Climate Change Concepts (CC)

1. METHOD DESCRIPTION

Objective

This tool summarizes and explains the key terminology related to climate change, resilience, disaster risk reduction and management. Additionally, it provides references for further reading. The tool contains this method description and an information sheet.

When to use

This activity supports the following task:

Phase/Element	Element I: Substantive Process	Element II: Resources and Capacities	Element III: Policies	Element IV: Institutions and Stakeholders
Phase A: Feasibility and Diagnosis	✓ Identify urban-related climate change issues, mainstreaming objectives and climate actions			
Phase B: Formulation				
Phase C: Implementation				
Phase D: Monitoring and Evaluation				

Additionally, it can be used prior to embarking on the mainstreaming process, as well as for general reference throughout the mainstreaming process to gain a more thorough understanding of climate change concepts and terminology, climate change impacts on urban areas in the Asia Pacific region, and vulnerable groups of people.

Key Points Covered

- Definition of Climate Change
- Historical, observed and projected changes (both globally and in the Asia-Pacific region)
- Climate change impacts on urban areas (global and Asia-Pacific)
- Concepts of climate resilience (climate change mitigation, adaptation and disaster risk reduction and management)
- Definition of vulnerability
- Vulnerable groups of people

2. INFORMATION SHEET

What is Climate Change?

Climate change refers to changes to the average weather and weather variability of a region or the planet over time. It is measured by changes in temperature, precipitation, wind, storms and other indicators. Other important indicators, including sea level rise, are also used to measure climate change.

The key climate change indicator that scientists look to is the average surface temperature of the earth. Over the past 50 years, the global average temperature increased by 0.65°C[1].

Global ocean temperature is also an important factor to consider due to its effect on surface temperatures. The world's oceans are absorbing much of the heat added to the earth's climate system and, as the ocean circulates, much of that heat is released into the atmosphere, increasing the warming effect over time. As illustrated in Figure CC 2.1, no regions are immune to rising temperatures, although some have witnessed sharper increases in the last 25 years[2]. The continental temperature increase in Asia is displayed in Figure CC 2.2.

In its 5th Assessment Report in 2013, the Intergovernmental Panel on Climate Change (IPCC) stated that, "Most of the observed increase in global average temperatures since the mid-twentieth century is very likely (>95 per cent) due to the observed increase in anthropogenic greenhouse gas concentrations." In other words, most of the global warming from the past 50 years is believed to be caused by human activity. The increase in carbon dioxide levels in the atmosphere, primarily from the burning of fossil fuels and land use change, is increasing global temperatures at a rate never before seen in human history.[3]

[1] [2] [3] Planning for Climate Change: Guide – A strategic, values-based approach for urban planners, pp. 14-29 Climate Change: A Review to the Asia Pacific context.

Figure CC 2.1: Projected changes in global average surface temperature and precipitation[4]

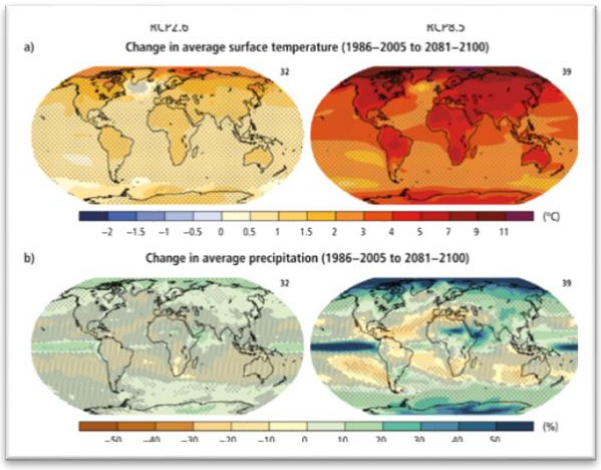
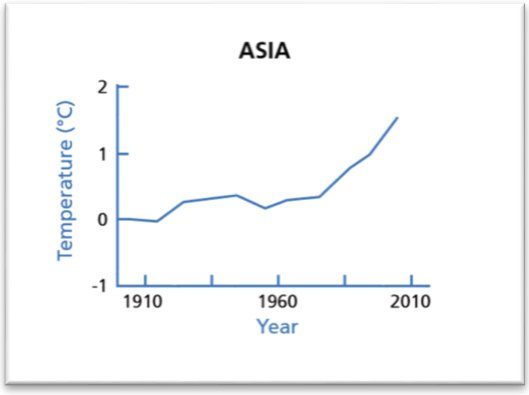


Figure CC 2.2: Continental Temperature Increase: Asia[5]



The IPCC's Fifth Assessment Report also determined that global temperatures are likely to rise by 0.3 -4.8 degrees Celsius by the end of the century, depending on how much governments control carbon emissions. The first map in Figure CC 2.1 illustrates the change in average surface temperature: the best-case and worst-case scenarios to the year 2100. Both maps show the change since 1986. The lower map shows the change in annual precipitation, by percentage, from 1986 to 2100.

Climate Change Impacts on Cities

The changes in temperature and precipitation are leading to **increased storm severity** and extent, **extended drought** conditions, **sea level rise** and associated **coastal erosion** and **flooding**, and increased or intensified **flash flooding**, among other biophysical effects. These changes will impact human settlements throughout the world, with particularly severe impacts in low- and middle-income countries where the capacity to manage impacts may be limited and vulnerable populations are larger.

[4] IPCC. 2014. IPCC Fifth Assessment Report.
[5] IPCC. 2014. IPCC Fifth Assessment Report.

Currently in the Asia Pacific region, over 50 per cent of the population lives in cities[6]. As major centers of consumption and production, they are great energy consumers and as a result, major greenhouse gas emitters. The Fifth Assessment Report of the Intergovernmental Panel on Climate Change states that urban areas "account for between 71% and 76% of CO2 emissions from global final energy use (medium evidence, medium agreement)". Urban populations are projected to continue growing rapidly, and cities in the Asia Pacific region are projected to contribute more than half the rise in global greenhouse gas emissions over the next 20 years if no action is taken[7].

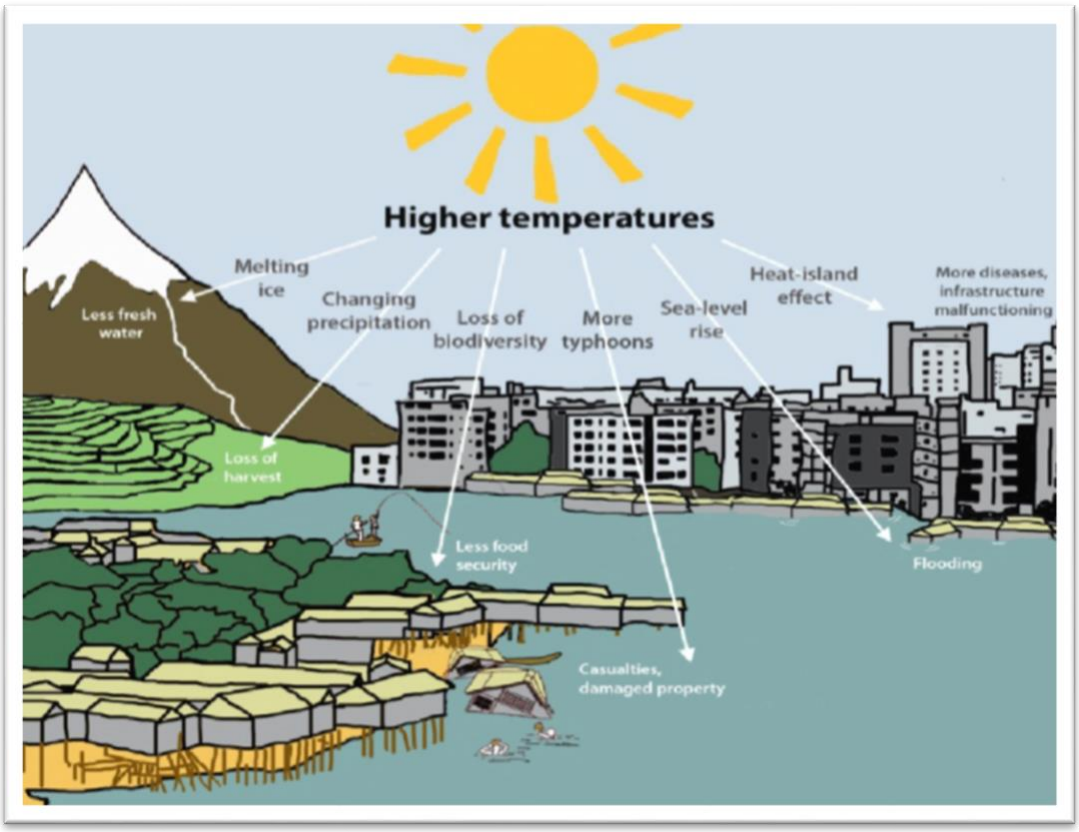
Cities are complex systems. The energy that cities consume and the associated emissions they produce can be attributed primarily to building construction, cooling, heating and electrification, vehicle use, industry and manufacturing. Multiple urban planning considerations help to determine the level and intensity of these emissions, including how we arrange our cities (urban form), population densities (urban density), and how we move in and through cities (urban mobility). Additionally, how we manage the wastes we produce, both liquid and solid, can either contribute to our greenhouse gas emissions or help to reduce them.

In addition to being major contributors to climate change, cities in developing countries, and in particular the urban poor are disproportionately *vulnerable* to the impacts of climate change. The concept of "vulnerability" will be explained in further detail in a later section.

Figure CC 2.3 illustrates the major climate change impacts in urban areas. Climate impacts are often categorized as primary impacts (i.e. those that are directly caused by a climate hazard) and secondary or tertiary impacts (i.e. those that are a result of the primary impacts). While not always the case, primary impacts are often biophysical, such as landslides or flooding, and secondary impacts are often socio-economic (that is, impacts on human lives and livelihoods). Table CC 2.1 demonstrates some examples of primary and secondary impacts stemming from climate change-related hazards. The table is followed by more detailed information on three key climate change impacts on urban areas: 1. flooding, 2. water scarcity, and 3. Heat Island Effect.

[6] [7] UN-ESCAP: Urbanization and sustainable development in Asia and the Pacific: linkages and policy implications

Figure CC 2.3: Climate Change and Cities[8]



[8] Illustration by Daphna Beerdsen and Joris Oele. Derived from UN-ESCAP 2014 Quick Guide for Policymakers, p. 10

Table CC 2.1: Climate Change Impacts on Cities

CLIMATE HAZARD	POTENTIAL PRIMARY IMPACTS	POTENTIAL SECONDARY IMPACTS
Increased Temperatures	- Groundwater depletion - Water shortages - Drought - Degraded air quality (smog)	- Water shortages - Distress migration to cities/towns due to droughts in rural areas - Reduced food supply and higher food prices - Potential energy price increases (e.g. from reduced hydro-electricity generation in places where it exists) - Exaggerated urban heat island effect - Increased energy demands for cooling - Need for higher or additional wastewater treatment - Population health impacts (e.g. increased mortality during heat waves, decreased access to food/nutrition)
Increased Precipitation	- Increased flooding - Increased risk of landslides or mudslides on hazardous slopes	- Reduced food supply and higher food prices - Property damage (homes and businesses) - Disruption of livelihoods and city/town economies - Damage to infrastructure not designed to the standards necessary to withstand the occurrences being experienced - Distress migration to cities due to floods in rural areas - Displacement and population movement from informal settlements built on steep slope hazard lands, etc. - Increased vector borne diseases (malaria, dengue, encephalitis) and water borne diseases (acute diarrhoea, cholera, dysentery)
Sea Level Rise	- Coastal flooding - Salt water intrusion into groundwater supplies in coastal areas - Increased storm surge hazard - Coastal erosion	- Displacement and population movement from coastal areas - Property damage (homes and businesses) - Damage to infrastructure not designed to the standards necessary to withstand the occurrences being experienced - Disruption of livelihoods and city/town economies - Reduced food supply and higher food prices - Population health impacts (e.g. injuries, increased mortality and illness) - Loss of productive/residential land due to erosion
Increased Extreme Weather Episodes (storms, cyclones, hurricanes)	- More intense flooding - Higher risk of landslides/ mudslides on hazardous slopes - Intense and disastrous wind speeds	- Property damage (homes and businesses) - Damage to infrastructure not designed to standards of occurrences being experienced - Population health impacts (e.g. injuries, increased mortality, distress) - Disruption of livelihoods and city/town economies - Reduced food supply and higher food prices

1. Flooding is expected to be the most far-reaching climate impact in the Asia Pacific region. Climate change has the potential to increase flooding in three ways:

- Sea level rise and coastal inundation: Climate change is causing higher sea levels due to increasing glacial and polar ice melt. It is also causing sea levels to rise by warming the oceans themselves, which causes their overall volume to increase. There are estimates by the United Nations that sea levels could rise between 18cm and 59cm on average by the end of the twenty-first century. [9] In combination with the increased frequency and magnitude of marine storms (e.g. cyclones, typhoons, and hurricanes), storm surges associated with these events are becoming larger and more damaging. Currently, more than half of the Asia Pacific region's urban population lives in low-lying coastal areas, and 119 urban agglomerations out of a

[9] Planning for Climate Change: Guide – A strategic, values-based approach for urban planners, pp. 14-29 Climate Change: A Review to the Asia Pacific context.

total of 305 are located in flood-risk coastal zones and susceptible to sea-level rise (i.e. less than 10-metres above sea level).[10] Pacific Island states are particularly threatened by sea level rise.

The impacts of sea level rise on a given city will vary depending upon its location and level of development (e.g. some cities may have built sea walls or preserved protective natural ecosystems such as mangrove forests to protect their coasts from the impacts of rising sea levels, while other cities have coastlines that are more prone to coastal inundation, flooding and erosion). Urban planning is key to determining appropriate actions to reduce vulnerability including: the location and scale of marine defenses like sea walls; the identification and avoidance of development in sea level rise hazard areas (or ensuring that new development in hazard-prone areas can withstand storm surges and related hazards); and the identification and protection of shoreline areas (e.g. conservation of mangrove forests) that provide a natural defense for storm surges and coastal flooding, while simultaneously serving as greenhouse gas sinks.

- Increased rainfall: Intense, heavy rainfall events are likely to increase in frequency and magnitude in the Asia Pacific region because of climate change. Due to the large amounts of impermeable surfaces (roads, buildings, paved areas) in cities and towns, places with inadequately designed or limited storm sewer and drainage systems will be faced with flooding during these storm events. There are potential health impacts, through increased incidences of water-borne diseases in areas where open sewage ditches or combined sewer-storm water systems are overwhelmed during storms and introduce raw sewage into the floodwaters. There is a growing body of research that indicates increased rates of injury and death from flooding in urban areas in Asia with inadequate drainage and flood protection systems.[11]

  The impacts of increased/intensified rainfall will again vary depending on the urban area's level of development and infrastructure. For example, some lesser-developed cities may have more pervious surface (e.g. unpaved areas) where rainfall can be more easily absorbed (absorption rates will depend on how dry or pervious land is). Other cities may have more developed storm water management systems and infrastructure with which to manage the increased and intensified rainfall events, although the intensity of the events may overwhelm even the most comprehensive systems.

- Increased/intensified river flooding: Increased and intensified rainfall from storms ultimately leads to higher incidences of rivers overflowing their banks. In urban areas, particularly those in low-lying areas or river deltas, this type of flooding has been increasing. Increased river runoff as a result of climate change may be compounding this situation.

  As with the other areas explored in the flooding theme, the impacts of river flooding vary depending upon the location (e.g. some cities are located on river deltas, river confluences, or around larger rivers) and the level of development (e.g. some cities may have built protective dikes or controlled development in the flood plain to mitigate the impacts of river flooding).

2. Water Scarcity: Access to clean water will be further threatened as a result of climate change. Lack of access to safe drinking water and adequate sanitation is a major cause of ill health and life-threatening disease in the Asia Pacific region[12]. In many towns and cities in the developing world, access to potable water is not universally available and sanitation coverage is still low. Many cities and towns will not only face increased water demands

[10] [11] Planning for Climate Change: Guide – A strategic, values-based approach for urban planners, pp. 14-29 Climate Change: A Review to the Asia Pacific context.

[12] [13] Planning for Climate Change: Guide – A strategic, values-based approach for urban planners, pp. 14-29 Climate Change: A Review to the Asia Pacific context.

with population increases – brought about in part from rural migration from water scarce areas – but also water supply issues as their own freshwater sources are impacted by climate change. These problems will be further compounded in cities and towns with limited, poorly maintained or outdated water supply systems and infrastructure.

As with any climate impact, the scale and severity of potential impacts vary depending upon the region and where its water supply comes from (e.g. glacier-fed water systems will be impacted differently than non-glacier fed systems). As both a supply-side and demand-side issue, water scarcity also depends on the size of the city and its water consumption patterns and rates. It also varies depending on the efficiency of water management systems along with many other factors, including upstream diversions of potable water.

3. Heat Island Effect: Climate change will likely increase temperatures in most cities and towns in Asia. Higher temperatures will be compounded in urban areas by the urban heat island phenomenon – an occurrence where a city's buildings, roofs, paved areas and other infrastructure hold and retain solar heat. This can make a city several degrees warmer than the surrounding rural areas, which have more green space and less heat absorbing materials. It is anticipated that towns and cities will be subject to more frequent and intense heat waves, which will directly impact the health and quality of life of urban residents. In Asia, heat waves have proved to be associated with dramatic short-term increases in mortality for the elderly and very young[13].

Heat Island Effect in cities will also vary depending on the location and the level of development, as some cities may have fewer paved roads and/or other types of surfaces that absorb solar energy.

Climate Resilience

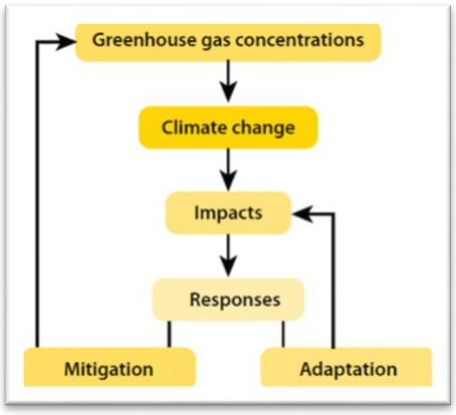
The IPCC Fourth Assessment Report defines resilience as "the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change."

The concept of resilience has been useful in addressing climate risk and unexpected events, and in enhancing efforts to survive and thrive in the context of climate change. Climate change resilience is an umbrella concept that embraces the concepts of climate change **adaptation**, **mitigation**, and **disaster risk reduction**.[14] Each of these approaches will be elaborated below.

Adaptation and *mitigation* are two complementary strategies for responding to climate change (Figure CC 2.4). **Mitigation** is the process of reducing emissions or enhancing sinks of greenhouse gases (GHGs), so as to limit future climate change. **Adaptation** is the process of adjustment to current or project climate and its effects in order to either lessen or avoid harm or exploit beneficial opportunities.[15]

[14] Asian Development Bank.
[15] IPCC. 2014. IPCC Fifth Assessment Report.

Figure CC 2.4: Climate Change Adaptation and Mitigation[16]



- Climate Change Mitigation

Climate Change Mitigation refers to efforts to reduce or prevent emissions of greenhouse gases. Mitigation can mean using new technologies and renewable energies, making older equipment more energy efficient, or changing management practices or consumer behavior. It can be as complex as a plan for a new city; or as a simple as improvements to a cook stove design. Protecting natural carbon sinks like forests and other urban ecosystems or creating new sinks through creating new public green space, for example, are also elements of mitigation. Various examples of mitigation actions that are relevant in the Asia Pacific region are provided in the Climate Change Issues to Actions tool.

- Climate Change Adaptation

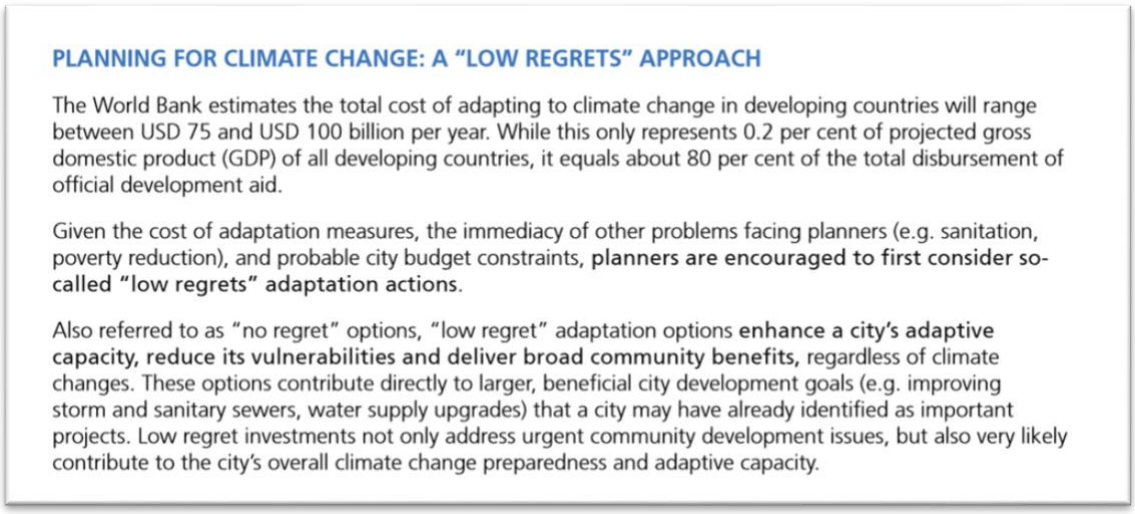
Climate change adaptation, on the other hand, is the proactive adjustment to both current and future climatic changes and their adverse impacts[17]. Adapting to climate change therefore presents the opportunity to build more resilient cities. For example, to reduce damage to housing that is not designed to withstand climate change impacts, the adoption of climate /disaster resilient building design standards may be mainstreamed into national-level housing policy or national building codes.

Various measures to adapt to climate change in the Asia Pacific are also introduced in the Climate Issues to Actions tool. When mainstreaming climate actions into national level urban-related policies, policy makers are well advised to take a systems perspective to mainstreaming and to explicitly design their mainstreaming objectives and actions so as to maximize co-benefits. In other words, it is beneficial to adopt win-win strategies where a climate policy or action also has sizable other developmental benefits, or measures that simultaneously provide adaptation and mitigation benefits. Examples include mitigation or adaptation measures that also reduce air pollution (health benefits) or support energy savings or job creation (reducing poverty). Also, some measures are called "low or no regret measures" when their co-benefits alone are large enough to justify

[16] UN-Habitat. 2015. Cities and Climate Change Initiative: Building Resilient and Low Emission Cities. Presentation prepared for Fukuoka International Exchange Foundation Lecture Series.
[17] drawing on LEG (2011) and IPCC (2014)

implementation even if direct climate benefits are difficult to quantify or can be expected in the long term rather than immediately[18] (see Box CC 2.1 below).

Box CC 2.1: "A Low Regrets" Approach to Adaptation[19]



PLANNING FOR CLIMATE CHANGE: A "LOW REGRETS" APPROACH

The World Bank estimates the total cost of adapting to climate change in developing countries will range between USD 75 and USD 100 billion per year. While this only represents 0.2 per cent of projected gross domestic product (GDP) of all developing countries, it equals about 80 per cent of the total disbursement of official development aid.

Given the cost of adaptation measures, the immediacy of other problems facing planners (e.g. sanitation, poverty reduction), and probable city budget constraints, **planners are encouraged to first consider so-called "low regrets" adaptation actions.**

Also referred to as "no regret" options, "low regret" adaptation options **enhance a city's adaptive capacity, reduce its vulnerabilities and deliver broad community benefits,** regardless of climate changes. These options contribute directly to larger, beneficial city development goals (e.g. improving storm and sanitary sewers, water supply upgrades) that a city may have already identified as important projects. Low regret investments not only address urgent community development issues, but also very likely contribute to the city's overall climate change preparedness and adaptive capacity.

- Disaster Risk Reduction

There is a very close relationship between disaster risk reduction and climate change adaptation. Disaster risk reduction is formally defined in the United Nations International Strategy for Disaster Reduction as "action taken to reduce the risk of disasters and the adverse impacts of natural hazards, through systematic efforts to analyze and manage the causes of disasters, including through avoidance of hazards, reduced social and economic vulnerability to hazards, and improved preparedness for adverse events".

Disaster risk reduction and management activities should be coordinated with climate change adaptation measures so that they can also counteract the added risks arising from climate change.

Vulnerability to Climate Change

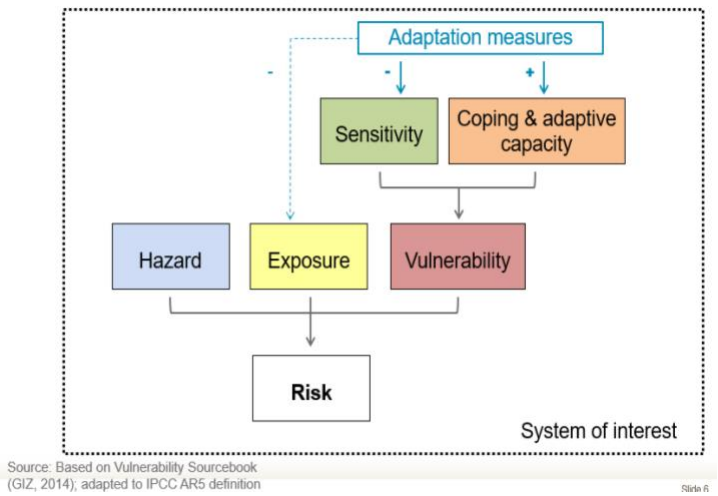
People have always adapted to changes in climate through a variety of means. However, anthropogenic climate change experienced in recent years is pushing vulnerable populations beyond their capacity to cope and adapt to the changes they have traditionally dealt with; and is making more people **vulnerable** due to their increased **sensitivity** to climate change, coupled with limited **adaptive capacity** to cope with climate change impacts (see Box CC 2.2 below for definitions of these terms).

[18] Mahendra Sethi, Jose A. Puppim de Oliveira (ed) (2018) 'Mainstreaming Climate Co-Benefits in Indian Cities: Post-Habitat III Innovations and Reforms', p. 11

[19] Source: Rasmu Heltburg et al. (2008). Addressing Human Vulnerability to Climate Change: Toward a "No Regret" Approach. World Bank. November. Retrieved from Planning for Climate Change, p. 29.

Box CC 2.2: Vulnerability and Risk

The figure visualizes the different components of risk by adapting the "impact chain" introduced in the Vulnerability Sourcebook to the IPCC Fifth Assessment Report. As illustrated, ***Vulnerability*** results from the interaction of sensitivity and coping & adaptive capacity (e.g. high sensitivity coupled with low adaptive capacity would result in a high vulnerability scenario, whereas low sensitivity coupled with high adaptive capacity would result in a low vulnerability scenario). ***Risk*** results from the interaction of climate hazards, exposure and vulnerability. Undertaking adaptation and mitigation actions can serve to reduce vulnerability and risk. The respective terms are defined below.



Source: Based on Vulnerability Sourcebook (GIZ, 2014); adapted to IPCC AR5 definition

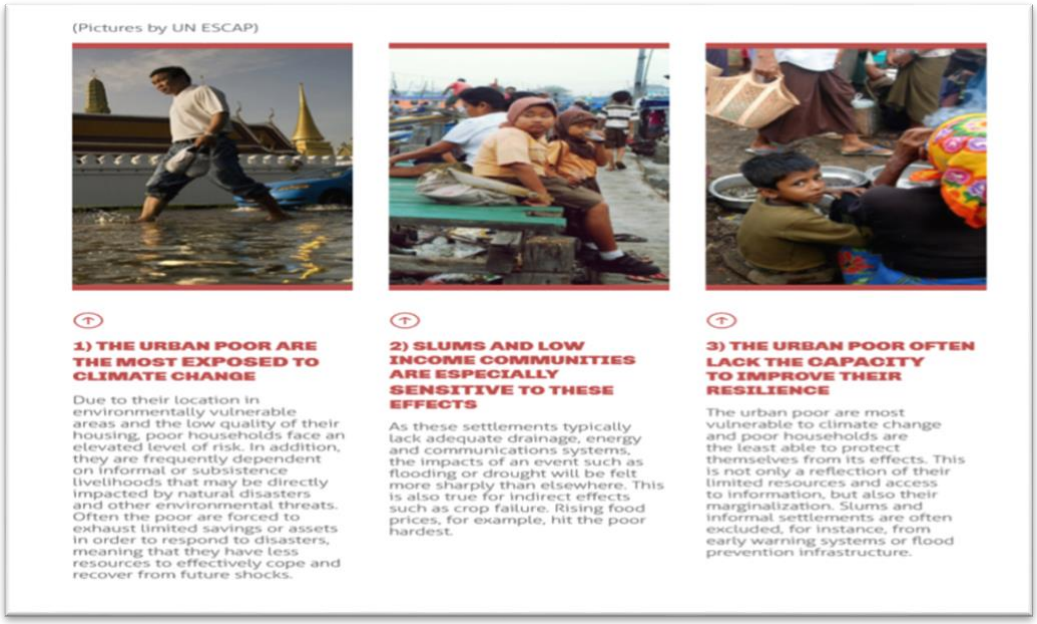
- ***Hazard:*** Refers to hazards such as drought, flooding, sea level rise, increased frequency in storms associated with climate change, as well as their impacts to ecosystems and urban systems. Considers both current climate information and projected climate scenarios.
- ***Exposure:*** Considers both current and projected changes based on a review of historic and current climate information and projected climate scenarios. It also identifies the climate change hazards associated with the change, including their current and future magnitude and frequency.
- ***Sensitivity:*** The degree to which exposed people, places, institutions and sectors are impacted, either positively or negatively, by climate change today, and the degree to which they could be impacted in the future.
- ***Coping & Adaptive Capacity:*** The degree to which people, places, institutions, and sectors are able to adapt and become more resilient to climate change impacts. Adaptive capacity typically is indicated by socio-economic and environmental factors and local realities that enable a city or community to adjust its system in view of current and future risks.

While the impacts of climate change are felt around the world, they are distributed unevenly, with some areas and people being affected more than others. Vulnerability to climate change is also distributed unevenly in cities and towns, with some groups being impacted more severely than others. This sub-section describes three of the groups most vulnerable to climate change that will require additional consideration in the climate change mainstreaming process: **1. the urban poor**, **2. women**, and **3. the elderly and young**.

1. **The Urban Poor:** Poor people in cities may have higher incomes than in rural areas, but these may rely on unstable and inadequate sources of livelihood. The urban poor often do not own the land they occupy or have a formal legal identity needed to possess housing registrations and building permits. Environmental health, especially for women and children, can significantly impact their livelihoods and well-being. These factors can make recovering from risks and shocks, both natural and man-made, a challenge.

   Rapid, inequitable and unplanned urban growth in developing countries has led to the emergence of highly vulnerable urban communities, particularly those living in informal settlements. Between 2000 and 2014, the proportion of the region's urban populations living in slums has reduced from 40 percent to 27 percent. This still means that around 560 million people in the Asia-Pacific region live in slums, typically in poor-quality housing with insecure residential status, built on marginal land such as flood plains or erosion prone slopes, and with inadequate access to safe water and sanitation.[20] Given the deprived living conditions in slum or squatter settlements, the urban poor are more susceptible to climate-related risks, such as the increased likelihood of more frequent and severe flooding, compounded by non-climate factors such as land subsidence and poor drainage.

Figure CC 2.5: Climate Change and the Urban Poor[21]



2. **Women:** In many poor, urban communities, women and girls are likely to bear disproportionate hardships with respect to climate change impacts. This is because climate change tends to impact the sectors that

[20] Planning for Climate Change: Guide – A strategic, values-based approach for urban planners, pp. 14-29 Climate Change: A Review to the Asia Pacific context.

[21] UN-ESCAP 2014 Quick Guide for Policymakers

form the basis of livelihoods for which women are traditionally responsible, like food and agriculture (small-scale), water supply and gathering, and energy supply. Moreover, because of gender-based inequalities in terms of property rights, resources, access to information and socioeconomic roles, the effects of climate change will have a disproportionately severe effect on women. As a result of gender-based inequalities, women need to be involved in the process of adaptation and processes need to be designed to be supportive and accessible.

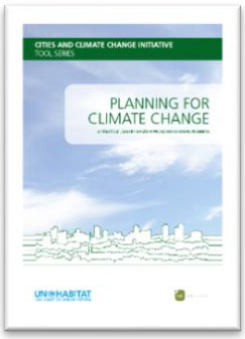
Recent World Health Organization research[22] confirms growing evidence that women and men suffer different negative health consequences following extreme climate change-related events like floods, drought and heat waves. This research found that while disasters create hardships for everyone, natural disasters on average kill more women than men, or kill women at a younger age than men. The research found that "these differences persist in proportion to the severity of disasters, and also depend on the relative socioeconomic status of women in the affected country", but that the "effect was strongest in countries where women have very low social, economic and political status".

3. The elderly and the young: The elderly and the young are less able to avoid the direct and indirect impacts associated with climate change due to their age and physical abilities. They are also less able to cope with any resulting injuries or illness. Urban heat waves have been shown to take a significant toll on elderly people and the very young.[23] Many of the diseases that are predicted to become more common because of climate change, like malaria, have been shown to impact younger age groups more severely.[24]

[22] Gender, Climate Change and Health. World Health Organization (2011), p.3.

[23] [24] Planning for Climate Change: Guide – A strategic, values-based approach for urban planners, pp. 14-29 Climate Change: A Review to the Asia Pacific context.

Additional Reading Material



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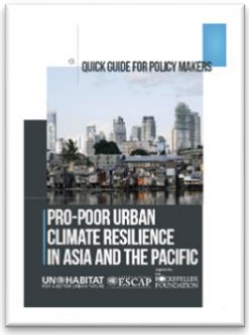

Additional reference has been made to p.9-10 and p. 16 of Quick Guide for Policy Makers: Pro-Poor Urban Climate Resilience in Asia and the Pacific