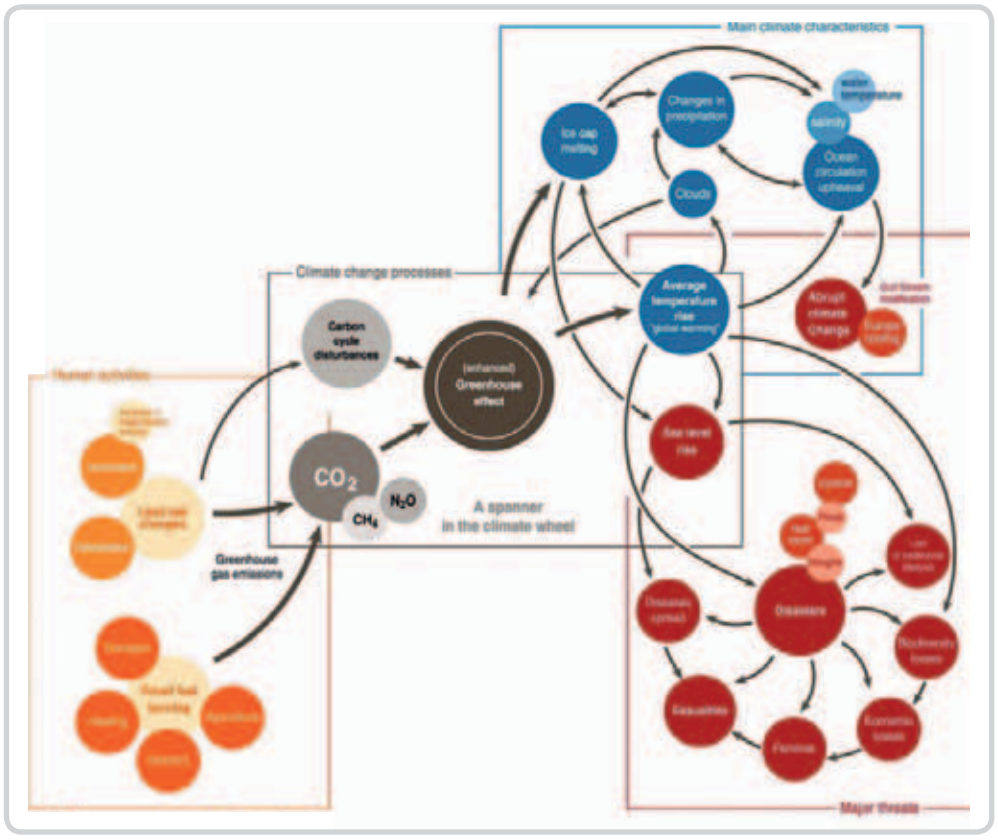
Figure 5: Temperature change and potential climate change impacts



Source: http://ccsl.iccip.net/climate_resilient.pdf

Image: rssfhs / iStock.com

Figure 6: Climate change interlinkages



Source: www.grida.no/graphicslib/collection/vital-climate-change-graphics-update

Image: Barbara Anton / ICLEI

Figure 6 illustrates how emissions of GHGs from different sources are causing the greenhouse effect, which in turn influences the main climate characteristics leading to climate change. In turn, climate change affects social, environmental and economic aspects of the city, compromising the well-being of its residents. This means that reducing the impacts of climate change (adaptation) is as important as reducing emissions to slow down climate change (mitigation).

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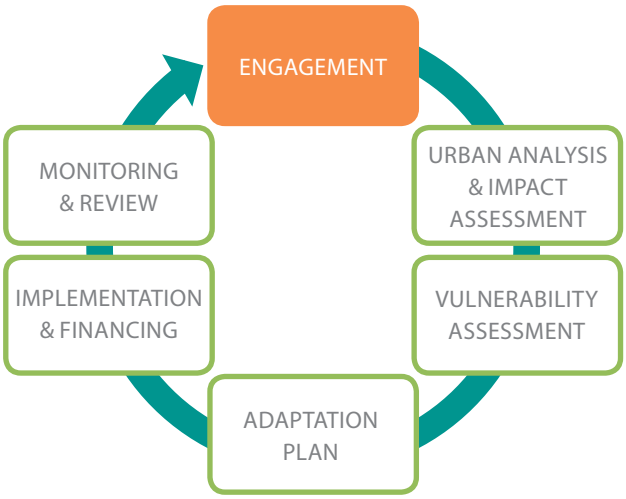
2. Local Government Engagement in Climate Change Adaptation

While local governments will have to take the lead in addressing climate change in their city, political, expert and practical support will be needed from various sides. In the first place, forward thinking local officials will have to find the right entry point to lobby for adaptation and increase political buy-in for getting an official mandate for moving ahead. On the other hand, they will have to find allies and contributors all across the city to share knowledge and ideas, capacities and resources.

2.1 Entry points for engaging in climate change adaptation

Climate change is a multifaceted and complex issue, and options for adaptation comprise a wide range of diverse interventions. Each local government will have to find its own way to engage, often starting with a mix of smaller immediate actions before a comprehensive and long-term planning process is set into motion.



2.1.1 Adaptation and mitigation

There are two principal options when responding to climate change:

- Mitigation: Mitigation actions are 'intervention[s] to reduce the sources or enhance the sinks of greenhouse gases' (Intergovernmental Panel on Climate Change - IPCC). As climate change is largely caused by humans its pace and scope can be curbed and the negative impacts better managed. Possible options for mitigation are, for example, the use of renewable energy instead of fossil fuels, shifting to low emission forms of transportation, and improving energy efficiency in buildings or in industrial processes.

- Adaptation: As climate change is already happening and the consequences are being felt in many ways and multiple locations, it is important to deal with irreversible developments and to prepare to cope with the new conditions. Adaptation actions are 'adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects which moderate harm or exploit beneficial opportunities' (IPCC).

Adaptation includes the anticipation of local impacts of climate change in order to avoid or alleviate damages by reducing exposure to hazards and ensuring better coping capacities when certain climate conditions change.

Adaptation is also closely linked to disaster responses and the ways and means to recover from shocks and adjust systems to new circumstances to prevent further damage in the future.

