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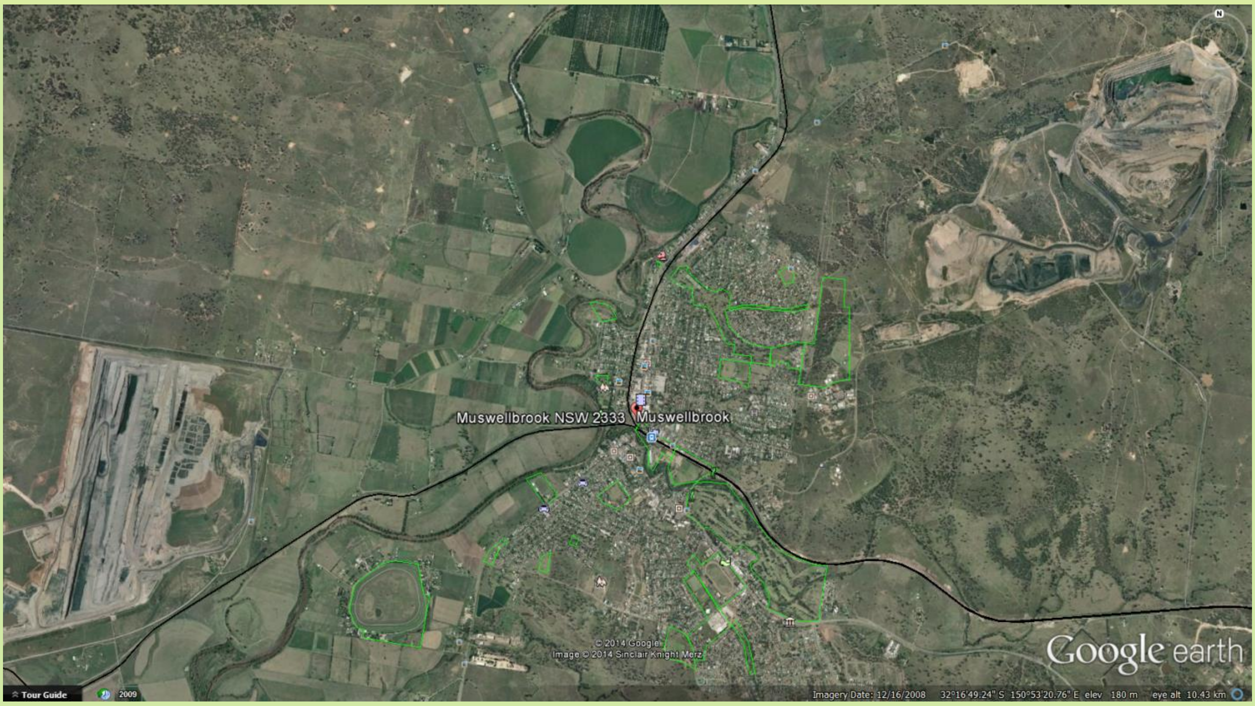

Understanding and managing cumulative impacts of coal mining and other land uses in regions with diversified economies

RESEARCH REPORT – ACARP C22029

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Cover image: Google Earth

Centre for Social Responsibility in Mining

The Centre for Social Responsibility in Mining (CSRM) is a leading research centre, committed to improving the social performance of the resources industry globally. It is part of the Sustainable Minerals Institute (SMI) at the University of Queensland, one of Australia's premier universities. SMI has a track record of working to understand and apply the principles of sustainable development within the global resources industry. CSRM's focus is on the social, economic and political challenges that occur when change is brought about by resource extraction and development.

Director: Professor Saleem Ali

Disclaimer

This Report relates to a project which also produced three detailed regional case studies and an electronic (XMind®) database of relevant legislation and policies in New South Wales and Queensland as at 2014 (see appendices). It outlines overall understandings of policies and institutions in terms of how they might function to manage cumulative impacts of multiple industries. It focuses on the perceptions and practices of those working with regulatory instruments in industry, in mining-affected communities and in government.

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Executive Summary

The coal industry operates in the context of competing land-uses that share many resources with high economic and also environmental, social and cultural value. A range of planning and policy instruments and new institutions have been introduced to manage the cumulative impacts of coal mining, and some of the competition over resources such as land, water, labour and infrastructure.

This project sought to improve understanding and management of the cumulative impacts of coal mining and other land uses in regions with diversified economies including coal mining. It aimed to profile relevant policies and their application in practice, as well as promote adaptive management and systems approaches to assessment and management of cumulative impacts of multiple industries.

Study Methodology

This study adopted a three phase approach:

- Phase 1: Desk top review and mapping of relevant policy contexts of Queensland and New South Wales
- Phase 2: Consultations with industry practitioners, planners, regulators, governments and community stakeholders connected with three case study regions with diversified economies including considerable mining.
- Phase 3: Consolidation of phases one and two and analysis to develop models and guidance to systems approaches to assessing and managing cumulative impacts.

This body of this report concentrates on the analysis from phase three. It also presents brief reviews of phases one and two. The detailed outputs of these phases are appended. The Instruction Manual for phase one's XMind® files is appendix 1 and the phase two Case Study reports form appendices 2, 3 and 4. The appendices are also available separately.

The challenge of assessing cumulative impacts

The impacts of individually minor, but collectively significant activities taking place over time, when considered together, can compound or increase their effect. These cumulative impacts present greater management challenges than individual activity impacts. Distinctive challenges for assessing cumulative impacts include:

- simultaneously focussing on multiple stressors and multiple impact areas
- considering how many effects interact and combine
- standardising and synthesising data
- sourcing reliable data from diverse sources
- encompassing appropriate time dimensions
- accommodating multiple overlapping spatial dimensions
- characterising hard to assess impacts and aspects like vulnerability.

Summary of Findings

Overview of cumulative impacts policy contexts

The project examined recent initiatives in environmental protection, planning and mining laws that seek to incorporate the dimension of cumulative impacts. This showed how regulators seek to deal with the issue of cumulative impacts and the ways they apply to assess and manage the potential consequences, benefits and risks of various combinations of industries.

The cumulative dimension of impacts and the interaction of impacts from multiple mines and multiple industries are relatively recent concerns and so relevant measures are often additions to established processes for tackling single stressors or protecting individual assets.

Disparate bodies of legislation from the two main coal mining states are compiled into electronic databases of XMind® files. These files represent multiple tiers of information about the cumulative impacts policy context in two states:

- Queensland
- New South Wales

The databases include a range of information on more than a dozen specific areas of impact both environmental and also community/ social. They position these in the assessment and approvals process and provide model conditions, relevant legislation, regulations and policy as well as links to additional information.

