REGIONAL CLIMATE VULNERABILITY ASSESSMENT: GOLDFIELDS-ESPERANCE

Preliminary overview for CSIRO-GEDC workshop

The Hannan's Club, Kalgoorlie-Boulder, August 16th, 2010

Barton Loechel, Jane H Hodgkinson, Kieren Moffat, Steve Crimp

Enquiries should be addressed to:

Dr Barton Loechel
e: barton.loechel@csiro.au
ph: +61 7 3327 4072

CSIRO Report EP104138

Copyright and Disclaimer

Introduction

Future climate variability and change is expected to impact on the mining industry and its communities in diverse ways across Australia. The Goldfields-Esperance (GE) region is a significant mineral province for Australia and an understanding of the implications of climate change for its mining operations and communities is important. The adaptation responses of mining companies and communities will have knock on effects for one another and there is therefore a need to bring together industry, government and mining community stakeholders in the region to respond effectively to the challenges.

This report has been developed as a preliminary overview of the region and of climate projections and adaptation information relevant to it. The report is designed to inform a workshop being held by the CSIRO and the Goldfields-Esperance Development Commission (GEDC) in Kalgoorlie-Boulder on August 16th 2010. The workshop brings together a range of stakeholder groups to investigate mining climate adaptation within the region.

Regional overview

In the state that produced 48% of Australia's mineral and energy exports by value in 2008-09 (financial year) , mining activities in Western Australia's Goldfields-Esperance region contributed over $10 billion (19%) of the state's exports (2006-07 figures) (DLGRD 2010). Further, the GE region is vast (770,438 km^2) and diverse in nature, encompassing desert, temperate eucalypt woodlands and coastal national parks. It is the largest of the state's nine regions and over three times the size of the state of Victoria. The GE region is bounded by the Pilbara Region and Gibson Desert to the north, the Wheat belt and Mid-West Regions to the west, the Great Southern Region to the south-west, the Southern Ocean and the Great Victoria Desert, the Nullarbor Plain and the South Australian border to the east.

With a regional population of around 60,000, the main towns are Kalgoorlie-Boulder (K-B), approximately 600km east of Perth, with a population 28,000. And Esperance, population 14,500, located on the coast approximately 720 km east-southeast of Perth and 400km south of K-B. The other townships, most of them reliant upon mining, are much smaller, ranging from Kambalda (pop. 4250) near Kalgoorlie, Ravensthorpe (pop. 2,400) closer to the coast, and the more remote towns north and west of K-B with populations of less than 1000. The region is comprised of nine local government areas (Fig. 1.)

While the shires of Ravensthorpe and Esperance on the coast are characterised by higher rainfall and a mix of industries (agriculture, mining, tourism, fishing and forestry), shires further north are increasingly more remote, arid environments, and more dependent upon mining and to a lesser extent tourism for their economic prosperity (GEDC & DLGRD 2006). There is considerable mining infrastructure located across the region, from actual mines that operate in most, if not all shires, minerals processing, and minerals transport, including roads, rail and port facilities.

