

Curtin University

CLIMATE CHANGE, VULNERABILITY AND HEALTH: A GUIDE TO ASSESSING AND ADDRESSING THE HEALTH IMPACTS

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Assessment



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This guidance document has been produced to assist decision makers and others to undertake assessment of potential health impacts and associated social implications arising from climate change. A Health Impact Assessment (HIA) framework has been combined with key climate change terminology and concepts. The fundamental premise of this framework is an understanding of the interactions between people, the environment and climate. The objectives of the guide are to improve the methodology for understanding and assessing the risks associated with potential health impacts of climate change, and to provide decision-makers with information that can facilitate the development of effective adaptation plans. While the process presented here provides guidance with respect to this task it is not intended to be prescriptive. As such, aspects of the process can be amended to suit the scope and available resources of each project. A series of working tables have been developed to assist in the collation of evidence throughout the process. The information can contribute towards the development of policies and planning by decision makers for community adaptations to climate change.

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Glossary of terms

Adaptation	Adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in response to actual or expected climate stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, public and private adaptation, and autonomous and planned adaptation
Adaptive Capacity	The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences
Biodiversity	The numbers and relative abundances of different genes (genetic diversity), species, and ecosystems (communities) in a particular area
Climate Change	Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity
Co-benefit	A climate change adaptation or mitigation strategy which has additional, positive effects on health or other areas (e.g. reducing air pollution)
Coping Capacity	The means by which people or organizations use available resources and abilities to face adverse consequences that could lead to a disaster. In general, this involves managing resources, both in normal times as well as during crises or adverse conditions. The strengthening of coping capacities usually builds resilience to withstand the effects of natural and human-induced hazards
Exposure	Any condition which provides an opportunity for individuals or communities to be subject to agents that may result in harm to human health. The agents include climate variables such as extreme events or health determinants affected by climate. The extent of exposure is affected by the magnitude and frequency of the agent
Extreme Weather Event	An event that is rare within its statistical reference distribution at a particular place. By definition, the characteristics of what is called "extreme weather" may vary from place to place. An "extreme climate event" is an average of a number of weather events over a certain period of time, an average which is itself extreme (e.g., rainfall over a season)
Hazard	The capacity of an agent to produce a particular type of adverse health or environmental effect
Health Impact Assessment	A systematic process to assess the actual or potential, and direct or indirect, effects on the health of individuals, groups or communities arising from policies, objectives, programs, plans or activities
Health Risk Assessment	The process of estimating the potential impact of a chemical, biological, physical or social agent on a specified human population system under a specific set of conditions and for a certain time-frame
Impacts	Consequences of climate change on natural systems and human health
Infrastructure	The basic equipment, utilities, productive enterprises, installations, and services essential for the development, operation, and growth of an organization, city, or nation

Mitigation	The process of reducing the impact of climate change by reducing the driving forces thereof (i.e. reducing greenhouse gas emissions)
Risk	The probability that, in a certain timeframe, an adverse outcome will occur in a person, group of people, plants, animals and/or the ecology of a specified area that is exposed to a particular dose or concentration of a hazardous agent i.e. it depends on both the level of toxicity of the agent and the level of exposure
Sea-Level Rise	An increase in the mean level of the ocean
Sensitivity	The degree to which a system is affected, either adversely or beneficially, by climate-related stimuli The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea-level rise)
Vector	An organism, such as an insect, that transmits a pathogen from one host to another
Vector-Borne Diseases	Disease that is transmitted between hosts by a vector organism (e.g. a mosquito or tick)
Vulnerability	The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity

Preface

The health impacts of climate change are significant, measurable and far-reaching. Over the last decade it is estimated that, each year, between 100,000 and 200,000 deaths worldwide were attributable to the effects of climate change.

Due to their unique geography, topography and climate, each country is likely to have sections of the community that are more vulnerable to the impacts of climate change; including risks to human health. Trends in climate change will impact human populations through effects on the physical and biological components of the environment. Global efforts are being made to mitigate climate change however some change is inevitable and individuals and communities will need to adapt to these changed environmental circumstances to avoid adverse consequences. The severity of possible impacts on communities will be dependent on our ability to adapt to situations and environments that may be quite different from those we have now.

The World Health Organisation Collaborating Centre for Environmental Health Impact Assessment at Curtin University, Western Australia (WA) recognised that the Health Impact Assessment (HIA) process provides an appropriate means by which the potential impacts of climate change can be assessed. The application of the HIA process to climate change projects has been undertaken in collaboration with government and other stakeholders in several countries. It has been used to consider the implications of climate change on the health of the community and to develop a range of adaptive responses to provide government with the basis for future decision-making.

In addition to the typical procedural steps of HIA, this guide includes practical tools that have been developed to provide guidance on the specific issue of climate change. The key elements comprise of the identification of climate variables and their influence on a broad range of determinants of health. Subsequently, potential health impacts and current controls can be identified, risk assessments and rankings can be considered and adaptation measures, strategies and action plans can be developed.

The complexity of relationships between climate and health, the long time frames involved and gaps in our current knowledge represent a significant challenge for climate change adaptation planning with respect to health. While these challenges may limit our ability to provide quantitative assessments of health impacts related to climate change, the process presented here improves our understanding of the adequacy of current activities with respect to health in a changing climate and provides a solid foundation for adaptation planning.

Utilisation of this process should promote a proactive approach to community health protection in the respective country or region from any adverse health impacts associated with climate change. The outcomes can form the basis for future planning and decision making by governments and other relevant sectors providing adaptive responses that can be taken up by society.

The authors hope that this document will assist with plans to reduce the health impacts of climate change. We encourage those using the guidance document to provide us with feedback on the outcomes and any suggestions for improvement.

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Introduction

Management of climate change generally falls under two major areas: mitigation and adaptation. The long-term importance of mitigation is critical as our ability to reduce greenhouse gas emissions will ultimately determine the extent of climate change. However, even with the most optimistic mitigation scenarios, projections indicate significant changes to climate will occur, particularly over the next 50 to 100 years. Therefore it is important that planning for adaptation to projected climate change on a country or area basis is undertaken as soon as possible.

Uncertainty is a part of any planning for the future, perhaps more so with climate change than any other situation in recent history. While there is consensus on the broader potential health impacts of climate change on people, actual health outcomes for specific population groups are still largely unidentified. Regardless of the uncertainty, it is clear that we need to plan to protect our health from risks associated with climate change. The scope and extent of climate-related health impacts will be strongly influenced by location and it is paramount that strategies to adapt to climate change are formulated at the national, regional and local level. This planning must be done in conjunction with all levels of society. Planning should occur for all sectors but this process focuses on the health outcomes (the process has previously been modified for other sectors including the fisheries sector (Howieson et al., 2009)).

The World Health Organisation (WHO) definition for environmental health provides a basis on which to establish the range of health determinants that may be affected by climate change and the factors that require consideration.

“Environmental health comprises those aspects of human health, including quality of life, that are determined by physical, chemical, biological, social, and psychological factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling, and preventing those factors in the environment that can potentially affect adversely the health of present and future generations” (WHO, 1993)

HIA is a formal process that considers potential health issues during the planning stages of proposal development. HIAs aim to identify and examine both the positive and negative health impacts of activities and provide decision makers with information about the manner in which the activity may affect the health of people. The HIA framework follows the format of:

- Screening
- Scoping
- Profiling
- Assessment of risks and benefits
- Risk/benefit management
- Decision making
- Evaluation

The HIA framework has been modified to enable consideration of potential impacts to health from climate change. It uses the establishment of a single possible scenario, potentially the most likely given the current state of knowledge, rather than multiple predictions of future climate conditions in the specified location. The HIA process and outcomes can then form the basis of strategy updates for mitigation and adaptation with respect to the health impacts of climate changes as more information becomes available on the predicted changes to climate

parameters. Key climate change terminology and concepts have also been incorporated into the process.

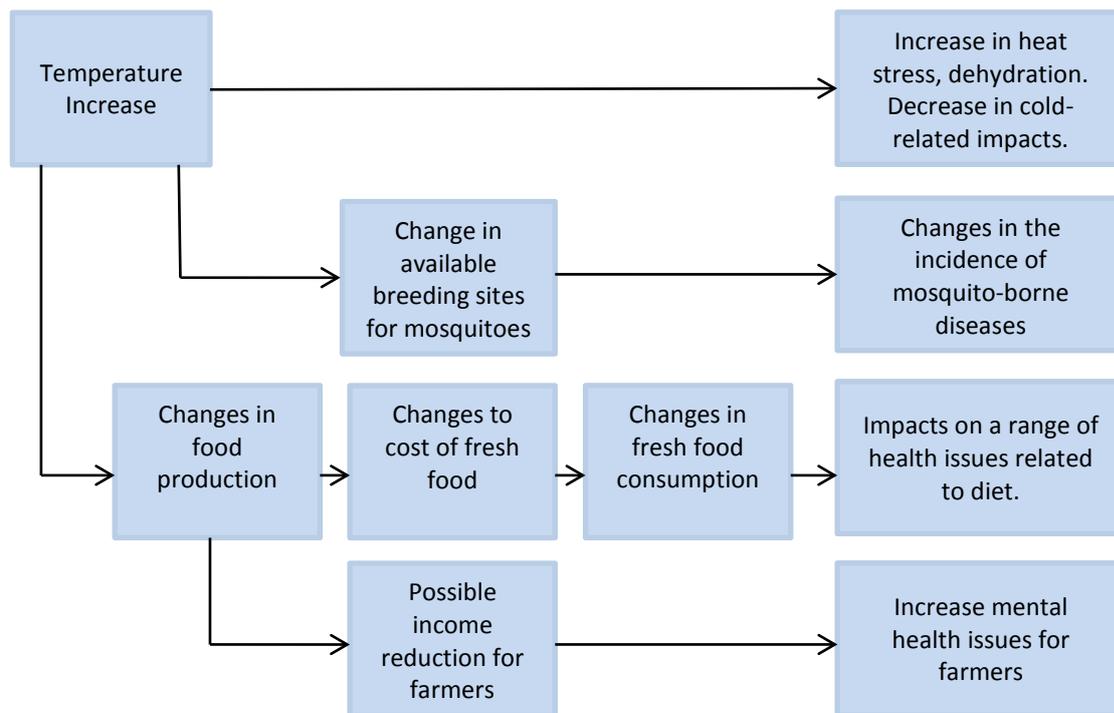
The key elements of the HIA process include consideration of the environmental changes that may arise from climate variations, the key potential health *impacts*, areas of *vulnerability*, assessment of *risk and potential benefits* and planning for *adaptation*. The specific processes for these elements are described in more detail in the following sections.

A chain of events or pathways for each identified potential health impact can be constructed to provide a logical analytical framework to address the:

- Identification of vulnerable groups, regions or sectors
- Assessment of current coping capacity and the need for adaptation
- Identification and development of opportunities for adaptation
- Identification of gaps in current knowledge needed for assessment of coping capacity and/or development of adaptation
- Identification of the appropriate sectors involved in each link of the pathway

Health impact pathways, such as shown in Figure 1, provide a simplified representation of the links between climate, the environment, and health that can be used as a starting point for more in-depth analysis. Understanding health impact pathways is a powerful tool for identifying points of vulnerability as well as opportunities for adaptation. This figure provides an example of some of the possible health impact pathways that might arise from gradual average increases in temperature by 2030. The impacts are likely to be positive and negative, as well as direct and indirect. Direct physical impacts on human health from high temperatures, such as heat exhaustion, are likely to increase. Conversely, cold-related health impacts are likely to decrease. Indirect impacts on food production and mosquito breeding patterns are highly likely; however, the extent and direction of such impacts is currently unclear in many locations. Other changes to climate variables such as rainfall and extreme weather events will also play a role; as will non-climate variables, such as land cover changes, urbanisation and salinity. The potential health impacts of these variables will also depend on a wide range of other determinants.

Figure 1: Examples of Potential Health Impacts of Temperature Increase in 2030



Planning for adaptation to climate change includes consideration of adaptive capacity. This describes the general ability of institutions, systems and individuals to adjust to potential damages, to take advantage of opportunities and to cope with the consequences. It requires consideration of current management practices in the light of future circumstances, their applicability under these future conditions and the need for change.

In health terms, current adaptive capacity is a measure of what could be implemented now to minimise the negative health impacts of climate change which may arise in the future and to maximize any positive impacts that may occur. An assessment of adaptive capacity is necessary to determine current vulnerability and to plan appropriate adaptations. Assessment of current management strategies at all levels and for all relevant sectors will provide a thorough understanding of what is needed for future management of potential health impacts from climate change.

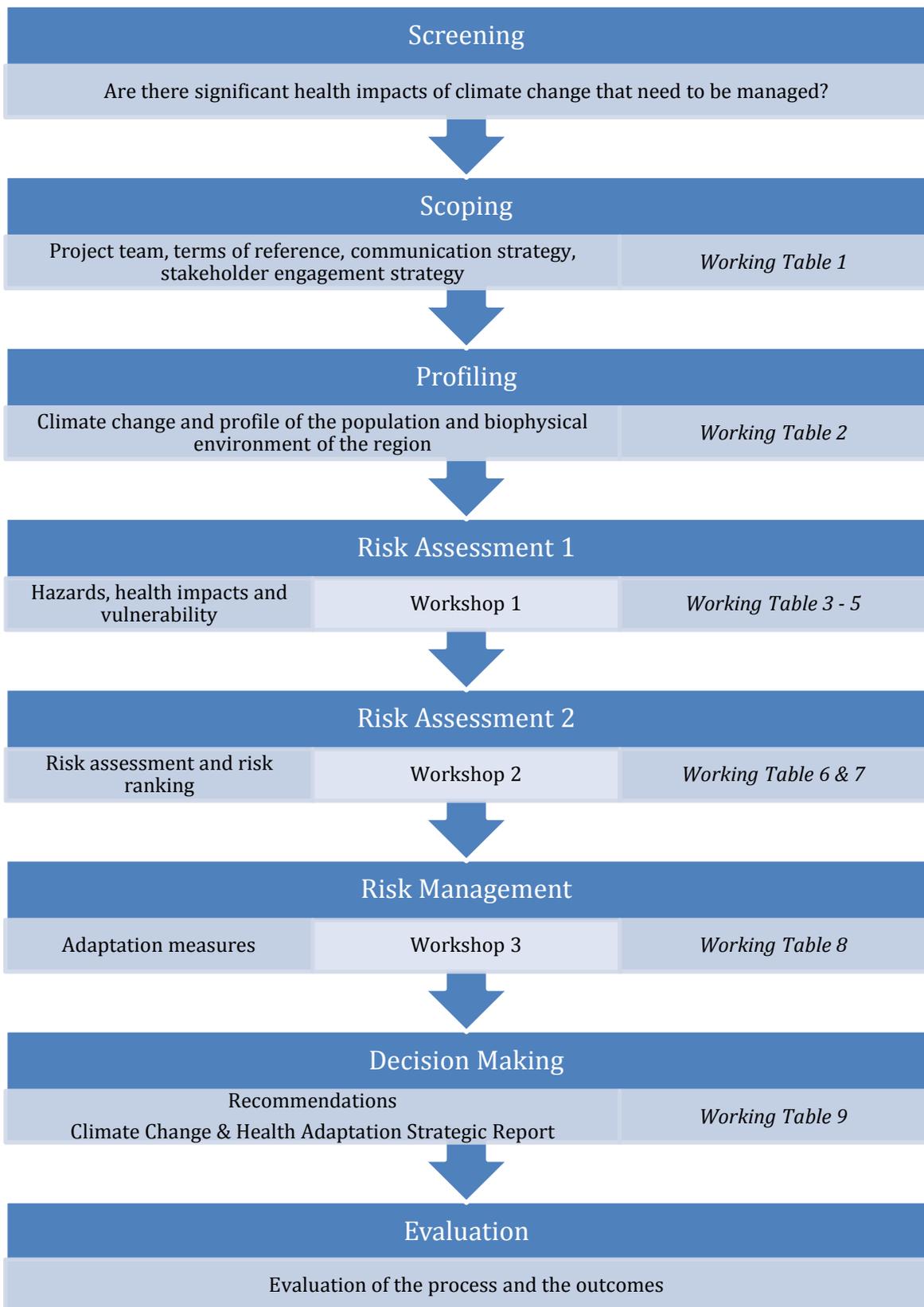
Summary of the HIA Framework for Climate Change and Health

An overview of the HIA framework is provided in Figure 2. A Project Team is established to plan and coordinate the process. The Project Team does not need to be large but should comprise representatives from the health sector (public and private) and the coordinating climate change group for the region. People with particular interest in the outcomes of the project should also be included. This may involve representatives from decision-making groups, other government sectors, community and business representatives and research sectors.

The process is typically undertaken in collaboration with stakeholders from multiple sectors in a series of three workshops. The process is supported in this document by a series of Working Tables that can be printed out and used at the steps as indicated below. The Working Tables for each of the workshops have been formatted for use as hard copy to capture comments and knowledge from workshop participants. It is suggested that the Project Team considers using computers to enter the data during the workshops but it is important that participants can concurrently review the entries. Users of this document are encouraged to contact the WHO Collaborating Centre for Environmental Health Impact Assessment at Curtin to obtain Word Document versions of the Working Tables if this will assist them in the process.

Additional background information which may be useful for the Project Team and participants in the workshops is available in the appendices. More detail of the overall process is outlined in Appendix 1 which provides guidance to the reader on the scope of issues to be considered. Appendix 2 directs the reader to sources of information to assist in undertaking activities. This additional information can be incorporated into preparatory information for stakeholders or printed and distributed as appropriate.

Figure 2: HIA Framework for Climate Change Vulnerability and Adaptation Assessment



Screening

Screening is the first step in any HIA. The aim of screening is to determine whether a HIA is required. The WHO endorses the use of a checklist which considers the:

- Description of the activity
- Questioning whether the activity has the potential to affect selected determinants of health
- Questioning whether the activity has the potential to affect the whole population or specific vulnerable groups
- Deciding whether the activity should undergo an HIA.

If we consider climate change as ‘the activity’ in the above points, it is clear that there is the potential for widespread and significant potential effects on human health wherever human populations exist. For the purpose of this Guide, the Screening step entails a consideration by the organisation or agency that is proposing to undertake the process to:

- Identify key climate variables that may impact, or are already impacting, the environment
- Identify risks to health that may be emerging
- Identify potentially affected communities and vulnerable groups
- Provide briefing explanations to decision makers to secure their support and commitment

Scoping

The scoping step establishes and identifies the key concepts of the project including; clear administrative procedures; a preliminary consideration of links between climate change and determinants of health and; factors affecting vulnerability to climate-related health effects.

This step includes:

- the establishment of the Project Team and its Terms of Reference
- development of a communication strategy
- development of a stakeholder engagement strategy

The Terms of Reference for the Project Team should establish the key factors for consideration such as:

- the key objectives of the project
- a shared understanding of the definition of health and of climate-related health impacts
- development of communication and stakeholder engagement strategies
- spatial and temporal boundaries of the HIA
- roles and responsibilities of members (e.g., compilation of relevant information, organisation of workshops)
- decision making processes within the Team including agreement on aims and methodologies for each component of the project
- resource requirements (e.g., funding, time, budgets, staff)
- time lines for activities
- final output (e.g., recommendations for decision makers)

The Determinants of Health

A shared understanding of health and the determinants of health by the Project Team and participants should be established early in the process. The WHO Constitution defines health as:

“...a (dynamic) state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity.”

Table 1 lists examples of determinants of health potentially affected by climate change that may give rise to positive and/or negative health outcomes. The table categorises the health determinants into nine main groups.

Table 1: Checklist of Health Determinants

Direct Effects of Extreme Climate Events	
1. Physical hazards associated with extreme climate events	
Indirect Effects of Climate Change	
2. Environmental <ul style="list-style-type: none"> • Air quality • Water quality • Soil quality • Food contamination • Pathogens • Vector-borne disease factors /vermin • Broader environmental issues (CO₂ emissions) • Food production—crops and animals • Visual amenities (green space, coastline) 	3. Ecological <ul style="list-style-type: none"> • Loss of habitat • Impacts on plant diseases, pests, weeds • Physical changes to land—coastline, rivers, erosion, landslides • Changes to groundwater levels • Flora and fauna—change in distribution
4. Socio-economic <ul style="list-style-type: none"> • Employment • Occupational health and safety • Social networks • Local business • Economic issues • Crime • Housing • Population changes 	5. Psychosocial <ul style="list-style-type: none"> • Mental health—control over life, stress, anxiety • Community well-being • Social conflict
6. Lifestyle <ul style="list-style-type: none"> • Exercise • Diet • Health behaviour • Alcohol/drugs 	7. Technological <ul style="list-style-type: none"> • Accidents (mechanical, chemical, etc.) • Fire, explosions • Waste treatment
8. Services <ul style="list-style-type: none"> • Resource availability • Access to emergency services • Routine access to health services (primary/secondary) • Routine access to other services (e.g. schools, shops, transport) 	9. Infrastructure <ul style="list-style-type: none"> • Energy • Transport • Telecommunication • Water • Waste

10. Add other determinants as required

-
-
-
-

The use of these groups helps to establish a common understanding amongst the Project Team and stakeholders of the range of health determinants that may be considered during the process. It is possible that limited resources may not enable a full consideration of all listed determinants or that some may not be relevant for specific locations. Other determinants of relevance to the specific location may not be included in the checklist and can be added as required.

Developing a Communication Strategy

As mentioned above, a key role of the Project Team is the development of a communication strategy. The overarching objective of the Communication Strategy should be to assist in achieving the objectives of the overall project. While the Communication Strategy is established during the Scoping step, it should be considered and updated throughout the entire process.

Development of an appropriate Communication Strategy should enable members of the Project Team to communicate activities and knowledge, reduce the potential for disagreement, and enhance participation of stakeholders in workshops and other related activities. The strategy should also consider the different forms of communication for both internal and external stakeholders and establish key responsibilities, reporting requirements and deadlines over the course of the project. Strategies should include:

- On-going communication amongst the Project Team guiding the project
- Planning for communication with stakeholders at specified stages throughout the Project

The aims of the Communication Strategy should be to:

- help the Project Team achieve its objectives
- engage effectively with stakeholders
- clarify the information on activities being provided to stakeholders
- clarify the communication mechanisms to be used
- demonstrate the results of the work undertaken
- ensure people understand what is being done
- change behaviour and perceptions where necessary

For further information on the development of a Communication Strategy, refer to Appendix 2.

Establishing a Stakeholder Engagement Strategy

Stakeholder engagement is critical as many of the potential health impacts are linked to effects that occur outside the jurisdiction of the health sector. Publications are available to assist with the stakeholder engagement process. The Department of Health in Western Australia produced the *Public health consultation: A guide for developers* to assist groups engaged in consultation on health issues.

The Stakeholder Engagement Strategy identified by the WA Department of Health is based on seven key steps:

1. Identifying
2. Profiling
3. Contacting
4. Discussing
5. Planning
6. Incorporating
7. Consolidating

Stakeholder consultation and engagement requires consideration of a number of factors as indicated in Working Table 1. This table can be copied for use in planning discussions.

Working Table 1 Stakeholder Engagement Strategy for Project Team

Issues for Consideration	Potential Responses
Who should take responsibility for consultation?	
Who are the key stakeholders with appropriate expertise at the national, regional and/or local level? These can include representatives from relevant sectors.	
How are the needs of, and consultation with, vulnerable groups to be addressed?	
Can representation for the needs of particular groups be obtained and is this useful?	
What should the outcomes of the consultation be used for?	
Are there different timeframes that should be considered for consultation and communication?	

Profiling

Three broad categories of health impacts are associated with climate conditions:

- Impacts that are directly related to weather/climate
- Impacts that result from environmental changes that occur as a result of climate change
- Impacts resulting from consequences of climate-induced economic dislocation, environmental decline, and conflict.

It is important that the Project Team identifies the specific climate, physical, and social features of the location to be assessed in the early stages of profiling. This involves the collection of background information on: current and potential climate changes, key characteristics of the natural and built environment, demographic and baseline data of the population including health status and data on existing health services. The extent of this data will be influenced by input from stakeholders and the decisions made during the scoping phase.

The activities that must be undertaken are listed below.

Developing a Climate Scenario

An understanding of future climatic conditions for the location being assessed is a critical component of the HIA. The Project Team should establish for which years climate projections are available in the location being assessed. Information on potential climate changes for the location and chosen timeframe can be sourced from government departments, meteorological services and other publically available sources such as Intergovernmental Panel on Climate Change (IPCC) reports. The Project Team is advised to choose only **one** time period and **one** climate change scenario for that time period; otherwise the process can become too confusing and unwieldy for participants. A clear rationale should be provided for the selection of the time period and the climate change scenario.

Previous Project Teams have selected the year 2030 or 2050; however this timeframe can be amended to suit the specific project. The basic climate data should include projections for:

- Gradual changes—temperature, rainfall and sea-level
- Extreme climate events—heatwaves, cold snaps, tropical cyclones, storm surges, floods, droughts and bushfires

Working Table 2 Developing a Climate Scenario

Scenario Requirements	
<ul style="list-style-type: none"> • Obtain climate data for the selected timeframe from a range of sources including the IPCC and meteorological sources • Choose relevant year and particular projection for the assessment 	
Climate Variables	Local Data
<ul style="list-style-type: none"> • Expected average temperature increases (e.g., 1° to 3°C) • Increases in the number of days over 35°C (or local classification of heatwave temperature) • Identify specific regions if necessary 	
<ul style="list-style-type: none"> • Rainfall changes • Seasonal changes across regions 	
<ul style="list-style-type: none"> • Sea-level increases by x cm 	
<p>Extreme Weather Events: For example:</p> <ul style="list-style-type: none"> • Heatwaves – number per year including maximum and minimum temperatures • Droughts – changes in frequency and severity • Bushfires – changes in risk • Flooding – changes in intensity • Storms – changes in intensity • Tropical Cyclones – changes in intensity frequency 	

Understanding the Physical Environment

The basic characteristics of the natural and built environment should be described including the topography, identification of specific features and areas of human habitation. These should also include descriptions of populated areas that are currently or potentially more vulnerable to climate changes as well as environments conducive to exacerbating or inducing certain health impacts (e.g. vulnerability of low-lying coastal areas to sea-level increase or urban areas to extreme heat). Information about these environments can be obtained from relevant government departments and other agencies. It is important to provide stakeholders and workshop participants with:

- Descriptions of the locations under consideration
- Locations and proximities of human settlements
- Appropriate maps

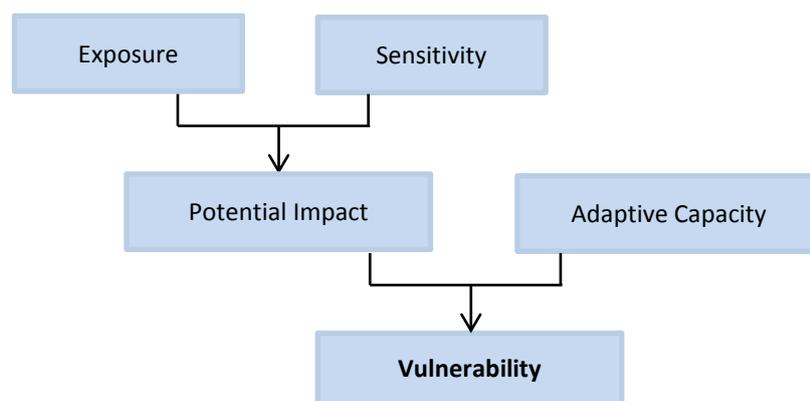
Understanding the Community

Risks to the health of a population depend on factors such as population density, individual characteristics such as age and gender, the level of economic development, food availability, income level and distribution, local environmental conditions, health status, and the quality and availability of health care. Distribution of these factors is not normally consistent across regions and may also vary with time. The current health status and leading causes of mortality and morbidity, particularly in relation to existing diseases that may be affected by climate, such as malaria and asthma, should be compiled.

An understanding of basic population demographics such as age distribution and life expectancy should be included to help identify vulnerable groups. The IPCC defines vulnerability as “the degree to which a system is susceptible to or unable to cope with, adverse effects of climate change”. In terms of HIA, vulnerability is strongly linked to the principle of equity. An understanding of vulnerability helps to ensure that adaptation strategies target vulnerable groups and reduce potential inequities with respect to the health burden of climate change.

Exposure, sensitivity and adaptive capacity are the three fundamental elements (See Figure 3) that contribute to overall vulnerability and it is critical that the Project Team and stakeholders consider these elements. The pathway between a climate variable and the subsequent health impact often involves multiple steps and vulnerability can manifest at any point on that pathway.

Figure 3: Components of Vulnerability



Source: Allen Consulting Group, 2005

Considering the concept of a health impact pathway, it can be noted that each step has a set of unique circumstances that will determine vulnerability. Analysis of each of these steps allows a logical determination of vulnerability and subsequent development of adaptive measures that aim to decrease vulnerability. For example, vulnerability to health effects of heat-waves can stem from: differences in exposure patterns based on occupational and social variables, the sensitivity of individuals to extreme heat, the capacity of the energy sector to meet peak demand during heat-waves, and differences in community and individual capacity to implement adaptation strategies.

There are multiple factors that affect the three main elements of vulnerability. It is recommended that vulnerability is considered in terms of regional, economic, infrastructure, services and social aspects. An early understanding of the elements influencing vulnerability highlights the importance of collaboration between multiple sectors and helps to inform the communication and stakeholder engagement strategies. Further information about the components of vulnerability is provided in Appendix 3.

Key basic information gathered by the Project Team from these early scoping and profiling steps should be provided to the stakeholders, preferably before the workshops commence. Participants and other key stakeholders should also be provided with information about vulnerability and adaptive capacity to ensure these are considered during the assessments.

Risk Assessment One

In respect to the year and climate change scenario outlined by the Project Team, the first stage of the risk assessment aims to identify:

- Health determinants that may be affected
- The type of health impacts that may occur as a result
- Aspects affecting vulnerability to each health impact

Workshop One – Identification of Hazards and Health Impacts

The first workshop is typically held over a day and includes stakeholders from a broad range of sectors, including: health, emergency services, environment, indigenous affairs, planning, housing, commerce and development, water, energy, transport, community and cultural services, education, fisheries, agriculture and any others of relevance.

The aims of this workshop are to:

- Engage with representatives from key sectors
- Determine the influence that predicted climate changes could have on determinants of health
- Identify the potential impacts to health that occur as result of these influences
- Consider the effectiveness of current management practices and their limitations
- Compile information on available data and evidence sources, and
- Identify potential uncertainties in collected information

The workshop has three components:

1. Identification of the biophysical, service and infrastructure and social changes to the location from the potential climate changes and the associated hazards,
2. Identification of the potential health impacts from these hazards,
3. Consideration of current management practices

Hazard Identification

The determinants of health listed in Table 1 are used to ensure a thorough approach to the identification of potential climate-related health hazards. The determinants of health are classified into three broad categories as shown in Table 2. Prior to the workshop, the Project Team assigns participants to one of the three categories based on their area of expertise. If there are sufficient participants it may be possible to form multiple groups within each category. For example in a HIA undertaken in WA, the Biophysical environment category included one group with expertise related to water quality and vector-borne diseases, while another had expertise related to air quality and food. Groups of 6–8 are recommended and participants will remain in these groups for all exercises in Workshop 1.

Table 2: Categories to Guide Formation of Participant Groups in Workshop One

Categories	Determinants of health	Expertise Required
Biophysical Environment	Environmental Ecological	Refer to Table 1 for the type of expertise required for each group
Service and Infrastructure Environment	Technological Services Infrastructure	
Social Environment	Socio-economic Psychosocial Lifestyle	

Although participants will be assigned to one group, they will be expected to consider each of the three categories, shown in Table 2, from their own perspective. Working Table 3 Example below which contains examples from the Biophysical environment group, illustrates this. The table shows that the shown effects on air quality, water quality and vectors (from the biophysical environment category) may also impact on the service and infrastructure, and social environments.

While the categories help to focus discussion it is likely that overlap between categories will occur. Discussions surrounding potential overlaps should be encouraged to ensure all relevant expertise is included.

Working Table 3 Example Potential Climate-Related Hazards: Biophysical Group

Climate Variable	<i>Biophysical environment</i>	<i>Service and infrastructure environment</i>	<i>Social environment</i>
Temperature	Ground-level ozone likely to increase with higher summer temperatures	Damage to buildings from high levels of ozone	Changes in sensitivity to ozone in population
Rainfall	Reduced water quality, water stress	Increased stress on water infrastructure	Reduced water availability for local use
Sea-level	Mosquito breeding sites may be affected	Changes in requirements for regional mosquito control	Changes in behaviour and requirements for local mosquito control
Extreme Events	Heatwaves—direct heat-related effects, air quality Bushfires—direct health effects, reductions in air quality, impact on food production	Stress on health services and infrastructure such as power, water distribution, roads and rail Damage to wide-range infrastructure & property from bushfires e.g. contamination of water supplies	Changes in behaviour to avoid heat impacts Economic losses Psychosocial impacts – stress

This step typically takes a few hours and many climate-related hazards are identified. At the end of the session each group reports their key findings in a plenary session. This ensures that participants are aware of information from other groups that may have relevance for subsequent discussions.

Health Impacts and Vulnerability Assessment

The outcomes of the consultation on climate related hazards are used as the basis for understanding potential health impacts. The potential hazards identified in Working Table 3 by the Biophysical, Service and Infrastructure and Social expert groups are transferred to the corresponding Working Table 4 for each category (Working Tables 4.1, 4.2, 4.3). The direct and indirect health impacts are identified and the factors influencing vulnerability to each health effect are discussed. The key elements of exposure, sensitivity and adaptive capacity, as well as the suggested categories (regional, economic, social and infrastructure and services) are used to guide the discussion. An understanding of the health impact pathway is critical in this step and must be underpinned by an appropriate level of knowledge and expertise of the workshop participants. Selected health impacts associated with temperature increase and heatwaves, identified by experts in the Biophysical environment group, and examples of responses, are shown in Working Table 4 Example.

Working Table 4 Example Health Impacts - Biophysical Environment

Climate Variable	Health Hazards & Impacts		Vulnerability (exposure, sensitivity, adaptive capacity)				Evidence/ Uncertainty
	Hazards (Transfer from Working Table 3)	Health Impacts Direct & indirect	Regional	Economic	Social	Infrastructure & Services	
Temperature increase	Ground-level ozone likely to increase	Respiratory and cardiovascular effects, including increase in mortality, hospitalisations and doctor visits.	Exposure likely to be higher in urban areas	-	Exposure tends to be higher outdoors → lifestyle and occupational factors may increase exposure.	Flow-on effects to health sector. May be heightened during heatwaves.	Link between ozone levels and temperature, and health effects of ozone exposure are well-established.
	Increase in aeroallergens	Asthma	Exposure likely to be higher in highly vegetated areas	-	Sensitive groups—existing respiratory conditions, including asthma.	-	Effect on aeroallergens is complex and uncertain.
Extreme Events Heatwaves	Exposure to extreme heat	Heat-related illnesses	Areas with higher temperatures. Urban areas due to urban heat island effect. Higher proportion of sensitive groups in some regions (elderly, isolated).	Low income groups—lower adaptive capacity and affected more by energy costs incurred during heatwaves. Food producers who may face crop losses, possible impact on tourism.	Elderly, isolated, pre-existing medical conditions. Low adaptive capacity—low income groups, homeless. Higher exposure—certain occupations or lifestyles	Power cuts caused by high levels of peak demand. Damage to transport systems. Flow on effects to industry. Increased demand on health services.	Link between exposure to heat and health is well-established. Possible synergistic effects of exposure to heat and air pollutants should be considered.

Current Management Practices and Limitations

Assessment of the current management practices for the identified health hazards and impacts is required. This section focuses on the likely effectiveness of the current controls in the light of the projections for the selected year and also considers areas for improvement. Identification of the sectors to be involved in the development or management of these controls can be made at this stage. Current management practices for each of the health impacts in Working Table 4 are recorded in Working Table 5. An example of Working Table 5 from the WA study is provided below. It may also be useful to record brief notes in this working table during the previous step as current management actions are often mentioned at that point.

Working Table 5 Example Current Management Practices and Limitations

Impact Type	Current Management Practices	Potential Limitations in Year 2030	Sectors
Air quality—range of respiratory effects	Air Quality Management Program Medical treatment	Air Quality Management Plan requires updating Lack of resources	Environment Health Transport
Heatwaves - Direct heat-related effects	State Emergency Management Committee All West Australian Reducing Emergencies (AWARE)	More extreme events—more demand Ageing population—larger vulnerable group Lack of specific heatwave response plan Lack of preparedness/education especially in remote indigenous communities Impact of energy blackouts on vulnerable groups	Emergency Services, Health, Energy, Indigenous Affairs

Excerpt from Spickett, Brown, Katscherian (2007)

The main output of the day’s activities is the completion of Working Tables 3–5. Blank Working Tables for Workshop 1 are provided on the following pages.

The volume of information obtained from Workshop 1 is substantial. Post-workshop, the Project Team collates the information and confirms key sources of evidence. This is likely to involve ongoing collaboration with stakeholders and further data collection from local health services and other sources. In preparation for the next workshop, the Project Team sorts the impacts from each Working Table 4 into determinant of health groupings from Table 1 as listed below:

- Extreme Events
- Environmental
- Ecological
- Socio-economic
- Psycho-social
- Lifestyle
- Technological
- Services
- Other

A summary of Workshop 1 outcomes should be disseminated to all participants, who are given an opportunity to provide further comments prior to the next workshop.

Working Table 3 **Climate Variables and their Influence on Health-Related Hazards**

Climate Variable	Relevant Health-Related Hazards		
	Biophysical Environment	Service and Infrastructure Environment	Social Environment
Gradual Changes			
Temperature increase			
Change in rainfall			
Sea-level change			
Extreme Events			
Heatwaves			

Droughts			
Bushfires			
Flooding			
Storms			
Cyclones			
Landslides			
Other			

Working Table 5 **Current Management Practices and Limitations**

Impact Type	Current Management Practices	Potential Limitations in Year X	Sectors

Risk Assessment Two

An assessment of the level of risk associated with the potential health impacts identified in Workshop One is required. This enables a comparison of the relative health risks to inform subsequent management decisions. Although potential benefits to health linked to climate change (such as reductions in cold-related deaths) may have been identified in Workshop One most impacts are likely to be negative and the objective of this project is primarily to consider adaptation strategies to reduce adverse health impacts associated with climate change. Recruitment of participants for Workshop Two should focus on those with the skills and experience to assess the risk to health posed by impacts identified in the first workshop. Fewer participants typically attend this workshop and many will be drawn from health-sector participants from the first workshop. Participants should be provided with the Workshop One summary and a description of the risk assessment process beforehand.

Workshop Two – Risk Assessment and Risk Ranking

The objectives of Workshop Two which is typically held over half a day are to:

- Assess the risks to public health associated with the health impacts identified in the first workshop
- Rank health impacts according to the level of assessed risk

Participants are allocated to groups that address health impacts related to their area of expertise. The determinant of health groupings are used as a starting point but it may be suitable to separate or combine components of these groups. For example a group of food experts may address impacts associated with food production and food contamination. Another group with expertise in social health may consider impacts associated with social networks, community well-being and social conflict.

The Risk Assessment Process

The health consequences of each impact identified in Working Table 4 and the likelihood of them occurring are assessed using predetermined scales. A five level qualitative scale for both consequences and likelihood, as described below, is recommended. In most cases, a quantitative assessment of consequences and likelihood is not practical given the current level of knowledge and evidence. Each group discusses the evidence and comes to an agreement with respect to the consequence and likelihood levels and records the rationale used. If consensus is not possible this is noted. Results are recorded in Working Table 6.

Three important assumptions are made for the assessment of both consequences and likelihood:

1. The climate change projections for the selected year, as outlined by the Project Team have occurred
2. Only current management practices for each health impact are taken into account
3. The assessment is based on the level of excess or additional risk linked to climate change

The risks for each specific health impact are based on the relationship between consequence and likelihood as shown:

Consequence x Likelihood = Risk

The assessment requires expert judgement based on available evidence and adheres to the three assumptions mentioned above. The level of risk is then determined by entering the consequence and likelihood rankings into a risk assessment matrix.

Health Consequence Rating

Health consequences are assessed using a scale which takes into account the magnitude of the impact, the severity of the health impact, the number of people affected, the duration of the impact and the socio-economic implications as shown below.

If sufficient evidence is available it is possible that a quantitative assessment of consequences for some health impacts can be undertaken. Examples of quantitative assessments for heatwaves, malaria and coastal flooding have been published by WHO (2014). In this case, the Project Team can refer to other scales that utilise quantitative measures of health risks associated with climate change (Hames and Vardoulakis, 2012; Brown and Spickett, 2014). However, for many impacts a quantitative assessment will be impractical and the qualitative scale in Table 3 is recommended. The key point is that the Project Team must specify the criteria and terminology of the scale and explain to all workshop participants.

Table 3: Health Consequence Scale

Consequence	Examples
Catastrophic	Large numbers of serious injuries, illnesses or loss of life Severe and widespread disruption to communities Long term inability to deliver essential goods and services Severe long-term reductions in quality of life Huge economic costs
Very High	Small numbers of serious injuries, illnesses or loss of life Significant, widespread disruption to communities Significant long-term decline in delivery of essential goods and services Significant long-term decline in quality of life High economic costs
High	Small number of minor injuries or illnesses Significant disruption to some communities Significant short-term decline in delivery of essential goods and services Significant short-term or minor long-term reduction in quality of life Moderate economic costs
Medium	Serious near misses or minor injuries Isolated short-term disruption to some communities Isolated but significant reductions in essential goods and services Minor reductions in quality of life Minimal economic costs
Low	Appearance of a threat but no actual harm Very minor disruption to small section of community Isolated, minor reduction in delivery of essential goods and services Insignificant impacts on quality of life Negligible economic costs

Likelihood Rating

The likelihood rating in Table 4 provides an estimate of the likelihood that the stated health impact will occur. The scale includes a descriptive element and a numerical guide that aligns with a likelihood scale developed by Mastrandrea et al., (2010) for climate change assessments.

Table 4: Health Impact Likelihood Rating

Likelihood	Description	Numerical Guide
Very likely	Is expected to occur in most circumstances	>90%
Likely	Will probably occur in most circumstances	>66%
Possible	Might occur at some time	33-66%
Unlikely	Could occur at some time	<33%
Very Unlikely	May occur only in some circumstances	<10%

Risk Priority Levels

The consequence and likelihood levels for each health impact assessed are entered into the 5x5 risk assessment matrix show in Table 5 below. The resulting risk levels range from very low to extreme.

Table 5: Risk Priority Levels

Likelihood	Health Consequence				
	Low	Medium	High	Very High	Catastrophic
Very Unlikely	Very Low	Very Low	Low	Low	Medium
Unlikely	Very Low	Low	Low	Medium	High
Possible	Low	Low	Medium	High	Very High
Likely	Low	Medium	High	Very High	Extreme
Very Likely	Medium	High	Very High	Extreme	Extreme

The results from the risk assessment process are presented in Working Table 6. An example of heatwaves and bushfires is shown in Working Table 6 Example.

Working Table 6 Example Risk Assessment Table for Extreme Events

Health Impact	Consequence	Likelihood	Risk	Rationale/Further Evidence.
Heat-related health effects during heatwaves	Catastrophic	Very Likely	Extreme	Strong evidence of link between heatwaves and health. Studies indicate increase in multiple heat-related fatalities due to climate change in Perth in 2030. Ageing population will increase size of vulnerable population.
Health effects related to bushfires	Very High	Likely	Very High	Drier and hotter conditions in WA are likely to increase risk of fires. Possible fatalities and injuries, exposure to high particulate levels, significant psychosocial and socioeconomic costs. Vulnerable groups in bushfire prone areas. E.g. South-West WA.

Once the risks for each of the impacts are determined, the risks from all groups are compiled and sorted from the highest to the lowest level of risk using Working Table 7. Ranking potential risks provides an effective means by which decision makers can compare different impacts, consider potential overlap between health impacts and prioritise responses. Given the qualitative nature of the assessment, it is possible that a comparison of risk levels from different groups may identify apparent anomalies in the final risk ranking. For this reason, the risk levels determined by each group should be collectively discussed in a plenary session. In these cases, the evidence is compared, and any final adjustments to risk ranking are made. Working Table 7 Example provides a hypothetical example of a final risk-ranking table for potential health impacts of climate change in a specific location.

Working Table 7 Example Final Risk Ranking Table for Potential Health Impacts of Climate Change

Potential Health Impact	Consequence	Likelihood	Risk
Health impacts due to extreme heat	Catastrophic	Likely	Extreme
Food-borne diseases	Very High	Very Likely	Extreme
Health impacts due to increases in ozone levels	Very High	Likely	Very High
Health impacts due to flooding	Very High	Likely	Very High
Health impacts due to bushfires	Very High	Likely	Very High
Mental health impacts due to extreme events	High	Likely	High
Health impacts due to higher particulate levels	High	Possible	Medium
Impacts from harmful algal blooms	Medium	Likely	Medium
Impacts from increased chemical exposure	Very High	Very Unlikely	Low

The main output of the day's activities is the completion of Working Tables 6 and 7. Blank Working Tables for Workshop 2 are provided on the following pages.

Risk Management

The risk management step of HIA is also referred to as adaptation, as this term is routinely used in relation to management of climate change impacts. Information Sheet 2 in Appendix 3 contains background material on climate change adaptation.

The Project Team collates all of the information from Workshop 2 and the final list of risk levels. As shown in the table below, descriptions of management actions for each risk level, including the level of community acceptability, helps to determine which impacts will be carried through to the final workshop. For example it may be determined that subsequent steps will only consider health impacts assessed as high, very high or extreme risk.

Table 6: Management of Climate-Sensitive Health Risks

Risk Levels	Description of Management Action
Extreme	Risks require urgent attention at the most senior level and cannot simply be accepted by the community
Very High	Risks are not accepted by the community and action must be taken to reduce level of risk
High	Risks are the most severe that can be accepted by the community and need planned action
Medium	Risks can be expected to be part of normal circumstances but maintained under review by appropriate sectors
Low	Risks will be maintained under review but it is expected that existing controls will be sufficient and not further action will be required to treat them unless they become more severe
Very Low	As above

The health impacts that will be considered in the final workshop should be compiled into similar groupings by the Project Team. As with Workshop Two, the determinants of health (Table 1) can be used as a starting point but it may be suitable to separate or combine components of these groups. In addition to the health determinant groupings, an additional group entitled “General Principles and Adaptation Measures” is also recommended. An example of the groups formed in the WA study is provided below. Ultimately, the exact content of this list will vary according to location and will be determined by the Project Team after the completion of Workshop Two.

- Health impacts of extreme events
- Health impacts of heat events
- Water-borne diseases and water quality
- Vector-borne diseases
- Air quality
- Food-borne diseases
- Food production
- Social/Community/Lifestyle
- General Principles and Adaptation Measures

The Project Team then compiles examples of adaptations in a separate Working Table 8 for each of the items in the list. The suggested headings for the adaptation measures to be recorded in each Working Table 8 are:

- Legislative or Regulatory
- Public Education and Communication
- Surveillance and Monitoring
- Ecosystem Intervention
- Infrastructure Development
- Technological and Engineering
- Health Intervention
- Research/Further Information

These examples should focus on strategies that can be implemented by decision makers to reduce adverse health impacts and to improve the knowledge base for future decision-making. The list is compiled by the Project Team and utilises local knowledge as well as information from the literature and previous workshops. The list of potential adaptation strategies provides a starting point for discussions in Workshop Three, but given the large number of potential adaptation strategies, it should not be considered as an exhaustive list. Examples of Working Table 8 that have been compiled from previous applications of the Guide are provided. However, as emphasised previously, the impact of climate change on health and the effectiveness of particular adaptation strategies, are likely to vary significantly between locations. It is therefore likely that the Project Team will be required to provide additional examples of adaptation strategies that suit the context of their setting.

Workshop Three – Adaptation Measures

The development of appropriate adaptation measures for the potentially affected communities is conducted in a final half-day or full day workshop. As stated above, the Project Team uses the risk rankings to guide which health impacts will be the focus of Workshop Three.

The objectives of Workshop Three with respect to the chosen health impacts are to:

- Review potential adaptation measures for their applicability to the communities at risk
- Propose additional adaptation measures
- Consider the current status of agreed adaptation measures with reference to the population and vulnerable groups
- Establish mechanisms and responsibility for implementation of adaptation measures

The Project Team must ensure that participants include those with the knowledge to identify appropriate adaptation measures and to influence decision-making with respect to such measures. Participants are likely to include, but not be limited to, those who attended Workshops One or Two. Examples include experts from government departments with responsibility for health, climate change, planning, water, energy, industry, environment, community services and welfare, as well as researchers with expertise in these areas. Participants are provided with an overview of the first two workshops and a summary of the final workshop format prior to attending.

Participants are assigned to a group focusing on specific health impacts determined by the Project Team prior to Workshop Three. As well as the specified group of health impacts, each group also considers the “General Principles and Adaptation Measures”. Each group is provided with the list of potential adaptation strategies prepared by the Project Team. This list provides a starting point for discussions, but it is not exhaustive and participants should also identify additional strategies relevant to their setting.

The members of each group discuss and rate the current status of each strategy as:

A—adequate;
I—inadequate;
D—developing and/or;
N—not in place

This rating includes a consideration of vulnerability for each impact. Participants provide suggestions on how current management strategies can be improved and identify the sectors that are likely to be involved in developing and implementing these improvements. Working Table 8 Example shows excerpts from the WA study of potential adaptation categories related to the direct physical impacts of extreme tropical cyclones, storms, floods and bushfires. As heat events posed a higher level of risk to health for this location than other extreme events they were considered separately in the WA study. Similar adjustments to the suggested categories can be made for specific locations as deemed necessary.

It should be noted that any additional impacts on health that may occur as a result of proposed adaptation strategies should be identified. Examples include health effects associated with: increased use of grey water, changes to amounts and sources of imported foods and the change in use of air conditioners and rainwater tanks.

On completion of the relevant tables, each group presents their results in a plenary session. This is a critical step as it disseminates information across traditional sectors and highlights potential synergies, conflicts or unintended consequences of proposed adaptation strategies. Opportunities for revision of strategies should be provided to participants during this session.

The main output of the day's activities is the completion of Working Tables 8.

Working Table 8.1 Example Potential Adaptation Strategies for Extreme Events (excluding heatwaves) in Western Australia

Categories of Adaptation	What Is Our Capacity —In General and for Vulnerable Regions and Groups?		Suggestions for Implementation or Upgrading	Sectors Involved
	A=adequate	I= inadequate D= Developing N = not in place		
1. Legislative or Regulatory <ul style="list-style-type: none"> • Cost sharing mechanisms for compensation and adaptation initiatives. • Regulations for minimum building standards to withstand extreme events in vulnerable regions. • Regulations regarding fire management, property management to reduce risk of injuries. • Mid to long-term strategies for land use planning that accounts for likely impacts 	N	Only private insurance	Appropriate upgrades of procedures and assessments as climate change projections and assessments dictate.	Treasury, Insurance Planning, Housing Consumer Affairs, Emergency Services
	A	Amend regulations as required		
	A	Amend regulations as required		
	N			
2. Public Education & Communication <ul style="list-style-type: none"> • Improvement in communicating risks of extreme events to vulnerable regions and groups. • Education of measures to reduce risk of damage or injuries • Evaluation of the effectiveness of educational materials. 	I/D	Continued improvement and greater investment required.	Wider community engagement needed Modern communication should be available to all (e.g., broadband)	Communication Health Local Government
	D	Coordination with Federal government is required.		
	I			
3. Surveillance and Monitoring <ul style="list-style-type: none"> • Standardization of information collected after disasters to more accurately measure morbidity and mortality. • Evaluation of responses and health outcomes of extreme events. 	I	Long-term follow up is not adequate Hospital morbidity data is okay	Access to GP data Up to date environmental and population forecasts Monitoring needs upgraded as required	Health, Planning, Environment, Climate Research Emergency Services Insurance industry
	I			
4. Ecosystem Intervention <ul style="list-style-type: none"> • Monitor the effects of altered land use on vulnerability to extreme weather events. 	A	-	Upgrade as needed Mostly mitigation but needs to address adaptation and prediction	Environment Agriculture Research Water, Planning

<p>5. Infrastructure Development</p> <ul style="list-style-type: none"> • Create or enhance emergency management— communication, preparation, training, volunteer recruitment, emergency response coordination, resource allocation. • Mapping of potential risks from extreme events— location of hazardous facilities, vulnerable properties/people. • Land use planning and management to minimize impacts from cyclones, flooding and fire (protective structures, controlled burning). 	<p>I/D I/D I/D</p>	<p>North-west seen as vulnerable All understood to some extent Need to highlight the necessity to Treasury to upgrade infrastructure as necessary.</p>	<p>Emergency system needs to expand to cope with more frequent and more severe extreme events</p>	<p>Emergency Services, Health, Local Gov't Planning, Water Energy, Transport</p>
<p>6. Technological or Engineering</p> <ul style="list-style-type: none"> • Improvement of systems to provide early and accessible warning to the populations most likely to be affected. • Modification of building codes for structures in vulnerable areas. 	<p>D/A</p>	<p>Systems are in place The main issues are access to information and the community response to early warning systems.</p>	<p>Expand resources as required</p>	<p>Climate Research Building Health</p>
<p>7. Health Intervention</p> <ul style="list-style-type: none"> • Improved training programmes and information on emergency management. 	<p>A</p>	<p>Enhance responses to rural and regional areas</p>	<p>Continue development</p>	<p>Health Emergency Services</p>
<p>8. Research/ Information</p> <ul style="list-style-type: none"> • Regional assessments of vulnerability to extreme events. • Regional identification of vulnerable communities and individual. • Evaluate effectiveness of early warning systems. • Further development of early warning systems— tropical cyclones, fires, droughts. • Modelling of affected regions 	<p>All either I or D</p>	<p>-</p>	<p>-</p>	<p>Whole of Government Health Research Climate Local Gov't Indigenous</p>

Working Table 8.1 Direct Physical Impacts of Extreme Events

Categories of Adaptation	What Is Our Capacity —In General and for Vulnerable Regions and Groups?		Suggestions for Implementation or Upgrading	Sectors Involved
	A=adequate	I= inadequate D= Developing N = not in place		
Legislative or Regulatory <ul style="list-style-type: none"> • Cost sharing mechanisms for compensation and adaptation initiatives. • Regulations for minimum building standards to withstand extreme events in vulnerable regions. • Regulations regarding fire management, property management to reduce risk of injuries. • Mid to long-term strategies for land use planning that accounts for likely impacts. 				
Public Education & Communication <ul style="list-style-type: none"> • Improvement in communicating risks of extreme events to vulnerable regions and groups. • Education of measures to reduce risk of damage or injuries • Evaluation of the effectiveness of educational materials. 				
Surveillance and Monitoring <ul style="list-style-type: none"> • Standardization of information collected after disasters to more accurately measure morbidity and mortality. • Evaluation of responses and health outcomes of extreme events. • Monitoring of appropriate management measures to reduce risk (fire breaks, trees near power lines) 				
Ecosystem Intervention <ul style="list-style-type: none"> • Monitor the effects of altered land use on vulnerability to extreme weather events. 				

Categories of Adaptation	Capacity		Implementation	Sectors
<p>Infrastructure Development</p> <ul style="list-style-type: none"> • Create or enhance emergency management - communication, preparation, training, volunteer recruitment, emergency response coordination, resource allocation. • Mapping of potential risks from extreme events – location of hazardous facilities, vulnerable properties/people. • Land use planning and management to minimize impacts from cyclones, flooding and fire (protective structures, controlled burning). • Restrictive land use zoning for potentially vulnerable regions (sea-level increase, storm surges, cyclones) • Assess ability of current infrastructure/buildings to withstand extreme events. • Make adjustments to infrastructure to ensure the safety of vulnerable groups. • Consider adequacy of current flood plain zones, in relation to sea-level rise and coastal erosion. • Sustainable infrastructure 				
<p>Technological or Engineering</p> <ul style="list-style-type: none"> • Improvement of systems to provide early and accessible warning to the populations most likely to be affected. • Modification of building codes for structures in vulnerable areas. • Construction of seawalls. • Construction of cyclone rated buildings. • Improvements in fire-fighting resources – technology, equipment. 				

Working Table 8.1 Direct Physical Impacts of Extreme Events

Categories of Adaptation	Capacity		Implementation	Sectors
<p>Health Intervention</p> <ul style="list-style-type: none"> • Improved training programmes and information on emergency management. • Medical supply management. • Increased level of first-aid training of community members in vulnerable regions. 				

Categories of Adaptation	Capacity	Sectors
<p>Research/ Information</p> <ul style="list-style-type: none"> • Regional assessments of vulnerability to extreme events. • Regional identification of vulnerable communities and individual. • Evaluate effectiveness of early warning systems. • Further development of early warning systems – tropical cyclones, fires, droughts. • Modelling of affected regions • Strengthening public health infrastructure in vulnerable communities • Climate change research. • Capacity of volunteers in extreme events – ageing population, more events. • Communication with remote and mobile populations. • Need to understand specific systems – more research from large regional scale to district and local scale • Information/research/data needs to be coordinated – data linkages between appropriate sectors, both public and private. 		

Categories of Adaptation	What Is Our Capacity —In General and for Vulnerable Regions and Groups?		Suggestions for Implementation or Upgrading	Sectors Involved
	A=adequate	I= inadequate D= Developing N = not in place		
<p>Legislative or Regulatory</p> <ul style="list-style-type: none"> • Heat Event Response Plan. Extreme Heat Alert • Regulations for minimum energy efficiencies in homes. • Regulations to introduce limited power use in high demand/emergency periods. • Load shedding – to ensure provision of energy for essential services and communal cooling centres (rec centres, shopping centres) • Legislation to commandeer infrastructure such as cold-storage 				
<p>Public Education & Communication</p> <ul style="list-style-type: none"> • Declaration of heat emergency and response plan • Communication plan to aged care facilities, refuges for homeless, day-care centres, schools. • Adequate communication for difficult to reach groups – remote, non-English speaking tourists, mobile population. • Implementation of education campaigns on heat avoidance procedures and management of health impacts. • Part of heat response plan – guidelines for school attendance, sporting events. • Examine previous successful health campaigns aimed at whole of population 				

Working Table 8.2 Direct Health Impacts of Heat events

Categories of Adaptation	Capacity		Implementation	Sectors
<p>Surveillance and Monitoring</p> <ul style="list-style-type: none"> • Analysis of daily mortality and morbidity data during heat events 				
<p>Ecosystem Intervention</p> <ul style="list-style-type: none"> • Plant more trees in urban environments. • Introduce green roofs • Reduce hard surfaces in urban areas • Increase education of importance of trees in residential areas • Use of grey-water and recycled water to provide green spaces 				
<p>Infrastructure Development</p> <ul style="list-style-type: none"> • Improved housing and public buildings (e.g., insulation, guidelines). • Improvement of urban design to reduce urban heat island effect. • Provision of communal cooling areas for vulnerable groups. • Diversify power supplies • Indoor swimming pools • Need correct management to ensure good hygiene • Consider the costs of vegetation loss in infill development. • Extend current regulations to water efficiency, building materials. • Encourage alternative energy • Infrastructure needs to be upgraded to deal with water recycling and reuse. 				

Working Table 8.2 Direct Health Impacts of Heat events

Categories of Adaptation	Capacity		Implementation	Sectors
<p>Technological or Engineering</p> <ul style="list-style-type: none"> • Implementation or enhancement of heat event warning systems. • Improved housing and public building design (e.g., insulation, guidelines, passive-solar). • Development of preventative measures other than air conditioning. • Pricing of energy and water – incentives for industry to reduce use. • Building codes need to be periodically reassessed in light of new climate projections and new advances in building material and technology. 				
<p>Health Intervention</p> <ul style="list-style-type: none"> • Better assessment of personal exposures associated with heat-related illness. • Improved training of medical and support staff in charge of vulnerable groups – aged cared, hostels, day-care centres, schools. • Hospital and nursing home staffing increases during heat-events • Adjust work schedules to avoid heat-stress exposure. • Identification of people at risk and register of vulnerable individuals/groups. 				

Working Table 8.2 Direct Health Impacts of Heat events

Categories of Adaptation	Capacity	Sectors
<p>Research/ Information</p> <ul style="list-style-type: none"> • Assessment of coping capacity in heat events for health care system and energy sector. • Improvement in the early prediction of heat episodes by determining the key weather parameters associated with poor health outcomes. • Better understanding of physiological and behavioural acclimatization. • Predictive modelling of temperature-mortality relationship in different populations. • Better understanding of the role of air conditioning in reducing impacts. • Urban design – investigate what level of vegetation is required to reduce heat-island impact. Research into the impact of the ageing population on our heat event responses • Development of strong ‘aged’ networks • Aged group is traditionally major part of volunteer base – how will vulnerability of this group affect volunteer capacity? 		

Working Table 8.3 Water-Borne Diseases and Water Quality

Categories of Adaptation	What Is Our Capacity —In General and for Vulnerable Regions and Groups?		Suggestions for Implementation or Upgrading	Sectors Involved
	A=adequate	I= inadequate D= Developing N = not in place		
<p>Legislative or Regulatory</p> <ul style="list-style-type: none"> • Development and enforcement of water quality standards. • Regulation for use of grey-water and grey-water products. • Building/construction standards for facilities that potentially impacts on water quality – e.g. chemical storage, waste-water treatment • Inclusion of climate change and health considerations in environmental impact assessments • Water Conservation regulations • Regulations for retrofitting 				
<p>Public Education & Communication</p> <ul style="list-style-type: none"> • Public awareness/hygiene campaigns in vulnerable communities about water-borne diseases after extreme events • Education on correct use and treatment of grey-water • Education on correct maintenance of private water storage. • Water conservation incentives for private and community based water conservation programs. • Financial incentives to ensure compliance with new standards and upgrading of existing substandard equipment such as rainwater tanks. • Community engagement to make informed decisions. 				

Working Table 8.3 Water-Borne Diseases and Water Quality

Categories of Adaptation	Capacity	Implementation	Sectors
<p>Surveillance and Monitoring</p> <ul style="list-style-type: none"> • Monitoring and data collection of water quality with reference to climate variables. • Enhanced private water testing. • Improvements in surveillance and prevention of water-borne disease outbreaks. • Monitoring of grey-water use • Water quality monitoring and availability • Related monitoring of environmental toxins and reduction targets • Possibility of easy to use water testing kits, e.g. swimming pool kits 			
<p>Ecosystem Intervention</p> <ul style="list-style-type: none"> • Protection of water catchment areas from contamination - preservation of natural habitat/wetlands, re-vegetation of river catchments. • Protection of quantity as well as quality – ecosystems do use the water • Better ecosystems based planning for urban development 			

Categories of Adaptation	Capacity	Implementation	Sectors
<p>Infrastructure Development</p> <ul style="list-style-type: none"> • Emergency management plans • Assessment of water and waste-water infrastructure with regard to increased risk of extreme precipitation events and droughts. • Use of climate forecasting in water planning. • Improved housing and sanitation practices in vulnerable communities. • Ensure equal access to safe, clean potable water and sanitation. • Development of water quality protection from agricultural, industrial and municipal wastes. Power outages and desalination, wastewater systems, particularly household systems have emergency management plans. • Wastewater requires power to pump – extreme events reduce energy available. • Climate resilient resources • Carbon neutral water sources. 			
<p>Technological or Engineering</p> <ul style="list-style-type: none"> • Redesign of water control structures to handle greater variability of precipitation – storm-water drains, increased absorption capacity of urban landscapes. • Improving reliability of water and waste-water systems in vulnerable communities. • Temporary measures to reduce the pathogen concentration in drinking water, such as chlorine tablets and boil-water alerts. • Use of smart technology; remote telemetry; innovative technology • Development of water testing kits much like swimming pool kits. • Increased use of non-potable water sources in homes. 			

Working Table 8.3 Water-Borne Diseases and Water Quality

Categories of Adaptation	Capacity	Implementation	Sectors
<p>Health Intervention</p> <ul style="list-style-type: none"> • Appropriate medical treatments and responses in place in response to water-borne infections. • Ensuring access to treatment in remote & vulnerable communities. • Increased training on symptoms and early treatment of water-borne diseases in vulnerable communities 			

Categories of Adaptation	Capacity	Sectors
<p>Research/ Information</p> <ul style="list-style-type: none"> • Regional assessments of water-climate health issues and identification of vulnerable communities. • Determination of links between land-use and water quality - better assessment of the watershed level of the transport and fate of microbial pollutants associated with rainfall. • Relationship between temperature, extreme rainfall events and incidence of water-borne infections. • Molecular tracing of water-borne pathogens. • Understanding of the links between drinking water, recreational exposure, and water-borne disease monitoring. • Undertake vulnerability studies of existing water supply and sanitation systems. • Development of new systems that aim to reduce vulnerability in high-risk communities. • Research on grey-water use and potential health risks. • Effect of temperature and extreme rainfall on Cryptosporidiosis in water supplies (including groundwater) and treatment options. • Consideration of the viability of remote communities 		

Categories of Adaptation	What Is Our Capacity —In General and for Vulnerable Regions and Groups?		Suggestions for Implementation or Upgrading	Sectors Involved
	A=adequate	I= inadequate D= Developing N = not in place		
<p>Legislative or Regulatory</p> <ul style="list-style-type: none"> Regulations/guidelines for container breeding habitat control e.g. rainwater tanks, ponds. Ensuring vector control is considered by all relevant sectors. 				
<p>Public Education & Communication</p> <ul style="list-style-type: none"> Health promotion, disease prevention and health care of migrant populations and travellers. Public education program regarding the risks associated with mosquito breeding habitat. Improved collaboration between the health, agricultural, forestry, environment and conservation sectors on issues influencing vector-borne disease. 				
<p>Surveillance and Monitoring</p> <ul style="list-style-type: none"> Conducting surveillance of vector density and disease transmission – improved training and resources for this. Surveillance programs to detect new diseases through uncontrolled movements such as illegal fisherman, refugees. Improved reporting of animal health and diseases by agricultural sector. Improvement of active laboratory-based disease surveillance and prevention systems at the state and local level. More effective and rapid electronic exchange of surveillance data. Increased testing for exotic diseases in tourists/migrants/ refugees. 				

Working Table 8.4 Vector-Borne Diseases

Categories of Adaptation	Capacity		Implementation	Sectors
<p>Ecosystem Intervention</p> <ul style="list-style-type: none"> • Elimination of disease vector breeding sites. • Ecosystem diversity and health along with appropriate land-use planning 				
<p>Infrastructure Development</p> <ul style="list-style-type: none"> • Management of vectors during periods of high risk. • Collaboration between health, forestry, environment and conservation 				
<p>Technological or Engineering</p> <ul style="list-style-type: none"> • Developing selective and sustainable vector control, including preparedness for emergency control • ‘Over-design’ engineering to allow for extreme events. • Contingency planning for allowing access of emergency personnel and equipment to isolated regions • Road design that does not pool water. • Building design that excludes rodents. 				
<p>Health Intervention</p> <ul style="list-style-type: none"> • Ensuring early diagnosis and prompt treatment of dengue haemorrhagic fever • Ensuring early diagnosis and prompt treatment of other vector-borne diseases. • Decentralised facilities – quarantine and disease response and testing • Provision of more doctors with appropriate awareness. • Vaccine Development 				

Categories of Adaptation	Capacity	Sectors
<p>Research/Information</p> <ul style="list-style-type: none"> • Assessment of current effectiveness of vector control measures. • Studies of transmission dynamics, including reservoir host and vector ecology • Improvements in epidemic forecasting • Research into improved treatment and diagnosis of vector-borne diseases. • Research into development of vaccines. • Influence of human population shifts in next 30 to 50 years on vector-borne diseases. • More accurate projections on climate change impacts likely to influence incidence – e.g. rainfall in northwest. • Cost–benefit analysis to assess the value of the intervention/ monitoring programs. • Quantitative risk assessments on a regional basis. • Likelihood of exotic mosquito incursion • Vector competence of our Anopheles species for malaria transmission • Vector competence of native mosquitoes for exotic pathogens • Natural control mechanisms – competition between dengue mosquito and native species in container habitats. 		

Working Table 8.5 Air Quality and Associated Health Impacts

Categories of Adaptation	What Is Our Capacity —In General and for Vulnerable Regions and Groups?		Suggestions for Implementation or Upgrading	Sectors Involved
	A=adequate	I= inadequate D= Developing N = not in place		
<p>Legislative or Regulatory</p> <ul style="list-style-type: none"> • Development and enforcement of air quality standards. • Vehicle inspection programs • Land Management • Local Government implementing and educating • Sealing roads • Regions important • Ability to control activities relating to air quality in times of high risk (traffic, industry, fires) • Indoor air quality standards required. 				
<p>Public Education & Communication</p> <ul style="list-style-type: none"> • Bushfire/control burn pollution – health warnings • Smog alert warning systems and response plans. • Public education on benefits to air quality of reducing car use, wood fires. • Public education on potential risks of Legionnaires Disease from poorly maintained evaporative air conditioners and use of water-conserving garden products. • UV monitoring and advisory schemes. 				

Working Table 8.5 Air Quality and Associated Health Impacts

Categories of Adaptation	Capacity		Implementation	Sectors
<p>Surveillance and Monitoring</p> <ul style="list-style-type: none"> • Increased monitoring of air quality • Surveillance of air pollutants of concern during high risk times (city ozone in heat events, fires) • Analysis of primary health care morbidity data, hospital admissions, emergency attendance. • Monitoring of seasonal patterns of respiratory disease • Use of ‘sentinel’ populations in different regions, particularly vulnerable groups. • Pollen monitoring 				
<p>Ecosystem Intervention</p> <ul style="list-style-type: none"> • Control burning to reduce risk of major fires • Fire breaks • Provision of natural shade for UV protection. • Weed management programs. • Re-vegetation to control dust. 				
<p>Infrastructure Development</p> <ul style="list-style-type: none"> • Incentives to reduce air pollutants • Reduce reliance on cars • Increased shaded areas in cities and public places • Renewable energy infrastructure needs to be increased. • Government contributions and incentives for improved public transport, hybrid cars etc. 				

Working Table 8.5 Air Quality and Associated Health Impacts

Categories of Adaptation	Capacity		Implementation	Sectors
<p>Technological or Engineering</p> <ul style="list-style-type: none"> • Development of innovative transportation approaches to reduce air pollution. • Reducing emissions from range of sources. • Urban weather modelling of conditions of inversions in urban weather. • Improvements in UV resistant materials and UV protection. • Incentives to use green power • Support R&D and implementation. • Development of low VOC materials. 				
<p>Health Intervention</p> <ul style="list-style-type: none"> • Improved diagnosis and medical treatment for the range of potential health impacts related to air quality and UV exposure. • Increased recognition of the possible links between climate change, air quality and health impacts. • Sunscreens, eye protection. 				

Categories of Adaptation	Capacity	Sectors
<p>Research/Information</p> <ul style="list-style-type: none"> • Relationship between air pollutants and climate parameters (e.g. ozone levels may be affected by cloud cover and wind speeds) • Coordination with IOCI on obtaining information about the critical climate parameters. • Health impacts of long-term exposure to high levels of ozone, particularly for vulnerable groups. • Health impacts of possible increased exposure to dust. • Mechanisms of adverse health effects of air pollutants in the general population and within susceptible subgroups • Moderating the impact of air pollution on health through nutrition and other lifestyle characteristics. • Better understanding of potential health impacts of increased air conditioning use and increased time indoors. • Better understanding of the role of aeroallergens in respiratory morbidity. • Better understanding of the relationship between temperature, behavioural changes and UV exposure. 		

Categories of Adaptation	What Is Our Capacity —In General and for Vulnerable Regions and Groups?		Suggestions for Implementation or Upgrading	Sectors Involved
	A=adequate	I= inadequate D= Developing N = not in place		
Legislative or Regulatory <ul style="list-style-type: none"> • Food safety laws and regulations. • Agricultural laws regulations. 				
Public Education & Communication <ul style="list-style-type: none"> • Increased education campaigns on food safety and hygiene, particularly in warmer months. 				
Surveillance and Monitoring <ul style="list-style-type: none"> • Increased monitoring/surveillance of food poisoning, particularly in high-risk periods. • Increased monitoring/surveillance of ocean temperatures and incidence of marine toxins – Ciguatera. • Monitoring of pathogens in aquaculture/fisheries in areas of risk of contamination during extreme rainfall events • Monitoring of mycotoxins, particularly in high-risk periods. • Enhancement of collaborations across health, agriculture, fisheries. • Fisheries practices. 				
Ecosystem Intervention <ul style="list-style-type: none"> • Protection of wetlands and natural habitat surrounding fisheries. • Protection of natural habitat surrounding agricultural land. 				

Working Table 8.6 Food-borne Diseases

Categories of Adaptation	Capacity		Implementation	Sector
Infrastructure Development <ul style="list-style-type: none"> • Improved food storage facilities, particularly in remote communities. 				
Technological or Engineering <ul style="list-style-type: none"> • Improved food storage methods, particularly in remote communities. • Improvements in farm storage methods. • Control of sewerage treatment near aquaculture and fisheries, particularly in extreme events. • Development of independent power sources in remote communities. 				
Health Intervention <ul style="list-style-type: none"> • Standard medical treatment 				

Categories of Adaptation	Capacity	Sectors
Research/Information <ul style="list-style-type: none"> • Data collection examining potential links between climate parameters and food poisoning – identification of organisms likely to proliferate under new climate conditions • Emergence of new food-borne pathogens • Research into impacts of behavioural changes (more outdoor eating) on incidence of food poisoning. • Emergence of new marine organisms with health impacts. 		

Working Table 8.7 Food Production

Categories of Adaptation	What Is Our Capacity —In General and for Vulnerable Regions and Groups?		Suggestions for Implementation or Upgrading	Sectors Involved
	A=adequate	I= inadequate D= Developing N = not in place		
<p>Legislative or Regulatory</p> <ul style="list-style-type: none"> • Integration of climate change and health considerations into food import and regulatory activities. • Potential impacts of climate change incorporated into national food and nutritional policies • Mechanisms to support equitable prices and access to nutritional foods, especially in remote communities. • Risk assessments of food imports and local foods need to be undertaken with climate change considerations. • UK – food rule – fresh produce must display place of origin – encourage local production and purchase of food. 				
<p>Public Education & Communication</p> <ul style="list-style-type: none"> • Education regarding nutritional standards. • Education programs for primary producers on potential impacts of climate change on agricultural practices. 				

Working Table 8.7 Food Production

Categories of Adaptation	Capacity		Implementation	Sectors
<p>Surveillance and Monitoring</p> <ul style="list-style-type: none"> • Monitoring of crop yields. • Monitoring of nutritional content of foods. • Monitoring of food prices and affordability, especially in relation to climate and extreme events. • Monitoring of imported food levels. • Increased surveillance and monitoring programs for food safety in imported foods. • Monitoring of potentially emerging contaminants such as mycotoxins. • Monitoring of antibiotic use in animal feed that may increase due to higher heat stress, particularly with imported foods. • Alternative strategies for monitoring increased level of imports – need more than end product testing. 				
<p>Ecosystem Intervention</p> <ul style="list-style-type: none"> • Conservation measures for natural habitat. 				
<p>Infrastructure Development</p> <ul style="list-style-type: none"> • Development of long-term strategic plans for agriculture. • Land-use- appropriate agricultural precincts in urban areas. 				
<p>Technological or Engineering</p> <ul style="list-style-type: none"> • Diversification of agriculture • Drought-resistant, pest-resistant crops. • Improvements in crop yield modelling • Improvements in shelf life especially for remote commun • Post-harvest strategies for fresh food and seafood. • Encourage systems for producing own food. 				

Categories of Adaptation	Capacity		Implementation	Sectors
Health Intervention				

	Capacity	Sectors
<p>Research/Information</p> <ul style="list-style-type: none"> • Relationship between climate change – extreme weather events, rainfall and temperature changes on the cost and availability of locally grown food. • Alternative crops. • Drought resistant crops. • Pest resistant crops. • Sustainable crops. • Assessment of regional agricultural vulnerability • Research into alternative foods and development of independent food sources. • Acceptability of alternative food sources • Relationship between availability and food standards (scarce food – quality level drops) 		

Categories of Adaptation	What Is Our Capacity —In General and for Vulnerable Regions and Groups?		Suggestions for Implementation or Upgrading	Sectors Involved
	A=adequate	I= inadequate D= Developing N = not in place		
<p>Legislative or Regulatory</p> <ul style="list-style-type: none"> • Requirement to disclose regional vulnerability to sea-level rise. • Regulations regarding compensation arrangements for forced relocations. • Provision for insurance in areas where private insurance is unavailable. • Issue of risk communication and disclaimers to land purchasers. (similar to noise issues or contaminated sites) • Regulatory restrictions on land-use and development in coastal zones • Shared responsibility – appropriate funding for vulnerable regions. 				
<p>Public Education & Communication</p> <ul style="list-style-type: none"> • Raise awareness in coastal regions with respect to future risks of sea-level rise. • Strengthen community resilience and health through community based health programs • Raise awareness on impacts of climate change and risks in vulnerable regions. • Education on energy sustainability. • Cross department information sharing. • Taskforce for impacts of climate change on coastal communities. • Open dialogues 				

Working Table 8.8 Social/Community/Lifestyle

Categories of Adaptation	Capacity		Implementation	Sectors
<p>Surveillance and Monitoring</p> <ul style="list-style-type: none"> • Improvement in monitoring of mental health in rural areas. • Evaluation of mental health care in response to extreme events, especially groups vulnerable to the adverse psychosocial effects of extreme events, such as children, elderly people and bereaved people. • Surveillance programs for agricultural pests and weeds, native flora and fauna and marine environment. 				
<p>Ecosystem Intervention</p> <ul style="list-style-type: none"> • Protection of natural habitat. • Education regarding ecosystem impacts and role in health. 				
<p>Infrastructure Development</p> <ul style="list-style-type: none"> • Development of healthy communities. • Long-term planning for alternative income streams for vulnerable populations. • Long-term planning for communities vulnerable to climate change and depopulation. • Identification of new industries and businesses that may emerge from climate change • Long-term planning for land-use with respect to sea-level rise. • Develop contingency relocation plans in case of sea-level rise • Regional investment funds • Support for Local Government – currently not in a position to fund ‘partnerships.’ 				

Categories of Adaptation	Capacity		Implementation	Sectors
<p>Health Intervention</p> <ul style="list-style-type: none"> • More resources for mental health services in vulnerable regions. • Training for the potential mental health impacts of climate change. 				

Categories of Adaptation	Capacity	Sector
<p>Research/Information</p> <ul style="list-style-type: none"> • Better understanding of the mental health effects of extreme events and gradual impacts such as drought, particularly in vulnerable regions • Research into early warning systems for social impacts of climate change. • Assessment of sea-level rise and extreme weather impacts on coastal communities • Policies to protect low-income groups from added financial pressures of climate change. • Population modelling in relation to climate change – health implications of projected population changes. • Research into relationship between temperature, heat events and rates of crime, accidents. • Community - comprehensive review on impacts on communities and how to sustain and promote healthy communities 		

Categories of Adaptation	What Is Our Capacity —In General and for Vulnerable Regions and Groups?		Suggestions for Implementation or Upgrading	Sectors Involved
	A=adequate	I= inadequate D= Developing N = not in place		
<p>Legislative or Regulatory</p> <ul style="list-style-type: none"> • Policy development for a coordinated body to organise adaptation responses. • Integrated assessments of environmental, economic and health impacts of climate change. • Integrated assessments of environmental, economic and health impacts of climate change mitigation and adaptation measures. • Incorporate adaptation measures into long-term policies and action plans. • Cost sharing mechanisms for compensation and adaptation initiatives. • Need to be coordinated through whole of government approach. • More prominence to health impacts. • Need to set up coordinated funding to assess and implement appropriate adaptations. • Need to develop a long-term approach to reducing the risks of climate change (bipartisan support) 				

Working Table 8.9 General Principles and Adaptation Measures

Categories of Adaptation	Capacity		Implementation	Sectors
<p>Public Education & Communication</p> <ul style="list-style-type: none"> • Increased awareness of links between climate change and health. • Increased awareness of adaptation. • Education programs targeted specifically for vulnerable groups. • Upgrade strongly • Web resources – need development, needs to be populated with information • Need a central coordinated government sanctioned information source. 				
<p>Surveillance and Monitoring</p> <ul style="list-style-type: none"> • Monitoring of climate parameters. • Monitoring of health impacts. • Monitoring of population changes. • Monitor early impacts of health changes around the world • Monitor adaptations and technologies being implemented elsewhere and assess for relevance 				
<p>Ecosystem Intervention</p> <ul style="list-style-type: none"> • Conservation and biodiversity measures. 				
<p>Infrastructure Development</p> <ul style="list-style-type: none"> • General improvements in public health infrastructure and resources. • Long term assessment of infrastructure needs. • Financial consideration of the long-term economic impacts of infrastructure spending due to climate change • Establish methods of cost-sharing where economic burdens are high. 				

Working Table 8.9 General Principles and Adaptation Measures

Categories of Adaptation	Capacity	Implementation	Sectors
<p>Technological or Engineering</p> <ul style="list-style-type: none"> • Solutions to withstand new climate parameters. • Solutions to prevent or reduce risk of health impacts from climate change. • Solutions to improve access and affordability of adaptation measures. 			
<p>Health Intervention</p> <ul style="list-style-type: none"> • Improved medical access for remote communities and vulnerable groups. • Improved education and awareness of health professionals of links between health and climate • Understanding of the risk for the emergence of new, unfamiliar diseases and health impacts. 			

Categories of Adaptation	Capacity	Sectors
<p>Research/ Information</p> <ul style="list-style-type: none"> • Regional Assessments – Identification of Vulnerable Groups, areas and infrastructure. • Regional Adaptation Plans • Sustainable adaptation • Quantitative assessments where practicable. • Improved climate projections. • Understanding the links between climate parameters and health impacts. • Strong collaboration/communication between health and climate scientists. • Evidence of effects of climate change that may impact on health. • Cost-benefit analysis of adaptation measures. • Assessment of the affordability of adaptation measures – especially in relation to low income groups. • Assessment of coincidental costs and benefits to health of adaptation and mitigation. • Evaluation of adaptation options 		

Decision Making

Adaptation Strategy and Actions

Once all the information is collected, a mechanism to present the findings to decision makers is required. This is the responsibility of the Project Team and it is recommended that a final “Climate Change and Health Adaptation Strategies Report” is developed and disseminated to all participants and key decision-makers responsible for the implementation of the potential adaptation strategies. The report should include an overview of the process and a summary of key outcomes including:

- A clear health impact statement including the final risk rankings and vulnerabilities
- Key adaptation actions, especially for priority risks and vulnerable groups

A guide to presentation and content of the Climate Change and Health Adaptation Strategies Report is provided in Appendix 4.

It is recommended that adaptation strategies are provided in a summary table with impacts ordered from the highest to lowest level of risk. Working Table 9 is provided as an approach that could be used to summarise the key information with respect to risk, potential actions and the responsible sectors. The example below from the WA study, shows that heatwaves were assessed as an extreme risk level and provides examples of ‘Legislative or regulatory’ strategies. This table is completed for each of the eight categories of adaptation. The process is repeated for other impacts, with a clear distinction made between different risk levels.

Working Table 9 Example Adaptation Action Plan for Heatwaves

Adaptation Strategies	Actions	Lead Government Agencies	Support Agencies
Heatwaves: Risk Level = Extreme			
1. Legislative or Regulatory			
Heat Event Response Plan	Extend state emergency plan to include heatwaves	Health, Emergency Services	Housing Planning Aged Care
Limit power use in emergency periods	Sectors to discuss feasibility	Energy, Health	Planning Local Government
Regulations for minimum energy efficiencies in homes	Expand energy star codes to existing homes.	Housing, energy	Building industry Businesses
2. (complete for all 8 categories of adaptation strategies)			

The recommendations to decision makers and other key stakeholders should include:

- Strategic Direction—incorporation of climate change adaptation strategies into key sustainable development and health plans
- Government Responses—identify lead and support stakeholders particularly with respect to high risk impacts and ensure that high level management are aware of the report and the role of their sector in ensuring appropriate responses to climate change. The health sector should take a lead role by increasing cross-sector awareness of connections between health and climate and encouraging appropriate actions to protect the health of the community.

- Community Involvement—education programs regarding the potential health impacts of climate change and the key role of local government or councils with respect to community education.
- Key Activities/Projects—outline the specific projects required. Include cross-cutting measures that have the potential to affect multiple impacts or reduce multiple vulnerabilities. Highlight the potential need for more detailed assessment by other sectors with respect to their role in addressing high priority health risks.

If the project team has access to information that provides an indication of costs associated with recommendations this can also be included in the final report.

Working Table 9 Adaptation Action Plan Summary

Risk Level _____ (list in order from highest to lowest risk level being considered)

Adaptation Strategies	Actions	Lead Government Agencies	Support Agencies
1. Legislative or Regulatory			
2. Public Education & Communication			

Evaluation

The evaluation of both the process undertaken and the outcomes is an important component of HIA.

Evaluation of the process should consider any particular problems encountered during the process or suggestions for improvement and be recorded for future reference. On a broader scale, users of this report are invited to provide an evaluation of their own experience of the process to the authors. Any evaluation received will be compiled and distributed to a wider audience, either through the WHO Collaborating Centre website <http://ehia.curtin.edu.au> or in future versions of the guidelines.

Evaluation of outcomes considers the appropriateness of any recommendations made. Evaluations should include progress of implementation of the recommended adaptation measures, including the involvement of key stakeholders and the incorporation of health impacts of climate change into planning processes, as well as monitoring and surveillance of the health status of the potentially affected communities. It may be relevant to include new mechanisms for collection of health data that demonstrates links to climate conditions. Baseline indicators established during the scoping stages are used as reference for assessment of changes over time.

Appendices

Appendix 1

Summary of the Overall HIA Process

Concurrent activities:	Process Component	Issues for inclusion	Stage
<ul style="list-style-type: none"> • Communication • Stakeholder Engagement • Country/regional agreements, approaches and implementation plans 	Screening	Description of project Briefing for decision makers	
	Scoping Terms of reference Communication Strategy Stakeholder Engagement Strategy	Formation of Project Team Stakeholder identification Project objectives & methods	Working Table 1
	Profiling Climate variables Physical variables Community variables including population health demographics	Develop climate scenario (year & climatic variables) Description of region being assessed: <ul style="list-style-type: none"> • human settlements • relevant maps • vulnerable groups 	Working Table 2
	Risk Assessment One Workshop One Identification of hazards	Addressed through identification of changes to following environments: <ul style="list-style-type: none"> • biophysical • service and infrastructure • social 	Working Table 3
	Identification of potential health impacts and vulnerability to impacts	Identification of health impacts arising from changes to hazards Identification of factors affecting vulnerability: <ul style="list-style-type: none"> • regional • economic • social • infrastructure & services 	Working Tables: 4.1 – 4.3

Concurrent activities: <ul style="list-style-type: none"> • Communication • Stakeholder Engagement • Country/regional agreements, approaches and implementation plans 	Identification of current management practices and limitations	Consider current management practices and their limitations for chosen timeframe and climate scenario	Working Table 5
	Risk Assessment Two <i>Workshop Two</i> Assess risks to health	Undertake risk assessments of the identified health impacts Identifying experts in: <ul style="list-style-type: none"> • risk assessments • specific fields 	Working Table 6
	Risk prioritisation	List impacts according to level of risk Reach consensus based on expert knowledge	Working Table 7
	Risk management <i>Workshop Three</i> Development of adaptation measures Consider capacity of measures and suggestions for upgrading Identify key sectors	Identify and consider current status of each measure in the setting with respect to: <ul style="list-style-type: none"> • general population • vulnerable regions or populations 	Working Tables 8.1 – 8.9
	Decision Making Development of Action Plans	How to address in home country Identify roles and responsibilities within the Project Team	Working Table 9
	Recommendations	Are different recommendations required for different groups of decision makers?	Climate Change and Health Adaptation Strategies Report
	Evaluation	How could the process be improved? What were the outcomes?	
	In addition	Health sector responses to climate change	How can each health sector reduce its own environmental footprint?

Appendix 2

The following provides some potential resources to assist with the vulnerability assessment.

Development of Communication Strategies

The type of communication and target or purpose of communication strategies should be identified. The forms of communication should be determined for both internal and external stakeholders. These can include:

Type of communication	Purpose or Target
Providing information	Government or specialised group business
Obtaining feedback	Providing information
Working together on issues of concern	Stakeholder engagement
Establishing partnerships	Public Relations
Releasing decision making to others	Social activities
	Other

Effective communication can:

- Foster motivation and involvement
- Improve performance
- Provide information
- Assist with identification of activities
- Influence attitudes
- Assist with the management of operational processes

Development of the Communication Strategy should provide for and enhance:

- Clarity
- Consistency
- Opportunities
- Networking
- Maintaining/Improving relationships with stakeholders
- Responsibilities
- Accountability
- Gathering relevant information

The stakeholders who should be involved in the Project need to be identified. A non-exhaustive list is provided in the table below.

Within Health Sector	External
<ul style="list-style-type: none"> • All public health groups within Government • Ministry/Department of Health representatives • Medical specialists in climate specific fields • Other health groups: • Non-Government Organisations (NGOs) • Universities and research institutions • Other institutions 	<ul style="list-style-type: none"> • All Government Ministers • Government representatives from all sectors • Local Governments • NGOs • Media • Industry/Business • Community • Other specific groups as identified

Existing communication activities should be reviewed and, where relevant, updated and incorporated into the Communication Strategy. Issues for consideration include understanding of:

- Various components of current activities
- The issues associated with each
 - What works?
 - What can be improved?
 - What else might be needed?
- Who is involved in?
 - Initiation
 - Implementation
 - Responsibility
 - Accountability

Timeframes need to be considered including:

- Reporting requirements
- Specific deadlines
- Other

Communication examples:

External	Internal
<ul style="list-style-type: none"> • Ministerial & other Government briefings • Letters • Reports • Newsletter • List server • Website • Meetings • Workshops • Emails • Social Media • Other 	<ul style="list-style-type: none"> • As for External • Verbal • Notes • Web portals and shared sites • Existing internal communication strategies • Phone calls/teleconferences/webinars • Other

Online Resources

Screening information

The [UCLA HIA Clearing House](#) has identified the criteria to be considered for decisions on the extent of the assessment which include:

1. Significance: Likelihood and magnitude of significant health impacts
2. Value, including:
 - a. Added value of HIA to policy-making process
 - b. Valuation of added information
 - c. Impact of added information
3. Evidence to support the analysis, including
 - d. State of current knowledge
 - e. Data availability
4. Feasibility: Available resources to conduct HIA (time, money, personnel)

Communications Planning

Other resources for communications include:

- [Community Tool Box - Developing a Communication Plan](#)
- [Pinnacle Public Relations Training - Communications Handbook](#)
- [Hieran - How to develop a communications plan](#)
- [Pellin Institute - Develop a communications plan](#)
- [Mind Tools - Communications Planning](#)
- [Bandwidth Online - How do I develop a communications strategy?](#)

Appendix 3

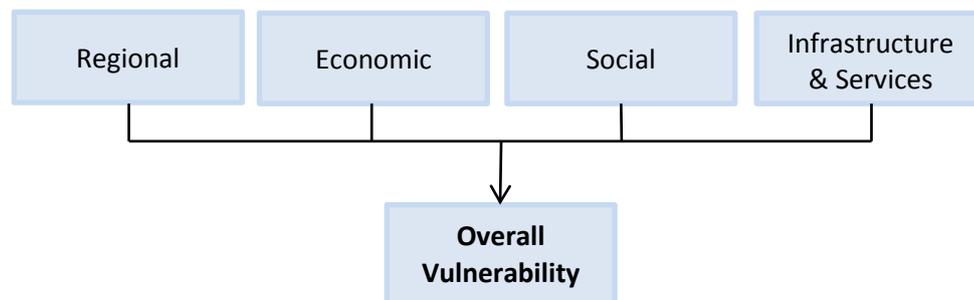
Additional Information for Stakeholders

The following information has been formatted for printing or incorporation into preparatory documents for stakeholders, especially workshop participants.

Information Sheet 1: Understanding Vulnerability

Previous applications of this Guide have identified four common aspects of vulnerability that are useful in guiding discussions on the three fundamental elements of vulnerability; exposure, sensitivity and adaptive capacity. Figure 1 below summarises these aspects, with examples and other details provided under each heading. Individuals and communities with vulnerabilities that cut across multiple aspects are of particular concern and should be identified as early as possible in the process.

Figure 1: Common Aspects of Vulnerability



Regional Vulnerability

Regional vulnerability can occur in terms of exposure, sensitivity and adaptive capacity. Climate change projections indicate that changes to climate may not be experienced equally across countries or regions. For example, reductions in rainfall may have an uneven distribution over large areas. Communities in coastal regions, particularly low-lying areas, could be identified as potentially vulnerable to sea-level rise, storms and sea-surges.

In terms of sensitivity and adaptive capacity, regions with a high proportion of rural or isolated communities may be identified as more vulnerable to a range of potential health impacts of climate change. Reduced access to essential services and a greater reliance on climate factors for economic prosperity may be identified as potentially major contributors to vulnerability.

Economic Vulnerability

Economic vulnerability is likely to be a common theme for a wide range of potential health impacts. Areas or communities where there is a strong link between economic prosperity and climate may be more sensitive to climate change than others. For example farmers and tourist-based industries may be vulnerable due to loss of income. Possible flow-on effects in these communities include reduction of available goods and services, a decrease in community resilience and reductions in population – all of which can contribute to a decline in quality of life and adverse changes to mental and social health.

Economic vulnerability is likely to be strongly linked to adaptive capacity. Communities, households or individuals with low socio-economic levels will be less likely to afford adaptive measures and possible price increases in a range of goods and services. Examples include lack of access to adaptive strategies for temperature increases and heatwaves, such as energy efficient housing and air-conditioning. Low-income families will be more vulnerable to price increases in a wide range of goods and services, including fresh food, water, energy and insurance.

Regions with greater exposure to the impacts from climate change may have economic difficulty in adapting to climate change. Some coastal communities may require major infrastructure expenditure to adapt to sea-level rises and storm surges. Financial difficulties are likely for small regional communities faced with such expenditures. Inhabitants of particularly vulnerable regions may suffer financial losses as property devalues. Higher insurance premiums, restricted coverage and withdrawal of insurance may occur in high-risk areas, leading to negative impacts on business, investment and the community.

Social Vulnerability

A number of population sub-groups may be identified as particularly vulnerable to many of the potential health impacts of climate change. For example, certain occupational or lifestyle activities may result in increased exposure to hazards such as vector-borne diseases, extreme heat or elevated levels of air pollutants. Other groups including the aged, the young, indigenous groups, disabled groups, homeless people and those with a range of pre-existing health problems, may be more sensitive to the adverse health effects of particular hazards as well as having a lower adaptive capacity to respond. The extent of vulnerability within these groups will vary widely according to the specific health impact being considered and the interplay of factors that make them vulnerable. Some groups may be more vulnerable because of existing physical and or mental health problems and lower standards of living than other groups. A lack of basic infrastructure in remote communities may contribute to a poor adaptive capacity at a community scale.

Aged groups may be identified as vulnerable to a wide range of potential health impacts. Direct impacts from increases in summer temperatures and frequency of heatwaves may be identified as major concerns. Other impacts for which aged groups may be considered vulnerable are food and water-borne diseases and respiratory effects of reduced air quality. An ageing population will increase the significance of impacts on this group. Children are more sensitive to certain impacts for a range of reasons including higher metabolic and breathing rates than adults and an immature immune system. Pre-existing illnesses or disease and medication can increase their vulnerability to a range of potential health impacts.

Infrastructure and Services Vulnerability

Many of the current infrastructures and services will probably have been planned using historical climate data. There is a risk that these may be inadequate for future climate conditions. Vulnerability may occur from direct physical damage to existing infrastructure or from a combination of diminishing resources and increased demand for essential services. For example, information from the insurance industry has shown that even small increases in the severity of extreme events (< 10%) can cause multiple increases in damages (Mills, Lecomte & Peara, 2001).

The health of communities is dependent on the provision of reliable infrastructure and services. Changes in capacity to provide clean water, reliable energy, transport, communication, medical and other services will have direct and indirect impacts on health. Health services in regional and remote communities and outer metropolitan regions may be identified as having limited resources.

The potential impacts of climate change on coastal development and infrastructure may be identified as a major concern. Current planning guidelines in many areas have limited adjustments for projected increases in sea-level and this may be identified as a major concern.

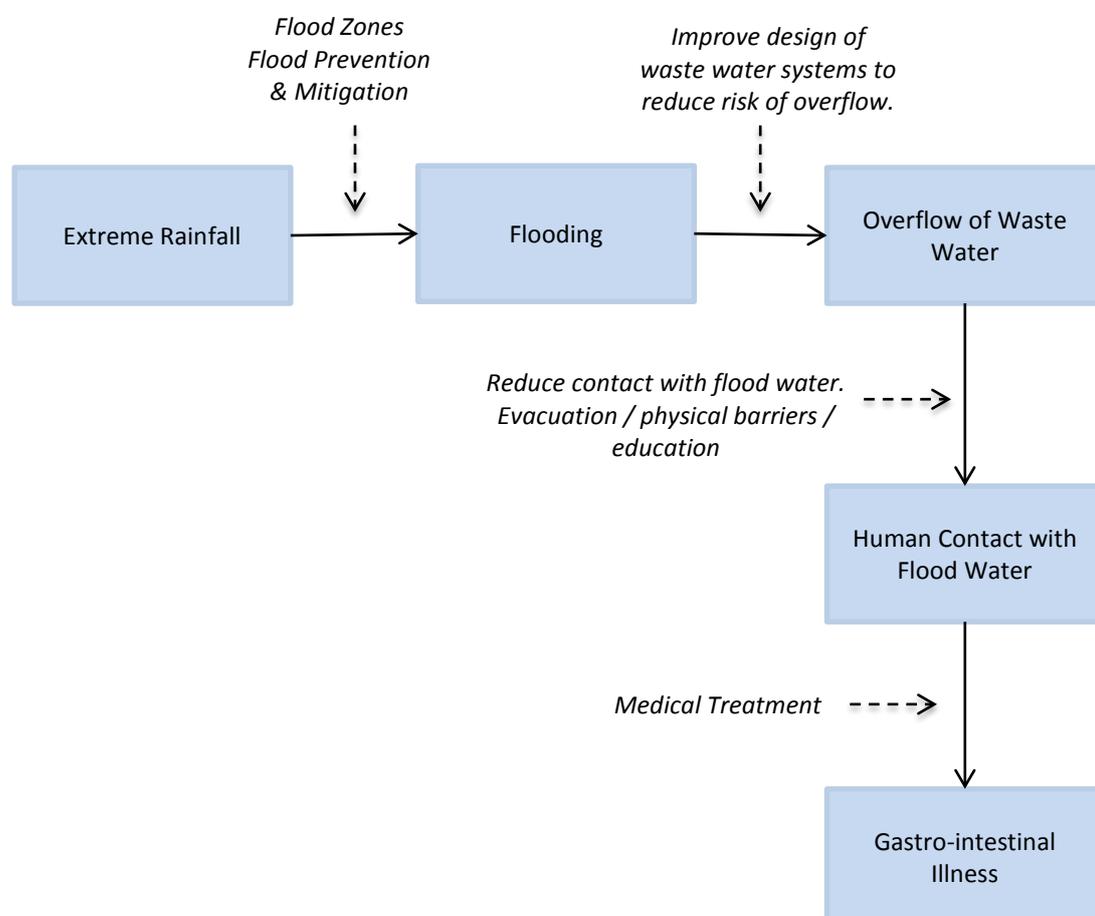
Information Sheet 2: Understanding Adaptation

Adaptation to climate change refers to adjustment in response to actual or expected climate stimuli or their effects, which moderates harm or exploits beneficial opportunities. Adaptation to climate change in health terms can be broken down into primary, secondary or tertiary measures similar to those used for public health more broadly:

- *primary adaptive measures*: actions taken to prevent the onset of disease arising from environmental disturbances in an otherwise unaffected population
- *secondary adaptive measures*: preventive actions taken in response to early evidence of health impacts, and
- *tertiary adaptive measures*: health-care actions taken to lessen the morbidity or mortality caused by the disease” (McMichael and Kovats, 2000)

Consideration of the chain of events from climate parameter to health impact is a useful way to identify opportunities for adaptation. In general the earlier in the chain of events that adaptations are applied the better. The example in Figure 5 shows a possible health impact pathway from an extreme rainfall event to a case of gastro-intestinal illness.

Figure 1: Health Impact Pathway – Opportunities for Adaptation



Each link in the chain of events represents both a potential for vulnerability and an opportunity for adaptation. The primary, anticipatory adaptation measures are the appropriate consideration of flood zones in land-use planning, flood mitigation measures in areas considered at risk and appropriate flood risk waste-water infrastructure. This example also serves to

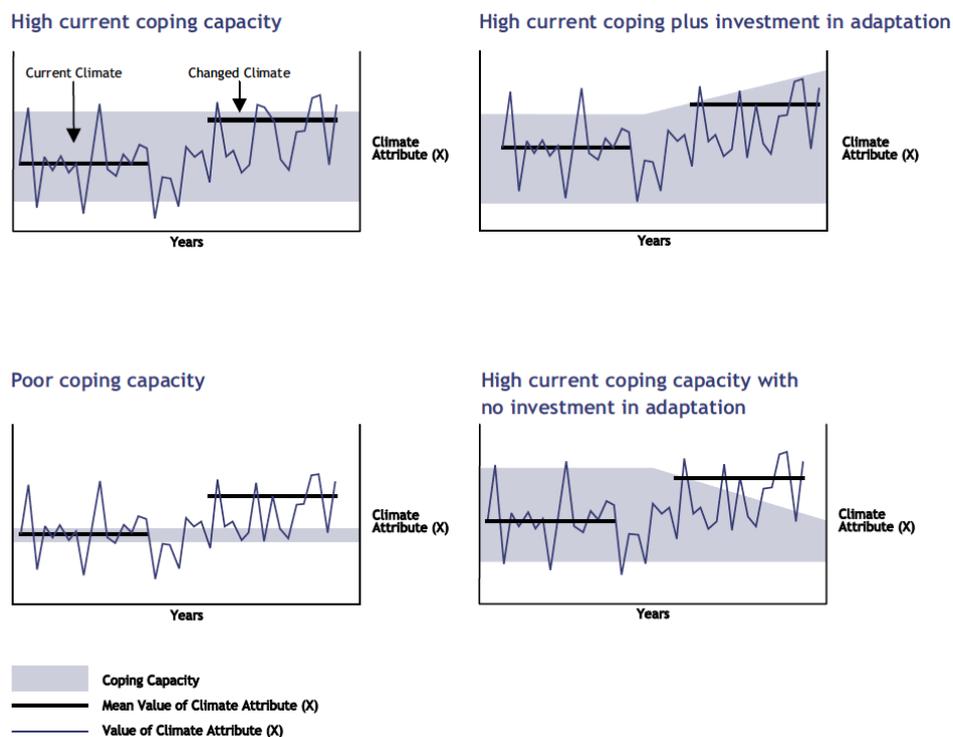
demonstrate the importance of non-health sectors in the reduction of potential health impacts of climate change. Similarly, the benefits of these adaptations are not limited to health-related outcomes. There are obvious economic benefits of minimising physical damage to major infrastructure, property and agriculture.

Secondary and tertiary adaptations are implemented in reaction to the contamination of flood waters and are often referred to as reactionary adaptations. Minimising contact with flood waters, through physical separation or improved education, is a secondary adaptation aimed at reducing the extent of the exposure to water-borne pathogens. Medical treatment is a tertiary adaptation taken in response to a health impact that has occurred.

All measures aim to increase adaptive capacity. Adaptive measures may be targeted at the whole population, vulnerable regions or vulnerable subpopulations. Measures focused on vulnerable groups are likely to provide the greatest reductions in risk and therefore the greatest improvements in health outcomes.

Figure 2 depicts different public health coping capacities for current and future climate attributes. The first example depicts a region with a well-developed public health system and a high capacity to cope with variations in the current climate. This example shows how capacity will be substantially diminished under the changed climate. The second depicts how investment in adaptation enables the region to deal with future climate changes. In contrast, the third example depicts a region with poor coping capacity. This situation can apply to specific regions or vulnerable groups within a particular region. The final example reflects the outcomes of little or no investment in adaptation. The difference between these panels highlights the importance of strong investment and planning for climate change adaptation. These examples highlight why it is important to ensure that assessment of current management practices considers all groups, especially vulnerable groups, as well as the changing climate.

Figure 2: Climate Change and Coping Capacity



Modified from Jones and Mearns (2005)

Appendix 4

The Climate Change & Health Adaptation Strategies Report

The following provides a suggested format for the final report.

Executive Summary

Provide an overall summary of the process, the key stakeholders and the most significant outcomes.

Include recommendations for:

- Strategic Direction
- Government Responses
- Community Involvement
- Key Activities/Projects

1. Introduction

Provide a general introduction on the issue of climate change and health in the study area and the background to the study. Include information on existing policies and any relevant WHO publications for the study area. E.g. Regional Strategy for Protecting Health from Climate Change (WHO, 2012) for the South-East Asia region. Refer to the climate change section of the WHO and WHO Regional Offices websites for relevant information.

1.1. Country profile

Provide a general introduction to the country or study area. This will be expanded in the next section.

1.2. Brief description of the health sector in the country

This should include any available health status data and mention of the health system and health sector plans.

2. Methodology

Provide an overall summary of the HIA framework and the involvement of the Project Team and stakeholders in the process. Include an explanation of the key role of the workshop setting.

3. Results

Present the results of your investigation. The following sections provide suggestions for each step of the process. You can use a format similar to that used in the *Health impacts of Climate Change: Adaptation Strategies for Western Australia*. The Project Team should determine which of the Working Tables are included in the final report.

3.1. Scoping

Terms of reference

Development of a communication strategy and stakeholder engagement plan

Resource

- Working Table 1: Stakeholder Engagement Strategy for Project Team

3.2. Profiling

3.2.1. Develop Climate Scenario

This section should include:

- Identification of the relevant climate variables
- Means by which this information was obtained
- The consultation undertaken
- The predicted changes for the selected year in your country/region

Resource

- Working Table 2: Developing a climate scenario

3.2.2. Physical Environment Profile

- Location of communities and their proximities to biophysical characteristics that may have climate significance

3.2.3. Community Profile

- Basic demographic and population health data
- Factors that may affect vulnerability such as age, socioeconomic status and existing health conditions.

3.3. Risk Assessment One

3.3.1. Hazard Identification

This requires identification of potential impacts arising from climate change variables in your country/region. Categorise into biophysical environment, service and infrastructure environment and social environment.

. This section should include:

- The potential changes
- Means by which this information was obtained
- The consultation undertaken including government and community involved in this

Resource

- Working Table 3: Climate variables and their influence on health-related hazards

3.3.2. Identification of Health Impacts and Vulnerability Assessment

This section should include:

- Identification of the health impacts
- Means by which this information was obtained
- The consultation process
- Identification of vulnerable groups
- Identification of known evidence as well as gaps in the information

Resource

- Working Table 4.1 Health Impacts – Biophysical Environment
- Working Table 4.2 Health Impacts – Service and Infrastructure Environment
- Working Table 4.3 Health Impacts – Social Environment

3.3.3. Understanding Current Management Practices and Limitation

This section is to include the understanding of current management practices and their limitations as applied to the 2030 (or chosen timeframe) scenario.

It should also identify the leading sectors for each management practice.

Resource

- Working Table 5: Current management practices and limitations

3.4. Risk Assessment Two

Provide an outline of the experts who attended Workshop Two

3.4.1. Risk Assessment

This section should include:

- The level of risk identified for each of the health impacts
- Means by which this information was obtained
- The consultation process
- The process for consideration of the vulnerable groups
- The evidence for the risk levels chosen
- The limitations or where further information may be required
- Other relevant information

Resource

- Working Table 6: Risk assessment table
This table will need to include the range of health impacts for each identified group

3.4.2. Risk prioritisation

This section follows from the previous section and ranks the identified risk levels. The risk assessment and risk ranking. These should be ranked according to the level of risk and therefore provide the priorities for action

Resource

- Working Table 7: Final risk ranking table for potential health impacts of climate change

3.5. Risk Management

This section should include:

- The adaptation strategies provided for the identified health impacts
- The process for inclusion of additional adaptation strategies for your country/region e.g. for sea-level rise
- The current status of relevant strategies
- Means by which this information was obtained
- The consultation process used
- The process for consideration of the vulnerable groups
- The limitations or where further information may be required
- The lead sectors for implementation of the strategies
- Other relevant information

Resource (amend list to suit findings in your country)

- Working Table 8.1 - Direct Physical Impacts of Extreme Events
- Working Table 8.2 - Direct Health Impacts of Temperature Related Changes
- Working Table 8.3 - Water-Borne Diseases and Water Quality
- Working Table 8.4 - Vector-Borne Diseases

- Working Table 8.5 - Air Quality and Associated Health Impacts
- Working Table 8.6 - Food-borne Disease
- Working Table 8.7 - Food Production
- Working Table 8.8: Social/Community/Lifestyle
- Working Table 8.9 - General Adaptation Measures

3.6. Decision Making

The adaptation action plan is provided in a summary table with impacts ordered from the highest to lowest level of risk. This should include a list of the agencies likely to be involved in the development and implementation of the action plan.

Resource

- Working Table 9: Adaptation action plan summary

4. Discussion of the results

The final discussion should indicate the scope of climate change related health impacts identified and specify those considered to pose the highest level of risk to human health. Any populations that are considered particularly vulnerable to these risks should also be mentioned. An overview of the critical adaptation measures required to reduce the level of risk to public health as well as an indication of the key sectors responsible should be provided. Serious shortfalls in the effectiveness of current management practices for future climate conditions should be highlighted. The report should also state any particular challenges or limitations of the study.

5. Recommendations

The report should conclude with recommendations arising from the study, with a clear indication of the responsible parties. Suggested headings are:

- Strategic Direction
- Government Responses
- Community Involvement
- Key Activities/Projects

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