Translating changes in climate variables into impacts that matter to you

Climate models provide projections of how various aspects of the climate are likely to change in the future as a result of increased levels of greenhouse gases in the atmosphere. However, the actual impacts that you or your organisation may experience may not be directly related to the data produced from the models. For example, the risk of flooding usually goes up if more annual rain is projected, but exactly how much depends on how intense individual storms are, and how run-off occurs on particular landscapes. Similarly, plant growth is affected in complex ways by the change in amount and timing of rainfall, average and extreme temperatures, as well as the CO_2 content of the atmosphere itself.

The *Climate Summaries* provided through the Regional Climate Explorer do some interpretation for you – for example they summarise not only changes in mean annual temperatures and rainfall, but the resulting effects in different seasons, on temperature and rainfall extremes, sea level rise, fire weather, humidity, solar radiation and evaporation. These variables and some others can also be found in the more detailed projections found under the Climate Future tool. A number of other tools – Extremes Data Explorer, Marine Explorer, and Thresholds Calculator – look at some interpreted changes.

But many impacts are not further derived. To find out about these, you will need to search other sources, or get an analysis done specially; however, do not rush into this until you have carried out some adaptation planning (e.g. *Scan* and perhaps *Portfolio Cycles*), to identify where your risks really need more information.

Here is a simple list of many of the general types of changes that different regions may experiences, and examples of the types of possible flow-on impacts. *Below this table, you'll find some more integrated specific examples. Then in the appendix there are two pictures from the latest IPCC report that puts what is happening in Australia into a global context, which may stimulate thoughts on how happenings elsewhere in the world might affect your operations here*.

Direct climate changes	Derived climate-related changes	Examples of flow-on impacts
Mean Temperature Maximum Temperature Minimum Temperature Rainfall Rainfall in different seasons Solar Radiation Evapotranspiraton[1] Wind Speed Relative Humidity	Extreme Temperature Extreme Rainfall Drought Coldest Night 1-in-20 yr Coldest Night Hottest Day 1-in-20 yr Hottest Day Wettest Day 1-in-20 yr Wettest Day Sea-level rise Sea surface temperature Salinity Acidification Fire weather	Coastal inundation risk Infrastructure damage Heatwave mortalities Transformer failures School or worksite closures Crop growth Change in growing seasons Biodiversity change Changing invasive species Damage from extreme winds Flood risk Bushfire frequency Food security Water supply security
These are the sorts of information that come direct from a climate model; you will find these, in different forms, through the tools on this website (see Data Explorers).	To obtain these forms of the data, often the original model outputs must be analysed in different ways, or 'downscaled'; even so, you will find some information on many of these on the website (see Data Explorers[1]: Marine Explorer, Extremes Explorer for some of these).	These impacts generally require further analysis to combine variables or to look at interactions with other trends like urban development or land use change to get detailed quantitative impacts; however, you can often make sensible assessments of the general ways in which changes will affect your organisation from past experience without much more analysis.

What climate change means for Australia

Climate change will lead to considerable risks to assets and productivity in a number of regions and sectors, which will impact on communities. Although human impacts of climate change can be both negative and positive (for example, hotter, wetter climates in certain areas of the world may improve food production in the short to medium term), numerous studies suggest that the current and future impacts of climate change on human society will continue to be overwhelmingly negative.

It is important to understand how climate change may impact on society. Here are three examples of potential changes and their impacts to illustrate the large scale nature of climate impacts for society.

Warming temperatures: As the climate warms, it changes the nature of rainfall, evaporation, snow, stream flow and other factors that affect water supply and quality. Freshwater resources are highly sensitive to variations in weather and climate. In areas where the amount of water in rivers and streams depends on snow melt, warmer temperatures increase the amount of precipitation falling as rain rather than as snow, causing the annual spring peak in water runoff to occur earlier in the year. This can lead to an increased likelihood of winter flooding and reduced late summer river flows. Warmer water temperatures also affect water quality and accelerate water pollution. Additionally, as temperatures increase, evaporation increases, sometimes resulting in more droughts.

South-east Australia is an area projected to become hotter and drier under climate change. Since 1950, this area has already experienced decreased rainfall, more extremely hot days, and more severe droughts. A key finding of a CSIRO study was that continuing climate change will increase fire-weather risk in most South-east Australian sites in 2020 and 2050, including the average number of days when the Forest Fire Danger Risk rating is very high or extreme.