Case studies

Details of measures deemed effective and relevant to key localities and of the challenges and opportunities in implementing them are best gleaned from practitioners and stakeholders. Hence, we interviewed a number of people from various sectors in three selected mining regions:

1. Upper Hunter Valley (Muswellbrook and Singleton Shires) with multiple coal mines, power stations, vineyards, horse studs and tourism.
2. Moranbah in Isaac Regional Council of the Bowen Basin with two CSG projects, multiple coal mines, two quarries, a chemical plant and grazing.
3. Western Downs Regional Council, in the Surat Basin, with coal mining (Wilkie Creek, Wandoan), Coal Seam Gasfields, a power station, cropping and grazing.

Each case study profiles the multiple industries in the region, the areas of impact deemed most material for that region and the perspectives of various sectors about the effectiveness of applicable measures. The reports also distil general themes and summarise approaches in practices for each region.

General observations and unresolved tensions

There were variations because of the particular contexts such as the difference between associated major industries with rangeland grazing in the Isaac Region, more intensive agricultural activities in the Hunter Valley and the Western Downs and a major CSG industry overshadowing coal mining on the Western Downs. There were also differences in the concentration of coal mines and their proximity to human settlements and centres of other industries. Despite a few resultant variations, the common priority areas that emerged related to:

- environmental impacts on water, air quality and biodiversity
- community/ social impacts on housing, social infrastructure and social fabric and amenity issues
- economic impacts on local and regional businesses and industries and on the local labour market.

From the specifics of each case study region and analysis of relevant policy contexts, some common observations emerged. These related to the fragmented and piecemeal approach to managing cumulative impacts; a focus on actors, activities and specific localised impacts rather than more holistic views; technical challenges to aggregating monitoring and conducting risk assessments for multiple impacts from multiple sources; and promising initiatives that often involved collaborative action. Common challenges about managing multi-industry impacts were also evident including:

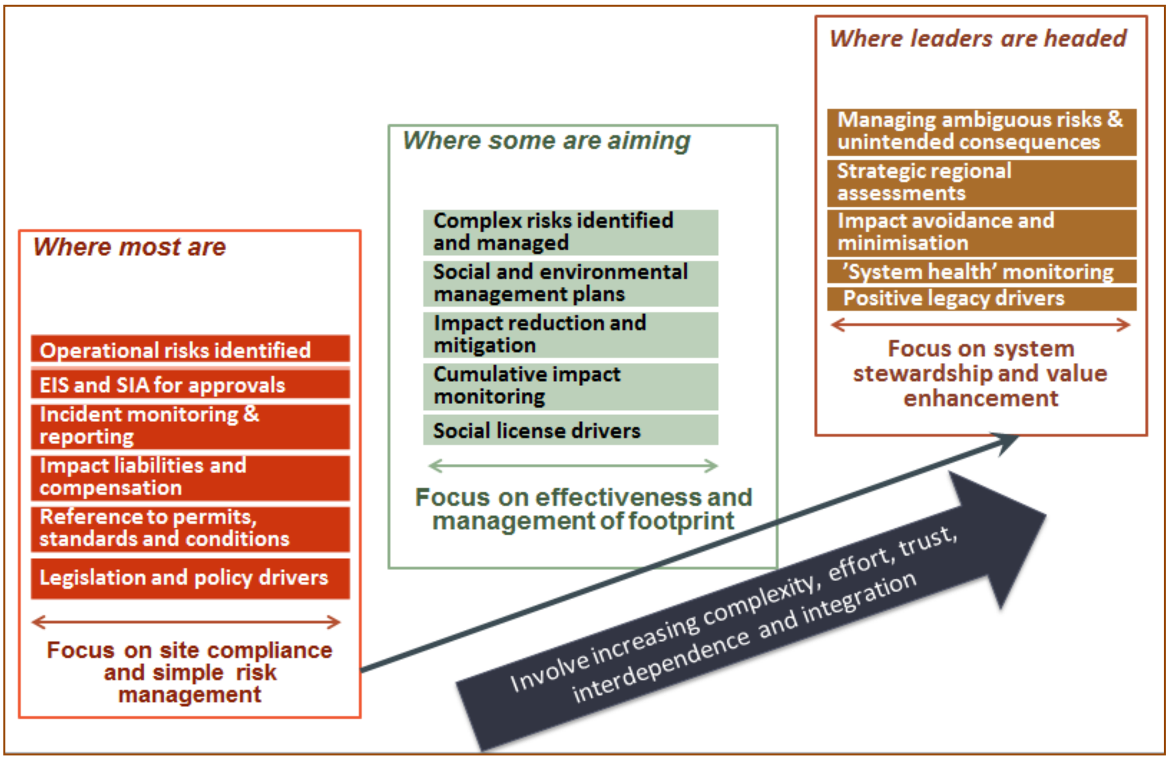
- Consideration of cumulative impacts throughout mine life-cycles.
- Considering aggregation and interaction of multiple activities.
- Cumulative impact management as risk and opportunity management.
- Outcomes-focussed management strategies.
- Responsibility for management of cumulative impacts.

Examples of assessment or management measures that were highlighted by practitioners in the case study regions are used to illustrate the overall analysis in section 5 of this report.

Frameworks for managing cumulative socio-environmental impacts

Adaptive management is a systematic and iterative process to achieve continual improvement and accommodate dynamic, unpredictable contexts. It involves appropriate forms of stakeholder engagement throughout the interlinked processes of planning, implementing, monitoring and revising strategies directed at managing the combined impacts of multiple activities and industries.

The shape that each of these generic processes of adaptive management takes will vary depending on the drivers for action, focus and goals adopted, risk calculations practiced and style of monitoring and assessments as well as standards or criteria applied. Given these various shaping factors, the report suggests three models for planning, implementing, monitoring and revising: (i) efficient, (ii) effective, and (iii) sustainable as illustrated here (and in Figure 5, page 25):



Policies and practice that seek to reduce inefficiencies and simple risks, and encourage site-focussed compliance align with the efficient model. More proactive policies and practices give broader consideration to the whole mine footprint and that of other mines and aim for a social license to operate. These are effective approaches to adaptive management. The sustainable model is characterised by stewardship of social, economic and environmental systems and value enhancement over multiple spatial areas and timescales.

The report provides examples of mining company practices, government policies or other initiatives intended to manage cumulative impacts of multiple industries. It uses these to illustrate the approaches to planning, implementing, monitoring and revising that are characteristic of efficient, effective or sustainable models of cumulative impacts management.

Conclusions and recommendations

The study has concluded that there are emerging examples demonstrating how the principles and practices of effective management of cumulative impacts of mining can be modified, extended or supplemented to provide sustainable, adaptive management of mining-intensive regions where mining encroaches onto productive agricultural land, co-exists with other industries and abuts urban settlements.

1. Build in active engagement of relevant stakeholders and a coordinating role for governments.
2. Wherever possible adopt a proactive planning based approach.
3. Consider the likely cumulative impact of a range of scenarios incorporating past, present and probable future projects recognising uncertainties and specific contexts.
4. Identify and incorporate interactions between the various activities and their impacts
5. Draw upon diverse knowledge and multidisciplinary expertise to build system understanding
6. Standardise and synthesise hard-to-match-data in innovative ways
7. Consider the various dimensions of the impacts from multiple perspectives
8. Collaborate on projects to share information, promote continual collective learning and integrate policies and practices where this will produce synergies (one simple example being maintaining an up-to-date repository of relevant policies).

1. Introduction

1.1 About the research.

The coal industry operates in the context of competing land-uses that share many resources with high economic and also environmental, social and cultural value. These include land, water, transport and communications infrastructure and skilled labour. Despite the mining industry's substantial economic contribution, the interactions associated with the location of coal mines close to human settlements, other industries (notably farming) and natural features is generating community concern. Partly in response to public pressure, in the last fifteen years a range of planning and policy instruments and new institutions have been introduced to manage the cumulative impacts of coal and other mining, and some of the competition over resources. Although the accelerated pace and scale of resource development has temporarily slowed, impacts will not disappear given the cyclical nature of the industry and the cumulative dimensions of impacts. Operators, various levels of government and co-existing industries need greater understanding and new insights to more effectively manage cumulative socio-economic and environmental impacts in such regions.

1.2 Purpose

This project sought to improve understanding and management of the cumulative impacts of coal mining and other land uses in regions with diversified economies including coal mining.

Objectives of the project were to:

i. Understand key recent initiatives intended to manage cumulative impacts of mining and the challenges and opportunities these policy responses present in mixed land-use regions.
ii. Provide assistance to industry and government in implementing new measures intended to ensure consideration and management of cumulative impacts of mining.
iii. Enhance the capacity of the industry to respond to community expectations in regions with competing and mixed land uses.
iv. Profile various institutions and policy instruments for effectively assessing the combined and interacting impacts (positive and negative) of multiple co-existing industries on nearby communities.
v. Promote systems thinking and improve understanding of the cumulative environmental and socio-economic impacts (both positive and negative) of co-existing industries rather than treating coal mining in isolation

1.3 Process undertaken

This research was carried out in three separate, but linked, phases.

Phase one involved a detailed desktop compilation of legal, policy and planning frameworks applying in regions with coal mining and other land uses. The resultant diagrams of regulations and endorsed management processes for identifying and managing specific cumulative impacts whether environmental or community and social, give an overview of key processes, institutions and responsibilities relevant to cumulative impacts in the two major coal mining states – New South Wales and Queensland. Brief results of this phase are reported in Section 3 of this report with the instruction manual forming appendix 1 and the files available on USB from ACARP or CSRM.

Output: XMind® files of New South Wales and Queensland policy contexts and User' Guide

Phase two was a practice-oriented phase involving consultations with industry personnel, planners, regulators, governments and other stakeholders in three regions selected to profile the different jurisdictions and different experiences of cumulative impacts of mining in the context of other industries. The consultations sought information about the challenges and opportunities of working with policies and cumulative impact measures in practice; and of useful tools and approaches to manage impacts. Specific details about the methodology for this phase are provided in each case study report. Brief results of this phase are provided in Section 4 of this report.

Outputs: *Three written reports: Isaac Region (Bowen Basin), Western Downs (Surat Basin) and Upper Hunter Valley Case studies.*

Finally, in **phase three**, the findings were analysed in terms of the theory of cumulative impact assessment and of adaptive management, to derive models and guidelines for using existing measures and others in managing cumulative impacts in a multi-industry context. Section 5 of this report provides an overview and characterisation of approaches being adopted by industry and government as well as details of several illustrative examples of current measures applied.

Output: *Models of adaptive management approaches to cumulative impacts in multi-industry contexts*

2. Challenges of managing cumulative impacts in multi-industry contexts

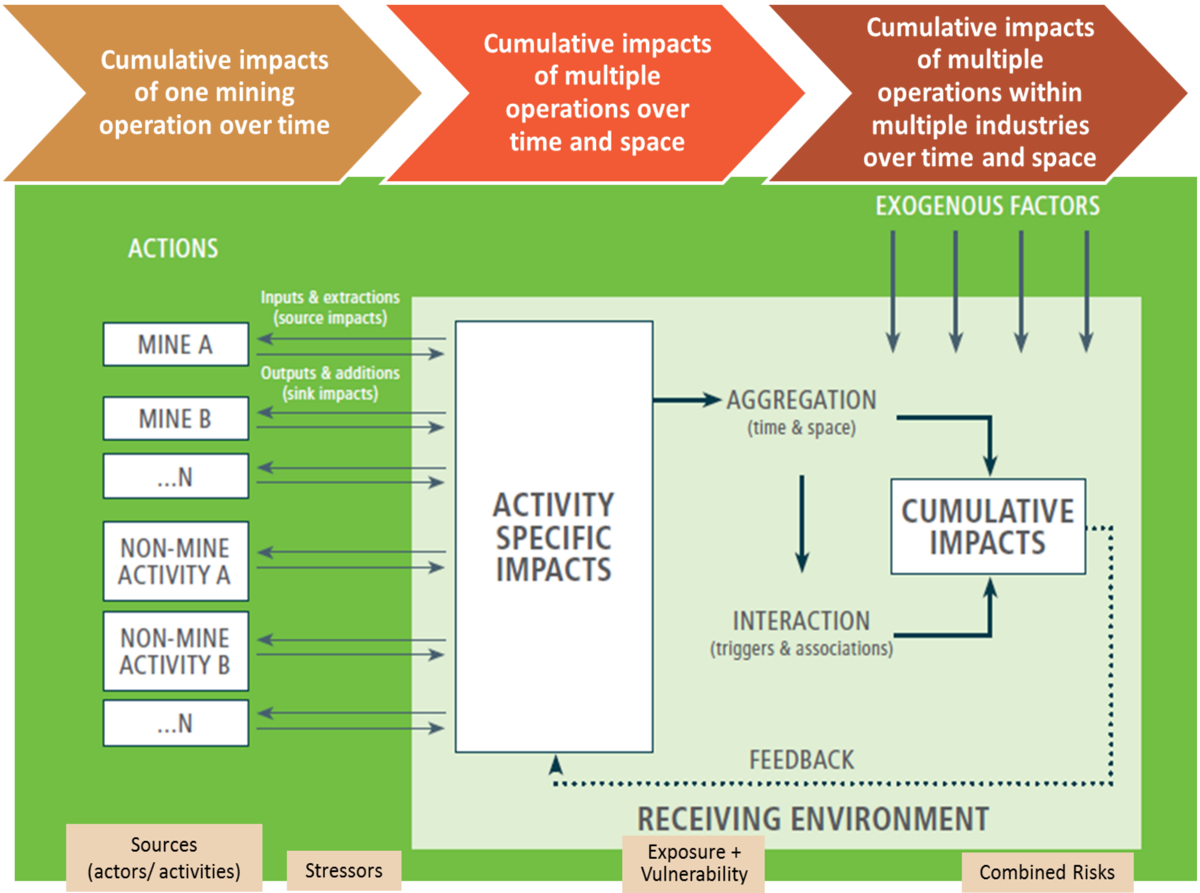
A key contemporary challenge is trying to evaluate the cumulative or combined impacts of concurrent or sequential exposure to stressors whose social, economic or environmental effects on receptors that are valued assets can pose risks to human health or to social and environmental systems.

Cumulative impacts are the successive, incremental and combined impacts of one or more activities on society, the economy and for the environment. They can result from the aggregation and interaction of effects of one activity on a receptor but are generally from multiple actors and multiple (similar or unrelated) activities (past, present and future) interacting with each other under the influence of exogenous factors[1].

Conceptualisations of cumulative impacts have progressed from initial realisation that assessments and management strategies for a project or operation needed to consider the impact of all activities over the long-term and the whole footprint of the mine including effects beyond the lease boundaries. It is now much more common in the mining industry for cumulative impacts to be understood as the combined effects of multiple clustered or overlapping mines over time. Much of that analysis considers other industries as aspects of the receiving environment. Hence the new challenge is to understand the many other activities in a context where all draw upon and contribute to the assets of the community or the ecosystem and so have effects that combine and interact with the effects of the mines – they are not simply receptors of those effects.

[1] This definition of cumulative impacts from Franks, D. M., Brereton, D., & Moran, C. J. (2010). Managing the cumulative impacts of coal mining on regional communities and environments in Australia. *Impact Assessment and Project Appraisal*, 28 (4), 300.

Figure 1: A conceptual framework of cumulative impacts of mining and evolving application contexts[2]



This progression of thinking involves a more holistic examination of cumulative impacts as represented in Figure 1 which also suggests that the difference between the incremental impacts of each separate activity or project and their cumulative impacts can be quite substantial (also illustrated in Table 1).

As for conventional impact assessment, a high priority for cumulative impact analysis is to understand and manage impacts on basic human needs: water, air, food (production), shelter and safety. In multi-industry contexts, this means recognising the combined impacts of sometimes contrasting activities. However, analysing cumulative dimensions of activities also requires methods that can fully consider the characteristics that distinguish cumulative impacts from activity specific impacts, particularly the additive, multiplicative and interactive pathways of accumulation.

[2] Conceptual model based on:
Franks, D. M., Brereton, D., & Moran, C. J. (2010). Managing the cumulative impacts of coal mining on regional communities and environments in Australia. *Impact Assessment and Project Appraisal*, 28 (4), 299-312.
Franks, D. M., Brereton, D., Moran, C. J., Sarker, T., & Cohen, T. (2010). *Cumulative impacts - A good practice guide for the Australian coal mining industry*. Brisbane: Centre for Social Responsibility in Mining & Centre for Water in the Minerals Industry, Sustainable Minerals Institute, The University of Queensland and Australian Coal Association Research Program.

Table 1: Examples of indicators used to assess project impact and cumulative impact[3]

PROJECT ASPECT CHANGED	INDICATOR OF INCREMENTAL IMPACT OF EACH PROJECT	INDICATOR OF CUMULATIVE IMPACT OF MULTIPLE ACTIVITIES
Jobs/ waged employment opportunities	• Additional numbers of employees and unemployed, participation rates of affected population in project employment • Incremental value of wages and other income to population • Average wages of employees	• Changes in number, size, skill levels of regional labour force • Shifts in employment sectors, sustainability of livelihoods, overall diversity and balance of labour market demand • Wage distribution and proportion of population living in poverty
Traffic	• Vehicle movements to and from site/s • Vehicle movements relative to license operating conditions • Traffic load from the project • Characterization of the traffic from the project (e.g., heavy v. light vehicles, washed down or not, time of day)	• Vehicle movements on the regional road network (= the receiving environment) • Concentration relative to regional standards • Total traffic loading (from all sources) • Characterization of the spatial pattern of traffic in the regional road network (types of vehicles, purpose of travel, time of day, specific roads, areas of the concentration, segments used)
Incidence of disease, alcohol and drugs problems, and crime	• Number of additional cases of asthma; alcohol and drug problems; crimes • Incremental changes to demands on health, social, and policing services	• Total number of cases, proportion of population involved and affected • Relationship to other factors (e.g. unemployment, wage rates) • Measures for community and regional health and wellness; safety and security
Land availability (/land alienation)	• Area and/or proportion of land lost, damaged, or inaccessible because of the project • Incremental change in benefits of affected land users (e.g., lost agricultural production, recreational use, environmental services)	• Total land area available for various uses, quality of land, value of land use • Total population losing use of land • Measures for sustainable livelihoods and landholder poverty • Fragmentation of habitats and landscapes

Some key differences between conventional environmental and social impact assessment and assessment of cumulative impacts are[4]:

(i) Conventionally the focus is on one 'stressor' at a time such as dust or saline water or traffic being added to the system, or skilled labour being extracted from it. Multiple stressors or perturbations of disparate kinds need to be considered in cumulative impact assessment and they cannot always be considered in isolation. Rather, the combined effects of more than one emission or extraction must be considered recognising that neighbours experiencing changes in dust, noise, vibration and

[3] Adapted from IFC (International Finance Corporation). (2013). *Good Practice Handbook: Cumulative Impact Assessment and Management.* Washington DC: IFC, World Bank Group. p. 59

[4] This list draws particularly on Callahan, M. A., & Cumulative Risk Technical Panel. (2003). *Framework for cumulative risk assessment.* Washington DC: Risk Assessment Forum, US Environmental Protection Agency.

outlook from a combination of a coal mine, wind power turbines and a cattle feedlot may be more severely impacted than those with only one of these operations and/or only one of the impacts – say noise – to contend with.

(ii) Incremental impacts are tracked in a linear fashion from source to receptor with considerable emphasis on avenues of exposure. Cumulative impact assessment needs to be more integrated and more iterative and it may be less feasible to attribute source/ causality. For example, system stress from increased traffic involves not just the direct addition of coal industry vehicles on the road, but also indirect increase with workers cars commuting to and from shifts, additional service vehicles, flow-on activities. And there are induced effects if the population increases and if parents drive children more often for fear of decreased safety, and if ancillary workers have longer working hours and choose to drive to work (rather than walk in darkness for example). Any traffic problems relate not just to numbers of vehicles but to relative locations, and hence routes most travelled, and to shift lengths and changeover times, and other determinants of periods of intense traffic. Full consideration of the additive and interactive pathways is more important to an appreciation of the impact than knowing the number of vehicles each operation has on the road and assuming that fully accounts for their impact.

(iii) Partly because of their non-linear nature and partly because of the interaction of disparate matters measured in diverse ways, data needs and availability can be quite different. For example, there is evidence that the housing market interacts with the labour market since a shortage of accommodation or high prices (for rent, real estate or mortgages) tends to drive some existing and potential employees out of town – particularly those in low-income occupations. However this is not a simple linear relationship that says shortages of unskilled labour rise relative to higher housing prices. Rather there are feedbacks and interactions with other factors including availability of land for housing, costs of construction and materials, consumer preferences, government or industry provided subsidies and concessions, employer-provided accommodation and workforce strategies, investor incentives, family dislocation and breakdown. The data on many of these factors is not readily available and they cannot all be measured in the same units. Indeed many are not amenable to quantification and are more appropriately considered in semi-quantitative or qualitative ways.

(iv) Because of the ‘system’ understanding of the receptor/ receiving environment that is appropriate, local contextual knowledge about both the stressors and also the susceptible sub-populations is more critical. In this respect, studies that consider the relationship between all variables in a particular case are unlikely to be available in the way they are about single stressors or single receptors. For example, thorough epidemiological studies track the incidence of certain health conditions in a community in relation to many known risk factors. However, they may not relate that information to wind directions, transport routes and location and area of impact of all potential stressors. As well, age, income-level, lifestyle and housing style of segments of the population are additional factors that could mediate the exposure or vulnerability of sub-groups to a stressor. In such cases, not only medical expertise should be tapped, but the knowledge of environmental scientists, and other disciplinary experts as well as input from long term residents, local authorities, Indigenous and historical records and community groups.

(v) Another important consideration in cumulative impacts is the time dimension – how the duration and different intensities of 'exposure' to the multiple changes and their interactions and transformations over time can moderate, mitigate, or exacerbate the total impact on receiving environments or valuable assets within it. In this respect, it is appropriate, for instance to consider how a particular change and its impact will vary across the life cycle of the mine. Negative impacts on biodiversity during construction may relate primarily to destruction of habitat, culturally or environmentally significant sites. During operations, the greatest risks to biodiversity may shift to questions of contamination, pollution and toxic emissions affecting surrounding land, water and air. At closure the issues may relate to acid mine drainage, tailings and waste dump rehabilitation and so on. These last for varying amounts of time and their impact relates to the scale of the activity but also other activities and conditions in the surround – such as the existence of wildlife corridors or the experience of a prolonged drought to name just two examples.

(vi) The spatial dimension is also a central consideration for cumulative impacts, and there has been welcome expansion of understandings of a mine's 'footprint' beyond lease boundaries. Nevertheless, the appropriate zone to consider will not be standard for all interacting elements of a holistic system. The pertinent size of particulate matter to consider varies with distance from source and the most relevant geographical boundaries of the 'impact zone' are not the same for surface water contamination and rental costs for instance. Nor should the boundaries be understood as fixed and impermeable since the interconnections between neighbouring systems can strongly influence the vulnerability of receptors and what their tolerance levels or resilience to disruption might be.

(vii) Assessing synergistic interactions and combined effects, especially when human, psychological and social factors are involved is substantially more complex methodologically than single stressor, source-oriented assessments (and likewise management strategies). One kind of compounding of multiple stressors can result in reaching a tipping point for the receiving environment. Characterisation of some relevant interactions is underdeveloped notably psycho-social stress with specific social or environmental changes.

3. An overview of the cumulative impacts policy context

Regulatory decisions typically focus on a specific project, pollutant or receptor. In contrast, a cumulative impacts assessment considers the multiple activities and factors influencing human, social and environmental well-being. Many departments, agencies and levels of government have roles in permitting, site rehabilitation, environmental monitoring, social service provisions, setting standards, assessing risks and other impact management processes that could be better executed by considering cumulative impacts. Consequently, recent initiatives in environmental protection, planning and mining laws seek to incorporate consideration of cumulative impacts.

This proves a complex challenge and regulators have struggled to deal with the issue of cumulative impacts and ways to assess and manage the potential consequences, benefits and risks of various combinations of industries. They are wrestling with the technical challenge of how coal companies manage inputs and extractions, the matter of collecting data in rigorous ways and of working out sophisticated ways of calculating interactions, feedback, and aggregation of data that may only be available in incompatible formats and with large gaps.

There is clear evidence that public perceptions are also influencing policy development at least as much as hard 'scientific' data is, and that the apparent escalation of risk associated with cumulative impacts necessitates involvement of the public and those with responsibility for the public good. Hence the Fraser Institute Annual Survey of Mining Companies in 2013 quoted an exploration company president as saying,

> *Across Australia, political and regulatory panic is seriously impacting the quality and timeliness of decisions, and certainty about access to land is very concerning. The "Twitter" factor is determining political attitudes and actions, and regulators are reacting to minimize the perceived "risk exposure" of their ministers.*

So the relevant actors in cumulative impacts management are not only companies, and the management strategies required are not unilateral company or industry matters. Appropriate (risk-)management strategies (for both environmental and social risk) must consider the public policy context and public perceptions. Hence this project focussed on the unfolding patchwork of legislation, plans, policies, regulations, new institutions, announcements and proposed legislation. Though the emphasis, of necessity was on measures with some documentation and firm details, it is evident that there are many forms of regulation besides direct prescriptions including:

- indirect regulation, e.g. property rights, liability laws, conduct and compensation agreements
- performance-based regulations, specifying required outcomes but leaving freedom in the means used to achieve those outcomes
- process-based, requiring management plans and policies to be adopted
- co-regulation, where government and industry both have involvement, e.g. through legislative endorsement of an industry code of practice
- information/education, raising public and consumer awareness of issues so they create incentives that business will respond to
- guidelines, explanation/criteria issued by government to provide processes and interpretation to help understanding of government objectives
- market instruments, e.g. economic subsidies, tradeable permits, tax incentives, environmental bonds, license fees

Even though most of this activity occurs at the state level, a further complication is the involvement of other levels of government. In particular the Federal Government and agreements through the Council of Australian Governments (COAG) are relevant.

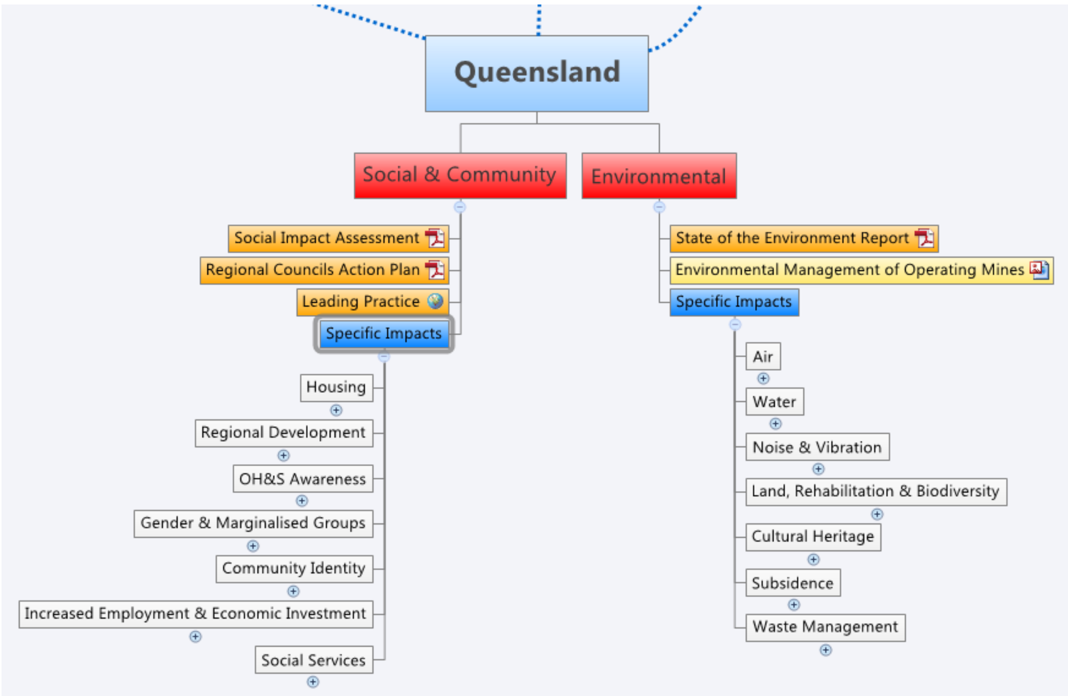
In examining this policy context, we sought to condense a disparate body of material concentrating on the three main areas of administration in each state – Development and Planning, Environment Protection and the Mining, Oil and Gas industry. We organised this into a diagrammatic database for each of Queensland and New South Wales. The diagrams map areas of impact and associated model conditions, and legislative and regulatory measures to deal with cumulative impacts in two main categories: (i) environmental, and (ii) community and social. The diagrams all contain additional information about each measure – whether as links to relevant websites, PDF documents, or notes.

Table 2: Specific environmental impacts and Community and Social impacts covered

Environmental	Community and Social
Air Quality: Dust	Housing
Water Quality: Saline Discharge	Community and Human Skills Development
Water Quantity: Groundwater Drawdown	Transport, Roads and Infrastructure
Noise and Vibration	Occupational Health and Safety
Land Use and Rehabilitation	Gender and Marginalised Groups
Biodiversity	Community Identity and Demographics
Cultural Heritage (Aboriginal and General)	Employment and Investment
Subsidence	Social Services
Waste Management	

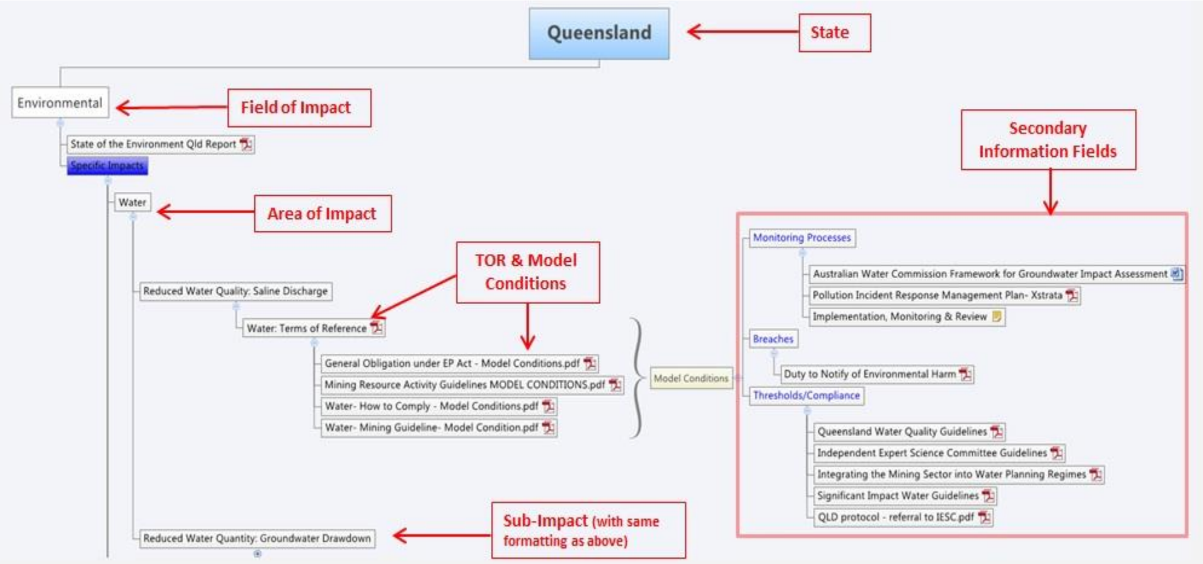
There are separate files for Queensland and New South Wales and the main diagrams of each file detail the cumulative impact measures in the respective states and show the links between measures (e.g. Figure 2). There is a legend on the XMind® map that shows the different tiers of information and helps reflect the importance they play. In each case the main diagram is structured into two main categories ('Environmental' and 'Community and Social') that expand to give details about the specific impacts listed in Table 2.

Figure 2: Impacts in Environmental and Community and Social areas included for Queensland



In the file, each specific area of impact can be expanded to reveal additional information about terms of reference for impact assessments and relevant model conditions as well as a range of secondary information (see Figure 3).

Figure 3: Information on expanded master diagram (Queensland)



A full set of instructions along with the Queensland and New South Wales electronic files are available on USB from CSRM and ACARP though please note that they are too large to email.

The XMind (X) software necessary to read these files is open-source and freely available for download. It is recommended, for the fastest processing speed, to save and run the files on a hard drive not on a USB. However, some companies may have firewalls that preclude downloading software to hard drives. A further caution is that the files are current at 2014 but do not reflect subsequent changes of legislation or policy in this ever-changing field – especially those associated with changes of government that have occurred in the focus states. One simple example of an initiative that industry and state governments could collaborate on would be refining and maintaining an up-to-date repository of relevant policies as demonstrated with the XMind® files in this project.

There are a number of options for keeping this as a live tool. The least efficient method would be for individual companies to establish systems for Environment and Communities staff to update their own files as policies and requirements change. Greater consistency would be achieved by having the task coordinated by an industry body such as ACARP, or the Minerals Council of Australia. Even more desirable would be for the relevant government departments and authorities in each state to collaborate in the exercise. For any of these options it would be possible to enlist the support of a consultant, legal advisors or a university. Some law firms provide briefings on major legislative changes and new policy directions to their clients and it would be a matter of placing these in the context of the consolidated policy context. The CSRM, having produced this 'pilot' version, has a number of insights to pass on for future developments of this nature.

4. Three case studies

4.1 Rationale for case studies

Details of measures deemed effective and relevant to key localities and of the challenges and opportunities in implementing them are best gleaned from practitioners and stakeholders. Hence, we undertook consultations in selected mining regions. We chose three coal-mining regions to cover the two main coal jurisdictions – Queensland and New South Wales – and to investigate if the main impacts (and associated approaches to managing cumulative impacts) were different with different stages of the mining life-cycle and different combinations of other industries. Two of the regions have decades of mining history and quite concentrated activity though contrasting neighbouring industries especially in terms of types of agricultural activities. A third region, also in Queensland, has a predominantly agricultural history with large-scale coal mining in its infancy and mining dwarfed by another resource extraction industry – coal seam gas. The characteristics of the three regions are summed up in Table 3.

Data from the case study region was collected through both open-ended, qualitative feedback and completion of a standard survey investigating people's familiarity with and assessment of the various measures applying in their jurisdiction. Full details of the methods and findings of the case studies are available in the individual regional reports that supplement this Project Report as Appendices 2,3,and 4.

Table 3: Case study characteristics

Jurisdiction	Experiencing Cumulative Impacts for some time	More recent Cumulative Impact concerns
New South Wales	1. Hunter Valley (Muswellbrook and Singleton Shires) *with multiple coal mines, power stations, vineyards, horse studs and tourism*	
Queensland	2. Bowen Basin (Moranbah, Isaac Regional Council) *with two CSG projects, multiple coal mines, two quarries, a chemical plant and grazing*	3. Surat Basin (Dalby, Western Downs Regional Council) *with coal mining (Wilkie Creek, Wandoan), CSG, power station, cropping and grazing*

4.2 General observations and unresolved tensions

Besides the specifics of each case study region, some generalisations can be made about preferred strategies and we identified some unresolved tensions associated with cumulative impacts management in multi-industry regions. These are embodied in the direction of recent legislation as well as in the ways industry practitioners are responding to those and are managing impacts. They also underlie some of the contentious relations between industries and between governments, companies and communities as well as the lack of consensus about management of cumulative impacts.

4.2.1 Consideration of cumulative impacts throughout mine life-cycles

Inevitably impact assessment begins in approvals stages for new and expansion projects with Environmental Impact Assessments (EIA) and Social Impact Assessment (SIA). These are sometimes collectively referred to as Environmental and Social Impact Assessment (ESIA), reflecting the fact that they are usually prepared as one document with the social dimensions historically receiving considerably less attention than the environmental. After approvals, it is not on-going assessments but rather the license conditions and associated Environmental Management Plans (EMP) that tend to guide impact management. For a brief period, Queensland also required Social Impact Management Plans (SIMP) and, although no longer compulsory, these have now been adopted as routine practice by some companies and are not inconsistent with the subsequent process outlined in the Queensland Government's *A new approach to managing the impacts of major projects in resource communities July 2013* and accompanying *Social Impact Assessment Guideline 2013*.

The powerful driver which license conditions evidently provide is a strong endorsement of the value of robust regulation and sound understanding of cumulative impacts in the state administration. Given this situation the inclusion of a cumulative impacts assessment in the model terms of reference for ESIA offers an opportunity to consider the cumulative dimensions of matters covered at an appropriately early stage. Strengthening the assessment of cumulative dimensions of impacts and the planning of appropriate management strategies at this stage can offer value over the project life.

4.2.2 Considering aggregation and interaction of multiple activities

As outlined in section 2, considering simple causal pathways of impacts of individual projects overlooks relevant interactions and feedbacks. However there are technical and practical challenges which limit practitioner's ability to factor these in. Some issues related to accessibility of information in standard forms are being overcome in some cases when trust between industry competitors and sectors grows. This is evident in some monitoring schemes using a network of strategically located monitors to measure the same variables and report in consistent formats. For example, the Hunter Valley Air Quality Monitoring Network involves more than a dozen monitors feeding into a common database with publicly accessible reports. Likewise the water quality monitoring by the Fitzroy Partnership for River Health processes data collated from a number of monitors – in this case shared from existing independent monitoring programs of partners. By collaborating, the 10 coal companies, two CSG companies and regional councils involved collected data based on over 770,000 sample results collected from 225 locations across the entire Fitzroy Basin.

There are also examples of tools and techniques emerging to satisfy the technical demands. For example, biodiversity management has been subject to considerable attention by the New South Wales Department of Environment which had developed and trialled an offsets credit calculator and biodiversity assessment methodology and certification assessment methods (see Box 2). The SIMP previously required in Queensland operated on the basis of negotiation between companies, department and consultants and provided an opportunity to consider new approaches to assessing and managing some more challenging cumulative social impacts such as housing affordability. Maintaining an adequate supply of dwellings for non-resource low to moderate income households in resource towns, particularly in the face of the cumulative impacts of a large mine construction workforce, is a challenge. In one case, it was estimated that one affordable dwelling was needed for every 90 construction workers and one for every 50 operational workers to mitigate the project's indirect impacts on housing demand[5]. Although the company planned to house all associated workers in accommodation villages, they were conditioned and also voluntarily assumed a series of other commitments to address impacts from its projects on the housing market and especially affordable housing supply. They included investing in an Affordable Housing Trust established by the council; offering rental subsidies to assist in housing employees of community organisations; relinquishment of company leases over a number of state dwellings to enable their uses by non-resource industry workers; delivering new housing stock and upgrading numerous company houses in the town.

4.2.3 Cumulative impact management as risk and opportunity management

A number of projects apply a risk-management approach to managing environment impacts and there was also application of social risk analysis by some proponents. Risk management involves two main dimensions of the appraisal of the risk on the one hand and, on the other hand, the implementation of actions and measures to remedy, transfer, reduce or avoid the risks. Hence dust may be seen as a risk to the health and well-being of both the workforce and neighbours (especially downwind neighbours). Actions can include suppression measures and adjusting the timing and/or location of activities.

For example, in 2011, the New South Wales Department of Primary Industries issued guidance on conducting a Land Use Conflict Risk Assessment[6]. The conflict situations envisaged were between agricultural enterprises and any other primary industry including mining, as well as between agricultural and residential uses. This assessment uses the typical two-dimensional assessment process of considering both the probability of an occurrence and the consequences of the impact. It therefore relies on reduction of either the likelihood of the event occurring or the magnitude of negative impacts. Such assessments are used as a basis to prioritise high risk impacts for action.

As an extension to standard risk analysis, there are suggestions that appraisals of social and environmental risks should consider added factors including vulnerability or sensitivity of the receptor or receiving environment and exposure assessments (which focus on duration, intensity and pathways of impact) as well as incorporating estimates of public concern and of multiplicative effects and interactions. The degree of uncertainty about the risks and all these calculation is another confounding factor. While many complex risks can be well managed by technological innovations based on comprehensive and rigorous science, it may be more appropriate to increase a system's coping capacity or resilience to manage uncertain risks and there are questions about when the precautionary principle should be invoked.

4.2.4 Outcomes-focussed management strategies

The focus when addressing cumulative impacts differs in the case of environmental impacts from social ones and is always somewhat multi-dimensional. Control efforts are directed in various ways and different performance measures are adopted. These variations relate to the focus including:

- **Actors**: Consideration of the individual companies or even the specific teams (whether exploration, environment, communities, or production crews) associated

[5] BMA's Caval Ridge Mine and Daunia Mine near Moranbah. See BHP Billiton Mitsubishi Alliance (2012) Bowen Basin Coal Growth (BBCG) Project Housing Impacts Plan.
[6] Resource Planning and Development Unit (October 2011) http://www.dpi.nsw.gov.au/factsheets Primefact 1134 first edition.

with the impacts as the relevant actors results in different approaches to considering whole industries or even all human activity as the relevant and responsible actors.