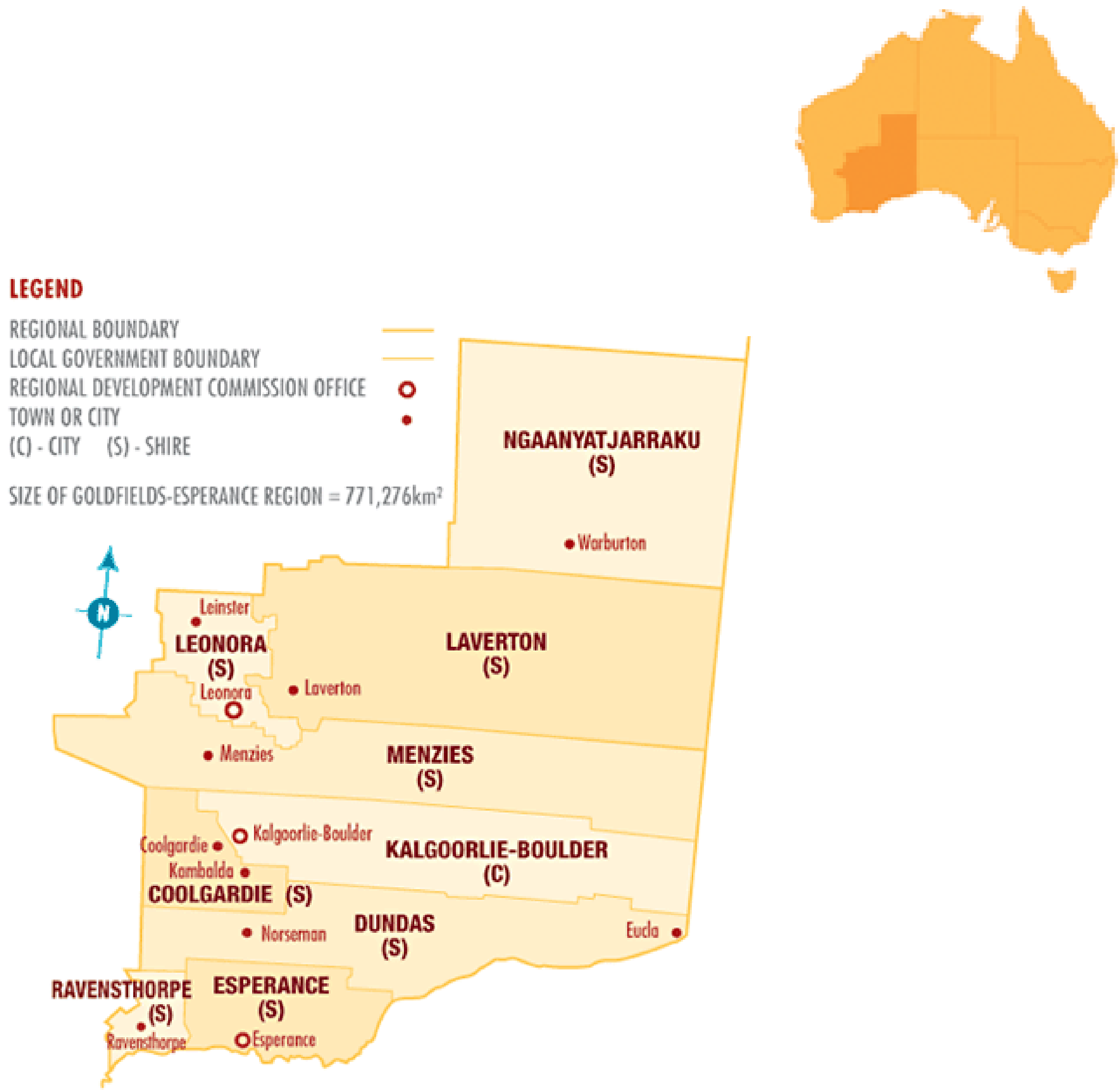

Figure 1. The Goldfields-Esperance region of Western Australia (Source: GEDC 2010)

The region is home to a significant Indigenous population, particularly in its northern shires of Ngaanyatjarraku, Laverton, Leonora and Menzies. Nearly 10% of the region's population are of Aboriginal descent, which is a substantially higher proportion than for the state as a whole. Many groups reside in small remote community settlements and warrant culturally sensitive approaches to addressing issues that affect them.

Future issues likely to have a major influence on the prosperity and wellbeing of the region include those specific to the region (DEC 2010) and those applicable to the resources sector more generally (Giurco et al. 2009). For example:

- the duration of current mines, success of exploration for new mining ventures, and development of minerals processing

- mining investments elsewhere that compete for finite resources (e.g. finance, labour, energy, water)
- commodity prices linked to global economic conditions
- corporate globalisation, mergers and acquisitions
- geopolitical events and shifting economic and political relations
- government taxation and regional investment regimes
- climate change affects, and mitigation and adaptation responses including the shift to a less carbon dependent economy
- energy costs and development of renewable resources
- changing social expectations that influence government regulation, especially those related to environmental and cultural heritage (e.g. Native Title) issues.