Some studies have shown that warming temperatures are likely to increase heat-related deaths, bushfires and the extent of dengue fever. While others have shown how warming temperatures affect ocean temperatures, current patterns, and marine ecosystems.

Alpine ecosystems are extremely vulnerable to future climate changes. This is due to their small geographical extent, high degree of sensitivity, relatively modest seasonal snow cover and depth, and high diversity of flora and fauna, many of which are already threatened. It is predicted that Alpine regions will experience an 18-66% reduction in snow cover by 2030, and a 39-96% reduction by 2070. Such outcomes will have a seriously adverse impact on Alpine regions and their communities, and will greatly increase the risk of fire in sensitive areas previously devoid of fire.

Sea level rise: Coastal and low-lying areas (where a majority of the population now lives) are exposed to increasing risks due to sea level rise. In a coastal area, there may be more frequent inundation of coastal infrastructure, increased damage costs to households, more regular disruption to service delivery in areas affected by flooding, loss of natural ecosystems, possible reduced access to affordable insurance cover, loss of public and private land through erosion, and greater expenditure on asset repair and maintenance. In a number of coastal areas, climate change is likely to require investment in protective works and asset strengthening, or in planned retreat. Rising sea levels may also cause saltwater to enter into fresh underground water and freshwater streams, reducing the amount of freshwater available for drinking and farming.

A report on Climate Change Risks to Australia's Coast found that mid-range predictions of sea-level rise this century would mean that "storm events that now happen every 10 years would happen about every 10 days in 2100. The current 1-in-100 year event could occur several times a year." The June 2007 storm in Newcastle that stranded a coal ship on a local beach was a 1-in-100 year scale event -- that storm caused more than 200,000 homes to lose power, thousands of people forced to evacuate their homes, and insured losses exceeded $1.3 billion.

Extreme events: Climate change projections show a marked trend towards more variable and anomalous weather, leading to an increase in the number and severity of extreme weather events such as floods and drought. This trend towards more variability and fluctuation is perhaps more important, in terms of its human impact, than that of gradual and long-term changes. Tropical cyclones and severe storms are likely to increase in intensity as a result of climate change, affecting communities in tropical areas. This could put some of Australia's tropical centres like Cairns, Broome, Darwin and Townsville, as well as remote communities, at considerably increased risk. Indigenous communities in remote areas will be particularly affected due to existing economic, housing and health vulnerability. There may also be effects on human health, as tropical storms can lead to drastic, though temporary, changes in temperature and flash floods that allow for greater disease transmission. Floods and droughts can also lead to large impacts on agricultural productivity and food security.

As Cyclone Larry's destruction of North Queensland banana crops demonstrated in 2006 and Cyclone Yasi in 2011, extreme weather events and adverse climatic conditions can affect the availability and cost of fresh food. ABS data points to adverse weather as a factor contributing to the rising price of fresh food. In 2005, poor weather and higher fuel costs drove up the prices of potatoes, broccoli, onions and tomatoes, as well as a variety of fruit. Overall, the price of vegetables rose 6.8% and fruit rose 5.8%, contributing to a total increase in food costs of 3.6% over the year to December 2005. From 2007 to 2008, due partly to the multi-year drought, wheat prices in Australia jumped 42% in one year.

APPENDIX 1: The following 2 figures are drawn from the IPCC's 2014 Summary for Policy-makers. They are very high level but they may help trigger your thoughts about:

- key areas of risk (and opportunity) and how these may vary across the world (Figure SPM 8), perhaps including how relevant international value chains may be affected
- key approaches to adaptation or risk treatment (Table SPM.3), showing their diversity.

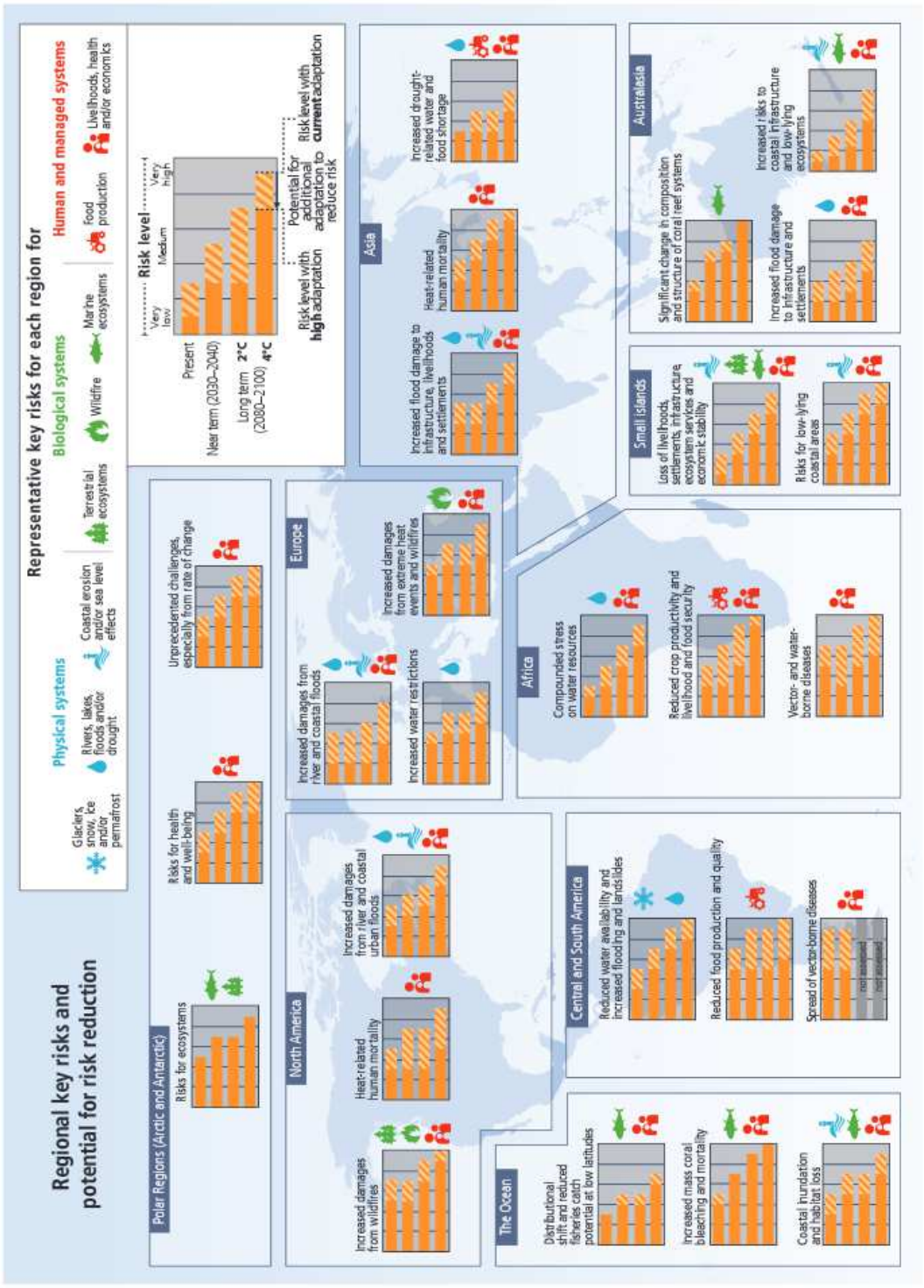

Figure SPM.8 | Representative key risks[14] for each region, including the potential for risk reduction through adaptation and mitigation, as well as limits to adaptation. Each key risk is assessed as very low, low, medium, high or very high. Risk levels are presented for three time frames: present, near term (here, for 2030–2040) and long term (here, for 2080–2100). In the near term, projected levels of global mean temperature increase do not diverge substantially across different emission scenarios. For the long term, risk levels are presented for two possible futures (2°C and 4°C global mean temperature increase above pre-industrial levels). For each timeframe, risk levels are indicated for a continuation of current adaptation and assuming high levels of current or future adaptation. Risk levels are not necessarily comparable, especially across regions. *(Figure 2.4)*

Table SPM.3 | Approaches for managing the risks of climate change through adaptation. These approaches should be considered overlapping rather than discrete, and they are often pursued simultaneously. Examples are presented in no specific order and can be relevant to more than one category. *(Table 4.2)*

Overlapping Approaches	Category	Examples
Vulnerability & Exposure Reduction through development, planning & practices including many low-regrets measures; Adaptation including incremental & transformational adjustments; Transformation	Human development	Improved access to education, nutrition, health facilities, energy, safe housing & settlement structures, & social support structures; Reduced gender inequality & marginalization in other forms.
	Poverty alleviation	Improved access to & control of local resources; Land tenure; Disaster risk reduction; Social safety nets & social protection; Insurance schemes.
	Livelihood security	Income, asset & livelihood diversification; Improved infrastructure; Access to technology & decision-making fora; Increased decision-making power; Changed cropping, livestock & aquaculture practices; Reliance on social networks.
	Disaster risk management	Early warning systems; Hazard & vulnerability mapping; Diversifying water resources; Improved drainage; Flood & cyclone shelters; Building codes & practices; Storm & wastewater management; Transport & road infrastructure improvements.
	Ecosystem management	Maintaining wetlands & urban green spaces; Coastal afforestation; Watershed & reservoir management; Reduction of other stressors on ecosystems & of habitat fragmentation; Maintenance of genetic diversity; Manipulation of disturbance regimes; Community-based natural resource management.
	Spatial or land-use planning	Provisioning of adequate housing, infrastructure & services; Managing development in flood prone & other high risk areas; Urban planning & upgrading programs; Land zoning laws; Easements; Protected areas.
	Structural/physical	***Engineered & built-environment options***: Sea walls & coastal protection structures; Flood levees; Water storage; Improved drainage; Flood & cyclone shelters; Building codes & practices; Storm & wastewater management; Transport & road infrastructure improvements; Floating houses; Power plant & electricity grid adjustments.
		Technological options: New crop & animal varieties; Indigenous, traditional & local knowledge, technologies & methods; Efficient irrigation; Water-saving technologies; Desalinisation; Conservation agriculture; Food storage & preservation facilities; Hazard & vulnerability mapping & monitoring; Early warning systems; Building insulation; Mechanical & passive cooling; Technology development, transfer & diffusion.
		Ecosystem-based options: Ecological restoration; Soil conservation; Afforestation & reforestation; Mangrove conservation & replanting; Green infrastructure (e.g., shade trees, green roofs); Controlling overfishing; Fisheries co-management; Assisted species migration & dispersal; Ecological corridors; Seed banks, gene banks & other *ex situ* conservation; Community-based natural resource management.
		Services: Social safety nets & social protection; Food banks & distribution of food surplus; Municipal services including water & sanitation; Vaccination programs; Essential public health services; Enhanced emergency medical services.
	Institutional	***Economic options***: Financial incentives; Insurance; Catastrophe bonds; Payments for ecosystem services; Pricing water to encourage universal provision and careful use; Microfinance; Disaster contingency funds; Cash transfers; Public-private partnerships.
		Laws & regulations: Land zoning laws; Building standards & practices; Easements; Water regulations & agreements; Laws to support disaster risk reduction; Laws to encourage insurance purchasing; Defined property rights & land tenure security; Protected areas; Fishing quotas; Patent pools & technology transfer.
		National & government policies & programs: National & regional adaptation plans including mainstreaming; Sub-national & local adaptation plans; Economic diversification; Urban upgrading programs; Municipal water management programs; Disaster planning & preparedness; Integrated water resource management; Integrated coastal zone management; Ecosystem-based management; Community-based adaptation.
	Social	***Educational options***: Awareness raising & integrating into education; Gender equity in education; Extension services; Sharing indigenous, traditional & local knowledge; Participatory action research & social learning; Knowledge-sharing & learning platforms.
		Informational options: Hazard & vulnerability mapping; Early warning & response systems; Systematic monitoring & remote sensing; Climate services; Use of indigenous climate observations; Participatory scenario development; Integrated assessments.
		Behavioural options: Household preparation & evacuation planning; Migration; Soil & water conservation; Storm drain clearance; Livelihood diversification; Changed cropping, livestock & aquaculture practices; Reliance on social networks.
	Spheres of change	***Practical***: Social & technical innovations, behavioural shifts, or institutional & managerial changes that produce substantial shifts in outcomes.
		Political: Political, social, cultural & ecological decisions & actions consistent with reducing vulnerability & risk & supporting adaptation, mitigation & sustainable development.
		Personal: Individual & collective assumptions, beliefs, values & worldviews influencing climate-change responses.

(The full Summary may be found on line at: https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf).