Impacts of Climate Change on Urban Infrastructure & the Built Environment

A Toolbox

Tool 1.7: Sources of information, help and expertise for climate change impact assessments & glossary

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Contents

1. Introduction

There is a vast amount of information, help, and expertise available to assist with climate change impact assessments. As a field of applied research, the body of available literature is growing rapidly in line with the uptake for such assessments globally.

Information can be found in published material such as scientific journal papers, reports (often based on peer-reviewed literature of the underlying scientific issues), books and web-based materials including online tools.

There is no shortage of robust, accurate information to inform a climate change impact assessment. However, given the relevance and political sensitivity of climate change, there are also a vast number of apparent information sources available (usually online) that can confuse the user.

Information sources listed here are considered to be robust and relevant to any climate change impact assessment and the organisations listed provide reliable sources of information. This list is not deemed to be exhaustive[1].

2. Information and Resources

2.1 Overview of Climate Change:

The IPCC's Synthesis Report summarised the underlying working group reports of the IPCC's Fourth Assessment into one concise document.

Core Writing Team, Pachauri, R.K and Reisinger, A. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II, and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. TERI Press. 104p.

http://www.ipcc.ch/publications_and_data/ar4/syr/en/contents.html

[1] Note: Website URL's were active and correct at the time of publication. Given that material may be moved within a website, carrying out a word search for the given area of interest may help locate material should the URL link be broken by the time you use this document.

2.2 Science of Climate Change:

The IPCC Working Group I (The Physical Science Basis) reports can all be accessed for free online and represent the largest body of summarised literature on climate change. Source literature can be accessed through the reference section of each chapter in each working group report.

Solomon, S.; Qin, D.; Manning, M.; Chen, Z.; Marquis, M.; Averyt, K.B.; Tignor, M.; Miller, H.L. (2007). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 996 p.

http://www.ipcc.ch/publications_and_data/ar4/wg1/en/contents.html

RealClimate is a website maintained by working scientists who publish in peer-reviewed literature that commentate on recent climate change publications and findings and is a highly useful resource for keeping up to date with climate change information and developments:

http://www.realclimate.org

2.3 Impacts, Adaptation, Vulnerability and Risk:

The IPCC Working Group II Report (Impacts, Adaptation and Vulnerability) provides the most comprehensive source of information on global, regional, and sectoral impacts of climate change including an in-depth analysis of risk assessment and management.

Parry, M.L.; Canziani, O.F.; Palutikof, J.P.; Linden, v.d.; P.J., H., C.E. (eds) (2007). Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom. 976p.

http://www.ipcc.ch/publications_and_data/ar4/wg2/en/contents.html

2.4 Climate Change Impacts for Australia and New Zealand

Australia and New Zealand-specific chapter of the IPCC 'Impacts, Adaptation and Vulnerability) report detailing the anticipated impacts that New Zealand is likely to face as a result of climate change over the coming century.

Henessy, K.; Fitzharris, B.; Bates, B.C.; Harvey, N.; Howden, S.M.; Hughes, L.; Salinger, J.; Warrick, R. (2007). Australia and New Zealand. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Parry, M.L.; Canziani, O.F.; Palutikof, J.P.; van der Linden, P.J.; Hanson, C.E. Cambridge University Press, Cambridge, UK. 507-540p.

http://www.ipcc.ch/publications_and_data/ar4/wg2/en/ch11.html

2.5 Climate Change Impact Assessment Guidance

The UK Climate Impacts Programme (UKCIP) helps organisations to adapt to inevitable climate change by providing methodologies and tools that organisations can use to prepare for the impacts of climate change and provides case study examples from across the United Kingdom. Methodologies presented can be employed in a similar way in/for New Zealand.

http://www.ukcip.org.uk

3. General Information on Climate Change in New Zealand:

Climate Change information in New Zealand may be found in primary literature, however useful, applied work has been carried out over recent years through Central Government funded research in the form of reports by research institutes either with, or on behalf of, Central Government agencies. For this reason, information on climate change for New Zealand may found in various formats either directly through Central Government agencies, from individual research institutes and from local government bodies and other community groups.

3.1 Ministry for the Environment

The Ministry for the Environments website provides a succinct summary of the basic science, impacts and adaptation measure of climate change as well as providing an overview of the emissions trading scheme (ETS).

http://www.climatechange.govt.nz

3.2 Climate change scenarios for New Zealand:

An explanation of what climate change scenarios are, how they are applied to New Zealand and what the associated impacts are likely to be can be accessed on the NIWA website.

http://www.niwa.co.nz/our-science/climate/information-and-resources/clivar/scenarios

3.3 Climate Change Effects and Impacts Assessment

This manual provides the latest projections of climate change for New Zealand and demonstrates how to incorporate risk assessment into local government planning processes to reduce vulnerability to the impacts of climate change.

Mullan, B.; Wratt, D.; Dean, S.; Hollis, M. (2008). Climate change effects and impacts assessment: a guidance manual for Local Government in New Zealand. MFE07305. Wellington, NIWA. 156p.

http://www.mfe.govt.nz/publications/climate/climate-change-effect-impacts-assessments-may08

3.3.1 Preparing for Climate Change

This guide for local government in New Zealand is an easy to read summary publication of the climate change effects and impacts assessment report.

MfE (2008). Preparing for climate change: A guide for local government in New Zealand. Wellington, 38 p.

http://www.mfe.govt.nz/publications/climate/preparing-for-climate-change-guide-for-local-govt

3.4 Coastal Hazards and Climate Change

This manual examines the implications of climate change on New Zealand's coastal margins, how society can respond to such a threat and in turn, manage risk by future proofing our development options in such an environment.

Ramsay, D.; Bell, R.; New Zealand. Ministry for the Environment. (2008). Coastal hazards and climate change : a guidance manual for local government in New Zealand. viii, 127p.

http://www.mfe.govt.nz/publications/climate/coastal-hazards-climate-change-guidance-manual/

3.4.1 Preparing for Coastal Change

This guide for local government in New Zealand is concise summary publication of the coastal hazards and climate change report.

MfE (2009). Preparing for coastal change: A guide for local government in New Zealand. Wellington, 30p.

http://www.mfe.govt.nz/publications/climate/preparing-for-coastal-change-guide-for-local-govt/

3.5 Tools for Estimating the Effects of Flood Flow on Climate Change:

This guidance manual for local government in New Zealand examines methods for estimating rainfall and associated flooding under climate change. It discusses methods for understanding changes in flood inundation and highlights location-specific case studies by way of example. Finally it discussed the challenges that engineers face when dealing with adaptation measures under climate change uncertainty.

Woods, R.; Mullan, A.B.; Smart, G.; Rouse, H.; Hollis, M.; McKerchar, A.; Ibbitt, R.; Dean, S.; Collins, D. (2010). Tools for estimating the effects of climate change on flood flow: A guidance manual for local government in New Zealand. Ministry for the Environment. 71p.

http://www.mfe.govt.nz/publications/climate/climate-change-effects-on-flood-flow/index.html

3.5.1 Preparing for Future Flooding

A concise guide drawing from the 'Tools for estimating the effects of flood floow on climate change manual' compiled for use by local government in New Zealand.

MfE (2010). Preparing for future flooding: A guide for local government in New Zealand. Wellington, 34p.

http://www.mfe.govt.nz/publications/climate/preparing-for-future-flooding-guide-for-local-govt/index.html

3.6 Climate Change Adaptation in New Zealand (Sectoral Perspectives)

A report compiled by the New Zealand Climate Change Centre containing 9 individual papers focussing on how various sectors within New Zealand are or could respond to climate change through adaptation. The report includes a paper that extensively examines risk assessment in the context of climate change.

Nottage, R.A.C.; Wratt, D.S.; Bornman, J.F.; Jones, K.; Centre, N.Z.C.C. (2010). Climate change adaptation in New Zealand: future scenarios and some sectoral perspectives, 133p.

http://www.nzclimatechangecentre.org/research/climate-change-adaptation-publication

3.7 Information on Natural Hazards:

Given that climate change will impact already existing hazards it makes sense to not view climate change as an altogether new threat as such, but rather consider the impact it will impart on those hazards we already have a reasonable understanding of. The Natural Hazards Centre examines such hazards either separately or in addition to climate change and posts recent reports and findings on its website.

http://www.naturalhazards.net.nz

3.8 Commentary on climate change

The Hot Topic website covers scientific and political issues of climate change in a timely manner and is based around the popular book of the same name.

www.hot-topic.co.nz

4. Help & Expertise

Given the vast nature of climate change and the challenges of understanding where, or even how, to start contemplating adapting to climate change, starting any research or implementing a strategy in such a field can be a daunting prospect. New Zealand, being a small country, lends itself well to providing appropriate help in the field of climate change adaptation, and for its size, is remarkably well-equipped with some of the most experienced researchers working in the subject area today. Using such researchers to provide direction, or to take on a more informed role in a given study, is considered prudent. The close nit nature of the research community usually means that if one cannot help, they will usually know someone else who will be able to. Whilst it is a growing field still, there are plenty of examples of climate change adaptation being enacted in real-time projects. Using Local Government New Zealand (LGNZ) to help point out where such examples are is good place to start. Here, we highlight other avenues for sourcing climate change adaptation-related information in addition to LGNZ.

New Zealand Climate Change Centre:

Further information regarding the science of climate change, impacts and adaptation for New Zealand can be sourced through one or more of the member organisations of the New Zealand Climate Change Centre (NZCCC). The members of the NZCCC comprise of all of New Zealand's Crown Research Institutes, University of Canterbury and Victoria University of Wellington. Additional members are expected to join in the future. The NZCCC website will include a climate change 'experts database' which assists the user to find an expert for their field of enquiry (in development at the time of writing this report).

www.nzclimatechangecentre.org

Ministry for the Environment:

The Ministry for the Environment can provide help and expertise for carrying out a climate change assessment. They have produced several documents aimed at assisting local councils deal with climate change adaptation in a practical sense.

http://www.mfe.govt.nz

Urban Impacts and Adaptation Toolbox Project Team

This Toolbox has been produced through a collaborative research effort across several organisations. Contact any one of them to be put in touch with the most relevant organisation to the specific area of expertise you require:

- NIWA: http://www.niwa.co.nz
- GNS Science: http://www.gns.cri.nz
- MWH: http://www.mwhglobal.com/nz
- BRANZ: http://www.branz.co.nz

Local Government

Local Councils are largely tasked with looking after climate change adaptation for their constituency. They are therefore often the best place to go for work being carried out at a local level to implement climate change adaptation strategies and planning. Local Government New Zealand can provide you with appropriate information relevant to your query, and/or put you in touch with the right person at your local Council.

http://www.lgnz.co.nz

5. Glossary

This glossary contains key words and terms used frequently in this Toolbox. They are organised alphabetically.

Adaptation is the process of adapting to the physical impacts of climate change on the environment, the economy, infrastructure and society at large. Examples are raising river or coastal dikes and the substitution of more temperature-shock resistant plants for sensitive ones. Various types of adaptation can be distinguished:

- **Planned adaptation** is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change, and that action is required to maintain, or achieve, a desired state.

- **Reactive adaptation** is adaptation that takes place in response to the consequences of a particular event.

- **Anticipatory adaptation** is that which takes place before impacts of climate change are observed.

- **Spontaneous (or autonomous) adaptation** does not constitute a conscious response to climatic stimuli, but is triggered by ecological changes in natural systems, and by market or welfare changes in human systems.

Adaptation assessment is the practice of identifying options to adapt to climate change and evaluating them in terms of criteria such as availability, benefits, costs, effectiveness, efficiency and feasibility.

Adaptation to climate change includes actions to reduce the vulnerability of a system to the negative impacts of anticipated human-induced climate change.

Adaptation to climate variability involves taking action to reduce vulnerability to short-term climate shocks. Often, adaptation to climate variability will also result in adaptation to climate change. The objective of adaptation is to reduce vulnerability to climate change and variability, and enhance the capability to capture any benefits of climate change.

Adaptation measures refer to actual adjustments, or changes in decision environments, which might enhance resilience or reduce vulnerability to observed or expected changes in climate.

Adaptive capacity is the inherent capacity of a system or population to adjust to climate impacts or climate change, to moderate potential damages, exploit opportunities, and cope with the consequences.

Annual exceedance probability (AEP) is the probability of a given (usually high) sea or flood level being equalled or exceeded in elevation, in any given calendar year. AEP can be specified as a fraction (e.g., 0.01) or a percentage (e.g., 1%). AEP = 1 / ARI.

Assessment endpoints are chosen to help establish the acceptability of the risk posed to an exposure unit by future circumstances and decisions. They are often referred to as thresholds in the climate impacts assessment literature. Thresholds are determined by past records or experience of previous events that defined the edge of the coping range and the limit of a tolerable climate. Thresholds, or assessment endpoints, may be

a fundamental property of a system (i.e. a biophysical discontinuity in space and time, such as the water level at which a river bursts its banks, or the wind speed that leads to the felling of large areas of forest), or behavioural (i.e. a point at which individuals, or society at large, responds to an issue by a change in behaviour that has an economic or social outcome). The concept of assessment endpoints is helpful in determining coping ranges for systems that are less readily quantifiable, such as biodiversity.

Average recurrence interval (ARI). A given (high) sea or flood level would be expected to be equalled or exceeded in elevation, once, on average, every "ARI" years. ARI = 1 / AEP.

Building adaptive capacity (BAC) involves developing the institutional capacity to respond effectively to climate change. This means compiling the requisite information and creating the regulatory, institutional and managerial conditions that are needed before adaptation actions can be undertaken.

Contingency planning: A Contingency plan is a plan devised for a specific situation when things could go wrong. Contingency plans are often devised by those who want to be prepared for anything that could happen. They are sometimes known as *Back-up plans*, *Worst-case scenario plans* or *Plan B*.

Climate refers to the average weather experienced in a region over a long period, typically at least 30 years. This includes temperature, wind and rainfall patterns.

Climate change risk is the additional risk to investments (such as buildings and infrastructure) and actions from potential climate change impacts.

Climate change impact is a specific change in a system caused by its exposure to climate change. Impacts may be harmful (impact) or beneficial (opportunity).

Climatic variability: The Earth's climate is not static, but varies on time scales of decades to millennia in response to interactions between the ocean and the atmosphere, changes in the Earth's orbit, fluctuations in energy received from the sun and volcanic eruptions. A fluctuation in the Earth's climate is known as climatic variability.

Cost-benefit analysis (CBA) is the term used to describe the appraisal of the merits associated with each option by quantifying in monetary terms as many costs and benefits as possible, including items for which the market does not provide a satisfactory measure of value. CBA is designed to help one select the option which offers the greatest excess of benefits over costs.

Critical threshold defines the point in a system at which sudden or rapid change occurs.

Diurnal is the observed range of a climatic variable in a single calendar day or 24 hour period.

Downscaling is the process of reducing coarse spatial scale model output to a finer scale. There are two main approaches to downscaling. Dynamical downscaling involves nesting a finer-scale Regional Climate Model within a coarser-scale Global Climate Model. Statistical downscaling involves applying historical large-scale to finer-scale statistical relationships (e.g. the relationships between large-scale wind patterns and finer-scale rainfall patterns) to coarse-scale Global Climate Model projections of future climate.

Ensemble is a set of simulations or model runs (each one an ensemble member) made by the same model and using the same emissions scenarios with either/both (i) different initial conditions or (ii) different yet plausible representations of the ocean-atmosphere system. The difference in climate between members is a measure of natural climatic variability and modelling uncertainty, respectively.

Extreme event: An event that is rare at a particular place. Definitions of "rare" vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of the observed probability density function. By definition, the characteristics of what is called extreme weather may vary from place to place. Single extreme events cannot be simply and directly attributed to anthropogenic climate change, as there is always a finite chance the event in question might have occurred naturally.

Global Climate Model (GCM) is a model of the global ocean-atmosphere system used to predict future climate scenarios, correctly called a General Circulation Model.

Greenhouse gases reflect heat from the Earth and stop it being lost into space, causing the atmosphere to warm up very slowly. Most greenhouse gases are natural – water vapour is the most common one – and without them the Earth would be 15-30˚C colder than it is. However, human activities have increased the concentration of certain greenhouse gases, such as carbon dioxide and methane, in the atmosphere, elevating global temperatures.

Impacts are the effects of climate change on natural and human systems.

Intergovernmental Panel on Climate Change was established in 1988 by the World Meteorological Organisation and the UN Environment Programme (UNEP), the IPCC surveys world-wide scientific and technical literature and publishes assessment reports that are widely recognised as the most credible existing sources of information on climate change. The IPCC was established to provide the decision-makers and others interested in climate change with an objective source of information about climate change. The IPCC also works on methodologies and responds to specific requests from the Convention's subsidiary bodies. The IPCC is independent of the Convention.

Inverse barometer (IB) is a measure of the change in sea level elevation due to changes in atmospheric pressure. The relationship is "inverse" because as the pressure decreases ("barometer" drops), the sea level rises.

Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1997 in Kyoto, Japan. It contains legally binding commitments for most developed (OECD) countries and countries with economies in transition to reduce their greenhouse gas emissions in the commitment period 2008 to 2012. The Kyoto Protocol entered into force on 16 February 2005.

Low regret options are options for which the implementation costs are low while, bearing in mind the uncertainties with future climate change projections, the benefits under future climate change may potentially be large.

Maladaptation is an action or investment that enhances vulnerability to climate change impacts rather than reducing them.

Mean-level-of-the-sea (MLOS) describes the variation of the non-tidal sea level on longer time scales ranging from a monthly basis to decades due to such things as sea temperature and variability in El Niño–Southern Oscillation (ENSO) and Interdecadal Pacific Oscillation (IPO) patterns.

Mitigation is action that results, by design, in the reduction of greenhouse gas emissions by sources or enhances removals by sinks. Mitigation and abatement are often considered to be equivalent terms. Examples include using fossil fuels more efficiently for industrial processes or electricity generation, switching to solar energy or wind power, improving the insulation of buildings, and expanding forests and other "sinks" to remove greater amounts of carbon dioxide from the atmosphere.

Multi-criteria analysis (MCA) is any structured approach used to determine overall preference amongst alternative options, where the options accomplish multiple objectives.

No-regret adaptation options are adaptation options that would be justified under all plausible future scenarios including the absence of human-induced climate change. A no-regret option could be one that is determined to be worthwhile now (in that it would yield immediate economic benefits which exceed its cost), and continue to be worthwhile irrespective of the nature of future climate.

Regions/Regional: The term used to refer to the administrative regions of New Zealand.

Regional Climate Model (RCM) is an atmospheric model of higher resolution than a Global Climate Model (GCM), it is nested within the GCM to provide more detailed simulations for a particular area.

Relative sea-level rise is the net rise in sea level in a region due to climate change taking into account the vertical movement of the landmass and is the sea-level rise that should be planned for in that region. Because tide gauges sit on the landmass, they automatically measure relative sea-level rise. In New Zealand, vertical landmass movements due to rebound following the last Ice Age are relatively small, so until definitive assessments from continuous GPS are analysed over at least 10 years and a better estimate of regional sea-level rise in the SW Pacific, we should use the global-average projections from IPCC.

Resilience is the ability of a social or natural system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity of self-organisation and the capacity to adapt to stress and change.

Risk is the chance of something happening that will have an impact on objectives. It is measured in terms of a combination of the probability (or frequency) of an event and its consequences. [*Source:* AS/NZS 4360 Standard on Risk Management].

Risk assessment is the structured analysis of hazards and impacts to provide information for decision making. Risk assessment usually relates to a particular *exposure unit* which may be individual, population, infrastructure, building or environmental asset etc. The process usually involves identifying hazards that could have an impact, assessing the likelihoods and severities of impacts, and assessing the significance of the risk, which is usually related to the probability multiplied by the severity of the impact.

Scenarios are plausible and often simplified descriptions of how the future may develop based on a coherent and internally consistent set of assumptions about driving forces and key relationships. Scenarios may be derived from projections, but are often

based on additional information from other sources, sometimes combined with a narrative storyline.

Season/Seasonal: Winter is the average for the three months June, July and August; Spring is the average for September, October and November; Summer is the average for December, January and February; and Autumn is the average for March, April and May.

Special Report on Emissions Scenarios (SRES) The IPCC commissioned the Special Report on Emission Scenarios (SRES) report to analyse how future greenhouse gas emissions may change in the future. The scenarios produced by the SRES team rest on assumptions regarding economic growth, technological developments and population growth.

Storm surge is change of sea level due to weather-related processes such as wind set-up and inverse barometer.

Storm tide is the peak sea level resulting from the combination of the astronomical tide plus storm surge, plus the mean-level-of-the-sea. The storm tide reaches its peak at or near the time of high tide. The name "storm tide" reflects the role of the astronomical tide and the storm surge, which are generally the largest components.

Time-slice is any period of time used as a representative in the future.

Uncertainty is an expression of the degree to which a value (e.g. the future state of the climate system) is unknown. Uncertainty can results from lack of information or from disagreement over what is known or even knowable. Uncertainty may arise from many sources, such as quantifiable errors in data, or uncertain projections of human behaviour. Uncertainty can be represented by quantitative measures or by qualitative statements.

United Nations Framework Convention on Climate Change (UNFCCC) is the framework treaty to which the Kyoto Protocol is allied. The Convention was adopted on 9 May 1992 in New York and signed at the 1992 Earth Summit in Rio de Janeiro by more than 150 countries and the European Community. It aims to stabilise greenhouse gas concentrations at a level that avoids dangerous human interference with the climate system. Under the Convention, Parties included in Annex I (all OECD member countries in the year 1990 and countries with economies in transition) aim to return greenhouse gas emissions not controlled by the Montreal Protocol to 1990 levels by the year 2000. The Convention entered in force in March 1994.

Urban is an area relating to or located in a city or other densely populated area.

Vulnerability to climate change is the degree to which these systems are susceptible to, and unable to cope with, adverse impacts.

Weather refers to the state of the atmosphere with regard to temperature, cloudiness, rainfall, wind, and other meteorological conditions.

Wind set-up is the "piling up" of water against the coast by an onshore (or alongshore) prevailing wind.