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## Framework for developing climate change adaptation strategies and action plans for agriculture in Western Australia

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# Framework for developing climate change adaptation strategies and action plans for agriculture in Western Australia

**Damien Hills and Anne Bennett**

**March 2010**



Department of  
**Agriculture and Food**



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## Introduction

The case for agriculture in Western Australia to adapt to climate change has been well made (see Foreword, DAFWA Climate change response strategy, 2010).

The recent focus of public policy has been on climate change mitigation. However, the generally agreed view is that, even if national and international efforts to reach agreement on mitigation strategies are successful "... *mitigation will come too late to avoid substantial damage from climate change*" (Garnaut 2008).

The Western Australian Government's priority tactics for the delivery of its strategic goals for the agricultural and food sectors in WA include:

- **Climate change response:** identify research priorities for localised and relevant data; **develop clear policy** for both emissions mitigation in the agricultural sector and **climate adaptation**.
- Lead development of a new approach to **resilience and preparedness to seasonal variability** e.g. the North Eastern Agricultural Region (NEAR) project.

The need for a Climate Change Adaptation Framework was identified in the Premier's Climate Change Action Statement (2007) and the DAFWA Climate Change Response Strategy (2010) and will complement development of a State Climate Change Adaptation and Mitigation Strategy.

For further background information please refer to the DAFWA Climate Change Response Strategy (2010) and *Climate change, vulnerability and adaptation for South West WA 1970 to 2006* (Morgan et al. 2008)

## Purpose and scope of the Framework

The Framework aims to assist users to design a process which will allow them to prepare a Climate Change Adaptation Response Strategy or Action Plan. This is done by offering a choice of methodologies, allowing users to map out a process that suits their needs.

**The primary user group of this Framework is Department of Agriculture and Food managers and officers.** However, while it has been created with the focus on developing internal adaptation response strategies or action plans, there is nothing specifically prohibiting its use with external partner groups.

The Framework aims to find a balance between offering a consistent approach to adaptation planning and providing enough flexibility for different users (e.g. regions, industry programs) to tailor a process that is suitable to their needs.

## Acknowledgments

The Framework was prepared by Damien Hills and Anne Bennett with input from a range of managers and officers from across a wide spectrum of the Department of Agriculture and Food.

The contribution of funds from the WA Office of Climate Change to support the development of this Framework is acknowledged.

This Framework builds on significant work undertaken by the Department of Agriculture and Food ('the Department') as well as a range of other State and Federal Government sectors. Most notably these include:

- contributors to the *DAFWA Climate change response strategy* (Bennett 2010)
- contributors to *Climate change, vulnerability and adaptation for South West Western Australia 1970 to 2006; Phase One of Action 5.5, Western Australian Greenhouse Strategy* (Morgan et al. 2008)
- facilitators and authors of internal regional and industry workshop proceedings *Threats and Vulnerability to Climate Change* (DAFWA unpublished)
- North Eastern Agricultural Region (NEAR) project team *Determining the Characteristics of Vulnerable and Resilient Farm Businesses*
- United Kingdom Climate Impacts Program
- authors of the Australian Government Department of the Environment and Heritage and Department of Climate Change (formerly Australian Greenhouse Office) report *Climate Change Risk and Vulnerability 2005*
- WA Office of Climate Change.

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## Section 1: Guide to using the Framework

### 1.1 What product can I expect at the end?

One of three products can be expected in the form of a climate change adaptation response:

- Desktop analysis – a quick, conceptual analysis of scenarios, impacts, vulnerability and/or risk, with some broad indications of possible directions for adaptation;
- Strategy – a deeper analysis, consulting with key experts and stakeholders, which should indicate prioritised response strategies; or
- Action plan – similar to the strategy, with the addition of explicit (who, what, when) prioritised actions or targets (specific, measurable, realistic, time-bound).

### 1.2 What does it offer?

A logical framework to help design your own process for analysing climate change impacts, vulnerability and/or risk, and then formulating and prioritising responses.

There is a range of methods and decision support tools available to assist in developing an adaptation response strategy or action plan. The Framework offers a brief introduction to these methods and support tools, as well as providing guidance on where you can quickly and easily obtain further information and support.

It should be noted that the methods and decision support tools identified in the Framework are provided as a starting point and not as a definitive list. New methods and tools are being developed continuously and existing tools are often refined and improved. If you have time, you may wish to undertake your own preliminary search for additional methods and decision support tools.

### 1.3 What won't the Framework do for you?

The Framework will not:

- Tell you what your priority adaptation responses should be. Instead, it will provide methods and tools to gather the information you need to develop and prioritise your responses.
- Tell you which methods you must use. Instead, it offers a series of options for you to choose to design a process suited to your needs. You make the choices.
- Offer any guaranteed certainty around climate change itself (see Section 4.1 *Issues of uncertainty*).
- Guarantee endorsement of, or investment in, your adaptation responses by investors, senior management or partners (see Section 1.7 *Enlisting support*).

The Framework is not a user's manual. It guides you to the detail contained in the methods and tools developed and tested by others. It also assumes, if you are undertaking any participatory process that you have access to a trained facilitator, who should have a range of practical methods at his or her disposal.

## 1.4 Background concepts and glossary

Often when dealing with climate change policy and literature you may come across new concepts and terms, or terms that may have different meaning in the context of climate change, than they would in normal use.

Section 4 provides an overview of some of the basic concepts that you should be familiar with before you begin.

A glossary (Section 4.6) has been provided for some of the more common terms used in climate change adaptation.

## 1.5 The ‘keeping-it-simple’ option

The Framework offers a ‘keeping-it-simple’ option, allowing you to undertake an adaptation response strategy in a relatively short time with relatively few resources. This option may be suitable for the following situations:

- Where resources (human and/or financial) are limited;
- Where a desktop analysis is preferred (potentially with a more detailed planning process to follow); and/or
- Where there is reasonably strong confidence that the particular asset/issue/process has a low sensitivity to the predicted effects of climate change. In this scenario the aim would be to focus on immediate ‘win-win’ or ‘no-regret’ options for adaptation.

The keeping-it-simple option includes:

1. Scoping (Section 2.1);
2. Identifying and defining assets and/or systems (Section 2.2);
3. Undertaking the simple matrix analysis to assessing vulnerability either in a small group or a larger workshop (see Section 2.3 and Appendix 1);
4. Identifying responses and opportunities (Sections 2.5 and 2.6); and
5. Undertaking a basic prioritisation process – derived from the UK Climate Impacts Program ‘win-win/no-regrets/low-regrets’ classification approach (Section 2.7).

With the right amount of preparation (scoping and workshop preparation), the keeping-it-simple option should require only one to two days of workshop time.

## 1.6 What resources will you require?

Some consideration should be given to:

- Obtaining relevant climate change data and scenarios for your process. Though data are publically available, you may want to consider the appropriate format – and therefore cost – of that data for your purposes, e.g. raw data, graphical, geographic representations.
- Expert input. Consider the expertise within the Department and make time to include this expert input.
- Cost of running meetings and workshop (venue, facilitator etc.). Allow a minimum of three half-day workshops (or two full-day workshops), plus an equivalent number of planning and debrief meetings for each workshop.
- Stakeholder engagement or consultation.

- Choice of facilitator (internal, external) – most processes recommend the same facilitator for each step of the process. If this is not possible, it makes the role of the individual coordinating the process even more important.

## 1.7 Enlisting support

It is vital to focus on enlisting the support of key decision makers, investors, clients or joint partners, i.e. those who can assist or block you in achieving the priorities you set.

Aim to enlist support at the outset and maintain it at key points in the process, e.g. after scoping, analyses and prioritisation steps are complete.

## 1.8 Building on previous work and coordinating with others

The intent of this tool is to allow for customisation of a process for particular needs. However, it is also important individual users make themselves aware of work being undertaken by their colleagues. In addition to saving time, this may also prevent future tension over differing priorities arising from separate planning processes.

## 1.9 Stakeholder engagement and/or consultation

There is significant evidence to show that engaging or consulting major stakeholders improves the potential for success. However, in widening your involvement too far there is the risk that you may lose focus on the specific requirements of your planning process.

Therefore to find a balance it is important to:

- Think carefully about the purpose of your own adaptation response strategy/action plan before deciding who to involve.
- Consider carefully the stakeholders who will add value by being actively involved e.g. providing technical expertise, those leaders with influence or potential to block actions (see enlisting support above), clients or partners who are directly impacted.
- Consider the stakeholders who you may want to consult (rather than actively involve) to determine their response to your adaptation response strategy/action plan.
- Assess the cost of involving or consulting each additional stakeholder, or alternatively the impact of not involving or consulting specific stakeholders.

If you are intending to design a process for use primarily with external stakeholders (e.g. landholders, community) it is advisable to seek further advice about the design of your processes. The Department has invested significant resources and time into the design and testing of numerous engagement, consultation and extension practices. A good starting point would be to review the information available on AgWeb, including the Extension and Communication page at [http://agweb/Regional\\_services/extension/index.htm](http://agweb/Regional_services/extension/index.htm)

Of special note are the sections on Planning extension, Links and other resources (including Departmental staff listed under Networks and contacts).

## Section 2: The Framework

There are eight steps to the Framework which are shown in Figure 1. As explained in Section 1.5 *The keeping-it-simple option*, not all steps are required to complete your adaptation response analysis, strategy or action plan.

### 2.1 Scoping and process design

You and your team should review the range of methods on offer, and determine which best suit your needs. If you are going to engage the services of facilitator, then it is important to consult with them about the design of your process.

It is important at the outset that you scope the following issues thoroughly:

- Determine your desired outcomes/aspirational targets – what are you aiming to achieve from the development of an adaptation response strategy or action plan?
- Determine the time horizon you are planning for (e.g. 10/20/40 years);
- Research and determine which climate change scenario/s (exposure) you wish to consider (see Section 2.1.1 below);
- Determine the geographical scale you wish to operate at e.g. district/regional/land division/statewide (see Section 4.2 below);
- Determine the other boundaries you may wish to place upon the extent of your analyses, e.g. are you planning to consider industry processes downstream of your primary focus? (see Section 4.2 below);
- Identify participants and stakeholders (see Section 1.9 above);
- Determine from whom you need to enlist support (see Section 1.7 above);
- Plan resources (see Section 1.6 above).

It is also recommended you consult colleagues who have completed similar processes.

#### 2.1.1 Climate change scenarios

There are several sources of climate change scenario data to choose from. Here are links to some currently in use:

OzClim [www.csiro.au/ozclim](http://www.csiro.au/ozclim)

Climate change in Australia [www.climatechangeinaustralia.gov.au/index.php](http://www.climatechangeinaustralia.gov.au/index.php)

Indian Ocean Climate Initiative (joint State and Australian Governments)  
[www.ioci.org.au/index.php?menu\\_id=19](http://www.ioci.org.au/index.php?menu_id=19)

It is also recommended that before proceeding, you discuss the climate change scenarios (exposure) you are planning to use with the Department's specialists. This may give additional insight into current research and forecasting, and guide you to the appropriate scenarios for your situation.

Primary contacts would be the Agricultural Systems Research Branch's climate futures team. Members may also direct you to other specialists within the Department or in other agencies such as IOCI, CSIRO.

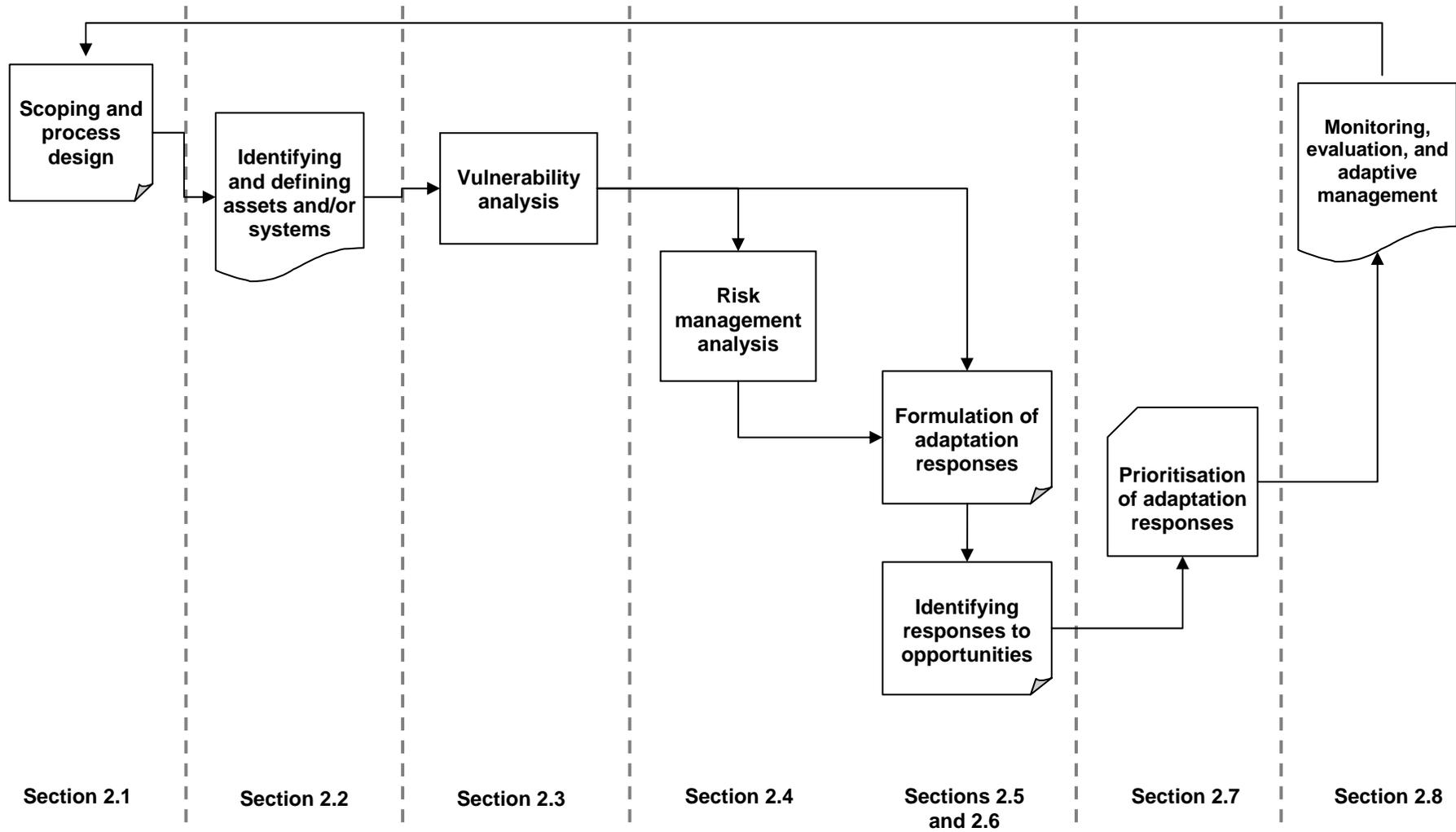


Figure 1 Adaptation framework overview

## 2.2 Identifying and defining assets and/or systems

Your analysis of impacts, vulnerability and risk needs to be focused on a particular set of assets or systems. It is therefore important to take the time to clearly define these assets or systems at the outset. Lack of definition will likely lead to confusion among participants further along in the process e.g. getting questions in the middle of a workshop like *What is it we are looking at again;* and *Are we talking about land type, or are we talking about the land use?*

For the purpose of this Framework, an **asset** can most easily be described as something that is tangible or real and has a degree of permanency. For example, it could be a parcel of land, a soil type, or an infrastructure item (such as a railway or grain silo).

A **system** can most easily be described as something that has a degree of impermanency or is more intangible than an asset. For example, a system may include a management system (e.g. a crop rotation, tillage style), a particular land use or enterprise mix (e.g. sheep-wheat, pastoral).

Assets and systems can usually be broken down into their constituent parts (e.g. a soil-landscape unit may consist of several soil management units). Decide which scale you wish to work with – too many assets and systems may overcomplicate your process, too few and you may miss an important variation.

## 2.3 Vulnerability analysis

For a definition of vulnerability in the context of climate change, see the glossary (Section 4.6). Undertaking a vulnerability analysis has several purposes. It allows for:

- a degree of prioritisation across different asset and/or systems (which asset or system is the most vulnerable and should get more focus in adaptation response);
- exploration and description of the potential impacts that may occur to an asset and/or system due to climate change;
- exploration and description of potential critical thresholds that should be taken into account when developing any adaptation responses; and
- exploration and description of the adaptive capacity of those managing/responsible for an asset or process – potentially identifying unknown weaknesses and strengths.

Figure 2 provides a basic conceptual overview of the components of vulnerability.

Issues to consider in undertaking vulnerability analysis:

- It is important to be familiar with the concepts of exposure, sensitivity, potential impact, and adaptive capacity before launching head long into vulnerability analysis. Be conscious of the need to keep workshop participants on the ‘same page’ (in terms of understanding each concept). See Section 4 *Background concepts* including the glossary of terms.
- Exploring adaptive capacity – how far should you go? An analysis of adaptive capacity should take into account the existing technological, economic/financial and social capacity to adapt. However, assessing adaptive capacity can be a very subjective process. If you are trying to keep things simple and minimise costs it is advisable that you explore adaptive capacity through discussion and make decisions through consensus of the workshop group (see the simple matrix vulnerability

analysis method in Appendix 1 for more guidance). However, you should be aware that there have been, and continue to be a number of attempts to consider adaptive capacity less subjectively. If this approach appeals then you may wish to consider which modelling or indexing approach suits your needs (see modelling options below).

### VULNERABILITY AND ITS COMPONENTS

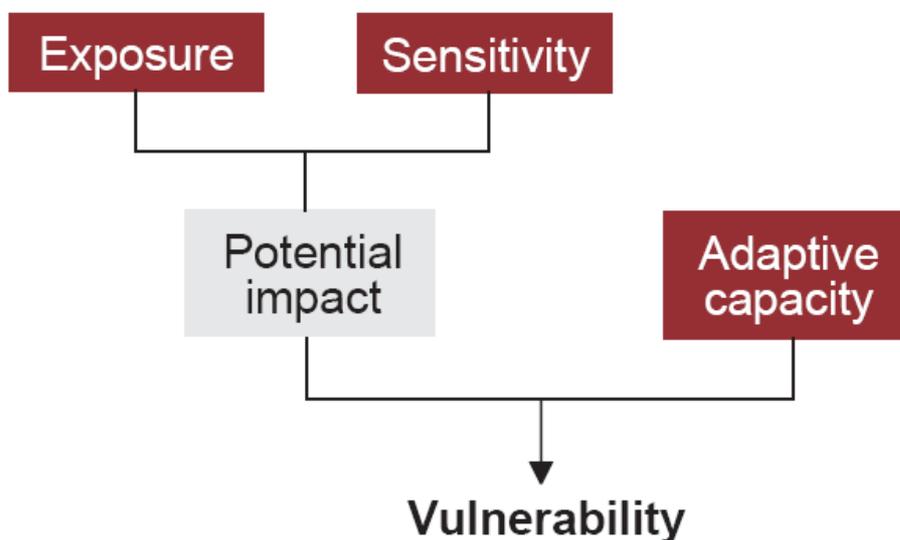


Figure 2 **Vulnerability and its components** from *Climate change risk and vulnerability* (The Allen Consulting Group 2005)

### 2.3.1 Workshop options

#### South West Catchments Council NRM Climate Change Risk Assessment Toolkit

This contains both vulnerability and risk management components. However, the first component relates to vulnerability assessment and it may be possible to use this as a stand-alone tool. (Note: At this time, using this as a stand-alone tool for vulnerability assessment has not been trialled.)

It should be noted that this tool was developed in a broader natural resource management (NRM) context. While it seems very adaptable for use in the agricultural context only, some examples provided may not be directly useful.

It is recommended that the tool be trialled in the agricultural context by a trained facilitator before it is adopted more broadly by the Department. See Section 2.4.1 to obtain a copy.

#### Simple matrix vulnerability analysis

A simple matrix analysis has been designed for use in a participatory workshop approach (see Appendix 1). This uses six steps to define impacts and vulnerability:

1. Assess exposure
2. Assess sensitivity
3. Determine and document critical thresholds and sensitivity to intra-seasonal variations
4. Define impacts
5. Assess adaptive capacity
6. Determine vulnerability.

## 2.4 Risk management analysis

Risk management analysis offers a further avenue to assist you to prioritise your effort.

Vulnerability analysis focuses on exposure, sensitivity and adaptive capacity, while risk management analysis will allow you to consider:

- The **likelihood** of a given climate change impact occurring; and
- The **consequence** that a given impact will have on the economic, social or environmental values of the asset or system being considered.

Undertaking a climate change risk management analysis requires considerable focus, planning and preparation before any participatory workshop process is initiated.

It is recommended that you clearly describe the categories to be used to define consequence before commencing any workshop. For example, what would be considered low, medium, high or extreme for each asset or system type being assessed; what would define a catastrophic outcome?

Consider convening a small group of people with expertise in the given area to assist you in defining your categories of consequence, as well as informing the issue of likelihood.

A lesson from developing the South West Catchments Council's NRM Climate Change Risk Assessment Toolkit (GHD 2009) was that, particularly at the early stages of undertaking a climate change risk management analysis, it was better to have participants who would inform the process, rather than participants being informed by the process.

### 2.4.1 Workshop process options

The following tools are recommended for consideration:

#### **South West Catchments Council's NRM Climate Change Risk Assessment Toolkit**

This resulted from a pilot project under the National NRM Ministerial Council Standing Committee's Climate in Agriculture and NRM Task Force (CLAN). SWCC adapted the national (CLAN) risk management framework further, to better align it with NRM systems. The toolkit was then road-tested with a number of groups, focusing on different natural resource assets.

The draft toolkit process includes a scoping stage, vulnerability analysis and risk assessment, as well as guidelines for facilitation, workshop design and a template for use either during workshops or as a recording mechanism for information arising from workshops.

While the toolkit was designed specifically for NRM issues, it could easily be adapted to the broader agricultural context in two ways:

- Replacing the step/title 'NRM attribute at risk' with 'Asset or system at risk' (using the asset or system defined in Section 2.2 of this Framework; and
- Developing consequence descriptors (Sections 4.8.1 and 2.8.2 of the SWCC toolkit, and column J of the toolkit template) that are specific to the agricultural context of your adaptation response strategy.

SWCC's NRM Climate Change Risk Assessment Toolkit and Guidelines are available from the Department's Climate Change Policy team or by contacting the South West Catchments Council directly on (08) 9780 6193 (at December 2009, the relevant Program Manager was

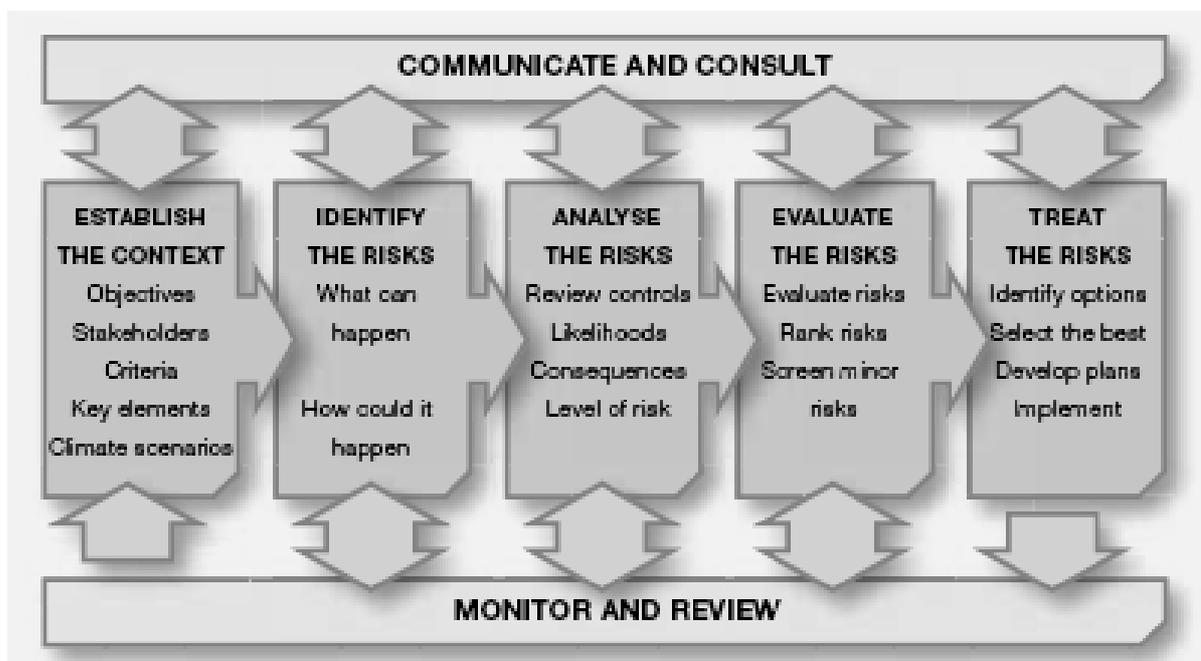
Mr Bill Bennell). If publishing any results arising from the use of this tool, appropriate acknowledgement should be given to SWCC and GHD (2009).

**United Kingdom Climate Impacts Program – Adaptation Wizard**

The United Kingdom Climate Impacts Program’s (UKCIP) Adaptation Wizard (‘the Wizard’) is a comprehensive adaptation planning framework (UKCIP 2008). It includes elements of vulnerability and risk assessment. It has been developed for UK local government, and thus is infrastructure-focused (as evident in the worked example). The Wizard does offer a number of principles and guiding questions that may be useful in preparing most adaptation response strategies or action plans. Adaptation Wizard can be found at [www.ukcip.org.uk/wizard](http://www.ukcip.org.uk/wizard). The website provides guidance to correct referencing of its work.

**Tailoring a tool based on the Australian Risk Management (AS/NZS 4360) Framework**

If you feel the tools suggested above do not suit your particular circumstances, one option is to tailor your own risk assessment. It is recommended you base this on the Australian Risk Management Standard – also known as Australian and New Zealand Standards (AS/NZS) 4360. Figure 3 provides overview of steps in the AS/NZS 4360 risk management process.



**Figure 3 Overview of AS/NZS 4360 Risk Assessment and Management Process (Broadleaf Capital International et al. 2006)**

Some of the steps described are already covered in this Framework (Section 2.1 *Scoping and process design*; Section 2.2 *Identifying and defining assets and/or systems*; Section 2.5 *Formulation of adaptation responses*; and Section 2.7 *Prioritisation of adaptation responses*).

A good starting point for understanding the use of the AS/NZS 4360 Risk Management Standard in the context of climate change is to look at the Australian Government’s *Climate change impacts and risk management – A Guide for Business and Government* (Broadleaf Capital International et al. 2006) at [www.climatechange.gov.au/community/local-government/risk-management.aspx](http://www.climatechange.gov.au/community/local-government/risk-management.aspx). Note however, that the guide, based on AS/NZS 4360, is fairly broad and you may have to either modify the suggested processes within the guide or be willing to flexibly adapt your processes to suit.

## 2.5 Formulation of adaptation responses

If you have not already done so, you now need to spend time generating alternative adaptation responses to the impacts and/or risks identified earlier.

Brainstorming is the simplest and most practical approach, and your facilitator should have a range of brainstorming techniques available.

You may wish for participants to consider responses related to some broad categories:

- Research, development and extension (e.g. new technologies);
- Information management;
- Economic and financial tools;
- Social and human capital development;
- Thinking outside the square (lateral thinking, alternative approaches).

When trying to identify adaptation options it is also worth considering the following three categories that make up the core elements of vulnerability, i.e. adaptation measures that:

- Reduce exposure;
- Reduce sensitivity; and/or
- Increase adaptive capacity.

For example, in viticulture perhaps one could reduce heat impact by using shade cloths to cover the vines on hottest days (reducing exposure), look at alternative heat resistant species (reduce sensitivity), or look at business models which accommodate reduced vine productivity (increase adaptive capacity).

It may also be helpful at this point to revisit your work on defining critical thresholds. Where climate change impacts are not too severe, incremental changes and adaptations (e.g. improvements in productivity) may be sufficient. However, it is possible that some climate change impacts may be so severe that incremental change in existing systems and processes will not be enough. In these cases transformational change may be required. It is worth considering whether, and if so when, transformational adaptation changes may be needed in particular systems (see Section 4.4 *Critical thresholds* for more discussion).

The scope of your adaptation response strategy or action plan will also guide the form and function of your adaptation responses (see Section 4 *Background concepts*, particularly the discussions at Section 4.2 *Scale and extent* and Section 4.3 *Role of government*).

## 2.6 Identifying responses to opportunities

At the broadest level, if little is done to adapt, under most climate change scenarios, the overall outlook for agriculture in WA is unfavourable if not severe. However, with every change comes opportunity. It is important that during the development of an adaptation response strategy or action plan that some time is given to considering the opportunities that may arise from the climate change scenarios that you have chosen to analyse.

Opportunities may arise from either the changes in various factors themselves (temperature, rainfall, carbon dioxide levels) or from a broader industry or market context (e.g. increased competitive advantage due to changes in markets arising from climate change).

Some of the vulnerability and risk management tools outlined above already include steps to identify opportunities; however, for those that do not it is highly recommended that you include an opportunities analysis before finalising your strategy or action plan.

Given the strong focus on negatives throughout much of the proceeding process, a good facilitator should look at techniques to generate some lateral, positive thinking. Some preparation prior to any participatory workshop would also be beneficial. You may wish to consider some or all of the following options:

- Literature and web searches (particularly any relevant research);
- Talking to those outside the participant group (to get alternative viewpoints);
- Getting the participant group to think outside the square, consider innovative ideas.

Finally, decisions to implement opportunities should be considered in the light of their overall cost-benefit. This can be a rough estimate (e.g. strongly positive, positive, neutral, negative, or unknown) or a more detailed analysis if you have adequate time and resources.

## 2.7 Prioritisation of adaptation responses

A degree of prioritisation should have arisen from either your vulnerability analysis and/or your risk management analysis, and this may be enough to give guidance as to the prioritisation of your adaptation responses (i.e. those responses related to highly vulnerable or high risk impacts will naturally be higher priority than those of lower vulnerability or risk).

However, you may choose or be required to undertake further prioritisation of your responses (particularly if resources available for adaptation responses are limited).

Prioritisation processes can be as simple as intuitive categorisation (e.g. win-win; no-regrets; low-regrets) or more sophisticated (e.g. a cost-benefit analysis).

The United Kingdom Climate Impacts Program Wizard (UKCIP 2008) offers some simple advice (including some basic categories) to help prioritise and select appropriate responses (or in the language of the UKCIP Wizard 'Options'):

Win-win options (nearly always the highest priority)

No-regret options (considered a high priority)

Low-regret options (considered medium-high priority).

The following excerpts from the Wizard explore each category in more detail:

“There may be practical, cost-effective options that deliver the required adaptation and which also minimise the risks associated with implementation even in the face of associated uncertainties. These options are normally referred to as no-regrets, low-regrets, and win-win options, and should be identified and selected where possible.”

**“Win-win options** – adaptation measures that have the desired result in terms of minimising the climate risks or exploiting potential opportunities but also have other social, environmental or economic benefits.

Within the climate change context, win-win options are often associated with those measures or activities that address climate impacts but which also contribute to mitigation or other social and environmental objectives.

These types of measures include those that are introduced primarily for reasons other than addressing climate risks, but also deliver the desired adaptation benefits.”

**“No-regrets options** – adaptive measures whose socio-economic benefits exceed their costs whatever the extent of future climate change. These types of measures include those that are cost-effective and justified under current climate conditions and are further justified when their introduction is consistent with addressing risks associated with projected climate changes. Focusing on no-regrets options is particularly appropriate for the near term as they can deliver obvious and immediate benefits and can provide experience on which to build further assessments of climate risks and adaptation measures.”

Such measures will require investments but overall are at least cost neutral when the immediacy of the targeted risks and realised benefits are considered.

**“Low-regrets (or limited regrets) options** – adaptive measures for which the associated costs are relatively low and for which the benefits, although primarily realised under projected future climate change, may be relatively large.”

“Both no-regrets and low-regrets options have merit in that they are directed at maximising the return on investment when certainty of the associated risk is low.”

The Wizard also points out that adaptation measures (responses) that are more flexible and more easily adaptable are an important mechanism for handling uncertainty. It is therefore recommended that the flexibility of any response should also be weighed up in any prioritisation.

You may also choose to ‘park’ certain responses, i.e. to make “*a conscious decision to do nothing*” (UKCIP 2008) at this point in time, even though the vulnerability or risk of the impact related to the response is high. This may be because a large degree of uncertainty surrounds the potential impact or the cost-benefits of the proposed response.

An option may therefore be to develop an overarching (meta) response to these types of impacts, risks or responses – which may be to review them regularly, if and when more information comes to light (see adaptive management below).

Finally, when prioritising adaptation responses be mindful of existing adaptive capacity (you will have considered this earlier on in your process). It may be that the adaptive capacity of individuals, enterprises or an industry etc. may increase over time. However, your current adaptive capacity should provide some guide to what may constitute a realistic adaptation response, or alternatively may give you an indication or where you need additional resources (outside your own) to implement your adaptation response/s.

## 2.8 Monitoring, evaluation and adaptive management

Monitoring, evaluation and adaptive management are practices that should be applied to any good program and project management. However, they have even greater significance in the context of climate change adaptation because of the levels of uncertainty surrounding climate change predictions.

Therefore, in finalising your adaptation response strategy or action plan, it is important to outline some of the specific monitoring and evaluation actions and adaptive management measures you plan to put in place such as:

- Set a timeline to review your adaptation responses strategy or action plan (e.g. annually, biannually, or in relation to other planning processes, such as in the preparation of new program or business plans.
- Consider framing your actions (if you are developing an action plan) in the form of targets that are specific, measurable, realistic, and time-bound. This will allow you to focus more effectively.
- If the next step is to consider the implementation of your action plan, it is strongly recommended you consider using a 'logic framework' to map out the details of your action plan. A logic framework will not only assist to realistically plan resources, but it will also allow you to more easily develop and implement an accompanying monitoring and evaluation plan.

The Department's Project Management Portal is a useful tool to translate your action plan into a project or projects for implementation, including setting up your monitoring and evaluation framework at the outset.

Even if you're not intending to undertake an internal project/s arising from your action plan (e.g. you are assisting external stakeholders in their planning) the Project Management Portal has information regarding logic frameworks that can help guide your project development as well as monitoring, evaluation and adaptive management: [//agweb/Strategic\\_services/pmo/evaluate.htm](http://agweb/Strategic_services/pmo/evaluate.htm)

For the Department's managers and officers, the project management team is also contactable through [//agweb/Strategic\\_services/pmo/contactus.htm](http://agweb/Strategic_services/pmo/contactus.htm)

- Set timelines to review the priority responses that you have determined to set aside (park) due to high degree of uncertainty (e.g. annually or when new information comes to light).
- Be prepared to review strategies or actions when major new developments occur (e.g. major technological breakthrough, any major changes to predictions).

## Section 3: Modelling and other decision support tool options

This section introduces some of the more sophisticated methods and tools available to investigate impact, vulnerability and risk.

Extensive work has been undertaken to model and/or geographically map vulnerability of agricultural systems. Some of this has been at a broad scale and some focused on specific industries (e.g. wheat). It should be noted however, that under the broader banner of vulnerability, some of the work focuses on impacts (i.e. exposure and sensitivity) and does not include assessment of adaptive capacity.

Modelling and mapping (using geographical information systems) has benefits. It allows the user to adjust assumptions and inputs much more easily (compared to a workshop process) and its obvious benefit is the visual nature of outputs (e.g. maps, graphs and figures). Of course, with benefits come costs, such as additional time, dollars and complexity.

Using these more sophisticated tools is only recommended if you and participants in your process have the time and resources to invest and make use of these tools.

You may also wish to consider using the simple (but more subjective) workshop techniques offered above as a 'first pass' option (these may indicate the 'low hanging fruit' of adaptation responses or actions), and then follow up with a more sophisticated modelling option to refine your decision making around more marginal responses or actions.

Some recent work on modelling and related instruments, within the context of agriculture in Western Australia, includes:

- Potential impacts of climate change on agricultural land use suitability: Wheat (van Gool and Vernon 2005). This work used a simple model and GIS-based system to generate climate change scenarios for wheat. The authors also published similar reports for barley, oats, lupins and canola.
- Vulnerability Assessment Australia - collaborative work of CSIRO and the Agricultural Production Systems Research Unit (APSRU), utilising the Agricultural Production Systems Simulator (APSIM) to provide an assessment of adaptive capacity based on a range of demographic and geographical datasets. The project is currently inactive; however the geographical analysis may still be useful to those operating at a regional or larger scale. The tool can be found at [www.apsim.info/VulnerabilityAssessmentAustralia/](http://www.apsim.info/VulnerabilityAssessmentAustralia/)

Further unpublished work by the Australian Department of Climate Change and CSIRO can be obtained by contacting the DAFWA Climate Change Policy team.

- The North Eastern Agricultural Region (NEAR) project *Determining the Characteristics of Vulnerable and Resilient Farm Businesses* aims to develop a series of indices, in partnership with landholders and agribusiness consultants, to measure the 'resilience' of farm businesses in the region. While not totally aligned, the proposed resilience indices will be similar to the concepts of sensitivity (inherent 'natural' resilience of existing farming systems) and adaptive capacity (current capacity of existing farm businesses to adapt). However, it should be noted that the indices are in the specific context of recent drought events, rather than broader long-term climate change. For those wishing to undertake more comprehensive adaptive

capacity of vulnerability/resilience analysis with landholder groups, the results (particularly the evaluation of the final methodology) could be valuable. For more information, the Department's project team includes Sam Harburg and Robert Grima, economists, Geraldton; Caroline Peek, Senior Development Officer, Geraldton; and Ross Kingwell, Manager – Economic Services, South Perth.

In addition to those specifically listed, the Department has a list of decision support tools that may assist in better identifying your exposure and/or the predicted impacts of climate change. These can be found at [www.agric.wa.gov.au/PC\\_92629.html?s=1003572071](http://www.agric.wa.gov.au/PC_92629.html?s=1003572071)

Alternatively, from the external website home page ([www.agric.wa.gov.au](http://www.agric.wa.gov.au)) click on *Farm Systems*; then on *Tools to Support Decision Makers*; and then scroll down to *Land, Water + Environment: Climate*.

## Section 4: Background concepts

### 4.1 Issues of uncertainty

There is a real risk that focusing on uncertainties surrounding climate change can result in a form of organisational paralysis, i.e. do absolutely nothing until we know more. In reality many decisions – business, government, private – are made in an environment of uncertainty.

If you choose to use one of the tools offered in the Framework that is qualitative in nature, there should be no reason to be overly focused on the quantitative detail of the climate change scenario you choose. A qualitative tool will offer a broad brush approach to analysis and prioritisation, and so a climate change scenario with a modest margin of error should be considered reasonable.

#### The ‘do-nothing for now’ response

This option is a legitimate response (e.g. if cost-benefits or risks are considered too great) but it is not recommended as the default response. It should only be considered after other alternatives have been explored, and completion of a prioritisation process (e.g. a cost-benefit analysis).

If you do choose to do nothing for now, then it is appropriate to park the issue (impact or risk) and any alternative responses identified; document your reasons for doing so and set a future review date to see if any new data changes your analysis (see Section 2.8 *Monitoring, evaluation and adaptive management*).

#### Intra-seasonal variability

A most important aspect of climate change for agriculture is the sensitivity that an asset or process has to intra-seasonal variations in temperature, rainfall and related events (frost, storms, fire etc.). While extremely difficult to predict accurately over the longer term, there is a general view that intra-seasonal variability will increase in much of Western Australia (particularly the South West Land Division). There is a need to be mindful, when analysing a particular asset or system, potentially when considering critical thresholds, to consider if it is particularly sensitive to intra-seasonal variability.

As mentioned in Section 2.8 *Monitoring, evaluation and adaptive management*, the importance of adaptive management takes on extra significance in the area of planning for climate change. It is essential that any strategy or action plan includes a monitoring, evaluation and adaptive management component to allow for review of new information and more accurate forecasting.

### 4.2 Scale and extent

During the scoping stage it is important to determine the geographical scale, as well as the extent to which your adaptation response strategy or action plan will apply.

Most climate change scenarios are modelled at regional levels. The user should be aware therefore that planning at a finer scale, while having its advantages (e.g. impacts can be

considered in a local context), will have the same data constraints as planning at regional scale.

Be mindful that if you are planning at a whole of industry level (e.g. grains, animal, horticultural), covering a large geographical area, undertaking multiple vulnerability analyses (e.g. for each region) will give you a more detailed level of understanding than a single analysis of the large area. Regional adaptation response plans may be more effective than a 'one size fits all' plan.

You may also wish to consider putting other boundaries around your planning processes i.e. boundaries around the extent of your analysis. For example, you may choose to either include or exclude consideration of upstream processes (e.g. inputs) and downstream processes (e.g. collection, processing and export). While it may be beneficial to consider the impacts of climate change on upstream and downstream processes, be mindful of the need to have access to expert advice in these other areas.

You may also consider include restricting yourself to specific agronomic issues or wider community (e.g. rural or regional) issues.

These decisions around scale and extent will have a significant impact with regard to participants and stakeholders you identify as part of your process.

### 4.3 Role of government

If you are using this tool with a group of external stakeholders, where the focus is on the external group planning their private adaptation responses (i.e. the focus is on private investment, rather than guiding the Department's investment), then there is no need to refer to this section, nor take into account the role of government issues.

However, if you are using this tool to plan potential agency expenditure, it is important you take into account the role of government issues.

While the role of government and the issues surrounding public investment are not always clear cut, there are some basic rules that should be applied to determining any investment of public funds:

- Is the investment based on an identifiable market failure, or a specifically defined government policy for overcoming socio-economic inequities;
- Does the net public benefit outweigh the costs; and
- Is it the most efficient option to achieve the public policy goal?

For deeper discussion and analysis of the theory behind role of government and public investment decision making in the context of climate change adaptation, the paper *Clarifying Economic Justifications for Government Intervention to Assist Agricultural Adaptation to Climate Change* (Sandall et al. 2009), published as part of the Victorian Climate Change Adaptation Program (VCCAP), run by the Department of Primary Industries (DPI), is recommended. A copy is available from the DAFWA Climate Change Policy team, or by contacting the VCCAP team directly ([Jean.Sandall@dpi.vic.gov.au](mailto:Jean.Sandall@dpi.vic.gov.au)).

In addition to considering the role of public investment, it is important to be mindful of the role of the private sector and functioning markets in developing adaptation responses to climate change. The Garnaut Climate Change Review (Garnaut 2008) has a good précis of the argument for why governments need to be careful they don't intervene to the extent of stifling innovation or healthy market forces finding their own adaptation solutions:

“The experience of climate change will vary between households, and across communities, businesses, sectors and regions. Geographic location, degree of exposure and the capacity of those affected to reduce their vulnerability will all influence the Australian experience. The appropriate adaptation response will always depend on a range of local circumstances. Therefore, unlike the mitigation effort, adaptation is best seen as a local, bottom-up response. Households, communities and businesses are best placed to make the decisions that will preserve their livelihoods and help to maintain the things they value.

Some may expect that government can, and should, protect the community from climate change by implementing the right strategy, program or initiative to allow Australians to maintain established lifestyles. This is not a realistic expectation for four reasons.

First, climate change will require adjustment of innumerable, locally specific customs and practices over time.

Second, the range and scale of impacts that is likely across Australia is such that it is not feasible for governments to underwrite maintenance of established patterns of life for all people in all places.

Third, the uncertainty surrounding climate change impacts makes it impossible to predict their timing, magnitude or location with precision.

Finally, appropriate responses to climate change impacts will be specific to circumstances. In many instances, centralised government will lack the agility to orchestrate a differentiated response with the necessary precision to address local needs. The informational requirements of government would be extreme and costly. It is unlikely that an intrusive or directive approach to adaptation would be as effective as one motivated by local interests.

The Review favours strong reliance on local initiative in determining how Australia as a whole adapts to climate change. Government, in its roles as manager of public land, national water and infrastructure assets, regulator of markets and other activities, and manager of equity issues, can provide support for this approach by creating the necessary conditions for effective and efficient decision making by communities, households and businesses as they begin (and continue) to adapt to climate change.”

## 4.4 Critical thresholds

In most cases, as you proceed through your chosen process, you will choose a scenario that gives you a range of alternative figures for the factors (rainfall, temperature, carbon dioxide levels) you are considering.

Within this range (which is usually built around a mean and probability, such as a normal distribution) there may be critical thresholds you believe, once crossed, will have a devastating impact, i.e. irreversible damage or extremely high likelihood of catastrophic consequences.

For example, the Indian Ocean Climate Initiative’s 30-year scenario for the South West of WA ([www.ioci.org.au/index.php?menu\\_id=19](http://www.ioci.org.au/index.php?menu_id=19)) is that “... rainfall will decrease by between 2 to 20 per cent” (Bates et al. 2008). If it is estimated that a rainfall reduction of greater than, for example, 10 per cent would result in an annual average crop failure of more than 99 per cent, you would want to document that critical threshold at some point in your process.

Being cognisant and documenting critical thresholds is important, as it may lead you or your participants to the conclusion that rather than an incremental adaptation response, you may need to think outside the square and consider more dramatic responses.

To use the example above, if it is determined that a crop failure of more than 99 per cent will likely occur (after a 10 per cent drop in rainfall), even after allowing for changes in management and crop varieties, then your conclusion may be to cease cropping and look for other viable land uses (e.g. pastoral, low-water use woody perennials, biodiversity).

In reality, because of the uncertainty surrounding climate change forecasts, you or your process participants are unlikely to rush to implement dramatic solutions (without further economic, social and environmental analysis). However, identifying these thresholds prepares individuals and organisations for the possibility of more dramatic action – after all forewarned is forearmed. Therefore an appropriate initial response strategy may be to monitor future predictive modelling and forecasting in your adaptive management approach (see Section 2.8 *Monitoring, evaluation and adaptive management*).

In addition, identifying critical thresholds might be the deciding point for you and your group to decide if an asset or system is in a higher vulnerability category.

To follow on from the example above, if in five years time the predicted range for decrease in rainfall became narrower, e.g. between 8 and 15 per cent, then it becomes increasingly likely a critical threshold will be crossed. At this point, a higher cost/risk/more dramatic adaptation response may be required.

## 4.5 Other issues that impact on adaptation responses

During the process of creating an adaptation response strategy or action plan, you will need a way of acknowledging the impact on your asset or process of other influences such as:

- Underlying ('normal') seasonal variation;
- Market forces not related to climate change e.g. fluctuations in global production, changes in prices and input costs (declining terms of trade);
- Other environmental change issues (e.g. salinity); and
- Other socio-economic and demographic trends (e.g. declines in rural population).

One option, particularly useful during any workshop, is to use a 'parking lot' tool (that should be familiar to your facilitator). If the facilitator believes a particular impact or risk will also be strongly influenced by other issues, this should be captured as it may be useful at the end of the process when:

- Defining adaptation responses (for example you may wish to put caveats on an adaptation response to take into account these other issues); and
- Prioritising particular adaptation response (for example you may wish to give an adaptation response a higher prioritisation because it gives additional benefits in dealing with other issues, such as coping with underlying seasonal variation).

*Please also note:* The Framework does not aim to deal with adaptation to impacts of mitigation policy (e.g. adapting to or seeking opportunities arising from a carbon trading scheme). It is recommended you consider, in undertaking an adaptation response strategy or action plan, the 'parking lot' tool to deal with issues related to the impacts of public mitigation strategies (e.g. the emissions trading scheme). Alternatively, you may wish to deal with these separately using an opportunities and/or threats analysis. The reason this

approach is recommended is that including responses to mitigation will add an extra dimension to your analysis that is likely to confuse or distract your participants.

While it is not recommended you deal directly with responses to mitigation strategies, it is implicit that when prioritising various adaptation responses, the user should be mindful that responses which would be overtly counter-productive to mitigation strategies (e.g. lead to a large increase in greenhouse gas emissions) should be considered carefully (for both public good and private economic reasons).

## 4.6 Glossary

### Adaptation response

Adaptation response broadly refers to either a strategy or action that assists in adapting to climate change. A strategy (or strategic statement) might indicate a general direction (e.g. more R&D in a particular area, greater focus on gathering a certain data type, or creation of a particular extension program), while an action usually refers to a more specific statement, and should indicate a time horizon, the resources to enable the action to be achieved, and the person or persons responsible for seeing the implementation of the action statement.

### Adaptive capacity

Several definitions occur in recent climate change literature. In some literature there is a lack of clarity between the concepts of adaptive capacity (for the purposes of defining vulnerability) and the development and prioritisation of adaptation responses.

Understandably, this lack of clarity could lead to confusion among workshop participants undertaking a vulnerability analysis, e.g. “Why are we considering the formulation of adaptation responses, when we have already considered our adaptive capacity earlier on the process?”

In addition, there is potential to confuse sensitivity (the inherent ‘natural’ adaptability of an asset or system to climate change) with adaptive capacity.

To avoid this potential confusion, adaptive capacity is defined as: The existing human capability to adjust to the impacts of climate change.

That is how much human (as opposed to natural system) capacity is there to adapt, taking into consideration current technologies, and current economic and social conditions.

It is easier not to begin consideration of any potential/future planned adaptation responses until you get to Section 2.5 *Formulation of adaptation responses*.

Participatory workshop processes are often exploratory. Not all dimensions of a particular element are explored in sequence. You may discover that, at a later stage in the process, your participants have over- or under-estimated their adaptive capacity. Use your, and the participants’, own intuition about whether this requires you to revisit any of your conclusions.

### Exposure

“...relates to the influences or stimuli that impact on a system. In a climate change context it captures the important weather events and patterns that affect the system, but can also represent broader influences such as changes in related systems brought about by climate effects. Exposure represents the background climate conditions against which a system operates, and any changes in those conditions” (The Allen Consulting Group 2005).

## Potential impact (impact)

This is the potential effect that a climate change scenario may have on the asset or system being considered, e.g. reduction in pasture growth as opposed to just the reduction in rainfall and temperature.

For the purpose of this Framework, this has two dimensions:

- A qualitative statement of the potential nature of the impact, e.g. a reduction in average yields; and
- The addition to that statement (either qualitative or quantitative) of the potential magnitude of that impact, which is derived from considering both the *exposure* and *sensitivity* of the asset or system in question, e.g. a large reduction in average yields; or an expected reduction in average yields of more than 20 per cent.

## Risk

Risk has most commonly been used to refer to the chance of something negative happening, e.g. a loss, injury or damage. More recently, risk has become more specifically defined as an assessment of the likelihood of a negative outcome and the relative consequence of that outcome:

$$\text{Risk} = \text{Likelihood} \times \text{Consequence.}$$

Likelihood can be described qualitatively, e.g. very unlikely, unlikely, likely, very likely, or quantitatively in the form of a probability (x% chance) or estimated frequency of event (X in Y years event).

Consequence can also be described qualitatively, e.g. catastrophic, major, minor or in numerous quantitative forms (e.g. \$\$ of loss, predicted loss of life or injuries). Thus, the risk to an asset/process is equal to the likelihood of something happening multiplied by the degree of the outcome (negative impact/damage) if it happened.

## Sensitivity

“...reflects the responsiveness of a system to climatic influences, and the degree to which changes in climate might affect it in its current form. Sensitive systems are highly responsive to climate and can be significantly affected by small climate changes. Understanding a system’s sensitivity also requires an understanding of the thresholds at which it begins to exhibit changes in response to climatic influences, whether these system adjustments are likely to be ‘step changes’ or gradual, and the degree to which these changes are reversible” (The Allen Consulting Group 2005).

## Vulnerability

There are several definitions for vulnerability in recent climate change literature, however for this Framework vulnerability is defined as how susceptible a given asset or system is to a given impact.

The level of vulnerability is a function of the estimated magnitude of the potential impact (this is determined by the magnitude of exposure from climate change and the degree of sensitivity to that climate change of the given asset or system in question); and an assessment of the existing human capacity to adapt (adaptive capacity) to the expected changes in climate. Refer to Figure 2 in Section 2.3 *Vulnerability analysis*.

# Appendices

## Appendix 1. Simple matrix vulnerability analysis

This analysis has been designed for use in a participatory workshop approach. While some steps require significant preparation before any workshop commences, it is assumed decisions at each step (e.g. determining where a particularly item is located on a matrix) are reached through a consensus approach, guided by the organiser or facilitator.

In addition to the steps and matrices described below, a template has been provided to record information from each step of this process.

It is important to note, that the **qualitative information that is generated from this workshop process is as important as the final categorisation of vulnerability**. The qualitative information generated in defining impacts, critical thresholds, and vulnerability will guide your direction when you move to defining adaptation responses.

### Step 1. Assess exposure

- Choose the asset/system you wish to consider;
- Choose the climate change scenario you wish to consider (see Section 2.1 *Scoping and process design* for information on climate change scenarios).

At this point, you have two options. The simplest is to focus on one primary climate change factor:

- Consider the primary factor that you believe may have the greatest impact on your asset/system e.g. rainfall, temperature rise, evaporation rate increase, storm frequency, increased frost incidence etc.
- Then consider the exposure (Very High, High, Medium or Low) for that factor.

Alternatively:

- Consider each factor that might impact on the asset or system; and
- Then for each factor consider the exposure (VH, H, M, or L).

It is important also, to be mindful not only of projected average (e.g. mean) figures, but also of potential extreme events (e.g. what might be the projected high temperature one standard deviation above the projected mean temperature). You will need to be particularly mindful of this issue when considering critical thresholds.

### Step 2. Assess sensitivity

Against each asset/system and exposure combination you have chosen (see Step 1 above), consider the sensitivity of the asset/system in question (Not Sensitive i.e. Robust, Slightly Sensitive, Sensitive, Highly Sensitive).

### Step 3. Determine and document critical thresholds and sensitivity to intra-seasonal variations

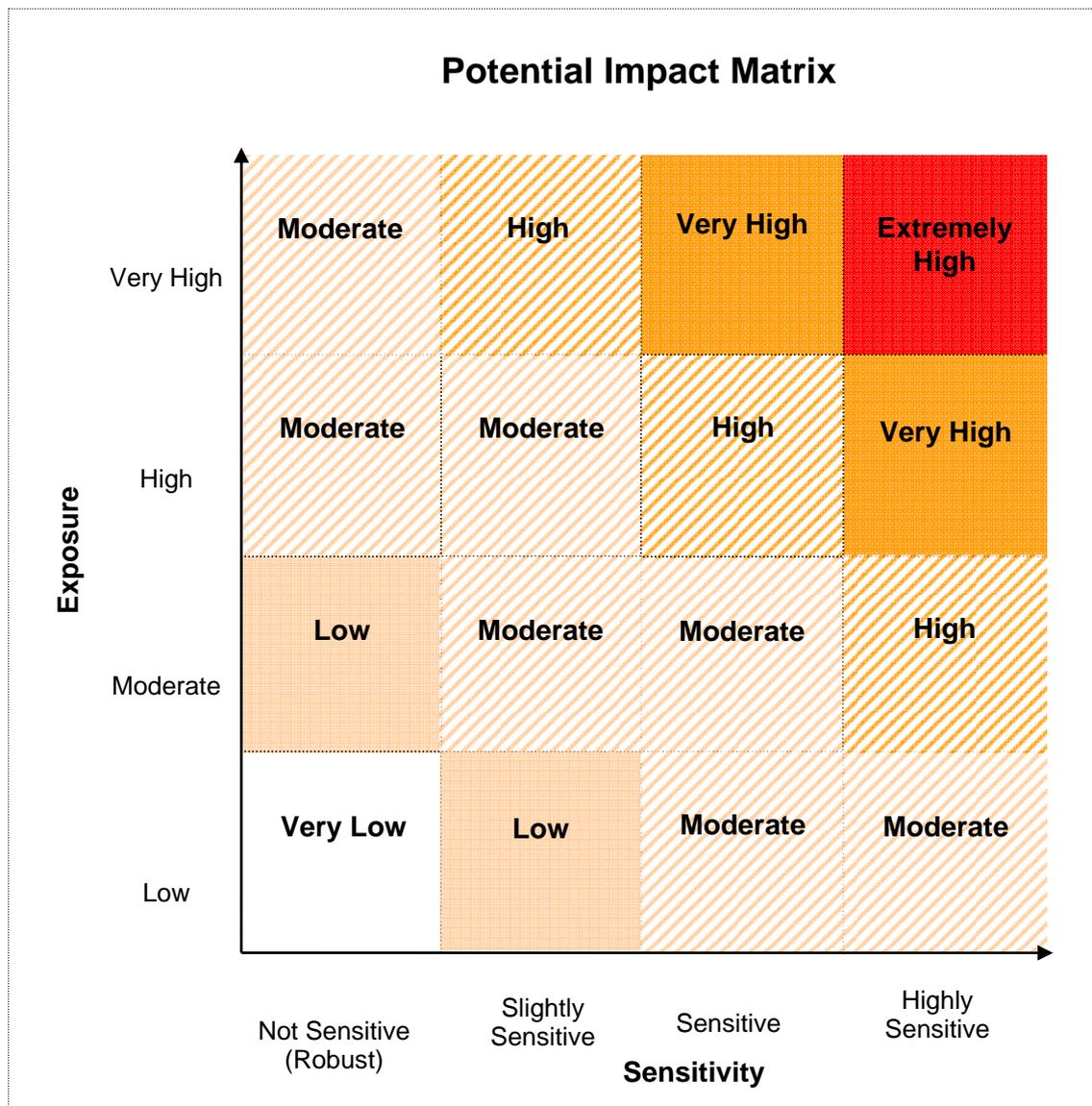
After you have explored and assessed the issue of sensitivity, it is timely to explore and document any critical thresholds that you believe may impact upon your asset or system.

At this point, you may also wish to identify if the particular asset or system in question is sensitive to intra-seasonal variation, i.e. variation (or extreme events) occurring within a defined growing season that may have an impact on the asset or system in question.

For more discussion on critical thresholds, refer to Section 4.4.

### Step 4. Define impact

Using a matrix of exposure and sensitivity (see example below) determine the level of impact (Very High, High, Moderate-High, Moderate, Low-Moderate, Low, Very Low); put a qualified descriptor on the impact (e.g. two out of three years more than 80% reduction in yield).



## Step 5. Assess adaptive capacity

As it relies on an assessment of social, economical and technological dimensions, judging adaptive capacity can be tricky. There are tools (see Section 3 *Modelling and other decision support tool options*) that aim to gather information in a more objective manner (e.g. demographic data collected via census or customised survey).

For the purposes of this simple matrix analysis the aim is to gather a consensus around participants' intuitive responses to the dimensions of adaptive capacity. Aim to keep this step as simple as possible and avoid getting bogged down in extensive discussion on detail (remembering that there are only four broad categories in the vulnerability matrix below).

Some guiding areas the workshop facilitator may want to explore include:

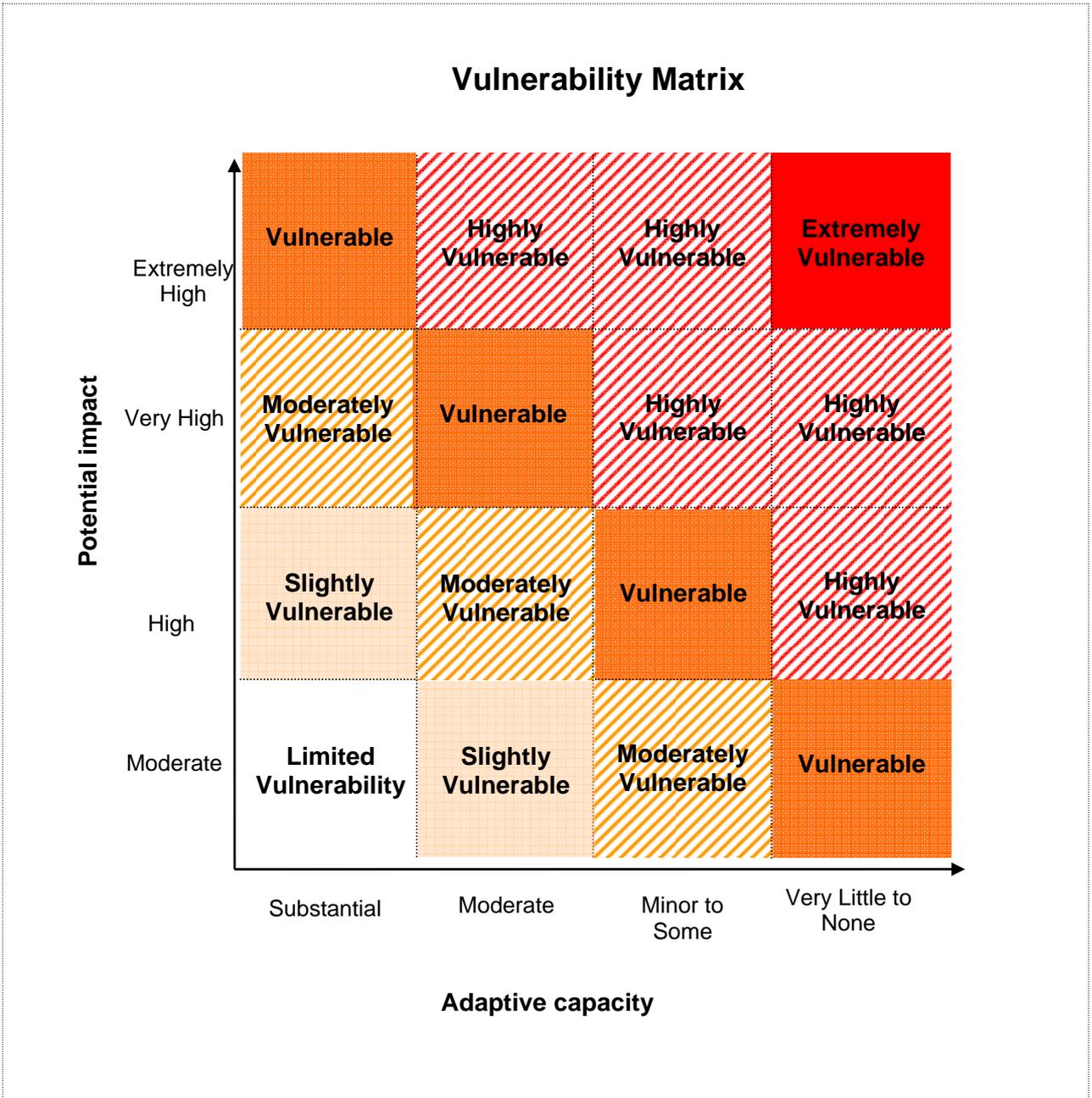
- **Economic/financial:** Is there capacity in cash flow and/or equity to adequately fund the adaption response? Are there economic or financial instruments (e.g. insurance, corporate governance structure, public funding) in place that may increase adaptive capacity? Do the current economic and financial structures (e.g. flexible markets, diversity in business/enterprise/industry, and liquidity of assets) favour or hinder capacity to adapt?
- **Technological:** Are there immediately available technologies (e.g. new species, varieties, hardware, and agronomic practices) that can be implemented?
- **Social:** Is there willingness for change (e.g. adoption of new practices or change of industry mixes); is there the human capital (e.g. population, skills, experience and education) and social capital (e.g. social networks, support structures, learning and technology transfer opportunities) available to implement adaptation actions?

## Step 6. Determine vulnerability

Using a matrix of potential impact and adaptive capacity (see example below), determine level of vulnerability (Extreme, Highly Vulnerable, Moderately, Slightly, Limited). The table on page 26 provides a template to record your assessments.

You may wish to add a statement giving more description as to why that asset or system (or asset/system and climate change factor) has been placed in that category (particularly against Extreme and Highly Vulnerable categories), e.g. description of impact (as above) combined with brief statement of adaptive capacity limitation, as well as any identified critical thresholds.

*Note:* For the purposes of saving time and resources in undertaking a vulnerability assessment, it has been assumed that nearly all impacts to an asset/system that are Low (see *Potential Impact Matrix*) will be only considered having either 'Slightly Vulnerable' or 'Limited Vulnerability'. As such, they are not considered in the matrix below. However, if you have the time or resources available, you may wish to consider these separately to determine if the vulnerability is 'Moderate'.



**Climate change scenario (e.g. IOCI scenarios – 450 or 550 ppm carbon dioxide)**

<b>Asset or system</b>	<b>Climate change factor</b>	<b>Exposure rating<sup>1</sup></b>	<b>Sensitivity rating<sup>2</sup></b>	<b>Critical thresholds? (brief description)</b>	<b>Potential impacts (brief description)</b>	<b>Adaptive capacity<sup>3</sup></b>	<b>Vulnerability rating<sup>4</sup></b>	<b>Vulnerability description</b>

<sup>1</sup> Exposure: VH - *Very High*; H - *High*; M - *Moderate*; L - *Low*

<sup>2</sup> Sensitivity: Not - *Not Sensitive (i.e. Robust)*; Slight - *Slightly Sensitive*; Mod - *Moderately Sensitive*; High - *Highly Sensitive*

<sup>3</sup> Adaptive Capacity: Sub - *Substantial*; Mod - *Moderate*; Min - *Minor to Some*; Nil - *Little to None*

<sup>4</sup> Vulnerability: E - *Extremely Vulnerable*; H - *Highly Vulnerable*; V - *Vulnerable*; M - *Moderately Vulnerable*; S - *Slightly Vulnerable*; L - *Limited Vulnerability*

## Appendix 2. Existing work to define generic adaptation strategies and actions

An overview of climate change adaptation in Australian primary industries – impacts, options and priorities – was prepared for the National Climate Change Research Strategy for Primary Industries (Stokes and Howden 2008).

This comprehensive study, summary and synthesis of climate change impacts and proposed adaptation strategies across a number of key primary industry sectors (grains, cotton, rice, sugar cane, viticulture, horticulture, forestry, broadacre grazing, intensive livestock, water resources, marine fisheries and aquaculture) and considerations by broad national regions, should be considered by anyone developing an adaptation strategy or action plan for agriculture.

As the report indicates, it “... should be seen as a starting point from which to engage with primary industries – not a final analysis.”

Internal Departmental workshops were held in 2009 on *Threats and Vulnerability to Climate Change* for the grain, livestock and horticultural industries and at several regional locations (Paul Carmody, Biosecurity and Research Services). Using a focus question approach the methodology aimed to identify and rank threats/impacts on the WA industry considering 20-year climate change scenarios. The workshops involved a range of staff from around the State. The results are available through AgWeb Discussion Forums or by contacting Paul Carmody directly.

Though its work is farther reaching than just climate change, the North Eastern Agricultural Region (NEAR) Strategy undertook significant work in identifying and engaging stakeholders, and consideration of adaptation responses. If you plan to use this Framework to develop a process for engaging with external stakeholders, it would be appropriate to contact members of the NEAR Strategy team (Geraldton Regional Office, Northern Agricultural Region) to identify learnings from their engagement processes.

## References

- Bates, B, Hope, P, Ryan, B, Smith, I & Charles, S 2008, Key findings from the Indian Ocean Climate Initiative and their impact on policy development in Australia. *Climate Change* 89: 339-354, Springer Science + Business Media BV, also [www.ioci.org.au/index.php?menu\\_id=19](http://www.ioci.org.au/index.php?menu_id=19).
- Bennett, A (comp.) 2010, Climate change response strategy. Department of Agriculture and Food, Bulletin 4790.
- Broadleaf Capital International, Marsden Jacob Associates 2006, Climate Change Impacts & Risk Management – A Guide for Business and Government. Australian Greenhouse Office, in the Department of the Environment and Heritage, Canberra.
- Garnaut, R 2008, The Garnaut Climate Change Review: Final Report, Cambridge University Press, Melbourne.
- GHD 2009, South West Catchments Council: NRM Climate Change Risk Assessment Toolkit – Guidelines to conduct climate change risk assessment in an NRM context. Unpublished report, GHD, Bunbury, WA.
- Morgan, L, Molin, JA, George, R, McKellar, R & Conte, J 2008, Climate change, vulnerability and adaptation for South West Western Australia 1970 to 2006 – Phase One of Action 5.5, Western Australian Greenhouse Strategy. Department of Agriculture and Food, Bulletin 4751.
- Sandall, J, Kaine, G & Johnson, F 2009, Clarifying economic justifications for government intervention to assist agricultural adaptation to climate change. Practice Change Working Paper 02/09, Department of Primary Industries, Tatura, Victoria.
- Stokes, CJ & Howden, SM 2008, An overview of climate change adaptation in Australian primary industries – impacts, options and priorities, Report prepared for the National Climate Change Research Strategy for Primary Industries, CSIRO, Australia.
- The Allen Consulting Group 2005, Climate Change Risk and Vulnerability: Promoting and efficient adaptation response in Australia. Australian Greenhouse Office, in the Department of the Environment and Heritage, Canberra.
- UKCIP 2008, The UKCIP Adaptation Wizard V 2.0, UKCIP, Oxford.
- van Gool, D & Vernon, L 2005, Potential impacts of climate change on agricultural land use suitability: Wheat. Resource Management Technical Report 295, Department of Agriculture, South Perth, WA.