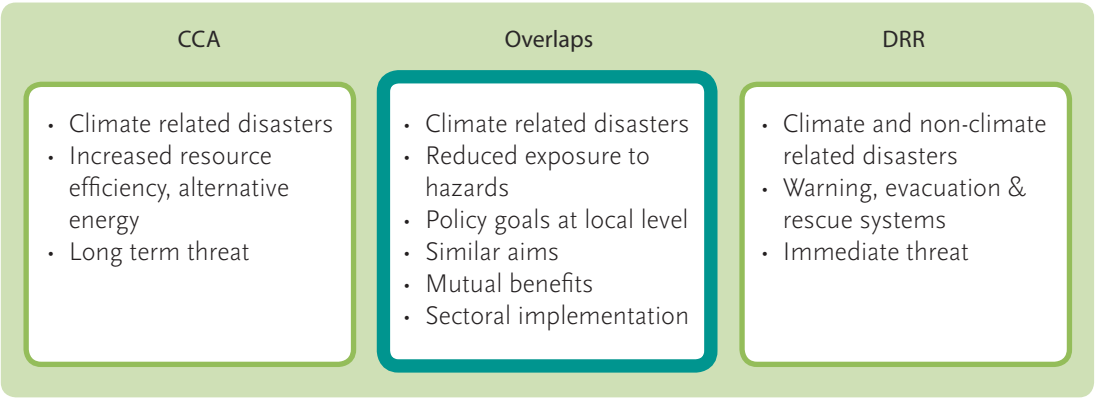
As the scope of climate change is related to GHG emissions, the degree of adaptation required in the future depends on our mitigation achievements today.

2.1.2 Adaptation and disaster risk reduction

Adaptation and disaster risk reduction are closely linked and partly overlap (Figure 7). They share a number of similarities but still differ in many ways.

Addressing disaster risk reduces vulnerability, as do measures to deliver climate change adaptation (and mitigation, at least in the long term). These two fields are becoming more closely linked in their approaches and objectives, as disaster risk management moves from reaction to including prevention as a major objective. It has also become apparent that disaster risk reduction that integrates climate adaptation needs is more economical and efficient. Both climate change adaptation and disaster risk reduction enhance a city's resilience. They also contribute to sustainability and to the long-term prevalence of communities, cities, humans and biodiversity, at best if they are shaped with sustainability criteria.

Figure 7: Climate change adaptation (CCA) and disaster risk reduction (DDR): overlaps and differences



2.1.3 Adaptation and development

Effective adaptation and progress in development go hand in hand (Figure 8). While development improves the social, ecological and economic capacities of society to foster human well-being in the long run, adaptation is necessary to ensure that development gains are not reversed by climate change impacts.

Adaptation has much in common with the concepts and approaches of sustainable development. Because of the uncertainties in climate change, adaptation actions are typically small or medium-scale, decentralised, flexible, include 'redundant' mechanisms in case of the failure of regular systems and rely on soft components such as ecosystem services rather than huge construction projects.

Finally, if actions are strategically chosen, adaptation can yield numerous other benefits. For example, green spaces, installed to reduce Urban Heat Island effects or to absorb excess water after extreme precipitation events, also provide a public social arena to meet, opportunities for recreation and linkages to the larger urban biodiversity network. Planting trees can help regulate the urban climate and provide more shade on hot days while also making the city more liveable, healthy and attractive, fostering local business development.

Figure 8: Adaptation and development

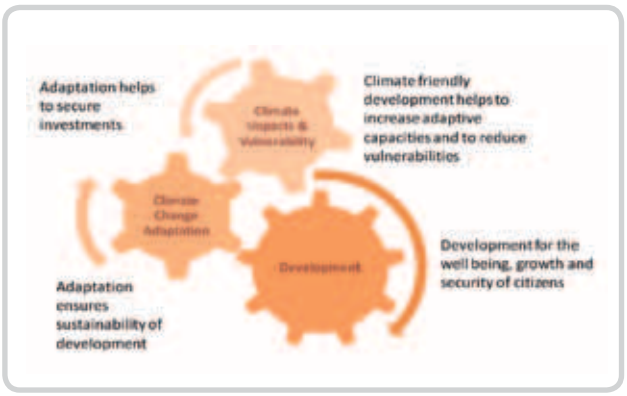


Image: Barbara Anton / ICLEI

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2.2 Bringing stakeholders on board

Climate change is a complex issue and adaptation requires a multi-level approach based on the expertise, perceptions, opinions, expectations, and interests of representatives of many disciplines, sectors, and social contexts.

While local governments play a central role in adaptation to climate change, their policies, plans and programmes can only succeed if they enable stakeholders to participate in their development and implementation.

Figure 9: Possible stakeholders

Stakeholders are institutions that are either affected by certain decisions for climate change adaptation or can influence and take relevant decisions themselves. Stakeholder groups range from community representatives, the private sector and research institutions to sector specialists from urban planning, water and sanitation, transport, health, as well as other disciplines. Some examples of possible stakeholders are shown in Figure 9.

The most important actors in responding to climate change, however, remain local governments themselves. With their general responsibility for managing the city and their mandates for planning, development, infrastructure, urban transport, and basic service provision, climate change needs to become a key parameter for the daily decisions and actions of local governments.

The leading decision-makers in the city can mainstream climate change aspects through planning processes, the regulations and in statutory control mechanisms. Local governments can act as a role model for climate-sensitive behaviour and practices by routinely taking mitigation and adaptation issues into account. They can also bring all knowledge together in one place, act as the central point of coordination, and mediate between conflicting interests and needs.

A participatory approach at critical points in decision-making, planning and implementation is still necessary. In particular economically and otherwise disadvantaged people need to have a platform on which they can raise their concerns, as they are usually the ones who are most vulnerable to climate change.

2.3 Communicating uncertainty

Adaptation to climate change is not yet a regular priority in policy - let alone in people's daily lives. Even where a local government has taken the decision to engage in adaptation it will require contributions from many different sectors and actors to make it work.

Communicating climate change to the wider public is not a simple task for a number of reasons:

- In many locations really severe impacts are only expected to take place in a few decades or even in a few centuries.
- Uncertainty is very high: When modeling future climate trends scientists have to rely on past data which is partly incomplete, partly irrelevant, or partly inaccurate. Additionally, when using different scientific models, different scenarios will result from the analysis.
- Climate change comes with many extreme events and multiple chain reactions which no human generation has ever experienced or investigated firsthand. Therefore, the connections between different effects are still unknown and projections are made on the basis of past evidence, which might not hold true for the future.
- Downscaling global and regional models to an urban territory is still a major challenge - even for megacities such as Mumbai or Bangkok. The smaller the area under investigation, the higher the level of uncertainty.

Because of the complexity of climate change and its consequences, and the fact that it will affect virtually all sectors and all groups of society to a certain extent, it is essential to convey the key messages to stakeholders and the wider public effectively and encourage them to join activities for planning and implementation.

Some tools and approaches for engaging citizens are:

- **Dissemination of pamphlets, brief reports and other communication products** referring to climate vulnerabilities of the city, proposed adaptation measures as well as sources to more information and how citizens can get involved;
- **Public consultations** in which potential climate impacts and corresponding adaptation responses are jointly discussed;
- **Web-based interactions** to which citizens can be invited to share their points of view and ideas on adaptation measures;
- **Focus group discussions**, in particular with the most vulnerable groups of society to better understand their specific situation and the most suitable solutions to protect their livelihoods - civil society organizations can help facilitate such a process;
- **GIS-based climate change vulnerability maps** which have proven useful for communicating and reviewing local areas most likely to be impacted by climate change;
- **New social media** such as online fora which can help attract the younger generation and reach out to large audiences.

Image: Barbara Anton / ICLEI

Image:thavornc / iStock.com

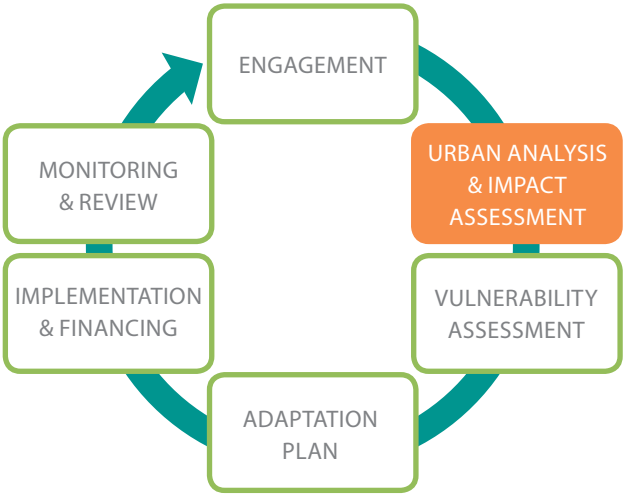
3. Urban Analysis and Impact Assessment

The urban analysis and the assessment of climate change impacts provide the scientific evidence for the vulnerability assessment. Indeed, the urban analysis and impact assessment can be defined as part of the vulnerability assessment process itself.

The analysis of the local situation and climate relevant information on the one hand and the actual assessment of the identified vulnerabilities on the other are nevertheless described in two different chapters. This is to emphasise that the first is a more objective review of where things stand and where they are expected to develop in the longer term, while the vulnerability assessment is more political in nature. It will be local decision-makers who will have to determine which issues to prioritise.

The urban analysis and the assessment of climate change impacts will usually be carried out more or less in parallel. It might be advisable to link and correlate certain parameters during the collection of relevant information so that the two activities gradually merge over time.

It needs to be taken into account that the urban analysis and the impact assessment are major activities in adaptation management and require the investment of a substantial amount of time. Information and knowledge needs to be collated from various stakeholder and other organisations in- and outside the city, thoroughly reviewed and validated again with stakeholders and eventually presented in a structured and coherent way to form a sound basis for the vulnerability assessment.



At the same time, however, it must be recognised that the local situation will keep changing and knowledge of climate change will continue to advance, so such an analysis can never be regarded as final. In fact, the information collected will have to be regularly updated. This should not hinder local decision-makers in taking climate projections into their consideration as soon as an initial foundation of knowledge has been created. A certain degree of uncertainty will always remain - but whoever is involved in planning for the future will find this challenge familiar.

3.1 The urban analysis

The urban analysis looks at the city as a complex web of different components which are all mutually linked and thus depend on and influence each other.

A city's main components can be divided into the following three groups (adapted from "Catalyzing Urban Climate Resilience", ISET, Rockefeller Foundation, July 2011):

- **Urban systems**: Include ecosystems and infrastructure systems along with the knowledge required to manage, maintain, and develop them.
- **Urban actors**: Include individuals, households, and private and public sector organizations. They have different degrees of decision-making power and competence to contribute to new policies, plans and practices and their needs and interests can differ or even conflict with regard to specific issues.
- **Urban institutions**: Rules and practices which include rights, laws, regulations, mandates, planning procedures etc. that provide a structured framework for the relationships among actors and between actors and systems.

Figure 10: Relationship between urban systems, urban actors, urban institutions and climate change

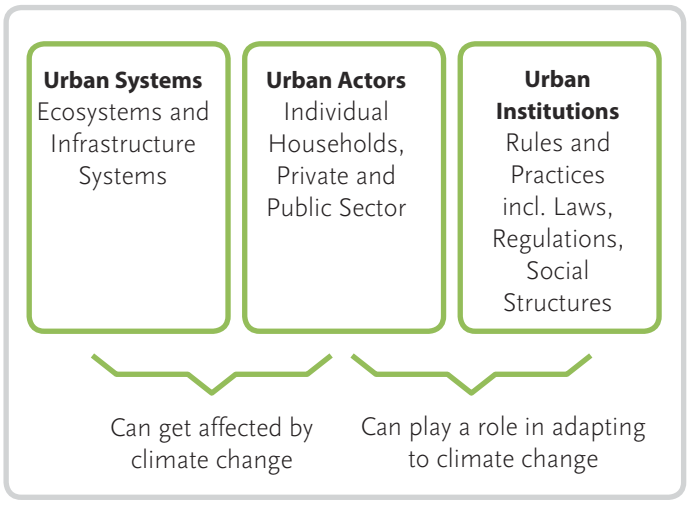



Image: wdstock / iStock.com

The close linkages between the different components imply that also their vulnerabilities are mutually dependent. For example, if local people are well educated, enjoy access to all basic services and have stable livelihoods they can be expected to be better equipped to cope with flooding events than people living in marginalised areas of the city, with little education and deprived from even the most fundamental rights such as basic shelter, nutrition and healthcare.

The final objectives of the analysis of the city's main components are to find out which urban systems, actors and institutions are most exposed and sensitive to climate change impacts and risks, and the extent of their capacities to deal with these impacts and risks. The analysis should consider both current and projected climate conditions.

- **Exposure**: This is the nature and degree to which urban systems, actors and institutions are exposed to climate change impacts.
  For example, people living in slums in low-lying areas are more exposed to flooding than people living in quality housing which is connected to a modern drainage system located on higher ground in the city.

- **Sensitivity**: Sensitivity is the degree to which an urban system or urban actors are affected by climate change impacts - either adversely or beneficially.
  For example, children and elderly people are more sensitive to climate change impacts than adults.

- **Adaptive capacity**: This refers to the ability of an urban system or urban actors to adjust to climate change, to moderate the potential damage from it, to take advantage of its opportunities, or to cope with its consequences.
  For example, the adaptive capacity of people settling along the coastline and dependent on fishing for their livelihoods will be lower than of those living in the same areas but earning their money in a factory further away from the sea, since the latter can more easily move to a different area.

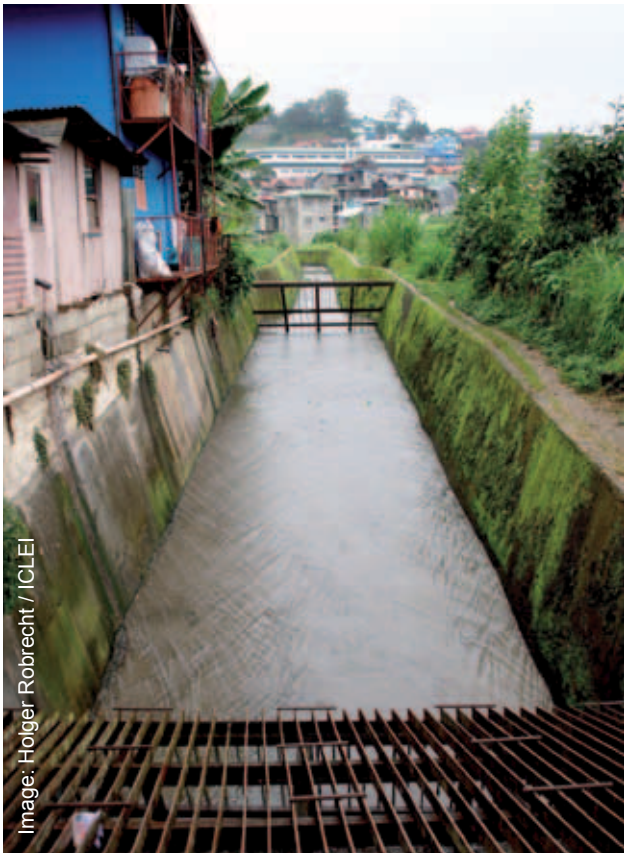


Image: Holger Robrecht / ICLEI

In order to investigate the points listed above, activities such as the following will have to be carried out:

- Collection of existing data and other forms of information such as topographic maps, data on the natural and physical environment (for example, on the distribution and density of the population of the city, infrastructure coverage and availability of energy, drinking water and health services), land use and development plans, and socio-economic data including urbanisation dynamics, income distribution etc.

- Mapping of areas and populations with special challenges in urban systems: zones in the city according to social criteria (in particular the level of income) and recurring disturbances of urban systems (which may or may not be affiliated with climate change, such as frequent flooding).

- A review of the city's development or master plan - and in particular the highest priorities reflected in it - as well as of the city's (or district's) disaster management plan to identify most critical systems.

- Targeted surveys and stakeholder consultations (for example, in the form of focus group discussions) to understand the specific concerns and needs of different social groups, in particular those who already - even without a changing climate - live in precarious situations, such as slum dwellers, migrant workers and other marginalised social groups.

- Development of future scenarios based on envisaged development trends of the city or the country more broadly.

3.2 Climate change impact assessment

Climate change impacts such as heavier precipitation, altering temperature patterns, longer periods of drought, stronger storms or other extreme weather events pose a real threat to urban systems and actors and can be classified as climate risks. To effectively face these challenges an improved understanding of the projected climate risks is necessary. This is a prerequisite for taking appropriate decisions with regard to resource allocation, infrastructural design and systems for service provision. It is therefore important to collate and analyse climate change data systematically and also generate climate risk scenarios.

Location specific climate projections are the most appropriate starting point for assessing potential climate risks, but in reality such projections are not always available. The Government of India, for example, has succeeded to a great extent in bridging this gap. It gives climate projections for the year 2030 on a regional basis covering four regions (Himalayan, Western Ghats, Coastal Areas, North East) and four sectors (Agriculture, Water, Natural Ecosystems & Biodiversity, Health).

In the absence of local climate projections, regional projections can be used as a starting point. In any case, the lack of city-specific data should not be a barrier to undertake a climate adaptation planning exercise. Most countries have a number of institutions - such as national government agencies, meteorological institutes, and universities - with substantial relevant data and information. Local governments should seek collaboration with them to strengthen the scientific basis of their risk assessment and their planning for the future.

The involvement of climate specialists is also necessary if two or more climate projections do not come to the same conclusions. They will need to be checked for consistency, i.e. whether they state similar projections for the same time period. If this is not the case, the adaptation strategy will have to be flexible enough to meet a larger range of risks - or a larger range of *levels* of risks.

Assessing climate change risks

A risk assessment helps determine which of the most critical systems are at the greatest risk and allows prioritisation of adaptation actions.

Risks can be assessed based on the following formula:
Risk = Likelihood x Consequence

'Likelihood' here refers to the expected occurrence of the climate change event, while 'Consequence' refers to the degree of expected impacts.

A risk assessment will usually need the involvement and consensus of sector experts. This is an example of how the result of such an assessment might look:

Likelihood rating	Score agreed	Consequence rating	Score agreed	Total Score (= level of risk)
5 - Almost certain		5 - Catastrophic		
4 - Likely	4	4 - Major		
3 - Possible		3 - Moderate	3	
2 - Unlikely		2 - Minor		
1 - Rare		1 - Insignificant		
				12

4. Vulnerability Assessment

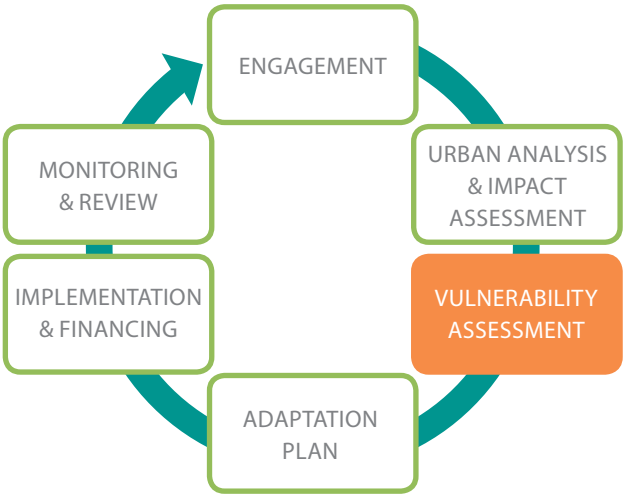
Once the urban analysis and the impact assessment are completed, and exposure, sensitivity and adaptive capacity of urban systems, actors and institutions are well understood, it will be the political decision-makers of the local government who are in charge again. They will have to provide their vulnerability assessment by discussing and forming an opinion - and eventually deciding - on the outcome of the analysis and assume responsibility for the measures to be taken to make the city more resilient.

Even after the most comprehensive and participatory process for capturing the local situation and trends of climate change, the outcome will leave uncertainties and have to be treated with caution. This is connected to the specific characteristics of climate change and the scientific disciplines dealing with it. Explained before, this is briefly summarised again in the following:

- *Mismatch between past and (expected) future conditions*: Intensive research is going on all over the world to understand the nature and the implications of the current dynamics in global warming. However, the magnitude and pace of current climate change is unprecedented since systematic recording of climate parameters began. Extrapolating and modelling data from the past into the future does not necessarily result in robust and reliable projections.

- *Wide range of scientific scenarios*: While the methodologies for the development of future climate scenarios are chosen with scientific scrutiny, there are still a lot of assumptions going into climate research, such as the future scope of GHG emissions. Different scientists work with different modelling tools and feed them with different sets of data meaning that they will lead to a variety of different scenarios. Researchers are not in a position to give any final answers on future conditions.

- *Difficulties of downscaling global and regional projections*: Researchers are able to ascertain that global warming is indeed happening, but climate change impacts can most reliably be observed and assessed only at global and regional levels. Scientific approaches and tools for downscaling global and regional data to smaller units and even to the size of an urban area are still under investigation. What the smallest unit for climate scenarios might eventually be remains to be seen.

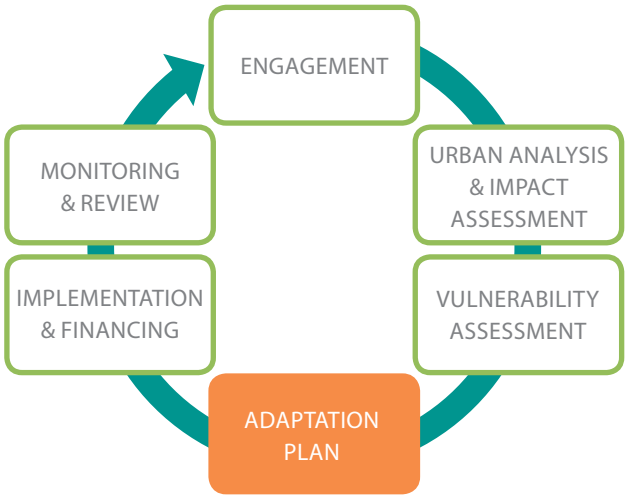


All of the above implies that local politicians will always have to face and deal with uncertainties when it comes to defining their vulnerability assessment. It is in the nature of the current dynamics of climate change that the projections on which decisions need to be based will only materialise to a certain degree. At the same time, the consequences of wrong decisions can be enormous. People's lives might be threatened, their health affected, critical infrastructure seriously damaged, local economic development brought to a standstill, and political accountability seriously diminished.

Furthermore, responsible local governments cannot afford to invest in potentially 'unnecessary' adaptation measures at the expense of other much needed investments such as job creation, housing, education, or the delivery of municipal services in the water, energy or waste sector.

However, not acting at all in the light of uncertainties is no option either - politicians will also be held accountable for the consequences in this case and the political damage can be severe. As described in the previous chapters there are ways and means to base decisions on the best knowledge and information available at a given moment in time. It is most feasible to go ahead by working with experts as they can guide local governments to trusted sources of information and by involving stakeholders to generate a sense of co-ownership and encourage others to share responsibility for climate change adaptation.

5. Development of the Adaptation Plan



Once a first version of the vulnerability assessment is completed (which may later be elaborated upon based on new scientific evidence or new developments in the city), the most suitable measures to strengthen local capacity for adaptation need to be identified.

A summary of the outcome of the vulnerability assessment process and the selected adaptation measures will form the body of the city adaptation plan. The following points outline how to select the adaptation measures and to develop the adaptation plan.

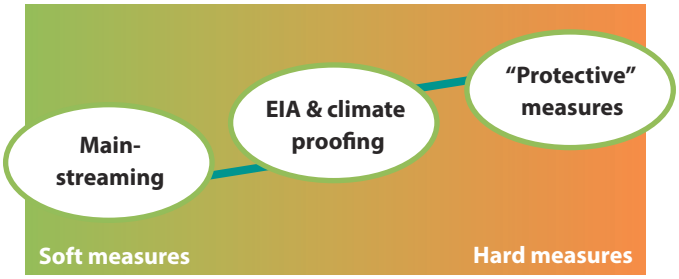
5.1 Review of potential adaptation options

Building on the climate change impact assessment, the urban analysis, and the vulnerability assessment, an extensive list of possible adaptation measures needs to be compiled. Ideally, this is done in consultation with stakeholders in order to take advantage of a broader range of expertise and a bigger pool of ideas. While listing potential adaptation measures, the respective technical, financial and institutional requirements for their implementation should also be taken into account and some of the initial considerations be noted down.

Solutions in climate change adaptation are manifold and range from no- or low-cost measures in policy and plans to major and long-term investments in infrastructure.

'Soft' adaptation measures start with making climate change a routine parameter in the decision-making of all departments of the local government. Such a process of mainstreaming climate change does not require additional resources, but rather a solid understanding of climate risks at the local level. It refers to including climate change information in policy formulation, planning documents and processes, as well as in rules and regulations. For example, land use plans should take climate change and its impacts into account in order to avoid further investment in infrastructure and housing in areas at risk of flooding or landslides. Building codes can also play a role in adaptation to climate change. They can establish standards to make buildings less sensitive to climate change impacts and can include regulations concerning efficient water and energy use.

Figure 11: Adaptation options



Strategic Environmental Impact Assessments (EIA) analyse the effects of planned projects, for example the construction of buildings or roads, on the environment. In a similar way, 'climate proofing' can be included in infrastructure and service provision to ensure that new programmes and investments can withstand future climate stress.

'Hard' adaptation measures, including physical protection, might also be necessary depending on local geographical and climate conditions and expected climate change impacts. Embankments protecting against flooding are an example of such measures.

5.2 Prioritisation and selection of actions

In the next step the adaptation options identified need to be prioritised. This process shall take into consideration, amongst others:

- the potential benefits of the measures for vulnerable groups and sectors;
- the required resources (cost-benefit analysis); and
- the feasibility under local conditions.

After evaluating and prioritising the proposed adaptation measures, those which address the most imminent climate threats, offer the highest benefits to vulnerable systems and groups, match available resources or are likely to receive funding from external sources and which are feasible in the city's context should be selected.

Finally, timelines, budgets and responsibilities for implementation need to be allocated.

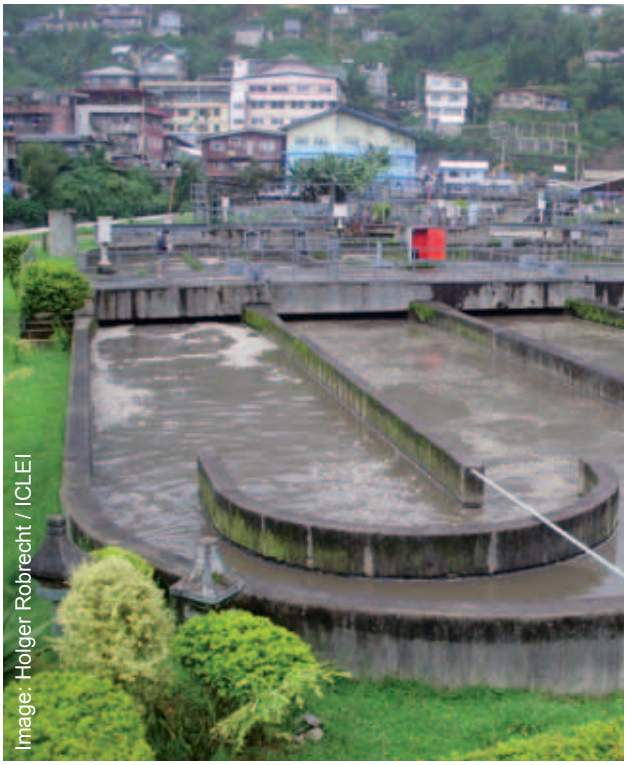
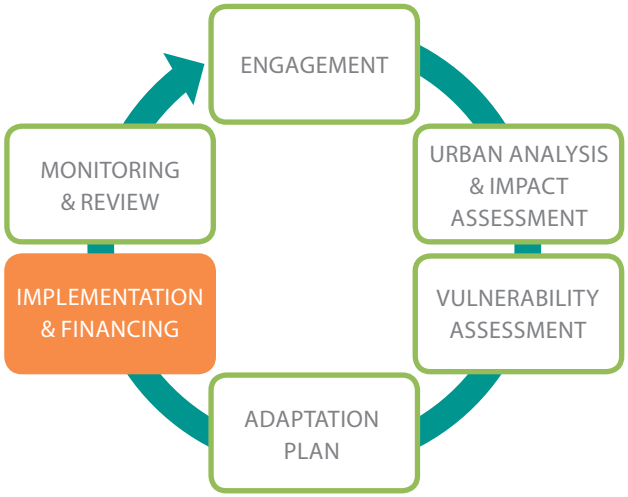


Image: Holger Robrecht / ICLEI

KEY COMPONENTS OF AN ADAPTATION PLAN

- **City background**
  Location, history, demography, topography, industry, livelihoods
- **Description of process**
  - How the process was started
  - Which stakeholders were involved
  - Consultations or other interactions with stakeholders performed
  - Studies/surveys undertaken
- **Current conditions and future projections related to urban systems and climate change**
  Climate change impacts, results from urban system analysis, socio-economic and climate scenarios, critical uncertainties
- **Risk, vulnerability and sector study findings**
  Results of the risk assessment, the vulnerability assessment, and from sector-specific studies
- **Strategy for climate change adaptation**
  - Key priorities identified
  - Links to overall development and/or master plan
  - Links to current and planned initiatives, and cross-sectoral considerations
  - Selected focus of short-, mid- and long-term investments
- **Actions for climate change adaptation**
  - Descriptions of actions including responsible departments and estimated budget
  - Indicators for monitoring and evaluation
  - Time plan
  - Budget
  - Allocation of responsibilities

6. Implementation and Financing



With the development of the adaptation plan the first milestone for implementation has been accomplished.

Actual implementation can start once the political decision-making body in the city has endorsed the plan and approved the budget. If there is no or insufficient local government budget to realise the plan, options for funding from other sources will have to be explored first.

Such sources might be, amongst others:

- State and central level funding
- Regional financing arrangements (for example, via regional development banks such as the Asian Development Bank)
- Multi-lateral development banks
- Bilateral development aid as direct and indirect climate change funds (for example, International Climate Initiative from German Federal Environment Ministry)
- Private investments (for example, insurances, financing products, crowd-funding, public-private-partnerships)

A good overview on international climate finance initiatives can be found here: http://www.climatefundsupdate.org

The implementation of the plan should not be blocked because larger projects cannot be realised immediately. As already indicated the plan should also contain soft measures which are equally important.

Mainstreaming climate change concerns and adaptation solutions across all departments is the most important aspect and promises the most lasting effects. Mainstreaming is first and foremost an internal affair which requires good communication and strong leadership to get all key decision-makers on board. Some further training might be required for key staff. Regular reviews will be necessary to monitor whether new projects in the different sectors consider future scenarios of climate change and follow the strategic direction identified in the action plan. All these soft measures can usually be financed within existing local government budgets.

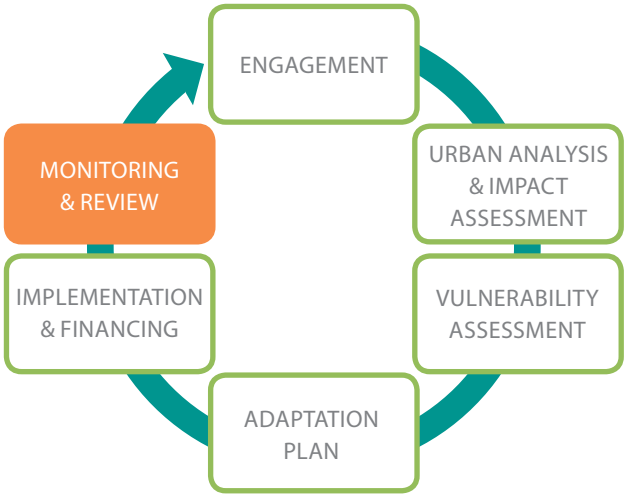
'Low-hanging' fruit and no- or low-cost measures should also be taken into consideration. Sometimes the relocation of a bigger investment project or the integration of adaptation in on-going and already financed initiatives, such as the rehabilitation of slum areas, can be a major step forward.

Furthermore, partnerships established for the development of the plan should continue to be fostered. Joint undertakings with the business sector might allow the sharing of costs and benefits in the implementation phase.

If loans or grants are provided by national government agencies, there is usually a prescribed country-specific process for submitting projects for funding. There are also a number of international financing mechanisms managed at country level. However, the requirements for these are often complex and subject to change, cannot be explained in further detail here. The advice of a financial expert is required for a good grasp of conditions and rules.

In any case, even where additional funding is not immediately available, opportunities to implement practical adaptation measures do always exist. These may be, for example, the adjustment of building codes, the consideration of climate change issues in land use planning and the climate proofing of new infrastructure investments by integrating criteria relevant for climate change in the statutory decision-making process.

7. Monitoring and Review



As in any other field of public management and service provision, regular monitoring is indispensable to keep the process on track and reflect on its effectiveness.

In adaptation, monitoring also serves a number of specific purposes which include:

- Observing changes in the local climate variables due to the impacts of global climate change;
- Determining changes in the exposure, sensitivity and the adaptive capacity of social groups and urban systems;
- Analysing the level of achieving the objectives of the adaptation plan as part of the review at the end of a management cycle and as a basis for correcting the course of action if results are not satisfactory;
- Assessing progress in the adaptation process itself - i.e. tracking whether responsibilities, budgets and timelines are respected and the process is progressing as foreseen.

While the process follows typical routines of public management, there are also a number of challenges that are more specifically connected with climate change adaptation.

- **Long timeframes** - Climate change adaptation is a long-term process that stretches far beyond the span of programme management and political cycles.
- **Uncertainty** - Models exist which allow the projection of climate conditions into the decades to come, but they have to make use of past climate data which do not necessarily compare to the magnitude and nature of change expected in the future. Different models also result in different projections. Finally, scientifically sound methodologies for down-scaling global and regional scenarios to urban territories are still under development. Uncertainty about the future climate implies that impacts also remain uncertain.
- **Measuring 'non-events'** - Particular adverse climatic events might not take place during a certain timeframe and success may then constitute stabilisation or preparedness rather than improved conditions.
- **Contribution rather than attribution** - Indicators usually provide evidence on changes that can be attributed to a specific project or measure. However, due to the complexity, the multi-sectoral nature and long timeframes of climate change, indicators for adaptation need to focus on how policies and programmes can contribute to the overall process.

In order to define indicators for climate change and climate change adaptation, existing ones in other sectors, such as urban development, natural resource management, or disaster risk management can provide inspiration. However, they will usually have to be adjusted to comply with the specific characteristics of climate change and adaptation as outlined above.


Image: Barbara Anton / ICLEI

A few types of indicators and the questions by which evidence is gathered are described below:

Type of indicators	Questions addressed by using the respective type of indicator (examples)
INDICATORS FOR CLIMATE CHANGE	
Climate change impact indicators	• What do the observed changes in the climate imply at local level? • What kinds of chain reactions might be triggered between direct and indirect impacts?
Vulnerability indicators	• What is the current situation of social, economic, environmental, physical and technical systems in the city? • How will different sectors, social groups and basic services likely respond to climate change in the future? • How will the impacts of climate change exacerbate existing socio-economic and environmental issues?
INDICATORS FOR CLIMATE CHANGE ADAPTATION	
Outcome indicators	• What is the long-term effect of implemented solutions on social groups and urban systems? • Have exposure or sensitivity to climate change hazards indeed been reduced? • Has the adaptive capacity of vulnerable social groups and critical urban systems been strengthened?
Process indicators	• Has the allocation of responsibilities, timelines and budgets been taken seriously? • To what extent has climate change adaptation been mainstreamed into city plans and processes? • What can we learn from the process of implementing the identified solutions in the short to medium-term?


Image: BDphoto / iStock.com

The following considerations can provide some direction for city officials when monitoring and reviewing their adaptation process:

- *Tailored approach to the type and scale of the activity*: The level of detail explored does not necessarily improve its usefulness for monitoring and review.
- *Combination of process and outcome indicators*: It should be recognised that adaptation outcomes often cannot be determined for many years.
- *Consideration of the unintended and unexpected*: The approach should be sufficiently flexible to take unforeseen outcomes into account. This may be where some of the most important adaptation lessons can be learnt.
- *Learning at the centre*: Monitoring should be seen as a way of learning to find out which adaptation interventions work well, in which contexts and why.
- *Connections between bottom-up and top-down information and decision-making*: This can help to avoid the duplication of efforts and pool scarce resources.
- *Communication of the accomplishments to the wider community*: Sharing the learning with as many concerned people as possible will make time and resources invested in adaptation pay-off in the future.
- *Engagement and involvement*: Enabling stakeholders to participate in the formulation of indicators, the gathering of data and in the actual review process helps validate outcomes and strengthens ownership among key players.