Climate scenarios for mining Region 4 (Goldfields)

Mining region 4 is situated in southern Western Australia covering the Goldfields region (Fig 2) where gold, nickel and copper for example, are among the main commodities mined.

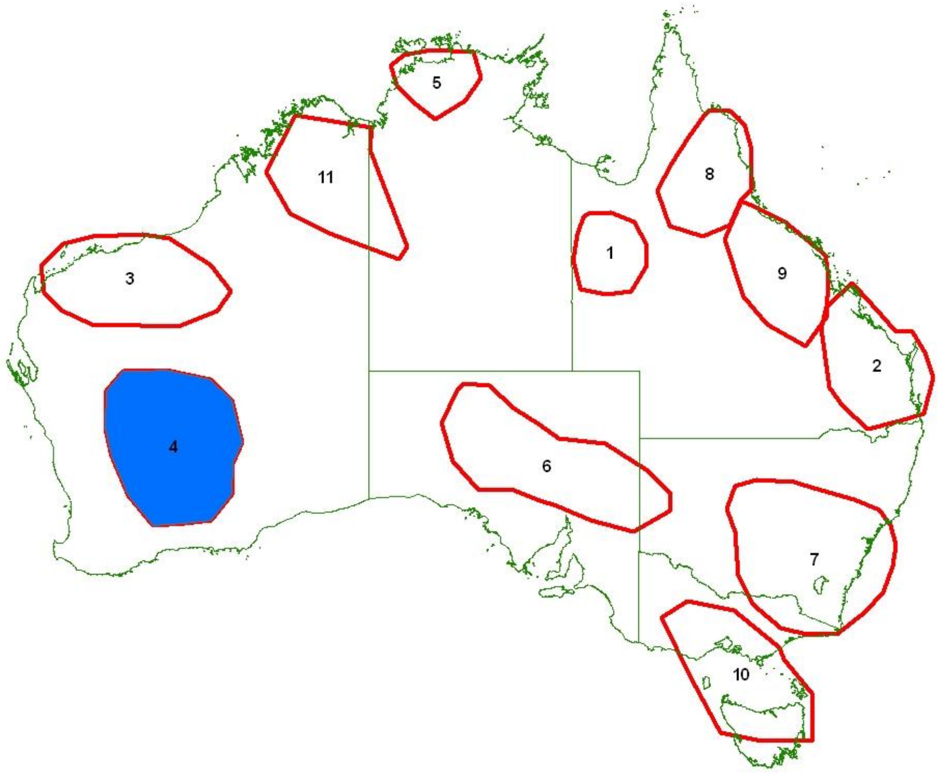

Figure 2. The 11 mining regions of Australia showing Region 4 (Goldfields) highlighted in blue

Current climate

Region 4 experiences 2 main seasons: hot and dry in summer and cool and dry in winter. During the summer, temperatures of 40°C degrees can occur frequently but the average summer temperature is around 33°C. Over the winter, average maximum temperatures are around 16°C and the lowest around 5°C occasionally falling below freezing at night. Rainfall is fairly evenly distributed throughout the year and averages about 260mm per annum, although annual figures can vary considerably. The most reliable rains occur in winter and June is typically the wettest month with approximately 32 mm. Summer rainfall occurs usually during thunderstorms and also, but rarely, through decaying tropical cyclones from the northwest. At such times, annual rainfall can exceed 500 mm. Evapotranspiration[1] is high, particularly in summer from November to April. (Source: Bureau of Meteorology).

[1] A combination of evaporation from soil and transpiration through plant tissue

Future climate

In Region 4 where the climate is generally dry at present, the small changes in average temperature suggested in the scenarios in Table 1 can have a significant effect on evapotranspiration and water availability.

Projected changes in temperature and rainfall REGION 4								
SOURCE:	NCAR Temp °C	NCAR Rain (%)	ECHAM Temp °C	ECHAM Rain (%)	GFDL Temp °C	GFDL Rain (%)	HADGEM Temp °C	HADGEM Rain (%)
November to April 2030	1.09	4	1.09	-1	1.16	-5	0.93	-4
May to October2030	1.14	-6	1.09	-6	1.02	-5	0.76	-5
November to April 2070	2.96	10	2.96	-2	3.13	-14	2.52	-12
May to October 2070	3.07	-16	2.46	-15	2.76	-47	2.07	-13

Table 1. Projected change scenarios for temperature and rainfall in Region 4 according to four of the best performing climate models available [NCAR = National Centre for Atmospheric Research; ECHAM = Max Planck Institute for Meteorology; GFDL = Geophysical Fluid Dynamics Laboratory; HADGEM = Hadley Centre Global Environmental Model]. (Source: CSIRO).

What the climate change scenarios mean to region 4

In the next 20 years, all the models shown in Table 1 project an increase in temperature of approximately 1°C and this will increase evapotranspiration in region 4. Although one model suggests an increase in summer rainfall by 4%, the remaining models show decreases by approximately 5% across both the summer and winter seasons, which are likely to exacerbate the water availability in the region.

The projections for 2070 show temperatures, compared with those of today, may increase by 2 to 3°C throughout the year. One projection (GFDL) shows a dramatic decrease in rainfall of 47% during the winter, which is concerning given that this is when the most reliable rains presently fall in region 4. The majority of scenarios show a decrease in rainfall, which, combined with higher temperatures will intensify evapotranspiration in a region that will have already experienced increased dryness since at least 2030.

Summary

The future climate scenarios presented here generally point towards a hotter, drier climate for region 4, which is already described as hot and dry for most of the year. Where water is already at a premium, increased evapotranspiration and less rainfall will put additional stress on the water resources available, suggesting that both mining companies and the local community will need to adapt their practices to use less water and cope in the hotter extremes. What these information do not show, but which is projected more generally across Australia and hence relevant for region 4, is greater incidence and severity of extreme weather events or storms, including high winds (10 to 15% increase by 2030) and intense rainfall (20 to 30% increase by 2030).

Climate change vulnerability and adaptive capacity assessment

Climatic change may bring opportunities and benefits as well as risks, and both need to be considered. However, most analyses tend to take a vulnerability assessment approach. Climate vulnerability is generally expressed in terms of 'potential impact' (derived from exposure and sensitivity), which, when combined with 'adaptive capacity', leads to an estimation of vulnerability (Fig. 3).

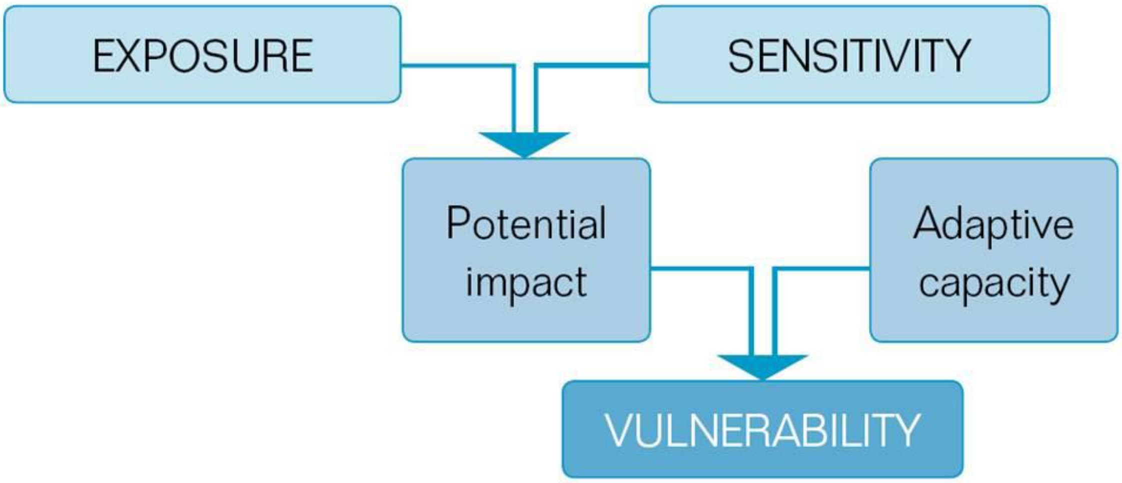

Figure 3. Model for assessing vulnerability (Garnaut 2008 p. 125).

Exposure refers to the types of environmental stimuli or changes that represent a potential threat, such as heat waves, more frequent and/or intense storm events, rainfall decline and so on.

Sensitivity refers to how great the impact will be on a system for a given change, for example a 1°C increase in average temperatures may reduce production efficiency or increase dust output by a certain percentage.

Adaptive capacity refers to the ability of a system to respond constructively to these changes in order to manage their situation so that detrimental affects are minimised, and any opportunities for improvement are exploited. Adaptive capacity tends to be mainly understood in terms of social, economic and technological characteristics, although biophysical characteristics such as alternative natural resources (e.g. water supplies) can also be important. These factors are sometimes referred to in terms of *resource* capacity, as expressed in the 'five capitals' model: the human, social, financial, physical (infrastructure, technology) and natural (biophysical) capital available to be utilised to adapt to change (Nelson et al. 2007; Preston & Stafford Smith 2009). Any final assessment of adaptive capacity requires an assessment of adaptation options and strategies based on these resources.

While assessments of potential impacts and adaptive capacity will produce a (net) calculation of vulnerability, converting this to an assessment of climate *risk* requires consideration of the probability or likelihood of the various components that make up the model (Preston & Stafford Smith 2009).

Mining climate vulnerability

Based on recent analyses conducted within the CSIRO (Moffat 2009; Hodgkinson et al. 2010) on the vulnerability of mining operations generally to climate change, a number of risk areas are prominent: energy, water, infrastructure and equipment, human resources and safety, and community relations. These risk areas were identified through a systematic desk-top assessment across the generic mining process cycle as well as through consultation with CSIRO mining scientists and technical specialists. It is likely that these types of risk areas will be similar in the Goldfields-Esperance region, although with some regional specifics.

Energy

Energy supplies appear an important issue for a number of reasons. Electricity transmission efficiency rates are reduced in hotter weather, and storm events, including those that cause bushfires, may disrupt supply. On the demand side, hotter, drier conditions and increased storm and flooding events, can increase energy demand for cooling and pumping, while necessitating the use of alternative, local generation. Under these scenarios energy costs could reasonably be expected to increase.

Water

Mining operations tend to be water intensive and a warming and drying climate presents considerable challenges, particularly in remote, arid areas like the Goldfields where supply is already constrained. The potential for competition for water between mining and communities was raised as a particular issue in recent CSIRO analyses (Moffat 2009; Hodgkinson et al. 2010).

Infrastructure and equipment

Infrastructure and equipment may be vulnerable in terms of damage and disruption by extreme weather events (storms, flooding) and reduced performance under less extreme conditions (e.g. heat waves). In relation to energy and water supply flash flooding may have the potential to damage critical energy (such as gas) and water supply pipelines. Transport infrastructure (roads, rail) used to import diesel for local power generation, as well as other supplies, services and freighting of ore, may also be vulnerable. Treatment and disposal of toxic waste in tailings dams would also be vulnerable to increased incidence or severity of flash flooding. Infrastructure and equipment tolerances may need to be increased to deal with conditions such as these.

Human resources and safety

Increased incidence and/or severity of extreme weather events, as well as drier and hotter conditions overall, may also have implications for the working conditions and safety of staff. Research with CSIRO mining specialists suggest that human tolerances under projected future hotter conditions may be a greater limiter to future mine design and operations than equipment and machinery limitations (Moffat 2009). It was suggested that employees will be less willing to work in hotter conditions, and that these conditions may also represent an emergent occupational health and safety issue in the future.

Community impacts and relations

Many of the effects noted above have potential knock-on implications for surrounding communities. For example, infrastructure damage and loss due to extreme weather events are likely to impact on local communities that also use these structures. Increased dust due to hotter, drier higher conditions may also be of concern to communities. Increased use of ground-water in mining activities, and the potential escape of material from tailings dams from flooding will also be of concern to local communities. Finally, as water becomes less available under future hotter and drier conditions, there is potential for conflict between mining, community and other sectoral users of this resource (e.g. environment, cultural heritage, agriculture, manufacturing).

Dealing with climate change: a process tool for regional assessment of climate adaptation options

It is apparent from the brief overview above of some possible implications of climate change that a broad range of people, professions, organisations and groups stand to be affected. Furthermore, there are likely to be inter-connected outcomes as the affects on one party (such as the bursting of a tailings dam) potentially have implications for many others. For this reason it would appear important that any approach to climate adaptation, including vulnerability assessment and strategy development, be undertaken at both the individual organisational level and at the broader integrated community and/or regional level.

Work within the CSIRO investigating community climate adaptation planning has suggested that any approach needs to consider a range of dimensions (Fig.4): what is being adapted to (e.g. what are the projected future climate conditions?); how can adaptation take place (e.g. what resources can be mobilised, what strategies and options are available?); what are the objectives of adaptation (is it specific or comprehensive, limited adjustment or transformational?) and who is involved in the adaptation process (e.g. will it be autonomous individuals and organisations or broader collective institutions such as regional planning groups?).

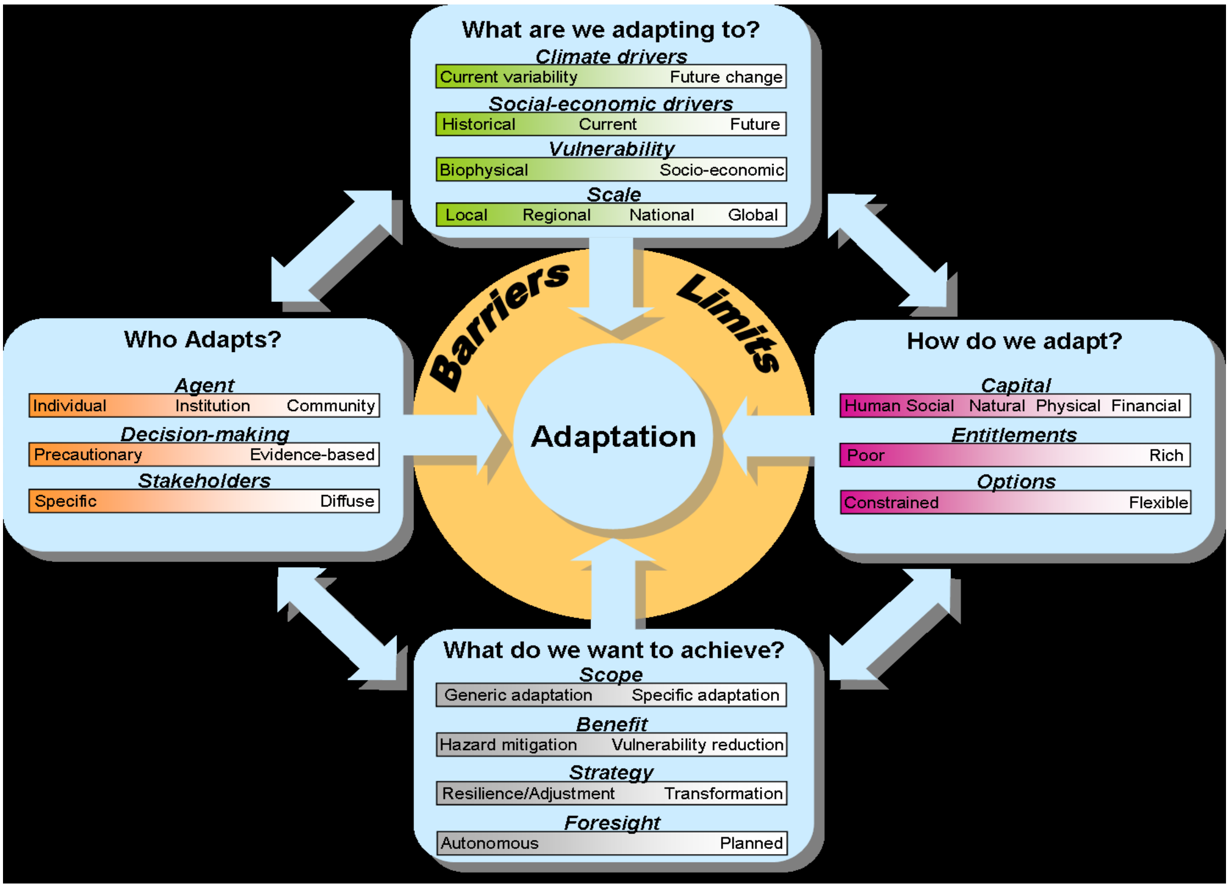

Figure 4. Dimensions of adaptation (Source: Preston and Stafford Smith 2009).

In addition to these considerations, lessons for community assessment from various vulnerability, capacity and adaptation studies (Hay & Mimura 2006; Ziervogel et al. 2006; Fussel 2008) suggest that broader, integrated assessments are required that:

- Consider a range of major related variables or issues that are likely to affect the area's future; for example, demographic shifts, land-use changes, new technologies, industry trends;
- Are integrated into on-going/ pre-existing community development and risk management processes, structures and pathways, and
- Help assess not only community vulnerabilities and capacities, but also include risk planning (risk management/mitigation options).

Stakeholder engagement for climate adaptation

Work within the CSIRO by Gardner et al (2009) has provided a useful framework for engaging a range of industry, government and community interests, or stakeholders, in relation to issues of climate change. This framework incorporates suggestions from a broad range of literature related to community engagement to establish best practice guidelines. The recommendations provided by the Gardner et al (2009:6) report are listed briefly below:

- **Prior to engagement**: set goals and plan; contextualise the issue; define the stakeholders; and, manage expectations.
- **Engagement processes**: use group discussion; use varied presentation formats; allow mutual influence; and, foster trust, respect and ownership.
- **Climate change issues**: address gaps in knowledge; acknowledge uncertainty; address scepticism; and, address emotional reactions.
- **Engagement follow-up and evaluation**: maintain contact and feedback; plan evaluation from the outset; evaluate both process and outcomes; acknowledge other impacts

The report incorporated a range of features specifically relevant to the issue of adaptation to climate change that have implications for engagement. These features included: the highly contextualised nature of climate change; the complexity of climate science and presence of misinformation and scepticism; people's typical reactions to uncertainty; and variations in the capacity for long-term planning. While some aspects of the climate change issue may make engagement more difficult, other aspects, such as its context specific nature and potential for significant impacts were considered likely to increase desire for engagement. However, the report also notes that communities are not homogenous and different individuals and stakeholder groups within them may require different engagement strategies appropriate to their stage along the pathway to taking action.

Conclusion

The Goldfields-Esperance region is currently a prosperous mining community. However, the mining industry upon which it depends faces a range of challenges in the future, including climate change. The climate is expected to become warmer and drier with increased incidence and severity of extreme weather events. These changes are expected to pose a range of challenges to the region in terms of water, energy, infrastructure, human resources and mining-community relations. Dealing with these issues will require careful assessment of vulnerabilities, opportunities and adaptation options by individual organisations. However, the greatest value for the region will be achieved through engagement processes that integrate climate adaption planning across a broad range of regional stakeholders. This workshop is intended as an important step along this journey.

References

Department of Environment and Conservation (DEC) 2010, 'Towards Sustainability in the Goldfields-Esperance Region: Draft Position Paper'. Regional Sustainability Framework – Goldfields-Esperance, Feb 2010.

Department of Local Government and Regional Development (DLGRD) 2010, 'Statistical Snapshot - Regional Economy' Webpage: http://www.dlgrd.wa.gov.au/Publications/Docs/StatSnapshot_regionEconomy.asp

Fussel, H.M. 2008, 'Adaptation to climate change: A new paradigm for action or just old wine in new skins?' Paper presented at *International Workshop: Prospects of Safety and Sustainability Science for Our Globe*, Dec. 4, 2008, Tokyo, Japan.

Gardner, J., Dowd, A-M., Mason C. & Ashworth, P. 2009, 'A framework for stakeholder engagement on climate adaptation' CSIRO CAF Working paper#3.

Garnaut, R. 2008, 'The Garnaut Climate Change review: Final report', Cambridge University Press. Port Melbourne, Victoria.

Giurco, D., Evans, G., Cooper C., Mason, L., Franks, D. 2009, 'Mineral Futures Discussion Paper: Sustainability Issues, Challenges and Opportunities'. Prepared for CSIRO Minerals Down Under Flagship, by the Institute for Sustainable Futures (University of Technology, Sydney) and the Centre for Social Responsibility in Mining, Sustainable Minerals Institute (University of Queensland).

Goldfields Esperance Development Commission (GEDC) 2010, 'Goldfields-Esperance region' Webpage: http://www.gedc.wa.gov.au/region.php

Goldfields Esperance Development Commission (GEDC) and Department of Local Government and Regional Development (DLGRD) 2006, 'Goldfields-Esperance Economic Perspective: An update on the economy of Western Australia's Goldfields-Esperance Region'. DLGRD Regional Economic Perspectives. ISSN 1440-5687. http://rdl.wa.gov.au/Content/Publications/StatInfo/RegionEconomicPerspectives.aspx

Hay, J. and Mimura N. 2006, 'Supporting climate change vulnerability and adaptation assessments in the Asia-Pacific region: An example of sustainability science'. *Sustainability Science* 1:23-25.

Hodgkinson, J.H., Littleboy, A., Howden, M., Moffat, K. and Loechel, B. 2010 'Climate adaptation in the Australian mining and exploration industries: Project introduction and initial findings'. *CSIRO Report P2009/2093*, March 2010.

Moffat, K. 2009, 'Climate adaptation in the Australian mining industry: Summary of workshop outputs'. Internal CSIRO report. CSIRO Minerals Down Under National Research Flagship, Queensland Centre for Advanced Technology, Brisbane 12th November, 2009.

Nelson R., Brown P. R., Darbas T., Kokic P. and Cody K. 2007, 'The potential to map the adaptive capacity of Australian land managers for NRM policy using ABS data'. CSIRO, Australian Bureau of Agricultural and Resource Economics, prepared for the National Land & Water Resources Audit.

Preston B., and Stafford Smith, M. 2009, 'Framing vulnerability and adaptive capacity assessment: discussion paper'. CSIRO Climate Adaptation Flagship: Working paper#2. CSIRO.

Ziervogel, G, Bharwani, S. and Downing, T.E. 2006, 'Adapting to climate variability: pumpkins, people and policy'. *Natural Resource Forum*, 30, 294-305.

Contact Us

Phone: 1300 363 400
+61 3 9545 2176

Email: enquiries@csiro.au

Web: www.csiro.au

Your CSIRO