



Office of
Environment
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Guide to Integrated Regional Vulnerability Assessment (IRVA) for Climate Change



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Published by:

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ISBN 978 1 74293 978 0

OEH 2013/0016

January 2013

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Glossary

Adaptation	Action taken to avoid actual or anticipated impacts from climate change, or to attain potential benefits arising from climate change (IPCC 2007).
Adaptive capacity	The preconditions necessary to enable adaptation. The adaptive capacity inherent in a system represents the set of resources available for adaptation, as well as the ability or capacity of that system to use these resources effectively in the pursuit of adaptation. Such resources may be natural, financial, institutional or human, and might include access to ecosystems, information, expertise, and social networks. Adaptive capacity is expressed as actions that lead to adaptation that serve to enhance a system's coping capacity and increase its coping range, thereby reducing its vulnerability to climate hazards.
Asset / Capital	Assets in the sustainable livelihoods approach (also called capitals) comprise the portfolio of resources that an individual, community or region draws on to make a living. In the context of adaptation to climate change, they are the resources needed to promote adaptation that reduces vulnerability to climate hazards.
Climate	Average weather (or, more specifically, the mean and variability of variables such as temperature, precipitation and winds) over a time period ranging from months, to thousands of years, to millions of years.
Climate change	A statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use.
Emergent property	Emergent properties are novel properties arising from complex interactions of seemingly simple units. The group of units (e.g. people in a community, cells of a living organism, mechanical components in a bicycle, species in an ecosystem) together have an innate property that cannot be explained from observing the individual components, that is, the whole is greater than the sum of its parts.
Exposure	The degree to which a system or sector is exposed to climate factors, including in terms of the duration, frequency, and magnitude of changes in average climate and extremes.
Impacts (climate)	Consequences of climate change on natural and human systems.
Influence diagram	An influence diagram is a simplified representation of a complex system. It is often used to assist people to visualise the outcome of climate impacts as a 'chain of events'. In the IRVA process influence diagrams are used to visualise the direct and indirect impacts of climate change on a sector.
Integrated assessment	Integrated assessment is a participatory approach to understanding and addressing complex problems in a way that combines scientific knowledge with stakeholder lead learning and inclusive decision-making processes.
Integration	The process by which separately produced components or assessments are combined, and incongruities in their interactions are considered and addressed.

Maladaptation	Any changes in natural or human systems that inadvertently increase vulnerability to climate variables; an adaptation that does not succeed in reducing vulnerability but instead increases it.
Mitigation (natural disasters)	Measures to contain or reduce the severity of human and material damage caused by extreme weather events and natural hazards.
Resilience	The amount of change a system can undergo and still retain the same function and structure while maintaining options to develop.
Sector	A part or division, as of the economy (e.g. the manufacturing sector, the services sector) or the environment (e.g. water resources, forestry).
Sensitivity	The degree to which a system is sensitive to change.
System	A population or ecosystem; or a grouping of natural resources, species, infrastructure or other assets.
Systems thinking	A process for understanding component parts of a system in the context of their relationships with each other and with other systems. It focuses on considering the full system, rather than breaking it down into its component parts.
Transformation	A fundamental alteration of the nature of a system once the current ecological, social, or economic conditions become untenable or are undesirable.
Transition	The process or a period of changing from one state or condition to another. Transitional adaptation entails incremental reform at the level of individual policy sectors or specific geographical areas.
Vulnerability	The degree to which a system is susceptible to, and 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 change and variation to which a system is exposed, its sensitivity and its adaptive capacity.
Contextual (starting point) vulnerability	An approach to analysing vulnerability of people to climate change impacts by examining how social and economic processes influence their social disadvantage. It seeks to understand why some populations are more vulnerable than others, how they are vulnerable, and who in particular is likely to be most affected by climate change.
Outcome (end point) vulnerability	An approach to analysing vulnerability that aims to identify what things are exposed to particular climate impacts, where and when impacts may occur, and what the consequences of impacts might be. According to this approach, vulnerability is the remaining impact of climate change, after feasible adaptations have occurred.

Introduction

This document aims to present a ‘how to’ guide to the Integrated Regional Vulnerability Assessment (IRVA) for climate change developed by the NSW Office of Environment and Heritage. It will set out the steps involved in establishing and running the assessment, and analysing the data the process generates. Although it is not a formal review of literature, this guide will explain the theoretical principles that support the IRVA process. Issues such as the framing of vulnerability, ways of assessing it and its relationship to other concepts such as adaptation and resilience will be covered. The guide will also discuss the reasons behind the choice of the ‘region’ as the appropriate scale for assessment, the focus on government service provision and the need for participatory processes in an Integrated Assessment framework. A list of further reading will direct potential users of the IRVA to more detailed academic literature on the range of topics covered in the guide.

What is the IRVA?

The IRVA is a process designed to develop a shared understanding among stakeholders of the likely vulnerability to climate change and stimulate action to plan adaptation. While it was developed for use with public sector managers, it can be used with other types of stakeholders (private sector, NGOs, community) and at a range of scales (local, state or national). IRVA is carried out in such a way that it incorporates:

- a systems thinking approach that acknowledges communities exist within human–natural (or social-ecological) systems
- participatory engagement in which stakeholders co-create an understanding of vulnerability through their deep understanding of the region
- a focus on developing an understanding of the constraints to adaptation, and on identifying opportunities for building adaptive capacity so communities can deal better with climate shocks regardless of their nature or timing, and
- qualitative analysis supported wherever possible with quantitative data, which acknowledges that societal interactions are complex and contradictory in nature, and not amenable to expert-led, reductionist approaches to problem analysis.

Part 1: A primer on vulnerability assessment in the IRVA

1 Why measure vulnerability?

It is now generally accepted that some impacts of climate change are inevitable and that varying degrees of adaptation will be needed. Understanding vulnerability is central to identifying adaptation needs and developing adaptation policy. However, there are a variety of methods to assess vulnerability, which have been developed in the areas of food security, poverty analysis, sustainable livelihoods and other fields. Each of these approaches emphasises a particular aspect of vulnerability and uses different techniques.

The IRVA process draws on the IPCC definition of vulnerability as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes (IPCC 2001). Vulnerability is viewed as the state of susceptibility to harm from *exposure* and *sensitivity* to stresses associated with environmental and social change and from the *absence of capacity to adapt*.

1.1 Approaches to assessing vulnerability

There are three common approaches to vulnerability assessment. Each of these approaches tries to understand vulnerability from a different perspective. While all of them help understanding of some elements of vulnerability, none of them alone presents a complete picture.

1. *Risk-hazard* approaches aim to identify what things are exposed to particular climate impacts, where and when impacts may occur, and what the consequences of impacts might be. The risk-hazard approach assesses what is generally known as *end point* or outcome vulnerability. According to this approach vulnerability is the remaining impact of climate change, after feasible adaptations have occurred. End-point vulnerability is most often used to prioritise international assistance programs, and for technical adaptations to climate impacts. Spatial analysis using Geographical Information Systems (GIS) is often a feature of this approach. It may be used to map exposure of infrastructure or geographical features (such as low-lying coastal areas) to particular climate impacts.
2. *Political economy-political ecology* (also called entitlements) approaches analyse the vulnerability of people to climate change impacts by examining how social and economic processes influence their social disadvantage. They seek to understand why some populations are more vulnerable than others, how they are vulnerable, and who in particular is likely to be most affected by climate change. These approaches assess *starting-point* or contextual vulnerability and are most often used in policy and social development contexts.
3. *Ecological resilience* approaches view climate change as acting on the dynamic relationships between and within human and natural systems (or social-ecological systems). These approaches recognise that social-ecological systems can exist in a range of states, some of which may be more desirable than others. In applying ecological resilience to climate vulnerability the aim is to identify and avoid thresholds that might move a system to a new, less desirable state, or to encourage a system on a trajectory to a more sustainable state.

1.2 Vulnerability in the IRVA context

The IRVA employs aspects of all of the above approaches. The IRVA can therefore assess the way in which the vulnerability of people is influenced by socio-economic institutions and activities (with a focus on provision of government services) and

biophysical resources (Figure 1). The IRVA process attempts to consider the decision-maker centrally, as the point where action can be taken. It offers an integrated view of the relationships people have with the landscape system and the changes in its components (climatic conditions, bio-physical and socio-economic processes), and identifies links between people, institutions and places at a range of scales.



Figure 1: The IRVA assesses the vulnerability of people within the context of socio-economic institutions and activities, and regional biophysical resources, at a range of scales (after Dowling & Patwardhan 2004).

2 What is adaptation?

Adaptation is defined as actions taken to reduce or moderate or adjust to the expected or actual negative effects of climate change and take advantage of new opportunities. Adaptation may be planned, that is, result from deliberate policy decisions based on an awareness that conditions are about to change. Alternatively adaptation can be autonomous and reactive, triggered by signals of change in natural or human systems rather than by climate change. Natural systems respond autonomously, whereas human systems have the ability to plan for change. There is a danger that reliance on reactive adaptation alone would lead to action that lags behind emerging risks. The more rapid the rise in atmospheric concentrations of greenhouse gases, the faster the rate of climate change and the less effective reactive adaptation is likely to be.

Adaptation links the risks associated with climate hazards to social and technological development of communities (Figure 2). Adaptation can result in a range of outcomes from resilience (change to maintain existing system structure and function), to transition (incremental change through reform to existing governance arrangements), to transformation (fundamental change to the existing system).

However, a number of obstacles to adaptation in social systems have been identified and these include:

- *climate uncertainty*, due to difficulties in separating the effects of short-term, local weather from long-term changes in climate, in predicting future climate at local scale, and others
- *moral hazard*, for example, expectation in the community that government will provide disaster relief payments which stops people from taking action to reduce their risk
- *organizational behaviour*, whereby the actions and decisions taken by organizations are typically constrained by rules, routines, procedures, formulae, and precedents that make up 'the way we do things' and are slow and difficult to overturn
- *behavioural economics*, which demonstrate that people are short-sighted decision-makers who sharply discount events in the distant future or past. People tend to underestimate the risk that climate change will have an impact within their lifetime because the probability of impacts occurring in a single defined period in the near future is low. Furthermore, people are inherently conservative, preferring to maintain the status quo and make only small adjustments. They also tend to resist and deny information that contradicts their personal values or beliefs.

It seems that although the need for deliberate adaptation on climate change is high, the likelihood that people or communities will perceive potential climate impacts as part of their personal vulnerability and plan to modify the way they live is low. The requirement for early action and the complexity of the potential outcomes suggests that for adaptation to be effective it needs to be a guided process.

2.1 Focus on government in the IRVA

Successful adaptation to climate change depends on three elements:

- timely recognition of the need to adapt
- an incentive to adapt, which requires financial and other instruments to stimulate adaptation, and an environment that allows processes of adjustment to proceed, and
- an ability to adapt, which requires conditions that allow behaviour to change.

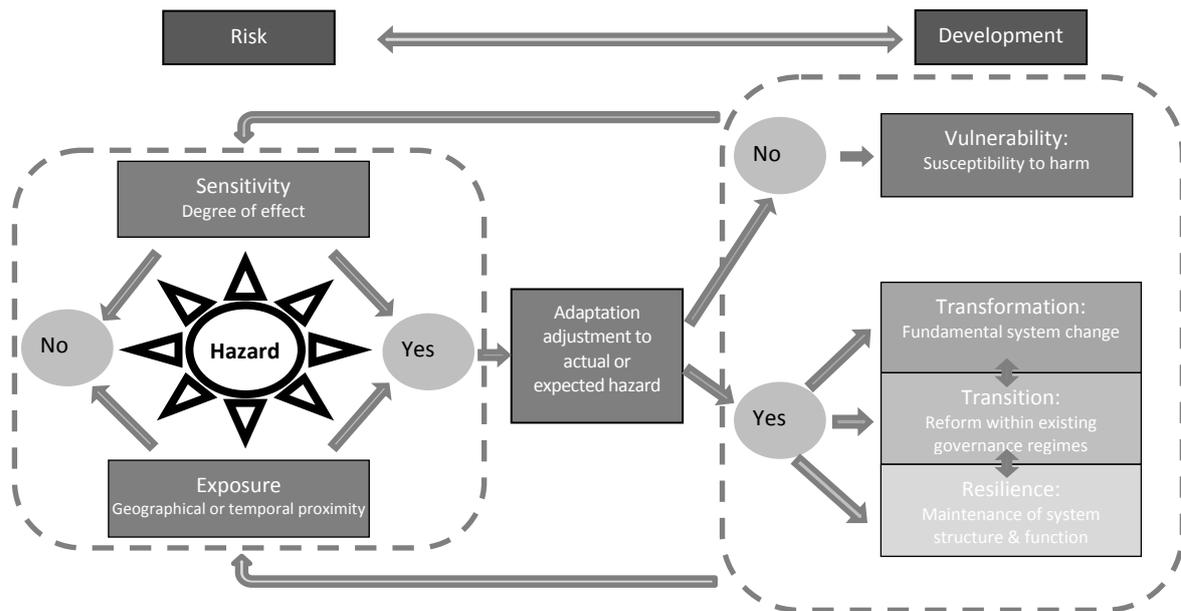


Figure 2: The conceptual relationship between the risks posed by sensitivity and exposure to a climate hazard, the resilience transition or transformation outcomes of adaptation, and persistent vulnerability where adaptation fails (after Pelling 2011).

These areas traditionally fall within the responsibility of government through its role in addressing public knowledge deficits to raise awareness, addressing the failure of markets through economic instruments, and providing a legal and regulatory environment that modifies behaviour to achieve broad public benefits. Furthermore, governments perform strategic planning functions necessary to manage a process of climate adaptation. Governments, therefore, have a responsibility not only to minimise the risks of climate change impacts on their provision of services, but also to work to reduce community vulnerability, particularly of those most at risk, and to build the adaptive capacity of the community to facilitate adaptive responses. Government is therefore central in the adaptation process and hence the primary concern of the IRVA.

2.2 Adaptive capacity in the IRVA process

The long time horizon and prevailing uncertainties about climate change imply that the best strategy for climate change adaptation is to increase the flexibility of systems to function under a wider range of climatic conditions. Adaptive capacity refers to the social and physical resources necessary to enable adaptation and the ability to mobilise these resources. It is an emergent property of a community that results from the interaction of that group with the complex systems in which they are embedded. For social systems, adaptive capacity is also considered as the component of vulnerability most amenable to influence, and therefore provides an entry point for adaptation planning.

To assess adaptive capacity for climate change four broad questions need to be answered:

1. What are the likely or current climate impacts?
2. Who needs to adapt?
3. What are the barriers to adaptation?
4. What appears to enable adaptation processes?

For the IRVA, the likely climate impacts are determined through the development of a region-scale climate impacts scenario. This involves identifying and synthesising the best available climate change science and impact information for the region. In most cases this will simply draw on existing science available through government agencies or research institutions. In some instances the groups carrying out an IRVA will be in the position to commission new science to improve understanding of the regional impacts of climate change.

The decision to focus attention on government, in the first instance, rather than the community provides the answer to the question 'Who needs to adapt?'. However, preparation of a region-scale socio-economic profile provides a contextual background on social and economic trends that might be expected to continue into the future. This information can be used to inform the IRVA workshops as well as to ground-truth the information provided by participants in the IRVA process.

To answer the final two questions an approach is needed that is practical to implement and able to be resourced. In addition the approach should allow users to develop an interdisciplinary understanding of adaptive capacity. In the context of the IRVA, the sustainable livelihoods analysis framework is used.

2.3 Livelihoods and five capitals framework

The IRVA process uses the five capitals framework to link an assessment of contextual vulnerability to the need for change in government services and operations. The sustainable livelihoods framework is usually applied at household scale and depicts people as pursuing their livelihoods in a *context of vulnerability* (Figure 3). People draw upon a portfolio of *livelihood assets* to make a living. These assets or resources are commonly categorised into five types of 'capital':

- financial capital, e.g. wealth, personal income and debt levels
- human capital, e.g. levels of education and health
- social capital, e.g. connections to community and society
- natural capital, e.g. security of natural resources or frequency of natural disasters
- physical capital, e.g. level and type of infrastructure such as roads, transport, and style and quality of housing.

The amount and balance of the capitals in a portfolio are important. People with larger portfolios have more livelihood options, and less vulnerability, than those with fewer assets. For example, in many regions of Australia agricultural livelihoods are critical to regional prosperity. Agricultural livelihood strategies are based on the access to and transformation of natural capital. Farmers make a living by using crops and livestock to transform natural capital (water, soil fertility, sunshine) into commodities for sale. Their sale creates income (financial capital) which can then be transformed into other types of capital: an education for their children (human capital), innovative technology and farming equipment (physical capital), and membership of clubs and social networks (social capital).

Governments play a major role in changing the ability of individuals and communities to access, combine and transform capital, through laws, policies and other governance frameworks. In the case of agricultural livelihoods, laws that regulate land clearing and surface water extraction are examples of ways governments act to modify access to resources, and thereby the livelihoods strategies of farmers, thus influencing *livelihood outcomes*.

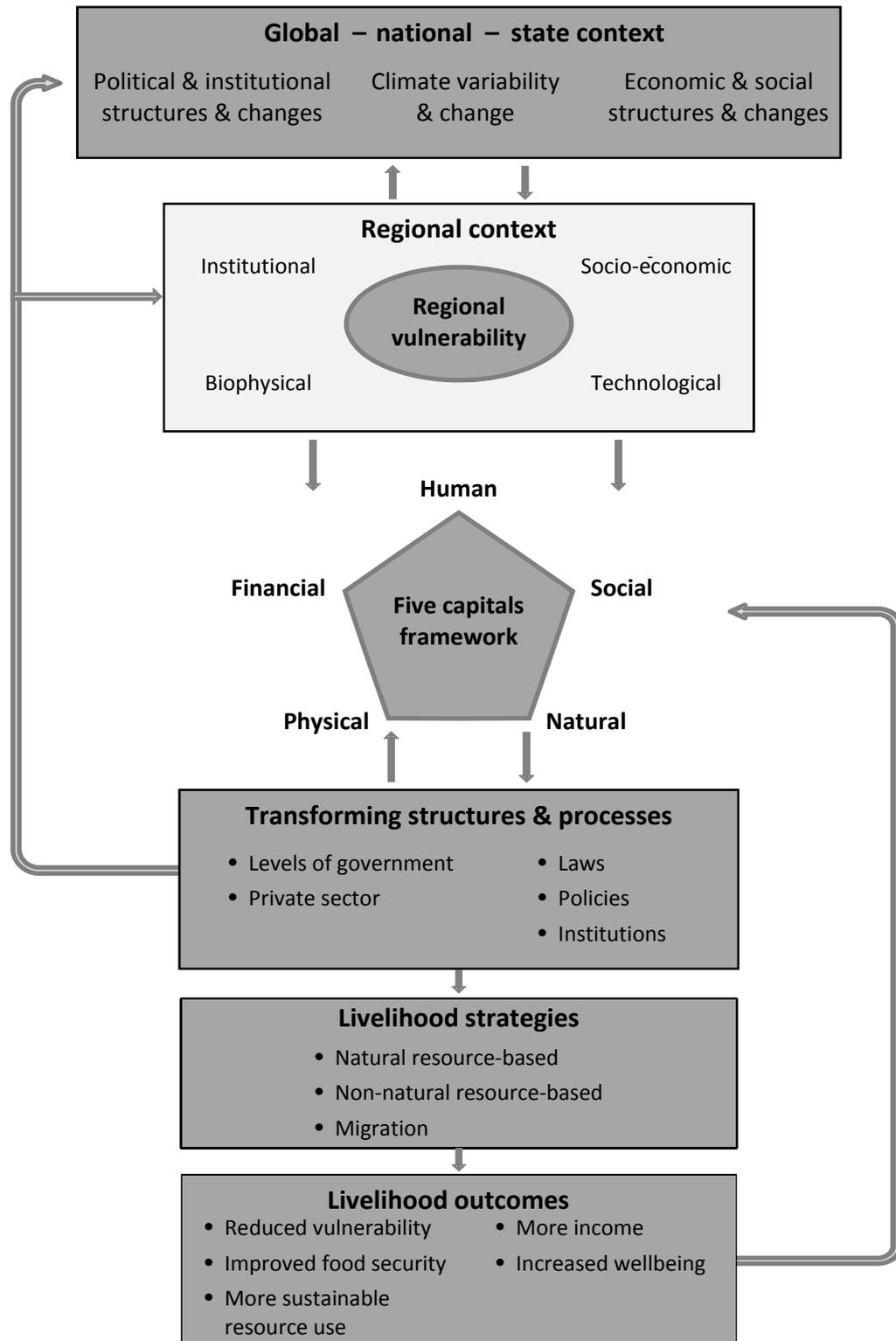


Figure 3: The IRVA assesses regional vulnerability to climate change in the context of political, institutional, social and economic changes occurring at global, national and state scales. Adaptive capacity is considered in terms of a ‘five capitals’ framework. Actions to remove barriers to adaptation may include changes to transforming structures and processes or to the bundle of livelihood strategies that comprise the regional economy with reduction in climate vulnerability as a central outcome.

The livelihoods approach can be used at a range of scales from the single household to a regional scale. Regions can be viewed as operating in a context of vulnerability; a region has a set of assets that it draws upon to support regional economic activity (businesses, industry and community livelihood strategies) which lead to outcomes in the form of regional economic security, trade with other regions, food production and security, and wealth creation. Just as with households, regions have larger and smaller asset portfolios – some are more reliant on natural resources than others; the region may support human populations of varying demography and social makeup. They are also subject to the influence of federal and state laws and institutions and have an influence on local government, regional NRM bodies, etc., which can affect strategies of resource use and the outcomes sought.

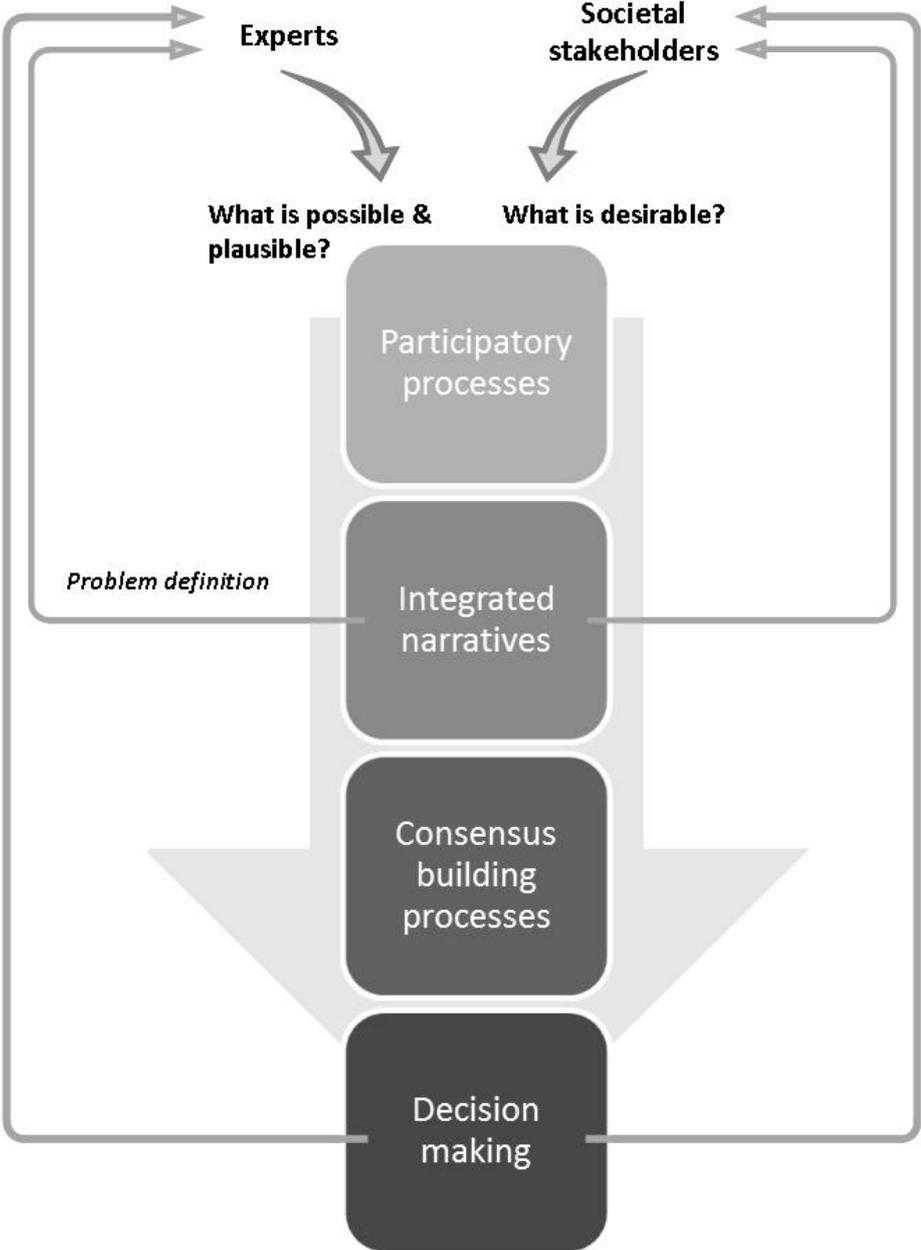


Figure 4: Model of Integrated Assessment (IA) (after Rotmans & van Asselt 1996).

3 Integrated Assessment for IRVA deployment

Integrated Assessment (IA) allows the IRVA to be deployed in practice. IA is an interdisciplinary and participatory process of combining, interpreting and communicating knowledge from diverse stakeholders. It provides new insights or a more comprehensive picture of the problem to assist policy formulation and decision-making (Figure 4). IA developed as a field of study because traditional approaches to dealing with complex problems were unable to provide solutions. The types of problems to which IA has been applied have many characteristics in common:

- they are usually difficult to clearly define
- they have many interdependencies and multiple causes
- attempted solutions may result in unforeseen consequences
- they are dynamic in nature, without a clear solution and are socially complex
- they span the responsibilities of a number of organisations or institutions
- they are often characterised by chronic policy failure, and
- perhaps most importantly, each stakeholder group perceives and defines the elements of the problem from their own perspective without being aware that other stakeholders may view the problem quite differently.

3.1 Stakeholder involvement – participatory processes

The engagement of stakeholders in participatory processes is fundamental to IA because it ensures human perceptions and preferences are considered as part of policy formulation. Participatory processes facilitate the inclusion of non-scientific knowledge, values and preferences into vulnerability assessments which:

- allows for the recognition of multiple drivers beyond those related to climate, to include political, cultural, economic, institutional and technological forces
- implicitly recognises the dynamic nature of exposures, sensitivities and adaptive capacities over time
- recognises that sources of vulnerability function across scales from the individual to the global
- encourages social learning, collaboration, conflict resolution, long-term visioning, and joint planning among participants, and
- improves the quality of assessments by giving access to practical knowledge and experience, and to a wider range of perspectives and options than purely top-down, science-led techniques.

Use of participatory approaches in IRVA allows stakeholders to actively contribute to shared problem solving, rather than passively receiving information from outside experts, who may not have local understanding of the impacts of climate change. It also recognises that much of the information about current vulnerability of government operations in a region is not codified (embodied in explicit, written rules and procedures). Such information exists in the collective store of experience and tacit knowledge of public sector managers who negotiate the formal and 'shadow' systems of regional administration.

Clearly, climate change impacts and the need for adaptation will cut across the range of government activities and agencies and will present significant implications for the policies

and programs related to specific sectors such as health, industry, infrastructure, planning and ecosystem protection. In order to access all the necessary tacit information in a region, stakeholders in an IRVA will need to be drawn from all of these sectors.

Participatory approaches encourage people to:

- share information, learn from each other, and work together to solve common problems
- change the balance of power between disciplinary experts and societal stakeholders
- generate shared understanding of problems, priorities and possibilities
- agree to achievable and sustainable change and action, and
- build the capacity of local stakeholders to initiate self-mobilised action.

4 Region-scale assessment

Recognition of the presence of interactions between local, regional and national scales and feedback loops in socio-ecological systems is important in developing adaptation strategies. Atmospheric CO₂ levels and global financial systems are significant global driving forces for change that affect local-scale systems. Conversely, problems with local-scale systems (such as deterioration in local environments and economic activities) can accumulate resulting in changes at wider scales. Adaptation responses that do not consider these interactions are less likely to be effective.

In general, local-scale or bottom-up assessments of adaptive capacity benefit from reduced system complexity, more easily manageable and representative stakeholder involvement, and greater ease of communication with the community. Local-scale assessments also embody the principle of subsidiarity; that is, adaptation policies should be designed and implemented at the lowest feasible levels of organization that reduce vulnerability to climate change.

Critics of bottom-up approaches argue that at fine scale, the limits of resolution of climate modelling do not allow meaningful predictions of climate impacts for stakeholders to consider, and that lack of consistency in assessment methods makes difficult the identification of generalised rules and transfer of learning from one location to another.

The IRVA is therefore carried out at a regional scale as there is scale appropriate climate modelling and impact information, which allows stakeholders to identify the likely affects of these changes on local socio-economic and biophysical systems. In addition, because the IRVA uses a consistent approach, findings from individual sector- or place-based workshops can be integrated across scales. This allows regional vulnerabilities and capacity constraints to emerge. This type of analysis is termed meta-analysis, or 'analysis of analysis'. Meta-analysis accumulates and integrates local study evidence to develop generic relationships, which help inform public policy at a wider scale.

It is important to recognise that regions are not closed systems, their boundaries are 'fuzzy', subject to external influences, and communities often do not recognise administrative boundaries. Through the IRVA process external influences that might distort vulnerability assessment or change capacity to adapt can also be identified. For example, in the South East region of NSW, it was identified that the Australian Capital Territory significantly affects communities throughout the region. For the Riverina–Murray Region, the River Murray forms the border between NSW and Victoria. Laws and regulations commonly vary between states, and communities on either side of the border are likely, where possible, to exploit such administrative differences.

Part 2: A step-by-step IRVA guide

The IRVA process (Figure 5) consists of a number of distinct stages:

1. alignment of assessment scale and project governance
2. information collection – quantitative and qualitative via participatory workshops
3. presenting the results.

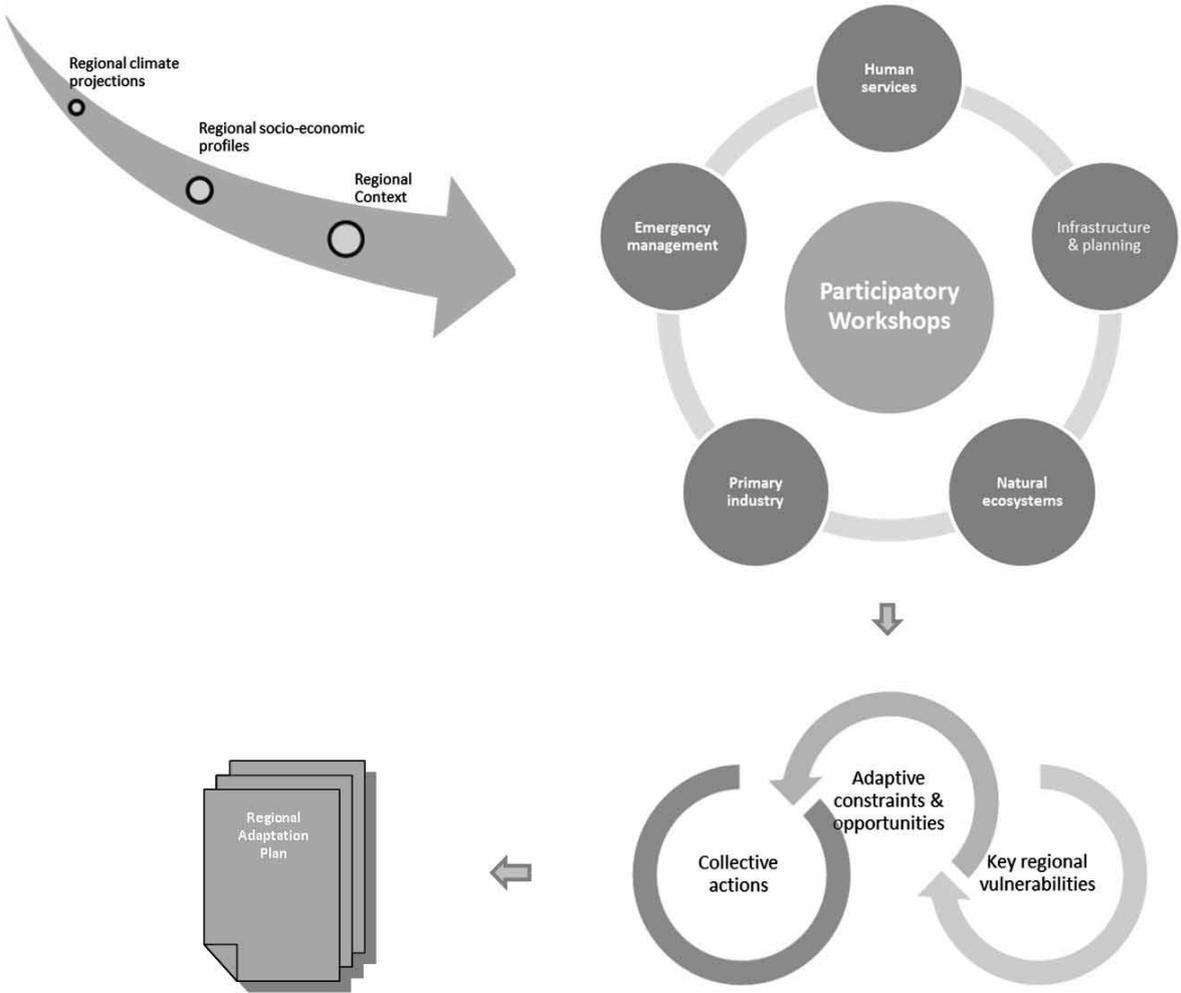


Figure 5: The steps in the IRVA process involve collecting quantitative information on regional context and, through participatory workshops with regional stakeholders, identifying key regional vulnerabilities, an understanding of adaptive constraints and opportunities, and a set of suggested collective actions to build capacity that can be developed into a regional adaptation plan.

5 Alignment of assessment scale and project governance

The IRVA focuses on a regional scale of assessment and hence requires a steering committee that matches this scope. The steering committee provides project governance, assists in engagement with regional stakeholders, and identifies any relevant existing reports to support the information-gathering process. In the South East IRVA the assessment was focused on the region as defined by the NSW Department of Premier and Cabinet (DPC). Within the region DPC convened a committee of the key agency managers, the Regional Manager's Network (RMN), and this network formed the steering committee for the IRVA. However, regions are often imprecisely defined and may be located within or may span administrative boundaries, and it is important to consider this when establishing the membership of the steering committee, as well as when deciding who should participate in the workshops.

A regional steering committee has the local knowledge required to identify significant sources of difference within the region that may lead to separate consideration of some climate impacts on sub-regions. For example, the South East Region of NSW was subdivided into coastal, alpine and tablelands sub-regions for assessment of vulnerability due to the variations in landscapes, socio-economic profiles and industries at the sub-region scale.

TIP – Regions differ from national averages

Regional populations vary considerably in their cultural make-up. Such differences are rarely accounted for in the published statistics that report national averages based on demographic groupings. However, understanding differences between 'cultures', such as urban versus rural communities, small towns versus larger centres, indigenous versus migrant populations or even graziers versus farmers, can reveal 'hooks' that are of interest and meaning only to the regional population and help in the design of communication strategies that can resonate with particular audiences.

A regional project steering committee is also required to identify the priority sectors, which:

- reflect planning and governance structures within the region
- form the topic areas that the workshops are based around, and
- define who is invited to the workshops.

These sectors may include tourism, water, primary industries, human settlements, emergency management, human health, infrastructure, natural landscapes or others.

6 Information collection

6.1 Quantitative information

Collecting reliable, up-to-date climate change projections, impact information, and socio-economic data is the first step in developing a regional scenario. Scenarios can be used in instances where the future is uncertain, such as in the case of climate change where the timing and extent of impacts are not well characterised. A scenario is a possible future, which is used to investigate the potential consequences of climate change and discuss possible action to counteract these consequences.

Scenarios represent many of the major driving forces that inform a vulnerability assessment, including physical, ecological and socio-economic impacts of climate change, and socio-economic trends. For the IRVA, collection and synthesis of regional climate change and socio-economic information was based primarily on the NSW Climate Impact Profile (DECCW 2010) and census data (ABS 2012). This information was supplemented with regional socio-economic research, demographic data and other peer reviewed scientific research where available. These sources were synthesised into a regional scenario emphasising the trends of changes. This synthesised scenario was supplied to workshop participants to inform the qualitative information-gathering processes.

TIP – Dealing with climate scepticism

Being a climate sceptic does not preclude participation in vulnerability assessment because there is no need for consensus on the cause of the changes – most people agree that some change is or has occurred even if they disagree about the permanence or cause of change. The focus of the assessment is on current regional vulnerability that might be affected by any number of system shocks, climate change being just one.

6.2 Qualitative information

The IRVA employs stakeholder workshops to collect a range of qualitative information about the vulnerability of a region. One of the issues to address in climate change vulnerability assessment within government are differences in sectors':

- way of thinking about vulnerability
- extent of consideration of climate change, and
- degree of incorporation of climate variability in existing planning.

To address these issues, the first round of workshops in the IRVA consider vulnerability within sectors or sector groups (e.g. a regional 'industry sector' might include tourism, agriculture and small business). This approach:

- allows groups with similar understandings of vulnerability to work together initially
- minimises the variation in the extent to which different stakeholders have considered climate change and included it in existing agency forward planning, and
- ensures that more advanced sectors do not dominate discussions.

For each sector workshop, stakeholders from a variety of organisations within that sector should be invited to attend.

TIP – Mix and number of participants

Involve participants from different levels in organisational hierarchies and mix local and state government representatives – there is a risk that mixing senior with more junior staff can stifle openness. However, the use of anonymous audience response metering can overcome this. Furthermore, there is usually considerable consensus about regional vulnerability, participants are often pleased to have an avenue to voice their opinion, and are generally united in their dissatisfaction with top-down decision-making.

Issues such as the size of the venue and the size and skills of the facilitation team determine the ideal number of participants. In practice, the practicalities involved in facilitating the semi-structured interview process for adaptive capacity will probably limit the number of participants to not more than 20.

The key element of the workshops is the use of participatory approaches, which allow stakeholders to actively contribute to problem solving. However, if there is poor facilitation, participants' views are misrepresented, or participants feel uncomfortable with the process, participatory approaches will fail and damage future opportunities for engagement.

The IRVA employs a number of different techniques in sector workshops including formal presentations by recognised regional experts, real-time surveys to track understanding, visualisation for climate impact analysis, and group semi-structured interviews for adaptive capacity assessment.

Participants are asked to consider impacts of climate change on their sector over the next 40 years (that is, until the year 2050) and the potential for interaction or 'flow-on' of impacts among sectors. Note that cross-sectoral integration of findings follows, once sectoral analysis is completed. A generic agenda for a sector workshop is included in Appendix 1 – Indicative sector workshop agenda.

6.2.1 Regional expert presentations

Workshops should include presentations by the facilitation team to explain the aims of and approaches employed in the IRVA. These presentations should introduce systems thinking, vulnerability and adaptive capacity, set expectations for the outcomes of the day, and explain how the information gathered will be used in the overall analysis. A sector background briefing from a recognised regional expert can provide information on the state of that sector in the region and how climate change may affect that sector. A regional expert may be an academic at a local university, a locally-based agency scientist or a regional manager with previous experience in climate change planning.

TIP – Alternate presenters

Keep things interesting for participants by alternating presenters and interspersing formal presentations with data collection and networking opportunities.

6.2.2 Real-time surveys

Inexpensive audience response systems (such as those that use radio frequency controlled key pads) provide instant feedback during the workshops. Questions can be inserted into MS PowerPoint™ presentations to anonymously survey participants and instantly report the results back to the group. These devices allow pre- and post-workshop surveys to compare the before and after levels of participants' knowledge and understanding of climate change science and the likely impacts on their role, organisation

and sector. From these data, differences between sectors and locations can be assessed. The data can also be used to gauge the extent of social learning that occurs during the workshops. Some 'ice-breaker' exercises can be incorporated into the workshops to familiarise participants with the use of key pads. Figure 6 is an example of a survey slide used in the IRVA.

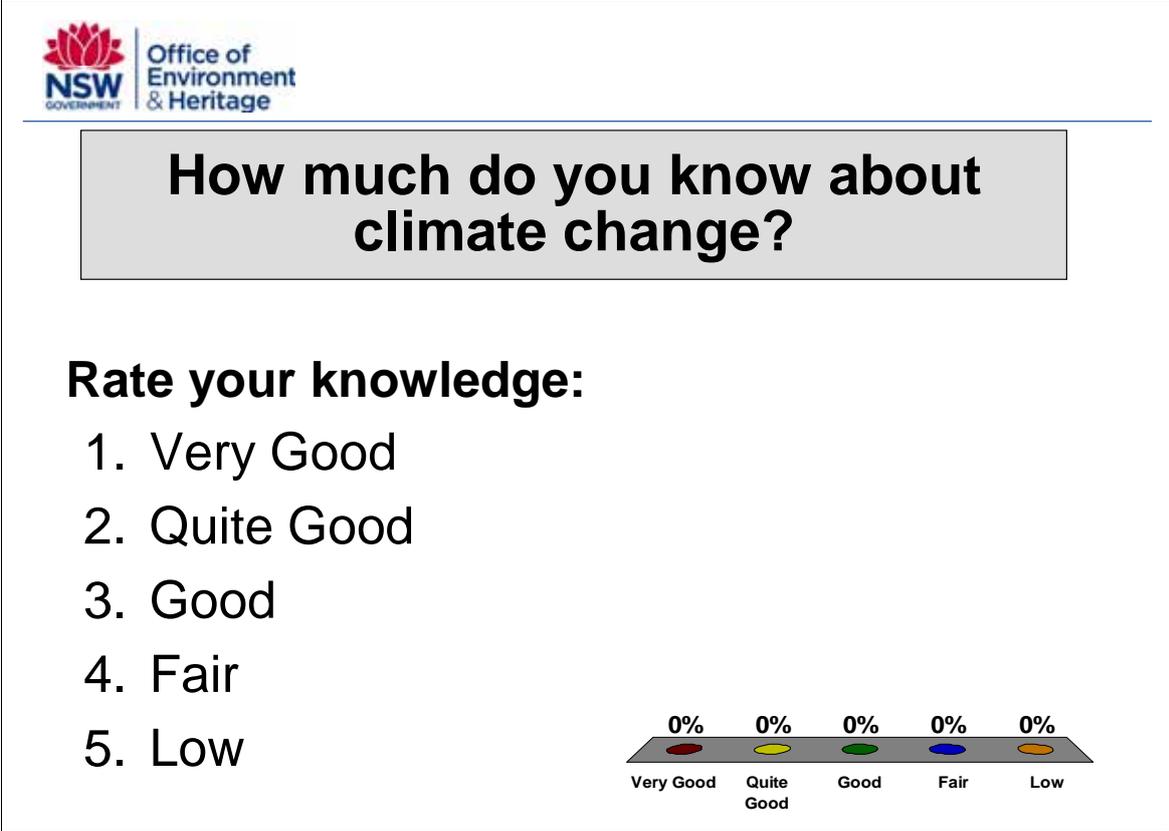


Figure 6: An example survey slide asking participants to rate their knowledge of climate change.

6.2.3 Visualisation of climate impacts

In recent years participatory approaches have increasingly incorporated diagram construction, visualisations and even artwork to supplement interviews and discussions. These approaches broaden the engagement of participants, draw on a wider range of participant skills and develop a richer picture of climate impacts on local systems. The IRVA engages stakeholders in the construction of network diagrams that illustrate impacts pathways of the major climate drivers for the region.

An influence or network diagram is a simplified version of a system of interrelated parts (Figure 7). It provides a tool for workshop participants to visualise as a 'chain of events' the direct and indirect impacts of climate change on their sector. Participants are told several key climate trends, likely to be experienced in their region. These are not detailed projections, but focused on the direction and likely intensity of the changes, for example: increasing temperatures, declining average rainfall, or changes to rainfall seasonality. Participants are then asked to discuss and record how these climate drivers could impact their sector. They should consider direct impacts, where the change in climate would result in an immediate change to their sector, as well as indirect impacts, where the change in climate would affect their sector via its interaction with another system.

Where participants are drawn from a group of related sectors, multiple influence diagrams can be constructed in separate 'break-out' groups that represent particular systems of interest. For example, impacts on roads could be considered separately from those on water infrastructure. Each group can then view the other subsystem diagrams to better understand the region in terms of a larger system of interrelated parts. In practice, there is likely to be considerable connection between these subsystems and the diagrams can be merged into a single diagram at a later stage.

TIP – Acceptance of qualitative methods

Qualitative (descriptive) research methods such as those used in the IRVA rely on transcripts and/or observations as raw data, rather than quantitative (mathematical) measurements. Participatory research is often referred to as 'purely subjective' observations. It is implied that rigour and accuracy are sacrificed in using such methods, and that the findings are informal and somehow inferior. Qualitative research is assessed for validity using four criteria:

- internal validity – confidence in the truth of the findings
- external validity – application of the findings to other contexts and with other groups of people
- reliability – the repeatability of the findings if the process were replicated, and
- objectivity – exclusion of biases, motivations and perspectives of the investigators.

A similar set of criteria for establishing trustworthiness of participatory findings has been identified, which includes:

- trust and rapport between participants and investigators
- a full understanding of context by investigators
- triangulation of sources, methods and investigators
- participant checking of findings
- peer review
- increased awareness by participants of their own and other people's circumstances, and
- reports that are rich descriptions of complex reality and that capture people's personal perspectives and experiences, and that provide a prompt for action.

6.2.4 Group semi-structured interviews

Semi-structured interviews are guided conversations that combine a fixed set of open questions (questions that prompt discussion) with the opportunity for the interviewer to explore new insights as they arise out of the discussion. Sensitive interviewing and active listening skills are essential for semi-structured interviewing. These skills ensure that everyone has an equal opportunity to participate, each person's contribution is valued, and, different points are explored. Techniques are best learned through practice and constructive feedback from colleagues.

In contrast to structured questionnaires or surveys, semi-structured interviews do not limit respondents to pre-determined answers. They are an ideal for exploring 'when' and 'where' climate will impact on local systems, as well as 'how' and 'why'.

The IRVA uses semi-structured interview techniques within the sector workshops to explore indicators of adaptive capacity, barriers to adaptation and suggested actions to build capacity. In light of the likely effects of climate change on the region (identified from discussion of background synthesis reports and construction of sector influence diagrams), participants are asked to consider three open questions:

1. What must change for your sector to service the community and why? (adaptive capacity indicators)
2. What is needed to enable change? (capacity constraints to action and potential opportunities), and
3. Where is change needed most/least? (spatial heterogeneity of adaptation).

These three questions are discussed for each of the five capitals (human, social, natural, physical, financial) to identify qualitative indicators of adaptive capacity. The use of the five capitals framework provides consistency across the sector workshops, which allows the narratives of change to be analysed across sectors at a range of scales. In practice, in a particular discussion, participants will range across several of the capitals and multiple temporal and spatial scales. This demonstrates the complex and interconnected nature of vulnerability and adaptation. The interviewer needs to recognise where discussion has moved to identify indicators relevant to other capitals or issues that should be 'parked' and used as prompts at a later stage in the discussion.

TIP – Make-up of facilitation team

Regional workshop participants often view facilitation teams from 'head office' in an urban centre with justifiable scepticism. A good facilitation team needs to be experienced, professional, multi-disciplinary and balanced in age, gender and regional experience, to ensure the team can engage with a broad range of participants.

The adaptive capacity sessions can stimulate detailed, intense discussion of long-standing local issues that contribute to regional vulnerability. Workshops need to minimise interruptions to the discussion by ensuring sufficient time is allocated and there is some flexibility in the agenda.

In addition to a written record of the session, a backup audio recording is advisable. This allows verification of the interpretations of the information provided in IRVA reporting. Permission from the group should always be sought before recording, stressing that comments will remain anonymous and the recordings will only be used to verify written records and for no other purpose.

7 Analysing information

7.1 Sector reporting

Following each sector-based workshop, brief reports can be written that include:

- a description of the project and its aims
- the agencies represented
- the sector impact diagram, and
- a table of the indicators of adaptive capacity, the narrative of their significance and suggested actions to build capacity.

Impact diagrams generated for multiple subsystems in workshop break-out groups should be combined to form a single sector diagram. Indicators of capacity may need to be moved from their original point in the discussion to another capital that is more suitable. Other indicators may be included within an overarching indicator or separated into several indicators to ensure the appropriate emphasis on important themes. These reports can be sent to participants to check that they accurately reflect the findings of the workshop.

7.2 Regional integration

7.2.1 Identifying key regional vulnerabilities with thematic analysis

Integrating qualitative data is not a simple task. Social scientists frequently use software tools to code and analyse the type of information that is produced by qualitative and mixed methods research such as the IRVA. These tools allow the collection, organisation and analysis of information from interviews, focus group discussions, surveys and audio recordings. However, analysing the data generated by the IRVA is easier because it is structured during the collection process. The use of the five capitals framework to guide and organise the discussion of adaptive capacity facilitates basic thematic analysis. For the IRVA, thematic analysis provides a method for identifying and reporting recurring themes across sector data to develop a regional story that is rich in detail.

Being familiar with the data is an important part of thematic analysis. It is best that someone who was involved in the workshops performs the analysis, as they will be familiar with any themes that emerged consistently through the discussions.

The first step of thematic analysis is to set up a 'chequer-board' that displays the capacity indicators from each of the sector workshops in a single table. Table 1 shows a chequer-board of hypothetical indicators categorised by capital for five typical sectors. From the chequer-board and familiarity with the data, various aspects of 'water' emerge as a recurring theme that links several sectors. In Table 1, the indicators related to the water theme appear across all sectors and within natural and physical capitals. They are shown as white text on black squares.

Next, the narratives of importance attached to other indicators are examined to see if they relate to the water theme. An effective way to interrogate the indicator narratives is to search for 'water' using word processing software. In this example, some aspect of water was discussed in relation to a further 23 indicators (shown as bold text in the Table 1) that ranged across all sectors and capitals. Preliminary construction of a regional narrative for the water theme can be achieved simply by extracting the text related to the theme from each of the sector reports into another document.

Table 1: Chequer-board of cross-sector linkages among adaptive capacity indicators

	Settlements & infrastructure	Natural landscapes	Industry	Human settlements	Emergency management
Human	Attract & retain skilled professionals	Adaptive regional communities	Knowledge gaps	Attract & retain skilled professionals	Skill levels of staff, volunteers and community
	Demographic change	Regional knowledge base	A case for change	Human resources surge capacity	Declining human resources
	Community attitudes	Demographic change	Diminishing skills base	Chronic disease	Demographic change
		Belief in CC	Demographic change	Regional training	
Social	Strong regional networks	Regional networks	Regional networks	Community attitude to service delivery model change	Volunteerism
	Top-down, uniform policies	Government administrative churn	Research linkages	Social networks & cohesion	Councils & LEPs
	Cross-border cooperation	Local community decline	Regional identity	New regional partnerships	Sharing of resources
	Government restructures		Government–community relationships		Networks
Natural	Water	Landscape connectivity	Water	Ability to service remote areas	Changed seasonality of rainfall & storms
	Murray–Darling food bowl	Land use options	Nature-based tourism	Water-related health issues	Changing water courses
	Land-use change	Regional river systems	Soil-landscape information	Connection to land	Water access & storage
Physical	Dam management	Water infrastructure	Water delivery and storage	Telecommunications	Utilities & critical infrastructure
	Sustainable regional infrastructure	Urban waste disposal	Grain handling & storage	Ageing infrastructure	Telecommunications
	Innovation	Transport infrastructure	Transport infrastructure	Transport links	Mitigation infrastructure
		High speed internet	High speed internet	Housing	Fire fighting equipment
			Private housing stock	Equipment & IT	
Financial	Local government funding base	Requirements of funding bodies	Banks & the regional economy	Funding models	Budgets restricted or declining
	Incentives for adaptation	Agriculture & the regional economy	Agricultural adjustment	Events not triggering financial relief	Trigger points for emergency declaration
	Carbon sequestration payments	Local government funding model	Viability of local governments	Funds for equipment & IT development	Disaster relief funding model
	Regional investment	Corporate funding	Investment in social capital		Insurance

There are no rules to determine in how many indicators or how frequently a theme should appear in indicator narratives for it to be considered a theme. Table 2 presents the elements of each sector’s expression of the importance of water to the region extracted from capacity indicator narratives. Identifying common threads across sectors contributes to the evidence that water is a key regional theme. For example, in Table 2 water is mentioned by a number of sectors as a source of community conflict and a driver of regional prosperity.

Table 2: The ‘common threads’ in storylines about water from sector perspectives make water a regional theme

Sector	Water
Settlements & infrastructure	<ul style="list-style-type: none"> Food production Water management policy trying for balance Availability – downstream Ground water sustainability Community & inter-state conflict Development & ‘river communities’ – river health Town water restrictions affect infrastructure / risk to human health
Landscapes & ecosystems	<ul style="list-style-type: none"> Amenity value Ongoing conflict Landscape connectivity Food prices & food supply Secure river access – advantage Woodland/ riparian communities – biodiversity River systems – biodiversity corridors River national parks – refuge & biodiversity adaptation
Industry	<ul style="list-style-type: none"> Attract tourists Advantages & opportunities Source of conflict & prosperity Uncertainty affects regional investment ‘Haves’ & ‘have nots’ in the regional community
Human services	<ul style="list-style-type: none"> Farmers & food production Low-lying water – vector-borne disease Floods trigger animal & pest plagues, and increase disease risk to humans Food availability & quality – nutrition & disease prevention
Emergency management	<ul style="list-style-type: none"> Community drainage infrastructure is not coping No changes or improvements to infrastructure and buildings Development of urban areas – hard surfaces and greater runoff Farming landscapes (e.g. laser levelling) – water flows, unexpected impacts from flooding

By repeating the process described above, several common themes can be identified. From the hypothetical dataset in Table 1, nine cross-sectoral themes were identified that define key regional vulnerabilities (Table 3). It is important to note that the themes identified through this process are not necessarily negative. In Table 3, *regional networks* and *high speed internet* were themes associated with a reduction in vulnerability and widely viewed as providing opportunities for the region.

Table 3: Common themes that define key vulnerabilities for the region

	Settlements & infrastructure	Natural landscapes	Industry	Human services	Emergency management
Water	•	•	•	•	•
Regional networks	•	•	•	•	•
Demographic change	•	•	•		•
Knowledge/skills/training		•	•	•	•
Administrative change	•	•	•		
Viability of local government	•	•	•		
Transport infrastructure		•	•	•	
High speed internet/IT		•	•	•	
Funding requirements		•		•	•

7.2.2 Compiling adaptive constraints and suggested actions

In addition to the identification of regional vulnerabilities, capacity narratives can be interrogated to compile a list of constraints to regional adaptation and suggested capacity building actions. Table 4 (overleaf) contains a hypothetical list of constraints that may restrict regional service providers from doing things differently to reduce regional vulnerability in relation to water. The list of suggested actions does not comprise an adaptation plan *per se*, rather it should be viewed as providing stimulus and input to a future process of detailed adaptation planning for the region.

7.3 Multiple loop learning: cross-sectoral reflection and sense-making

The IRVA is both a process to assist in the development of regional action on climate change and an opportunity for organisational learning by regional stakeholders. Learning in organisations has been conceptualised as a multiple loop process. Single loop learning involves asking whether an organisation is *doing things correctly* and makes improvements by designing new procedures or rules. Double loop learning asks whether an organisation is *doing the correct things* by questioning the underlying assumptions that drive actions. Triple loop learning seeks to understand the principles by which an organisation decides *what is the correct thing to do*. Triple loop learning creates a shift in understanding of context or point of view so that the rules can be seen from other perspectives. It aids in understanding how problems and solutions are related and how previous actions created the conditions that led to current problems. In the context of the IRVA, triple loop learning is critical to ensure that individual sectors appreciate the potential for maladaptive outcomes to occur for other sectors and the region if unilateral action is taken on climate adaptation.

Table 4: List of constraints that limit regional public sector adaptation to reduce vulnerability, and actions suggested by participants that might assist in building capacity to adapt

Adaptive constraints	Suggested actions
<ul style="list-style-type: none"> • Top-down blanket regulations • Community expectations • Financial dependence on water • Communities without water – disadvantaged • Uncertainty around infrastructure management • Declining skills base • Legacy effects • Financial viability of local government 	<ul style="list-style-type: none"> • Better balance the need for more water for the environment and recognise that farmers are good land managers • Better harness our water resources to remove supply pressures on the lower end of the catchment • Improve understanding of the impact of landscape and infrastructure changes on catchment hydrology • Ensure connectivity between restored/protected riparian areas and the broader landscape • Engage riparian communities along the river as a key asset for biodiversity protection • Increase recognition of the role of river systems as biodiversity corridors

The final step in regional integration is a cross-sectoral workshop, which provides an opportunity for triple loop learning. The workshop involves representatives from all of the sector workshops. It is best that attendees at this workshop have been to at least one of the sector workshops so that they are familiar with the processes used and information gathered in those workshops. The integration workshop uses a process of:

- review and validation of findings from sector-based workshops within small sector groups
- consideration of sector findings by other sectors to encourage an appreciation of the multi-dimensional nature of, and multiple perspectives on, climate change in the region
- presentation and general discussion of the regional vulnerabilities in plenary, and
- small cross-sectoral groups doing a preliminary assessment of suggested actions in terms of their scale (local to national), feasibility, time scale, collaborative partners, responsibility and governance.

The progression from considering sector outcomes to cross-sector understanding and finally discussion of regional vulnerabilities in plenary is important. It allows stakeholders to clearly map how the information gathered in sector workshops has contributed to the final outcomes. It helps stakeholders to understand how their sector and its vulnerabilities contribute to the regional picture of vulnerability. It also means that during the consideration of suggested actions to address vulnerability the discussion groups involve people from a range of sector backgrounds who now have a common understanding of regional vulnerability and the roles of each of their sectors in it. An example agenda from an integration workshop is included in Appendix 2 – Indicative integration workshop agenda.

8 Presenting results

The process of thematic analysis of sector information yields a series of narratives focused on each of the key regional vulnerabilities. These narratives of key vulnerabilities are also linked to one another.

To improve understanding of these complex and interlinked storylines simple conceptual models are used that summarise the findings of the IRVA (Figure 8). These models link the direct and indirect impacts of climate change (from influence diagrams), indicators of adaptive capacity, external non-climate drivers of biophysical and socio-economic change (from regional synthesis reports and discussions of adaptive constraints) and suggested actions to build regional adaptive capacity.

The results present the detailed narratives of regional vulnerability along with some of the contextual information about the region and likely impacts of climate change, which were provided to participants. This detailed synopsis is supplemented by conceptual models which summarise the findings as well as sector summary reports, which outline the key areas of vulnerability for each sector. The South East IRVA report provides an example of the outcomes of the IRVA process. It is available at:

www.environment.nsw.gov.au/climateChange/IRVAdescription.htm.

These reports, along with the capacity and shared understanding built with participants, are a strong basis for regional adaptation planning and action.

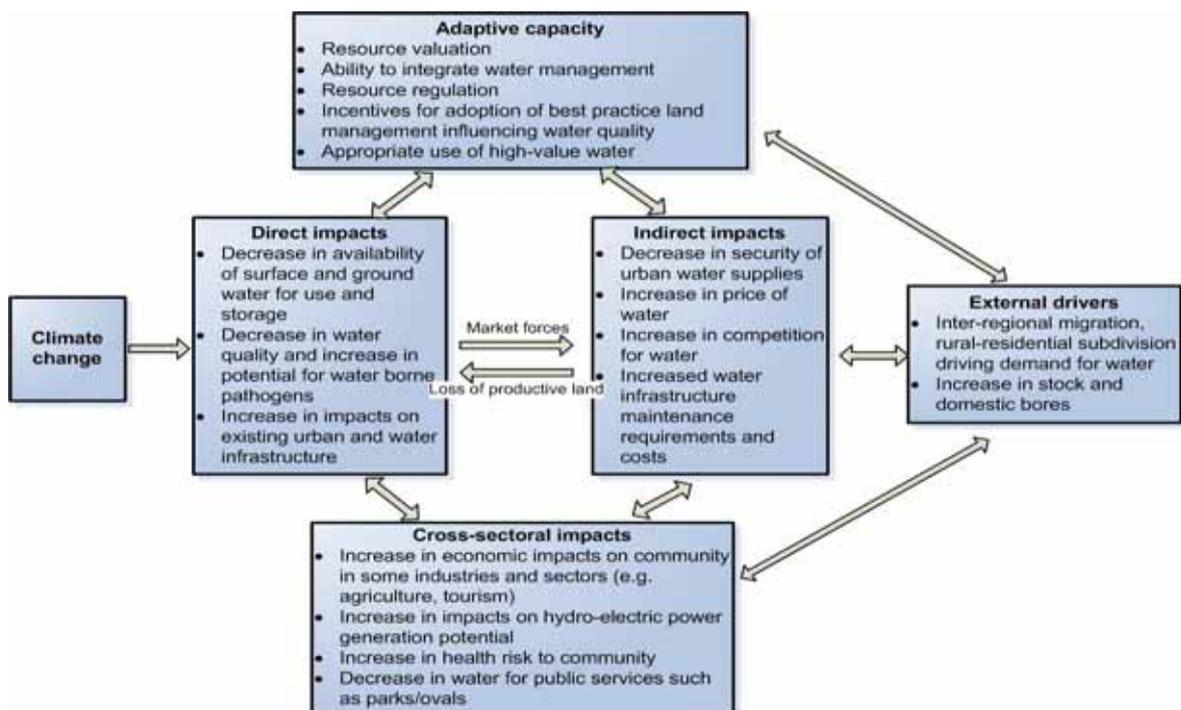


Figure 8: A conceptual model of vulnerability to increased competition for water resources from the SE NSW IRVA

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Further reading on some topics covered in this guide

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Appendix 1 – Indicative sector workshop agenda

Day 1

1:45 – 2:00	Registration, coffee
2:00 – 2:30	Welcome and introduction
2:30 – 2:45	RM IRVA process – vulnerability, risk and systems thinking
2:45 – 3:00	Pre-workshop survey
3:00 – 3:15	Future climate in the region
3:15 – 3:45	Climate change and the sector
3:45 – 4:00	Afternoon tea
3:45 – 3:50	Introduction to creating influence diagrams
3:50 – 5:00	Preliminary influence diagrams
5:00	Wrap up and what's tomorrow
6:30	Optional dinner – allows networking and builds group identity

Day 2

8:45 – 9:00	Welcome, coffee
9:00 – 9:15	Outcomes for today and warm up activity
9:15 – 9:45	Climate change impacts for the sector (influence diagrams) cont'd (if there is more than one sub-sector, swap diagrams for part 2)
9:45 – 10:00	Introduction to adaptive capacity
10:00 – 10:20	Morning tea
10:20 – 12:15	Discussion of adaptive capacity and barriers
12:15 – 12:45	Lunch
12:45 – 1:00	Workshop feedback and next steps
1:00	Close

Appendix 2 – Indicative integration workshop agenda

9:45 – 10:00	Registration, coffee
10:00 – 10:15	Welcome and introduction
10:15 – 10:45	Sector issues
10:45 – 11:15	Sector issues validation
11:15 – 11:30	Morning tea
11:30 – 12:00	Cross-sector exercise
12:00 – 12:30	First pass regional vulnerabilities
12:30 – 1:15	Discussion of regional vulnerabilities
1:15 – 2:00	Lunch
2:00 – 2:45	Suggested action analysis
2:45 – 3:15	Present analysis to full group
3:15 – 3:25	Next steps
3:25 – 3.30	Wrap up and close