Image: lovingyou2911 / iStock.com

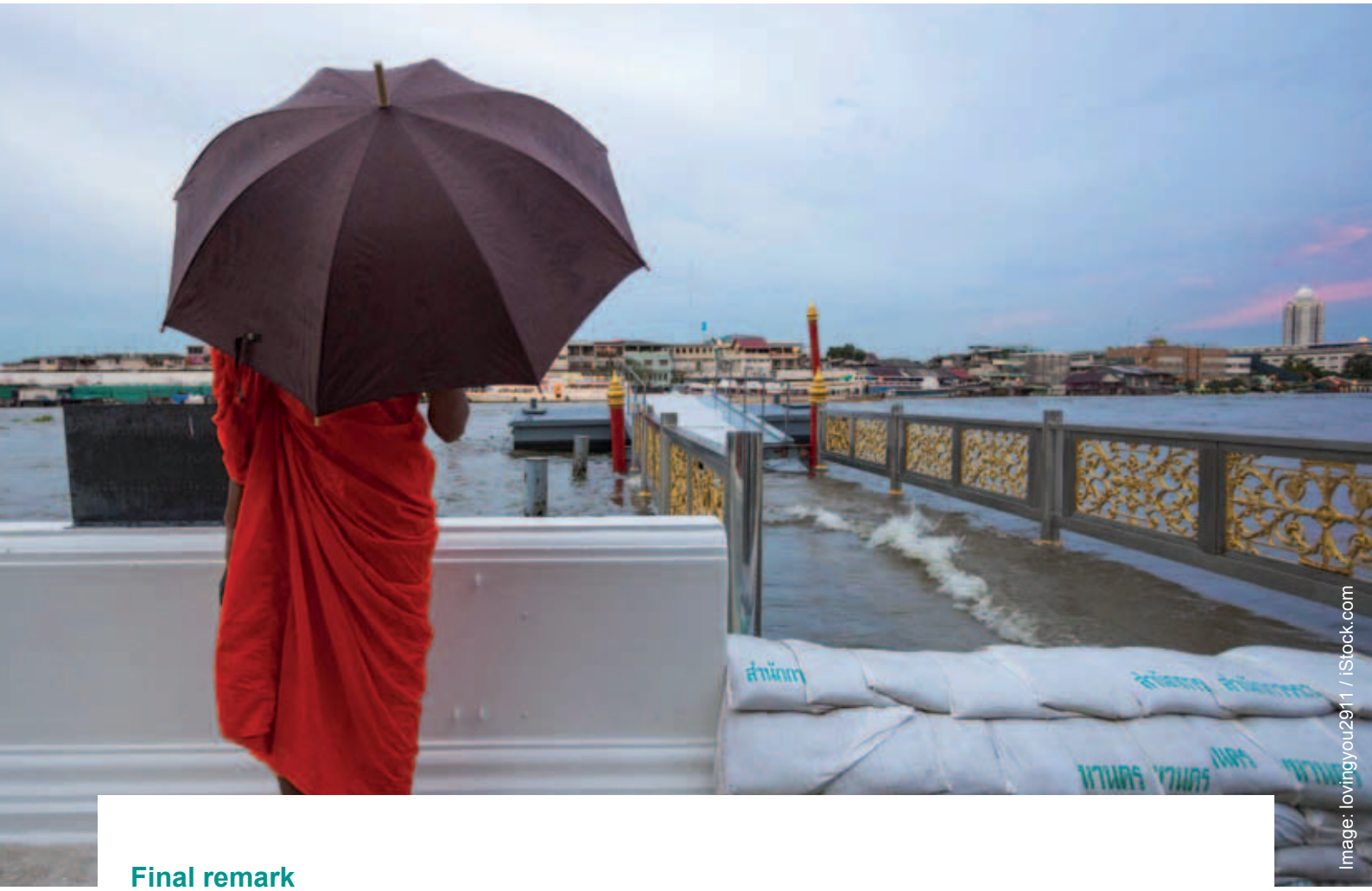


Image: lovingyou2911 / iStock.com

Final remark

While the full implications of climate change seem difficult to grasp, early experience with adaptation shows that much can be gained. Climate change adaptation can be easily reconciled with development goals and works best if mainstreamed across all sectors.

No one blueprint for adaptation exists. In cities, however challenging, it will be local stakeholders who will have to find the most appropriate solutions for their specific situation, which is defined by a complex web of social, cultural, political, economic, environmental and other characteristics.

The leadership of local governments in adapting to climate change is crucial. It helps to ensure a cross-sector approach, mainstream climate change into development plans and provide accountability. At the same time, adaptation can only become truly effective with the well-defined participation of stakeholders to share expertise and learning, resources and capacities and achieve tangible progress towards improved resilience.

Creating a solid foundation of knowledge before conceiving possible solutions is a critical factor when embarking on adaptation - despite the uncertainties which will always remain. Local governments therefore need to collaborate with scientific experts to collect the right facts and figures and to understand how to read and analyse them. Compared to other domains, climate change will, to a greater degree, require the continuous updating of information, on-going knowledge management and regular reflections on the observations made with regard to climate variables, local impacts and the resulting measures for reducing local vulnerability.

Many pioneering local governments all over the world have already developed their first strategies and plans. It is hoped that a lot of others will follow and the threat of climate change will gradually be transformed into a driver for more sustainable development.

Glossary

Below are some of the most frequently used terms in the area of climate change adaptation:

ADAPTIVE CAPACITY: The ability to adjust to climate change, to moderate the potential damage from it, to take advantage of its opportunities, or to cope with its consequences (for example, the level of ability to move to a safer location).

CLIMATE: The statistical distribution of weather patterns over long periods of time. The specific climate of a region is based on weather patterns which are generally predominant in the respective region; this is also the basis for dividing the globe into various climate zones (for example, tropical monsoon climate).

CLIMATE CHANGE: A significant shift in climate conditions that occur and persist for an extended period, typically decades or longer (for example, winters are not as cold as they used to be).

CLIMATE CHANGE ADAPTATION: An adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (for example, rooftop water harvesting).

CLIMATE CHANGE MITIGATION: An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases (for example, the use of renewable energies).

CLIMATE CHANGE PROJECTIONS: Envisaged responses of the climate system based on assumed greenhouse gas emission scenarios.

CLIMATE CHANGE SCENARIOS: Expected future climate conditions based on current conditions and climate projections (for a certain geographical region).

CLIMATE VARIABILITY: A range of weather events that, when averaged together, describe the climate of a region. Or in other words: weather conditions that vary in a particular season but are not repeated regularly (for example, variations in precipitation during monsoons).

DISASTER RISK REDUCTION: A set of activities carried out to minimise vulnerabilities and disaster risks in a society, and avoid (prevention) or limit (mitigation and preparedness) the adverse impact of hazards within the broad context of sustainable development (for example, the construction of earthquake proof buildings or bio-shields against tsunamis).

EXPOSURE: The nature and degree to which a system is exposed to significant climatic variations and/or its consequences and impacts (for example, slums in flood prone areas).

SENSITIVITY: The degree to which a system is affected either adversely or beneficially by climate related stimuli (for example, children and elderly are more sensitive to climate stimuli).

VULNERABILITY: The degree to which a system is susceptible to the adverse effects of climate change, including climate variability climate extremes and related direct and indirect impacts.

WEATHER: The day-to-day temperature, humidity, precipitation activity, wind and atmospheric pressure.


Image: Ramiz Khan / ICLEI South Asia

Interested in how local governments in India and the Philippines tackle climate change?
Looking for inspiration and real-life stories?

AsianCitiesAdapt

Knowledge and Action - Climate Change Impacts in Asian Cities and Ways to Adapt

This film, one of the results of the AsianCitiesAdapt project, features local protagonists in climate change adaptation in several cities in India and the Philippines which have all been involved in developing local adaptation strategies. You will also hear project partners - among them senior scientists from the Indian Institute of Technology Delhi and the Potsdam Institute for Climate Impact Research - share their own insights and views on climate change and its likely consequences for cities at risk.

A film by Ephraim Broschkowski and Bernd Hezel produced by the Climate Media Factory.

CLIMATE MEDIA FACTORY

Curious? Then watch it for free on
www.asian-cities-adapt.org or
http://youtu.be/Ywfoqbqza54
Or send an email to the following address to order your own copy:
asian-cities-adapt@iclei.org
Length: 32 min. Format: DVD (PAL)

ICLEI Local Governments for Sustainability

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

This primer introduces readers to the most important practical aspects of a process for climate change adaptation. It is dedicated to local governments in Asia and mainly addressed to city decision-makers who are on the point of moving climate change higher on their political agenda and creating a safer and healthier place for their communities to live and work.

The document outlines a process that urban planners, city developers, green space managers, health workers etc. - local government officials from all sectors can take up to become drivers for climate change adaptation through investigating the challenges, engaging their stakeholders and getting ready for action.

This publication has been produced in the context of 'AsianCitiesAdapt - Impacts of Climate Change in Target Cities in India and the Philippines and Local Adaptation Strategies' (2010-2013). The project brought together science and policy in order to support local governments in their adaptation efforts.

The following cities were directly engaged in the project: Howrah, Madurai, Kochi and Visakhapatnam in India; and Baguio, Dagupan, San Fernando (La Union), and Tuguegarao in the Philippines.

For more information on the project and all other results see:

www.asian-cities-adapt.org

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AsianCitiesAdapt has been part of the International Climate Initiative. The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety supports this initiative on the basis of a decision adopted by the German Bundestag.

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety