

Impacts of Climate Change on Urban Infrastructure & the Built Environment



A Toolbox

Message 5.1: Managing Information

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Acknowledgment

The Appendices to this tool draw extensively on information prepared for the Ministry for the Environment by MWH's Planning and Environmental Services group.

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1. Introduction

1.1 Background

The tools in this Toolbox demonstrate the wide range of potential impacts of climate change and how local authorities can take steps towards adaptation. The Toolbox contents together also show the diversity of roles and players involved in climate change responses.

It is generally accepted in literature¹ that, internationally, local government agencies have at least an equally important role as national-level governments in the multiplicity of decisions which can assist with climate change adaptation.. This is because of the specific relationships between local government and citizens in terms of key functions of land development management and building control, the provision of community infrastructure and on-the-spot emergency management.

New Zealand's strong tradition of local democracy means that citizens expect foresightedness and wise decision-making at local government level; however, an equally strong tradition of 'do it yourself' means that independent community organisations, many of them *ad hoc*, often shoulder local community-based responsibilities and work in partnerships with, or parallel to, local government.

These two factors, along with the country's generally well-educated and reasonably affluent population, and well-developed physical infrastructure, make New Zealand communities reasonably or highly resilient by international standards². Such communities are in a good position to plan for and begin to adapt to climate change.

Adaptation is not a static function: it involves a continual process of information review, risk assessment, identification and evaluation of potential responses to climate change risks, monitoring of effectiveness of actions taken in response to these risks, and revisiting the circumstances and making adjustments and improvements over time.

There are many calls on local government for information relating to climate change impacts, risk assessment, and adaptation options costs and benefits. Not only does local government need information for its own decisions, but it may receive requests from communities relating to climate change. Local government may wish to initiate consultation and discussion with communities relating to climate change when it perceives risks or identified opportunities at the community level.

¹ For example, Principle 10 of the Rio Declaration on Environment and Development, UN 1992, took this view and IPCC Working Group II reports also tend towards this approach. See also references list to Tool 4.1 (Climate change adaptation – key concepts).

² See 2007 IPCC Working Group II Report.

1.2 Purpose of this Tool

This “message” tool discusses managing the various types of information that may be needed by local authorities in response to the risks of climate change in the urban environment. It includes a discussion on the importance of checklists in identifying a means for adapting to climate change for specific parties (with suggested checklists for council planning officers, development professionals and householders included in the appendices).

A complementary tool, [Message 5.2], provides ideas on how local authorities can keep up-to-date with both climate change information and adaptation concepts.

2. Types of Information

In the context of this Tool there are three key types of climate change-related information that a local authority may need:

- information about climate change and its associated effects such as sea-level rise predictions;
- information about possible adaptive responses that can be explored at local level, including their costs and benefits; and
- information about the ‘operating environment’ within which local government works.

A further aspect of information relates to the community, and the types of advice and assistance that a local authority can give community groups, householders and local businesses to assist them with developing their own adaptation responses to climate change.

2.1 Climate Change Information

Basic information building-blocks to assist local authorities understand their urban communities’ exposure to climate change risk will depend on the location and geographic position of the district or region. However, it will generally include:

- temperature trends;
- precipitation trends;
- trends in extreme events; and
- sea level rise predictions.

This information, in itself, will help local authorities with the type of screening assessments advocated in the MfE publication “Climate Change Effects and Impacts Assessment – A Guidance Manual for Local Government in New Zealand” (2nd Edition 2008), which remains the internationally-accepted best practice approach to climate change adaptation in New Zealand.

For initial screening purposes, the available information should be collated, sourced, provided with indicative reliability bounds and related to a time scale. Generally, it is important not to get too focussed on absolute accuracy. With climate change effects, the scales are measured in at least decades and information that may not be resolved in terms of years does not comprise a fatal flaw, as long as trends are represented.

Given the cyclic approach of adaptive responses, reviews of both information and effectiveness of responses are an essential component, often providing the opportunities for adjustments when new information comes to hand. However, a slightly conservative view³ should generally be adopted for planning purposes as, given current trends, this is most likely to contribute to ‘low regrets’ outcomes.

Once likely priorities for action have been identified [see Tool 1.6], it will be necessary to improve information for scenario building and decision-making. The range of tools and examples in the Toolbox demonstrate how councils should focus on different climate variables in relation to different functions or areas where adaptation responses may be needed. For example, the peak 24-hour rainfall intensity for a catchment or sub-catchment would be important information for stormwater system planning, whereas for water supply planning, the future average seasonal or annual rainfall, in association with an estimation of future drought intensity and frequency, would be more relevant.

In this second stage of information gathering, appropriate focus and level of detail will need to be generated for each specific circumstance, as demonstrated in examples from the case studies in this Toolbox.

2.2 Information about Adaptive Responses

Once climate change risks have been identified and the potential impacts have been prioritised, effort needs to be put into identifying and evaluating options which will assist the community to adapt to the potential effects. It is normal good practice to identify at least four or five adaptation options, to compare to the ‘do nothing’ situation.

³ It is preferable to overestimate, rather than underestimate, the extent of change as, if the estimate is wrong, the adaptive response will be effective for longer. This holds regardless of the cost of the response, as the cost of failure of an expensive response (such as a highly-engineered sea wall) at an earlier date than predicted will also be high.

Such options may vary in type or scale. For example, the Westport flood hazard case study in this Toolbox identifies *types* of possible responses to increased flood risk for a community which include river flood protection banks, relocation of the settlement, raising floor levels of existing dwellings, provision of accessible refuges, as well as *scale* variations within responses – for example, different heights of flood protection banks. Tool 2.5.1 relates to water supply, and notes adaptive responses ranging from improved storage to water use restrictions. Options need to be evaluated in terms of cost and effectiveness.

It is useful for local authorities to maintain a general understanding of the range of adaptive responses that could be considered in terms of any climate change-related issue. This is because climate change adaptation responses are usually not undertaken in isolation. They are often likely to be most effective when undertaken on the basis of co-benefits (i.e. an adaptive action is a small add-on to something that would be done in any case: for example, over-sizing of drainage infrastructure). Adaptive responses are usually in line with concepts of urban sustainability and community resilience. It is beneficial for councils to be aware of opportunities to achieve climate change resilience in their day-to-day business.

Information on costs and benefits of adaptation options will need to be generated at the time that any evaluation is undertaken and decision are made. Often, climate change adaptation has a component of benefits which fall into the ‘intangible’ category. Such benefits need to be identified and ideally some type of non-dollar evaluation system should be applied to them.

A further area of council interest in any assessment is the potential for allocation of costs and an understanding of the spread of benefits, so that appropriate arrangements can be put in place for funding. Again, this information will need to be specific to the circumstances under consideration.

Development of checklists relating to climate change adaptive responses, as discussed below, provide one way of managing information about possible adaptive responses. Message 5.2 addresses the importance of local authorities having ‘corporate knowledge’ about climate change and climate change adaptation, and the need to regularly update such knowledge.

2.3 The Operating Environment

The operating environment for local authorities is formed by the plethora of national-level statutes and codes within which they are established and are required to act. This framework provides constraints, and also opportunities, in terms of how a council may respond to climate change.

Within this framework, a council's policies form the second level of operating environment. All significant decisions need to be evaluated in terms of key policies. Policy development is undertaken in association with the community, leading to the situation where the community itself is part of the operating environment.

A council needs to be fully aware of the climate change management opportunities that the national operating environment provides, and to ensure that policy development relating to climate change is generally reflective of community expectations, through consultative processes.

2.4 General Comment on Information

Climate change adaptation responses relate to so many aspects of modern life that a single local authority must prioritise [see Tool 1.6]. It must also frequently monitor and review both the risks and the effectiveness of adaptive responses introduced to date or under consideration.

While each local authority needs to maintain a reasonable level of understanding in the general areas covered in sections 2.1 to 2.3 above, much information to assist with climate change adaptive responses in the urban environment can be gained from the experiences of others, and repackaged or adapted to meet local circumstances.

New and innovative ideas and approaches are constantly being developed and tested, and it is effective and informative for councils to regularly review international and local information on climate change and adaptive responses [see Message 5.2, which deals with keeping up-to-date]. Local authorities can then focus their efforts in generating specific information relating to their own prioritised risk areas.

3. Who Needs the Information?

Climate change adaptive responses in urban environments potentially apply across the board, so the focus in a local authority administration needs to be at the highest policy level with a 'whole of business' mandate. Particular emphasis is likely to be placed on a council's strategic planning and policy development function, along with relevant land use planning and resource management responsibilities, and also on community infrastructure development and maintenance responsibilities.

However, other areas of council responsibility – from recreation and open space management to pest management, civil defence and emergency management services – are all potential contributors to climate change adaptive responses in urban environments.

In addition, community organisations and groups benefit from information and advice. For example, the work of a beach care group in an urban area may be given impetus if the group understands that the drivers for beach care work include climate change resilience as well as, for example, ecological restoration, tidiness, and civic pride.

This raises the need for a local authority to be in position to convey information about potential climate change impacts widely throughout a community. Providing information, on a website, through leaflets, or through periodic attendance at a range of community meetings, can assist individuals, families, businesses and community groups identify and undertake their own adaptive responses to climate change.

4. Use of Checklists for Climate Change Adaptation in Urban Environments

Checklists are a very effective way of ensuring appropriate practice in response to climate change. They have the benefits of:

- providing a comprehensively-scoped basis for consideration of options;
- providing for consistency over time;
- on-going application over time;
- adaptability to a wide range of circumstances; and
- being easy to update.

Checklists for use by local authorities are likely to be most useful when developed at the national level, whereas local authorities themselves may provide checklists for local developers or development professionals and householders. Appendices 1, 2 and 3 give examples of checklists that could be applied⁴. They offer the opportunity for further development by local authorities to reflect local adaptive needs and capacity.

⁴ Adapted from Climate Change Urban Adaptation Materials prepared by Amy Clore, Jane Puddephatt and Paula Hunter, MWH New Zealand, for the Ministry for the Environment, June 2010.

APPENDIX 1 District Plan Checklist (for use by Council Planning Officers)

Tool 1.5 of the Toolbox provides an audit tool for council policy and plans. The checklist below is focussed on specific district plan techniques that can be applied to assist adaptation to climate change risk in urban environments. Note that it does not provide a checklist for the policy content which would also be needed in the plan. The checklist is broad-based and may not be relevant in specific locations [see also Message 5.3 on the timeframes].

Specific Climate Change Issue	Checklist Questions for Climate Change Adaptation
<p>Flood risk adaptation</p>	<ul style="list-style-type: none"> • Are there existing or proposed urban areas that are subject to existing or future flooding? • Are the potential impacts in these areas sufficiently significant to justify restriction of subdivision and development in these areas? • Is there sufficient information to justify identification of these areas as ‘flood hazard’ on the district plan planning maps? • What types of activities could be located in a flood hazard zone e.g. reserves, playing fields, relocatable buildings, temporary activities, flood mitigation works? What types of activities need to be excluded from a flood hazard zone? • How should activities be classified in a flood hazard zone e.g. prohibited, non-complying, discretionary, controlled activity? • Can areas still be zoned for urban development (e.g. residential, commercial), but subject to an overlay that requires developments to meet certain standards? E.g. setbacks from water courses, finished floor level heights, establishment of reserves along water courses, riparian planting. • Are there overland flow paths in existing or future urban areas that should be protected? • Is there sufficient information to accurately identify overland flow paths on the planning maps? • What form of protection is needed for these areas? E.g. no urban uses, or urban uses subject to consent processes, or urban uses permitted subject to meeting specific standards. • For new or redeveloped urban areas, should the district plan or structure plan and/or consent requirements... <ul style="list-style-type: none"> - require integrated approaches to the provision and management of the three urban waters – stormwater, wastewater and water supply? - require at source and/or on-site management and disposal of stormwater?

Specific Climate Change Issue	Checklist Questions for Climate Change Adaptation
	<ul style="list-style-type: none"> - require specific provision for green infrastructure assets? - promote low impact design approaches including the use of green infrastructure? - manage permeable surfaces e.g. shared driveways, permeable paving, site coverage? - promote stormwater collection for garden watering, toilet flushing, clothes washing? • Does the district plan have a strong and cohesive policy framework which provides clear guidance when assessing resource consents in areas subject to flooding?
Water shortage risk adaptation	<ul style="list-style-type: none"> • Should the district plan include provisions that reduce water demand from urban activities? For example: <ul style="list-style-type: none"> - requirements for rainwater storage tanks for supply of non-potable water for outdoor uses and indoor toilets - requirements for household greywater reuse systems – E.g. outdoor irrigation - requirements to install water-efficient fixtures. • Has consideration been given to including in the district plan’s landscape planting or site open space requirements to use plants that reduce or eliminate the need for irrigation (‘xeriscaping’)?
Sea- level rise and inundation risk adaptation	<ul style="list-style-type: none"> • Are there existing or proposed urban areas that could be subject to effects from sea-level rise and coastal inundation? • Are the potential effects in these areas significant enough to justify the prevention or restriction of subdivision and development in these areas? • Is there sufficient information to justify areas as coastal hazards on the district plan planning maps? • What types of activities could be located in a coastal hazard zone e.g. reserves, removal and demolition of buildings, maintenance repair and replacement of existing buildings, relocatable buildings, coastal enhancement works, sea walls? What types of activities need to be excluded from a coastal hazard zone? • How should activities be classified in a coastal hazard zone e.g. prohibited, non-complying, discretionary, controlled? • Can areas still be zoned for urban activities (e.g. residential, commercial), but subject to restrictions that require developments to meet certain standards? E.g. setbacks, finished floor level heights, limits on earth works, riparian planting, relocation-capable buildings. • Are there urban areas that cannot/should not be protected from sea-level rise and coastal inundation and where the district plan can facilitate managed retreat? Should the

Specific Climate Change Issue	Checklist Questions for Climate Change Adaptation
	<p>district plan be restricting/preventing establishment or replacement of coastal protection structures in these areas?</p> <ul style="list-style-type: none"> • Does the district plan have a strong and cohesive policy framework which provides clear guidance when assessing resource consents in areas subject to sea-level rise and coastal inundation?
<p>High wind risk adaptation</p>	<ul style="list-style-type: none"> • Are there parts of the existing or proposed urban areas that are exposed to severe winds? • Is there sufficient information to justify provisions that require: <ul style="list-style-type: none"> - more stringent building design standards? - planting of shelter? - wind tunnel assessments/testing for new buildings? - design controls to mitigate wind effects on pedestrians?

APPENDIX 2 Development Checklist (for use by Development Professionals)

This checklist sets out a series of questions that local authorities might encourage the development community and its advisers to consider in preparing new developments for climate change effects. The checklist responds particularly to section 7(i) of the Resource Management Act. These types of considerations should be encouraged by local authorities, regardless of consent status. Note that not all questions will be relevant for all developments.

Stage of Development	Checklist Questions for Climate Change Adaptation
<p>Site selection and land acquisition</p>	<ul style="list-style-type: none"> • Is the site likely to be exposed to the effects of climate change (such as a low-lying or retreating coastal location, an estuarine or floodplain location)? • Have you checked local and regional council records (including LIMs) for information on flood and coastal inundation zones and other natural hazards? • Are there any signs of current problems relating to natural hazards on or around the site (e.g. flooding, erosion, inundation, instability, and drought)? • Have you sought advice on how the effects of climate change may exacerbate current natural hazards or create future problems associated with weather-related events on the site? Some factors to assess, and their potential effects, are: <ul style="list-style-type: none"> - Sea-level rise and storm surge that could lead to inundation or coastal erosion - Increased rainfall frequency and intensity that could lead to flooding - Site instability that could lead to landslides or slips - Drought that may lead to water shortages and restrictions on water use • Have you checked ‘upstream’ or ‘up-coast’ development potential and considered the potential for cumulative effects on the site? • Are there landscape features (e.g. ridges, existing vegetation, and waterways) that could enhance resilience of the site to the effects of climate change (e.g. shade and temperature regulation, stormwater management)? How can these best be integrated into the design of the future development?
<p>Site assessment</p>	<ul style="list-style-type: none"> • Have you undertaken a detailed ‘constraints and opportunities’ mapping exercise to identify site resources and climate change issues that will need to be considered and addressed in the design process? Examples of aspects to assess include geology, slope, aspect, soil type, streams, wetlands, coastline, groundwater levels, existing vegetation, etc.

	<ul style="list-style-type: none"> • Have you clarified potential climate change effects and identified features that could be enhanced or added to minimise the risk of exposure to natural hazards and extreme weather events? For example, existing vegetation to provide shade, temperature regulation and stormwater solutions, and lot configuration to manage solar exposure.
Site concept design	<ul style="list-style-type: none"> • Have you undertaken a risk assessment to identify the potential effects of climate change on proposed site infrastructure? For example, the effects of increasing frequency and intensity of heavy rainfall and increased temperatures on the capacity and function of reticulated pipe networks. • Have you contacted the local and regional council to confirm regulatory requirements and expectations for integrating the effects of climate change in development projects (e.g. rainfall frequency and intensity, amount of sea-level rise for planning purposes)? • In the absence of local or regional guidance to inform climate change risk assessments, have you referred to the Ministry for the Environment Guides for Local Government on ‘Preparing for Climate Change’ (July 2008), ‘Preparing for Coastal Change’ (March 2009) and ‘Preparing for Future Flooding’ (April 2010)? • Have you endeavoured to ensure the site layout and the location of buildings reduces the risk from natural hazards and maximises opportunities for adapting to the effects of a changing climate?
Consents	<ul style="list-style-type: none"> • Have the Regional Policy Statement, Regional Plan and District Plan been reviewed to identify objectives, policies and rules relating to climate change? • Have you checked the local infrastructure design standards and the New Zealand Standard for Land Development and Subdivision Infrastructure (NZS4404:2010) to identify infrastructure design requirements in relation to climate change? • Has an appropriate level of risk assessment been undertaken in accordance with the Ministry for the Environment publication ‘Preparing for Climate Change – A Guide for Local Government in New Zealand’ (July 2008)? • Do the resource consent applications include a description of how climate change effects have been assessed in relation to the development proposal? This should include details on the effects that have been assessed and how these have informed the design response.
Detailed site design	<p>Have you taken into account the following aspects?</p> <ul style="list-style-type: none"> • Ensure floor levels provide adequate freeboard above flood

	<p>hazard levels over the lifetime of the development.</p> <ul style="list-style-type: none"> • Identify and protect overland flow paths to provide appropriate stormwater management and minimise flood risk. • Identify and apply site features that could be maintained or enhanced to address the effects of climate change (e.g. shade and cooling, stormwater management, coastal protection). • Select plant species for use in landscape designs that are appropriate to the current and future climate (e.g. longer periods of drought, more frequent flooding). • Consider the role vegetation can provide in regulating indoor and outdoor temperatures (e.g. use of deciduous trees to manage sunlight entry in summer and winter). • Consider potential amenity values that could be provided by functional landscapes such as stormwater management features (e.g. boardwalk over a wetland).
<p>Building design</p>	<p>Have you taken into account the following aspects?</p> <ul style="list-style-type: none"> • Endeavour to ensure building orientation and structural design maximises solar gain and wind protection in winter. • Endeavour to ensure building orientation minimises sunlight entry and provides for ventilation in summer. • Incorporate adequate ventilation features in buildings for summer and winter needs. • Ensure specified building materials will perform adequately in the local climate throughout the lifetime of the development (e.g. resilient to flooding and heat exposure). • Investigate opportunities for enhancing water efficiency (e.g. low flow fixtures) and implementing rainwater harvesting for reuse. • When retrofitting or developing in a flood risk area seek to apply best practice design for the circumstances (e.g. use durable materials and elevated and/or removable fittings to minimise future damage). • Ensure building structures are strong enough to withstand wind or can be easily strengthened if wind speeds increase with climate change.

APPENDIX 3: Household Adaptation Checklist

This checklist sets out simple adaptive ideas for householders in response to three types of potential effects related to climate change: increased temperature; increased flood exposure; and increased drought exposure. Local authorities can adapt these ideas to their local circumstances, and add other adaptive concepts relating to other risks, as relevant.

Note: in connection with resilience of buildings to climate change, see also [Tool 4.4] that is specifically designed to aid in the screening and short-listing of flood damage reduction measures for existing housing at the small scale level; and [Tool 4.8] that provides a Building Flood Protection (BFP) Decision Framework with a linked set of tools for adaption of individual buildings that are prone to enhanced flood risk due to climate change.

Climate Change Effect	Possible Climate Change Adaptation Response
<p>Increased temperature (inside housing)</p>	<ul style="list-style-type: none"> • Disconnect unused appliances to minimise internal heat gain. • Use ceiling or desk fans to create localised cooling effects indoors, and/or shut windows and use heat pump, if installed. • Use eaves, blinds or awnings to protect rooms from the sun and internal heat gain during summer. • Plant trees to provide shade to the house interior during the summer. Ensure plants selected are appropriate for the circumstances and for local conditions, both now and in the future (e.g. deciduous or evergreen species, fully grown height, ease of maintenance). • Size and locate windows to manage solar access, and/or use window features such as tinting and stained glass to reduce internal heat gain. • Install window screens and screen security doors to enable safe household ventilation and night cooling. • Manage solar heat gain of house by painting roofs and external walls with reflective paint (seek advice from local paint suppliers). • Install insulation in the home for year-round temperature control.
<p>Increased flooding (house and section)</p>	<ul style="list-style-type: none"> • Determine if your house is located in a flood-prone area by contacting your local and regional council for information. (Note: Land Information Memorandum (LIM) reports may contain information on flood hazards for a specific property and can be obtained through your local council). • Regularly clean drains and gutters to ensure they can effectively transport water away from your home. • Store valuables and paperwork in elevated locations (e.g. cupboards or above the ground floor) to minimise the risk of damage from flooding.

	<ul style="list-style-type: none"> • Identify and protect drainage pathways on the property to take water away from the house and towards the stormwater system. • Use site landscape features such as gardens and natural low points to manage stormwater on site. • Ensure driveway levels provide for access in a flood. • Investigate the use of rain tanks for rainwater collection and non-potable uses. • Consider the potential for on-site stormwater soakage before paving over large areas of property. • Investigate options for water-resistant design in lower levels of the house (i.e. non-absorbent materials, concrete or tile flooring, rugs rather than fitted carpets). • If rewiring the house or installing new plugs or switches, consider raising the electrical points above flood levels.
<p>Water shortages (house and section)</p>	<ul style="list-style-type: none"> • Modify household behaviours to minimise water use (e.g. shorter showers, turn taps off while cleaning teeth, use dishwasher only when full). • Use a water displacement device in toilet cisterns (e.g. bricks or filled water bottles) to reduce water consumption when flushing. • Water outdoor plants early in the morning or late in the day to reduce the rate of evaporation. • Select outdoor plants that are drought-resistant, particularly key plants for long-term landscaping. • Repair leaking taps. • Ensure shower, toilet and tap fittings have low flow fixtures. • Select water-efficient appliances when replacing or purchasing dishwashers and washing machines. • Investigate the potential to install a rainwater tank for non-potable water use.