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SERIES L: ENVIRONMENT AND ICTS, CLIMATE  
CHANGE, E-WASTE, ENERGY EFFICIENCY;  
CONSTRUCTION, INSTALLATION AND PROTECTION  
OF CABLES AND OTHER ELEMENTS OF OUTSIDE  
PLANT

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### Use of information and communication technology for climate change adaptation in cities

Recommendation ITU-T L.1503

ITU-T

ITU-T L-SERIES RECOMMENDATIONS

**ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION,  
INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT**

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# Recommendation ITU-T L.1503

## Use of information and communication technology for climate change adaptation in cities

### Summary

This Recommendation is aimed at a broad audience of stakeholders interested in information and communication technologies (ICTs), climate change adaptation, and smart sustainable cities (SSCs), including city decision-makers and planners. Urban stakeholders, including mayors and city planners, are invited to consider novel approaches to sustainability by integrating the use of ICTs in their climate change adaptation strategies and policies. The following are the key steps:

- assess climate change risks and vulnerabilities;
- develop an action plan;
- identify the role of ICTs and infrastructure in the adaptation plan;
- implement adaptation actions;
- monitor and evaluate adaptation actions using ICT.

Climate change may negatively impact urban ICT infrastructure and the provision of key public services (e.g., health, water supply and sanitation, energy provision, waste management, mobility, urban planning and food security), which are all crucial dimensions for sustainable development and are becoming heavily dependent on ICTs for their operation.

The main areas where ICTs can support urban adaptation policies are:

- the development of effective climate-related disaster risk management (DRM) programmes in cities;
- the early stage of urbanization planning, by providing high quality data and information to help city planners to cope with climate change and build resilient cities;
- facilitation of communication and exchange of information between the relevant stakeholders involved in climate change adaptation for informed decision-making.

### History

| Edition | Recommendation | Approval   | Study Group | Unique ID*                                                                   |
|---------|----------------|------------|-------------|------------------------------------------------------------------------------|
| 1.0     | ITU-T L.1503   | 2016-06-22 | 5           | <a href="http://handle.itu.int/11.1002/1000/11830-en">11.1002/1000/12628</a> |

### Keywords

Adaptation, cities, climate change, ICT, information and communication technology, infrastructure, telecommunications.

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

## NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at <http://www.itu.int/ITU-T/ipr/>.

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## Introduction

Climate change is a serious challenge for cities around the world. [b-IPCC, 2014] indicates that

"Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen."

Although rapid urban growth is often seen as contributing to climate change and environmental degradation, cities forming the epicentre of urban growth can also be highly vulnerable to the effects of climate change. Climate change threatens to increase vulnerability, undermine economic gains, hinder social and economic development, and worsen access to basic services and the quality of life of citizens. Therefore, it is imperative for cities to adapt to climate change.

Information and communication technologies (ICTs) have the potential to play a leading role in climate change adaptation. They can help to enhance and improve climate change adaptation strategies in cities.

This Recommendation responds to the need to explore how ICTs can support urban adaptation to climate change and for the integration of ICTs in climate change adaptation programmes in cities.

Climate change adaptation strategies could receive a fundamental boost if national, regional and local governments choose to harness and utilize the transformational potential of ICTs.

This Recommendation recognizes that the impacts of climate change in cities could be significant. This is because cities contribute significantly to the gross domestic product (GDP), since economic activities are centred in and around them for every nation. Climate change could disrupt economic activities and services, damaging important sectors and services, including water supply and sanitation, agriculture, urban planning, mobility, building infrastructure, energy, health, waste management and food security.

This Recommendation identifies three enabling roles of ICTs for climate adaptation in cities. Using ICTs can: first, enhance disaster risk management (DRM); second, improve city resilience and adaptive capacity; and third, inform adaptation decision-making. For these three roles, this Recommendation provides detailed examples, drawing from a wide and prolific range of country and city experience.

In order to guide countries in their overall adaptation planning and implementation, a national adaptation plan (NAP) process has been put in place under the United Nations Framework Convention on Climate Change (UNFCCC). The NAP process allows countries to develop their adaptation activities in a coherent and strategic manner. Based on the NAP process, countries can reduce their vulnerability to the impacts of, and build adaptive capacity and resilience to, climate change. This process also helps to facilitate the integration of climate change adaptation into the already existing development planning processes within all the sectors in a city.

This Recommendation gives a general overview of the enabling role of ICTs in climate change adaptation plans and policies. It suggests a guiding framework to support cities in the challenging process of adapting to climate change.

This Recommendation also provides several case studies from developed and developing countries that could encourage other countries to develop climate change adaptation plans along similar lines.

# Recommendation ITU-T L.1503

## Use of information and communication technology for climate change adaptation in cities

### 1 Scope

This Recommendation identifies the impacts of climate change in cities and explains why cities need to adapt to its harmful effects. The roles ICTs can play in helping cities to adapt to climate change are presented. An ICT-based framework for climate change adaptation is included to assist policy makers in developing effective adaptation strategies and building resilient cities. Key stakeholders involved in urban climate change adaptation strategies are identified. A checklist is included to assess the integration of ICTs into an urban climate change adaptation plan, and to identify aspects that could be strengthened in local adaptation planning and response.

### 2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [ITU-T L.1501] Recommendation ITU-T L.1501 (2014), *Best practices on how countries can utilize ICTs to adapt to the effects of climate change*.
- [ITU-T L.1502] Recommendation ITU-T L.1502 (2015), *Adapting information and communication technology infrastructure to the effects of climate change*.

### 3 Definitions

#### 3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

**3.1.1 adaptive capacity** [[Glossary A–D](#) of b-IPCC, 2007]: The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

**3.1.2 climate change** [b-ITU-T L.1500]: Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity. The Intergovernmental Panel on Climate Change (IPCC) uses a relatively broad definition, referring to a change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forces, or to persistent anthropogenic changes in the composition of the atmosphere or in land use.

The IPCC makes a distinction between climate change that is directly attributable to human activities, and climate variability that is attributable to natural causes. For the purposes of this Recommendation, either definition may be suitable depending on the context of analysis.

**3.1.3 climate change adaptation** [b-ITU-T L.1500]: Adaptation to climate change can be defined as the adjustment in ecological, social or economic systems in response to actual or expected climatic stimuli and their effects. It refers to changes in processes, practices and structures to moderate potential harm or benefit from opportunities associated with climate change.

## **3.2 Terms defined in this Recommendation**

This Recommendation defines the following terms:

**3.2.1 smart sustainable city:** An innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects.

**3.2.2 snowpack:** A mass of lying snow that is compressed and hardened by its own weight. Snowpack forms from layers of snow that accumulate in geographic regions and high altitudes where the climate includes cold weather for extended periods during the year.

**3.2.3 vulnerability to climate change:** Vulnerability to climate change is the degree to which geophysical, biological and socio-economic systems are susceptible to, and unable to cope with, adverse impacts of climate change. Vulnerability can be described using the following components: exposure, sensitivity and adaptive capacity.

NOTE – Definition based on [19.1.2.1](#) of [b-IPCC, 2007].

## **4 Abbreviations and acronyms**

This Recommendation uses the following abbreviations and acronyms:

|     |                                          |
|-----|------------------------------------------|
| CB  | Cell Broadcast                           |
| DRM | Disaster Risk Management                 |
| EWS | Early Warning System                     |
| GDP | Gross Domestic Product                   |
| GHG | Greenhouse Gas                           |
| GIS | Geographic Information System            |
| GOS | Global Observing System                  |
| GPS | Global Positioning System                |
| ICT | Information and Communication Technology |
| m2m | machine-to-machine                       |
| NAP | National Adaptation Plan                 |
| NGO | Non-Governmental Organization            |
| SMS | Short Message Service                    |
| USN | Ubiquitous Sensor Network                |

## **5 Conventions**

None.

## 6 Adaptation of ICT infrastructure

### 6.1 Climate change adaptation in cities

Cities have started to address climate change by making efforts to reduce their emissions, putting in place several mitigation actions, such as sustainable transport strategies, waste management systems, establishing building codes or by promoting enhanced use of renewable energy. However, greenhouse gas (GHG) emissions continue to rise and cities are starting to feel the effects of climate change, evidencing the need for them to adapt to both current and future manifestations [b-UN-Habitat, 2012].

Clause 6.2 explores the main climate change risks, vulnerabilities and impacts that cities are facing, and will likely face in the foreseeable future. The analysis also addresses, in general terms, how cities are adapting to these risks and vulnerabilities, to provide a basis for an understanding of how cities can apply ICTs to better adapt to climate change.

### 6.2 Climate change risks, vulnerabilities and impacts in cities

There is an increasing recognition of the potential impacts of climate change in cities. Cities contribute to a large portion of a country's gross domestic product (GDP), therefore they are the dominant hubs of economic activities for every nation [b-Hallegate, 2011]. Climate change may affect urban economic activities and services, thereby damaging important sectors and services, including water supply and sanitation, agriculture, urban planning, mobility, building infrastructure, energy, health, waste management and food security.

Urban sectors are interconnected, and therefore, a failure in one sector (e.g., in the case of extreme weather events) could have a domino effect on other urban sectors and lead to an overall economic loss for a country or region [b-GTZ, 2009]. Studies suggest that windstorms and floods that took place in Asia between 1996 and 2005 caused over 70 000 deaths, with an estimated economic loss of around USD 190 billion. A large part of this loss is due to the lack of resilient and adequate infrastructure, including ICT infrastructure.

Similarly, rapid urbanization and population growth can worsen the impacts of climate change in cities. The United Nations Department of Economic and Social Affairs (UNDESA), has estimated that by 2050, about 70% of the world's population is expected to live in urban areas and over 60% of the land projected to become urban by 2030 is yet to be built. This high concentration of population and economic activity makes cities particularly vulnerable to climate change [b-UNDESA, 2014].

The effects of climate change will be felt by cities with varying degrees of intensity. Evidence from the field indicates that climatic changes, such as variation in rainfall or temperature patterns and sea level rise, are having an impact on development dimensions like agricultural production, food supply, water supply, health and disease proliferation in cities. Cities in both developed and developing countries are vulnerable to the effects of climate change. Cities located in developing countries are particularly susceptible due to their limited resources and capacity to adapt and recover from climatic extreme events.

Climate change impacts in cities also depend on their geographical location. For instance, low elevation coastal zones will face the combined threats of sea level rise and storm surges, while cities in hot climates may be affected by longer and more severe heat waves. Ultimately, cities located in port or coastal lines and inland cities are and will be affected by climate change.

Cities are the main engine for growth and development. They drive all national economies and generate substantial wealth. Any abrupt disruption that can occur has the potential to negatively affect urban productivity with impacts on public services and wealth. For example, if European economic hubs such as London, Paris or Rotterdam experience climate related problems, Europe's economy and quality of life can be affected [b-EEA, 2012]. Moreover, climate change impacts could also hamper the ability of developing nations in achieving the Millennium Development Goals [b-UN, 2016a] or working towards the Post 2015 Development Agenda [b-UN, 2016b]. The impacts of climate change

may also raise barriers to overcoming poverty and marginalization in urban areas [b-ITU, 2012a]. As such, it is essential that cities take the required action to strengthen their infrastructure and adapt to new climatic conditions.

Many cities already are undertaking various measures to adapt to the climate change risks and vulnerabilities as reflected in the following examples:

- **Coastal cities:** These cities tend to be more concentrated in low coastal zones and are exposed to extreme coastal water level events. 65% of cities in the world with population greater than 5 million located are in these areas; on which some of them are already below normal high-tide levels and prone to flooding and storm surges. The most threatened coastal urban environments include deltas, low-lying coastal plains, islands and barrier islands, beaches and estuaries [b-Hunt, 2011]. Cities facing these challenges are located across the globe, in both developed and developing countries. Some examples of cities facing these challenges include New Orleans, New York, Los Angeles, Tokyo, Amsterdam, Mumbai, Shanghai, Singapore, Jakarta and Dhaka [b-OECD, 2007].
- **Inland cities:** They are found in the interior part of the mainland. These cities, like their coastal counterparts, are also at risk. Settlements located along rivers are specifically considered high-risk locations. Inland cities will also face an increase in flooding potential due to more sizeable rainfall events. Equally, changes in climate that reduce precipitation and impair underground water will have impact on water resource availability especially in semi-arid and arid areas in both developed and developing cities [b-UN-Habitat, 2009].

Climate change has a range of short- and long-term consequences on cities. It will have both direct and indirect impacts on human health, physical assets, economic activities, and social systems, depending on how well prepared a city is and how it responds [b-World Bank, 2011]. The direct impacts of climate change in cities depend mainly on exposure to heat or cold waves, as well as to extreme weather events that can translate into storms, floods, and droughts, related landslides and wildfires. Indirect impacts are a consequence of the aforementioned events, e.g., food or water-related infections, diseases, people displacement, adverse psychological effects and other stresses [b-IPCC, 1997].

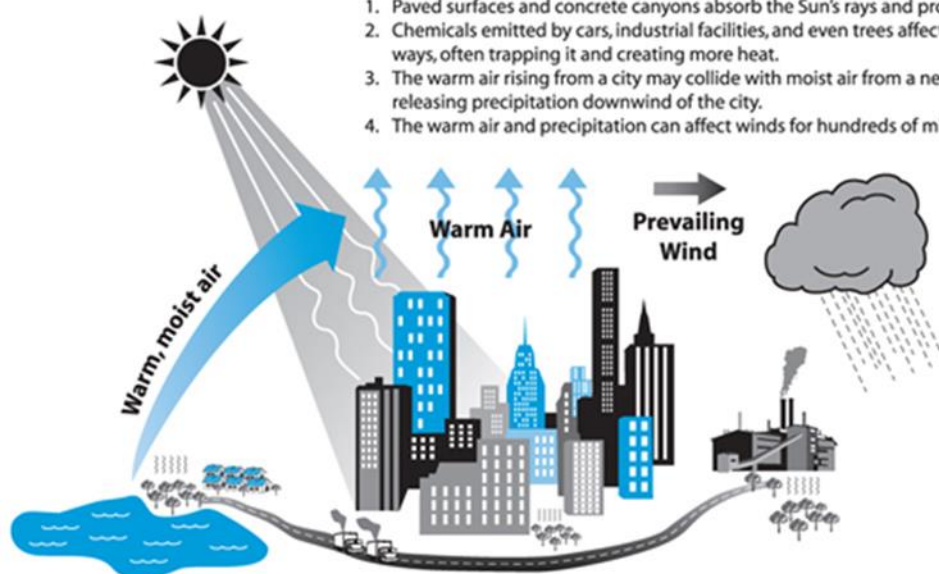
Examples of the impacts of climate change on ICT infrastructure are described in [ITU-T L.1502]. Examples of direct and indirect impacts of climate change that are particularly relevant to cities include:

- **Increased temperature:** Heat stress represents a serious public health concern especially in summer. Urban residents are particularly at risk of heat stress given that higher temperatures occur in urban regions more than in rural areas due to the urban heat island effect (see Figure 2-1). Illustrating these impacts, the 2003 summer heat wave in Western Europe has been linked to 35,000 deaths [b-UN-Habitat, 2009]. Indirect impacts include the overstress of energy transmission and distribution, due to the increased incidence or duration of summer heat waves, in conjunction with high energy demand for cooling [b-IEA, 2013].

## Urban Heat Island Effect

Urban areas influence the atmosphere through a number of processes:

1. Paved surfaces and concrete canyons absorb the Sun's rays and produce heat.
2. Chemicals emitted by cars, industrial facilities, and even trees affect sunshine in different ways, often trapping it and creating more heat.
3. The warm air rising from a city may collide with moist air from a nearby body of water, releasing precipitation downwind of the city.
4. The warm air and precipitation can affect winds for hundreds of miles.



Source: [b-UCAR, 2009]

**Figure 2-1 – The urban heat island effect**

- **Heat waves:** These events could reduce the ability to work and result in lower productivity, thereby shortening or delaying the delivery of products and services to clients within the city and elsewhere. They can reduce the use of public spaces and thus constrain social life. High temperatures can put infrastructure at risk, including ICT, as fluctuating heat levels can cause continuous thermal expansion and contraction of roads and railroad tracks, physically weakening the construction infrastructure, and in the process hamper the supply of goods and movement of commuters. This also adds to maintenance costs (in terms of labour as well as finances) of these structures. [b-EEA, 2012].
- **Sea level rise:** Rise in sea level is one of the most well-known effects of climate change, which has proved detrimental to human life and property. One common cause of sea level rise is accelerated glacial melting as a result of increased temperatures due to global warming. Such rises in sea level are unpredictable, and can cause coastal flooding that may lead to loss of life and property [b-UNFCCC, 2012]. Other direct effects of sea level rise include inundation and displacement, coastal erosion and land loss, increased storm flooding and damage, increased salinity in estuaries and coastal aquifers, rising coastal water tables and impeded drainage. Indirect impacts have been linked to changes in the distribution of sediments, changes in the functioning of coastal ecosystems, and impacts on recreational or tourism activities [b-Hunt, 2011].
- **Snowstorms:** The prime feature of lake effect snow storms is a dramatic crippling event out of season, with unprecedented cold air and wet snow. The associated uplift and dynamic cooling is so strong that it overcomes the boundary layer warming of the lake. These storms can be associated with severe cold spells with persistent weather patterns at mid-latitudes and are considered to be a direct consequence of warming due to climate change [b-NWS, 2006].
- **Droughts:** Climate change is also known to cause alterations in the global water cycle. Fluctuations in temperature caused by climate change can lead to significant alterations in precipitation patterns, e.g., areas that were previously receiving adequate rainfall may face drought, while other regions experience flooding. Cities are likely to face water stress, which will have a direct impact on energy supply sourced from hydropower. Furthermore, areas

affected by drought are likely to face land degradation with low agricultural yield and increased risk of food shortage. Indirect impacts can include reduced water quality and availability due to an increase in drought occurrence, especially from sources (e.g., snowpack) outside of city borders. This can threaten drinking water supply and reduce agricultural production, affecting food security in cities [b-World Bank, 2011]. Other indirect impacts include greater migration into cities by rural inhabitants pressured by drought or other climate extremes.

- **Floods:** These events can destroy homes, business sites and infrastructure, as well as contribute indirectly to the loss of employment and other income sources. People and businesses could have limited access to vital services, such as energy, transport and clean water, with consequent impacts on health [b-EEA, 2012]. Floods also have an indirect effect on the health infrastructure and other lifeline systems in terms of reduced access to energy, transport, food and sanitation services [b-EEA, 2012].
- **Human health:** Climate change is likely to affect human health in cities, either directly or indirectly. Impacts can range from physiological effects of heat and cold, or indirectly, through the transmission of vector-borne pathogens or effects on personal well-being from flooding episodes [b-Hunt, 2011]. Impacts of climate change may also facilitate the transmission of vector-borne (e.g., malaria, dengue and dengue haemorrhagic fever, yellow fever, and West Nile fever) and water-borne diseases (e.g., typhoid fever, cholera, leptospirosis and hepatitis A). According to the World Health Organization (WHO) "between 2030 and 2050, climate change is expected to cause approximately 250 000 additional deaths per year, from malnutrition, malaria, diarrhoea and heat stress" [b-WHO, 2014].
- **Global security:** Climate change is seen as a threat to the well-being, safety and survival of people around the world, although more evidence is needed to understand the nature of this relationship [b-World Bank, 2011]. Increasing water stress due to climate change can lead to mass migration to urban areas. This increase in urban population may cause conflict for scarce natural resources, leading to security concerns in affected regions. In [b-UN, 2011], the Security Council declares that the adverse effects of climate change would trigger or aggravate international and national peace and security issues.

Table 6-1 provides a comprehensive list of examples of climate change effects in cities as a guide to understand the link between direct and indirect impacts. The specific impacts on each city will depend on the actual changes experienced and on their geographical location, among other factors. Figure 6-1 is a risk heat map for climate change.

**Table 6-1 – Examples of direct and indirect impacts of climate change in cities**

| Projected climate change impacts                                            | Likelihood        | Direct impacts                                                                                                                                                                                                                                                             | Indirect impacts                                                                                                                                                                   | Geographical location affected                                                                     |
|-----------------------------------------------------------------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| <b>(1) Warmer with fewer cold days and nights, more hot days and nights</b> | Virtually certain | Exacerbation of urban heat island effect<br>increases risk of related mortality                                                                                                                                                                                            | Declining air quality                                                                                                                                                              | Inland cities and cities reliant on snowpack for water supply                                      |
| <b>(2) Hot spells or heat waves: increased frequency</b>                    | Very likely       | Increased demand for cooling, and reduced energy demand for heating.<br>Greater stress on water resources including those that rely on snowmelt from increased water demand and declining water quality                                                                    | Energy transmission and distribution maybe overstressed<br>Wider geographical incidence of vector-borne diseases (e.g., malaria)<br>Less disruption to transport from snow and ice | Inland cities and cities reliant on snowpack for water supply                                      |
| <b>(3) Heavy precipitation events: increased frequency</b>                  | Very likely       | Flooding, strong winds and landslides<br>Disruption of public water supply                                                                                                                                                                                                 | Withdrawal of risk coverage in vulnerable areas by private insurers                                                                                                                | Coastal and port cities, those on riverbanks or land marginal to flood plains, mountainous regions |
| <b>(4) Intensity of tropical cyclone activity increases</b>                 | Likely            | Damage and losses of physical assets and infrastructure<br>Increased risk of death , injuries and illnesses<br>Disruption of transport, commerce and economic activities                                                                                                   | Impacts on tourism and local livelihoods, psychological impacts on or stress in vulnerable populations                                                                             | Coastal and port cities.                                                                           |
| <b>(5) Areas affected by drought increase</b>                               | Likely            | Stress on water resources<br>Reduced energy supply from hydropower<br>Land degradation with lower agricultural yields, increased risk of food shortage and dust storms                                                                                                     | Water quantity and quality for consumption and food production<br>Population migration                                                                                             | Cities unused to arid conditions                                                                   |
| <b>(6) Rising sea level</b>                                                 | Virtually certain | Permanent erosion and submersion of land<br>Cost of coastal protection or cost of relocation<br>Decreased ground water availability<br>Increase salinity in estuaries and coastal aquifers<br>Effects of tropical cyclones and storm surges, particularly coastal flooding | Recreational activities are affected                                                                                                                                               | Coastal cities                                                                                     |
| Sources: Compiled from [b-World Bank, 2011] and [b-Hunt, 2011]              |                   |                                                                                                                                                                                                                                                                            |                                                                                                                                                                                    |                                                                                                    |

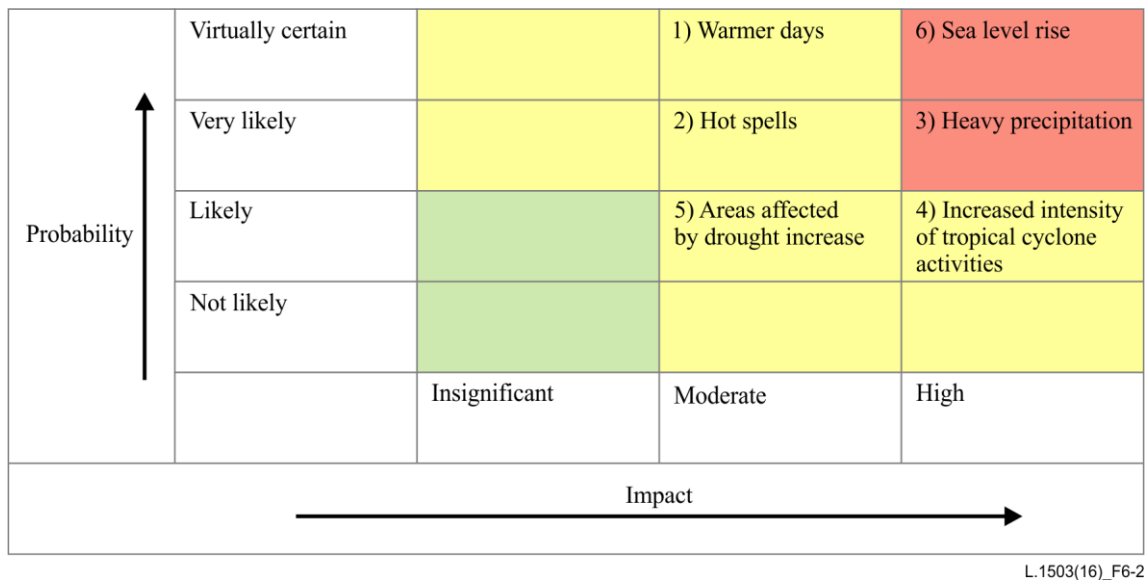


**Figure 6-1 – Risk heat map of the potential climate change impacts**

### 6.3 Approaches to climate change adaptation in cities

A number of cities have developed adaptation strategies, frameworks or plans using different approaches. These range from sector plans, strategic plans focusing on specific themes or risks, to broader holistic plans that integrate the various approaches or different aspects in a city. Selected examples are listed below:

- The New York City adaptation approach followed a multistep process that included identification of climate hazards and impacts, developing and evaluating adaptation strategies, implementing actions, and monitoring results. The work was led by the New York City Climate Change Adaptation Task Force, with the assistance of the New York City Panel on Climate Change [b-Rosenzweig, 2010].
- In developing its climate change strategy, the Durban Municipality identified a set of 10 interrelated climate change response themes: water, sea level rise, biodiversity, food security, health, energy, waste and pollution, transport, economic development, and knowledge generation and understanding. The approach included the development of a separate implementation framework, and a monitoring and evaluation system [b-DCCS, 2014];
- The Hoi An climate change vulnerability assessment approach involved a 10 step process following UN-Habitat's Cities and Climate Change Initiative:
  - establishing contact with the city government, gaining participation at city level and forming an assessment team;
  - identifying key issues through disaster profile and climate change scenarios for 2020, 2050 and 2100; developing the city profile;
  - mapping and mobilizing key stakeholders; consulting with local communities, government and private sector;
  - identifying the main climate hazards for Hoi An;
  - analysing sensitivity of the city infrastructure and physical systems;
  - developing an adaptive capacity analysis based on evaluation of technology, human and financial resources, policy and mechanism, and coordination and implementation capacity;