

# **Impacts of Climate Change on Urban Infrastructure & the Built Environment**



**A Toolbox**

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## **Tool 1.1: Urban Environments and Climate Change**

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# Contents

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1.	Introduction	1
2.	What is an urban environment?	1
3.	Why does this Toolbox have a focus on urban environments?	2
4.	Do New Zealand's urban environments have specific characteristics that distinguish them?	3
5.	What climate-related risks and issues are New Zealand's urban environments already vulnerable to?	5
6.	How will climate change affect New Zealand's urban environments?	6
7.	Are there any fundamental principles or approaches that apply in addressing impacts from climate change for urban environments?	7
8.	References	9

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## 1. Introduction

This report is a Type 1 Guidance Tool (see Toolbox Overview), providing basic background information on New Zealand's urban areas, outlining their importance, and briefly noting the risks to such areas associated with climate change.

The Toolbox as a whole is intended to assist local authorities (in particular) in identifying and responding to the impacts of climate change in urban environments, with a particular focus on urban infrastructure and the built environment.

This Tool endeavours to provide context for the whole of the Toolbox by setting out brief descriptions in answer the following questions:

- What is an urban environment?
- Why the focus on urban environments?
- Do New Zealand's urban environments have specific characteristics that distinguish them?
- What potential climate change risks are New Zealand's urban areas particularly vulnerable to?
- How will climate change affect New Zealand's urban environments?
- Are there any fundamental principles or approaches that apply in addressing impacts from climate change for urban environments?

## 2. What is an urban environment?

An urban environment can be described as the spatial area containing an aggregation of buildings, infrastructure and open spaces which provides for the physical interaction of an urban community.

In New Zealand, urban areas comprise cities, towns and other settlements of a thousand people or more. Statistics New Zealand defines three types of urban area:

- main urban areas, with a population of 30,000 or more;
- secondary urban areas, with a population of 10,000 to 30,000, and
- minor urban areas, which are small settlements of 1,000 to 10,000 people.

There are 16 main urban areas and 14 secondary urban areas in New Zealand, along with numerous minor urban areas. All the main and secondary urban areas are associated with at least one specific unit of local government – some with more than one (i.e. one or more city or district councils as well as a regional council).

Approximately 80% of New Zealand's total population lives in an urban area (2001 census), making it one of the most urbanised of nations. However, the population is strongly focused on the one "primary" urban area of Auckland, with an estimated 2010 population of 1,355,000, and two other main urban areas of Wellington and Christchurch, each with a population of approximately 400,000 people. The conurbation consisting of Auckland, Hamilton and Tauranga and several smaller urban areas contains well over one third of all of New Zealand's population of approximately 4.3 million.

Main and secondary urban areas are usually the centres of productive rural regions and are regional transport hubs, often with international as well as national connections.

Smaller ('minor') urban areas are widely spread, and provide essential services for the proportion of the population who live in rural areas and scattered low-density localities.

As well as accommodating a large number of people, an urban environment involves a complex physical form of variable textures (open spaces, buildings and paved areas); private, public and composite ownerships of land, building and infrastructure; and interactions between people, and between people and physical resources (such as buildings and built infrastructure) and natural resources (such as water), including consumptive uses.

Urban areas are connected to surrounding rural areas and nearby urban areas by transport and communication systems, and rely on these external areas and systems for much of their functioning.

### **3. Why does this Toolbox have a focus on urban environments?**

The Toolbox has a focus on urban environments for several reasons:

- Urban environments are where the large majority of New Zealand's population lives for all or most of their lives.
- Urban environments contribute significantly to economic activity and the country's gross domestic and gross national product (GDP and GNP).
- Urban environments contain most educational, cultural and health facilities, both in number and significance.
- Urban environments contain the large majority of the country's public and community investment, and much of the private investment.

Thus, urban environments are closely interwoven with concepts of both community and individual wellbeing in the broadest sense, along with economic

stability and advancement. Functional and attractive urban environments also contribute to national identity and sense of place in the world.

As well as accommodating present populations, urban environments can be expected to provide for future generations. Urban environments are not static entities but are subject to growth and change and, in some circumstances, to decline. Much of New Zealand's urban environment that exists now can, however, expect to remain partially or largely unchanged for decades, if not centuries, although new components can be added and minor modifications made.

It is thus important to consider the changes that may be needed to existing urban environments in the future, and to ensure that new and modified urban environments that are created are as efficient, effective and adaptable to future changes as possible.

The guidance and tools in this Toolbox are designed to help equip decision-makers with information and techniques to identify and consider risks to urban environments which may arise over time from climate change, and to seek outcomes which will best assist communities in responding to these risks.

The Toolbox has a distinct focus on the physical impacts from climate change on urban infrastructure and the built environment. While it is recognised that these impacts may have 'down-stream' socioeconomic impacts on urban communities, such analyses are the focus of other complementary research projects (see box in Section 6 of this report).

#### **4. Do New Zealand's urban environments have specific characteristics that distinguish them?**

New Zealand's urban environments are largely the result of the accumulation of past development. Some urban areas have developed over almost two centuries and others over a much lesser period. New Zealand's urban areas have both similarities and diversity. The following general characteristics can be identified:

- Many urban centres were established around water transport systems, and main commercial and administrative centres, transport hubs and main residential areas may all be close to sea level, or on flood plains.
- However, the topography alongside many of these early centres was often rugged, so the process of urban growth has often spread the urban environment onto hillsides and into nearby valleys or along the coast.
- New Zealand's urban areas are widely spread between latitudes 35° and 47° south. This global position (including the large distance from other major land

masses) combined with the rugged topography of the country means that New Zealand's urban areas experience a range of climatic circumstances and a considerable diversity of weather patterns.

- By world standards, New Zealand's urban environments are low density, and the centres of even the largest cities are relatively low rise. As a consequence, reticulated services and roading systems are relatively extensive for the population served, but open spaces (including space in public ownership such as streets and parks, and space in private ownership such as private gardens) within the urban environment are also extensive.
- Commercial and main community services in all but the largest urban area tend to be focussed in a single central location. Only the larger urban areas have significant subsidiary centres.
- New Zealand residents have very high rates of car ownership, and rely heavily on private car travel. Public transport availability and use is low with a few exceptions. This has consequences in terms of the urban environment and urban land use.
- New Zealand's average population is aging, and urban environments are increasingly accommodating a growing population of people with age-related needs in terms of health and wellbeing.
- There are generic trends towards increasing housing diversity which may mean intensification of some existing environments and greater density in redeveloped (brownfield) and new development areas.

These urban characteristics include some which reflect specific national circumstances and some which reflect international trends. Thus, while it is possible to benefit from an understanding of international approaches to responses and adaptations to climate change in urban environments, it is also important for New Zealand's urban communities to endeavour to understand and respond appropriately to their own circumstances.

These circumstances relate to the present urban environment (largely 'received' as a result of past decisions), the risks and consequences of climate change (on regional or local level), and also to the community's priorities and resource availability. [See Tool 1.4, Urban Environments and Climate Change – Statutory Context - for examples of different priorities identified by different communities].

## 5. What climate-related risks and issues are New Zealand's urban environments already vulnerable to?

Depending on location, age of settlement (including existing buildings and infrastructure), and other aspects such as a community's in-built resilience (including aspects such as robustness of lifelines or emergency services), the climate-related risks and issues vary between the country's urban environments. Some settlements have low exposure to risks, others have parts that are subject to one or more risks, and some settlements are subject to one or more recurrent risks.

The age and adaptability of services may be a key consideration in urban environments. The realisation in the late 1980s that large components of New Zealand's urban reticulated services required replacement led to capacity and performance improvements, but with this also came recognition of the community costs of risk reduction and new concepts of alternative means of providing for the same function – for example, a move towards more on-site stormwater management.

Risks that are relatively common in New Zealand's urban environments are river flooding (over a long period, the highest annual insurance payment has been related to flooding risk, much of which has been in urban areas), coastal erosion and inundation, and various forms of land instability. Risks relating to ice and snow are also common, if temporary, events in some New Zealand urban environments.

All of the above natural hazards have a weather and/or climate-related component, with risk resulting in damage and/or an emergency affecting the urban population during extensive or unusually prolonged events e.g. major rainfall or snow events, or high or persistent winds causing coastal storm surges and/or periods of coastal erosion. In all such circumstances, there are numerous variables which contribute to judgements and decisions on the need for short-term and/or more measured responses.

Other less common risks which affect some urban areas include the potential for extended drought with consequences such as reduced access to water supply or fire risk, and risks associated with high winds. All urban areas are to some extent 'heat islands' which can locally exacerbate elevated air temperatures.. This effect arises from the mass of heat-absorbing materials in urban environments.

When considering the implications and potential impacts of climate change, and in making decisions in relation to climate change, existing risks and vulnerabilities need to be taken into account. A range of tools included in this Toolbox address risk and vulnerability assessment and decision methods which are adaptable to a wide range of specific urban situations [e.g. see Tools 1.3 and 1.6 and all the tools in Tray 3].

## 6. How will climate change affect New Zealand's urban environments?

While there is still uncertainty in the detail, there is considerable guidance information now available on likely general trends in climate and how it may affect different parts of the country over time, and thus different urban environments.

A basic premise that can be adopted is that climate change is likely to exacerbate existing hazards that a town or city may already be exposed to, such as more frequent heavy rainfall causing flooding and landslides, more frequent extended dry periods causing water supply impacts, and higher sea levels causing more frequent coastal erosion, salt water intrusion and inundation. The tools presented in Tray 2 of this Toolbox demonstrate methods for analysing the effect of climate change on these hazards.

The most comprehensive general information is found in Chapter 2 of the Ministry for the Environment's Climate Change Guidance Manual for Local Government (Mullan et al., 2008), referred to as "the Guidance Manual". A general understanding of how urban areas may be affected can be gained from careful study of the material in this publication. More detailed information can generally be obtained in relation to any specific issue, as part of a special study, such as those case studies referred to elsewhere in this Toolbox.

Recognition of the heat island effect and an enhanced recognition that increased storminess is an effect associated with climate change largely post-date the publication of the Guidance Manual above, but are now widely recognised in overseas literature.

Effects relating to coastal processes and climate change including sea-level rise are addressed in an associated publication to the general Guidance Manual (MfE, 2008), and tools for estimating the effects of climate change on flood flow are presented in MfE (2010).

**Note:** This Toolbox has been prepared at a time of considerable research into climate change risks, potential impacts and adaptation options relating to the urban environment.

Three parallel studies under the Ministry for Science and Innovation (formally FRST) Global Processes (GLO) initiative relating to effects on coastal communities, public health implications and social/community impacts in connection with climate change (see references: NIWA, 2011; ESR, 2011; and NZCCRI, 2011) are also expected to yield information which will assist local government in the scoping of response options and decision making.

## **7. Are there any fundamental principles or approaches that apply in addressing impacts from climate change for urban environments?**

There are a number of principles that are found widely both in New Zealand literature and practice, and internationally in developed countries. These are listed and briefly discussed below.

### **1. Addressing the causes of climate change is the role of central, rather than local government**

This principle of management of climate change effects has been expressed in policy and statute for many years. It is based on the philosophy that the causes of climate change (excessive anthropogenic greenhouse gas emissions) are best managed through market or national regulatory incentive and/or other approaches, and that attempts at local or regional management of such emissions would be ineffective and distort local economies, and potentially adversely affect community wellbeing.

However, if local government initiatives and decisions can contribute to reductions in greenhouse gas emissions while achieving other aims (such as energy efficiency gains in infrastructure operating systems, or the uptake of public transport while reducing congestion), that is considered a beneficial win-win situation (see Point 6 below) and is not to be discouraged.

### **2. Seek opportunities to incorporate climate change adaptation into new and existing developments in the urban environment**

While knowledge of climate-related risks has increased, there is also a concomitant increase, both internationally and within New Zealand, in the understanding of opportunities for best practice in working towards community resilience and climate change adaptation.

Often it is easiest to achieve effective adaptation at the time that a new area of development is being considered. However, as much of the urban fabric for subsequent generations is already in place, it is important to undertake effective planning and implement actions to manage existing risks for existing areas.

Opportunities to implement ‘no-regrets’ and ‘low-regrets’ adaptations and to achieve win-win situations (see Point 6 below, and Tool 4.1 – Key adaptation concepts) are often found early in the planning and development process.

### **3. Work in consultation and/or partnership with communities**

Engagement with communities is essential in developing strategies and informing decisions relating to risk management of future climate change effects. This is

relevant regardless of whether the issue is of regional significance, affects multiple or individual urban areas, or is limited to parts of specific urban areas.

#### **4. Monitor existing vulnerabilities, determine priorities and identify critical thresholds**

It is important in most urban environments to identify and prioritise responses to climate change risks on an analytical basis. This is part of an ongoing responsibility for governments to keep abreast of knowledge about climate change and to identify risks, including in the public infrastructure sector as well as the wider community.

#### **5. Incorporate flexibility to deal with changing risk**

As the timing and extent of climate change risks are uncertain, responses that can be readily scaled up over time as necessary can be both efficient and highly effective in urban environments.

#### **6. Look for no-regrets, low-regrets, win-win and adaptable measures to manage climate risks**

Such approaches are particularly useful for managing the uncertainties associated with climate change. Briefly, they are:

- no-regrets – which will pay off immediately under current climate conditions and which have a no- or low-cost benefit in terms of climate change adaptation;
- low-regrets – low-cost measures which will have proportionately large benefits under climate change scenarios. Low-regrets measures can best be built in during early stages of planning new areas;
- win-wins – opportunities to address climate change issues while also achieving other benefits, such as a public open space also acting as a temporary flood detention area for extreme events;
- adaptable – measures which themselves can be added to if climate change effects turn out to be more significant over time than initially anticipated.

#### **7. Avoid actions that will make it more difficult to cope with climate risks in the future**

Such decisions are called ‘adaptation-constraining’ decisions which can involve high future costs. An example would be allowing development in areas of known

high risk such as exposed coastal locations already experiencing erosion, or intensified development in flood plains.

Examples of the application of many of these principles are found in the case studies and examples included elsewhere in this Toolbox.

## 8. Take a long-term view, which will usually exceed normal planning or administrative periods

Climate change effects are likely to be experienced in the long term, and over several generations, so it is important to consider the needs of future generations and the implications of the urban environments they will inherit.

An example is the need to take into account how climate might change over at least a 100-year timeframe when considering the nature of coastal hazard risks (New Zealand Coastal Policy Statement 2010).

There will be opportunities to revisit such planning decisions through future plan reviews and administrative processes, should the risks of climate-change related effects diminish or increase in future.

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