- **Activities**: A focus on individual activities such as blasting in open cut mines; discharging pitwater to streams; hiring long-distance commuting workers or sourcing inputs from local suppliers can include variable levels of detail of the nature of the related inputs or extractions (stressors) whether specific categories of labour, particulate matter or saline or acidic water.
- **Impacts**: When the incidence of specific diseases, change in frequency or severity of traffic accidents, changes to the accommodation supply or extent of species loss for example are priority considerations, a limited consideration of direct impacts of individual activities results in a different picture to considering the net effects as these combine, multiply and interact – especially if variable exposure is taken into account.
- **Receiving entity** (or receptor): The component of the social or natural environment experiencing the impact can be considered in a fragmented way or with more of a systems view as the catchment, airshed, local population or labour market as a whole[7].

While all of these were evident in the policies and practices we observed, we detected greater familiarity with focussing on actors, activities and their specific impacts although some expressed an aspiration to shift the focus of analysis to net impacts and receiving environments in other words from the left hand side of Figure 1 to the right hand side. This is appropriate to recognising the cumulative dimensions of impacts, but raises practical challenges and more complex considerations. For instance it draws attention to the particular importance of being able to assess and manage cumulative impacts in cases where the receiving environment has reached limits of its absorptive capacity (or resilience thresholds), as may be the case in regions of intense development. This requires greater understanding of thresholds and tolerance within social and ecological systems. As well, there is added importance in cases where the receiving entities are particularly valued or particularly vulnerable such as very young or very old people, and endangered species of plants or animals.

It is evident that such a shift to an outcomes focus has consequences for the priorities, estimations and relevant controls with respect to cumulative impacts management. For instance, anticipating and managing net impacts on key components of the receiving environment (or receptors) rather than managing site level stressors (extractions and emissions), alters the meaningful time and space scales.

There are examples of opportunities for this sort of approach to be applied or elements of it in practice – particularly in environmental fields. One is the Fitzroy Partnership for River Health where the focus is on the net effects on the condition of the catchment as a whole and monitoring and management strategies are voluntarily coordinated. This could support flexible discharge arrangements to manage salinity arising from flood events affecting coal mines in the Fitzroy River catchment. It would rely on consideration of overall water flows and quality of water rather than applying rigid conditions with occasional site-by-site transitional environmental programs (TEPs) allowing mine managers to operate outside of their agreed environmental.

[7] Franks, D. M., Brereton, D., & Moran, C. J. (2013). The cumulative dimensions of impact in resource regions. *Resources Policy*, 38(4), 640-647. See also MacDonell, M. M., et al. (2013). Cumulative Risk Assessment Toolbox: Methods and Approaches for the Practitioner. *Journal of Toxicology*, 36: (Article ID 310904).

4.2.5 Responsibility for management

On the whole, both mining companies and state governments accept that companies are responsible for managing direct impacts of their projects including any direct contribution to cumulative impacts. However it is not straightforward to define responsibility for cumulative effects in intensive mining contexts. One challenge has been with the additive dimensions of cumulative impact which can leave responsibility for management sitting only with new entrants. There are further challenges in calculating cause-effect links and dealing with the residual impacts inherent to cumulative impact situations. Direct linear cause-effect relationships are only one impact pathway. Relative contributions to the net result of counteracting, reinforcing and interacting effects are difficult to trace. Consequently comprehensive mitigation is unlikely and the potential impact after implementation of proposed management and mitigation strategies is difficult to predict.

Current assessment and management policies and practices concentrate on the direct impacts. For example, in Queensland, the Government has undertaken to provide all proponents with the necessary information and data for the social baseline assessment from state agencies and declared it will not seek company funding to deliver core state government services beyond the impacts that are directly related to their project/s. The *Social Impact Assessment Guideline* in Queensland requires proponents to identify and assess social impacts that are directly related to their project and propose measures to enhance potential positive impacts and strategies to avoid, manage, mitigate or offset the predicted negative project impacts[8].

When responsibility for managing impacts is linked to direct causal responsibility there may be situations where no actor is deemed responsible or where many are – in indeterminate proportions. For these, and for 'residual impacts' after all have implemented their mitigation measures, it may be impractical for a single operator to manage or offset cumulative impacts. Rather, regional remedies may be more feasible as part of a collaborative effort often involving government. For example, the Moranbah Cumulative Impacts Group is a collaborative approach to dust monitoring in a Queensland mining town which is surrounded by multiple coal mines operated by various companies. Some are underground and others open-cut operations and they are at various stages of the mine life-cycle. The main mine operators have joined forces with state agencies, local council and community representatives to coordinate monitoring and reporting of dust impacts and share information about dust management. There are moves to include other industries such as quarries and grazing interests. The time and financial investment to support this initiative is not levied in proportion to contributions to dust emissions, but takes a 'public responsibility' approach of equal contributions by companies and council as corporate citizens investing equally for the public good.

The Hunter River Salinity Trading Scheme is another coordinated scheme which incorporates a solution to the 'new entrant' problem (see Box 4). In this market-based scheme, 200 of the 1000 salt discharge credits expire every two years and are auctioned to new or continuing license holders.

[8] Queensland DSDIP (2013) *Social impact assessment guidance.* http://www.dip.qld.gov.au/resources/guideline/social-impact-assessment-guideline.pdf

5. Frameworks for managing cumulative socio-environmental impacts

Companies, regulators and most stakeholders recognise that the impacts of coal mining – including their cumulative dimensions – are both positive and negative. Understandably though, greater efforts are directed to the assessment and management of potentially negative impacts. A further general understanding is that the severity and duration of impacts will depend on multiple factors including the scale of the projects and the extent of spatial and temporal overlap between multiple projects. In the absence of standard methods for assessing and managing cumulative impacts – especially cumulative social impacts – methods are often adapted from the environmental domain and from project-specific impact assessments.

The emerging strategies and remaining challenges identified in our review of legislation and consultations with practitioners suggest different approaches to measuring and monitoring cumulative impacts. In particular, existing policy, institutional and practice frameworks increasingly refer to adaptive management. Industry expressed a strong preference for less prescriptive conditions and more adaptive management based on good monitoring. This was seen to be the direction espoused by governments as well – more so in Queensland than New South Wales. Many community stakeholders interviewed were more cautious about this proposition fearing it may be reactive and unsystematic. While adaptive management does imply flexibility about the methods adopted, it is much more than simply changing what you are doing when things go wrong. Elaboration of what is involved and how it might shape management of cumulative impacts could broaden acceptance and improve application.

5.1 Adaptive management

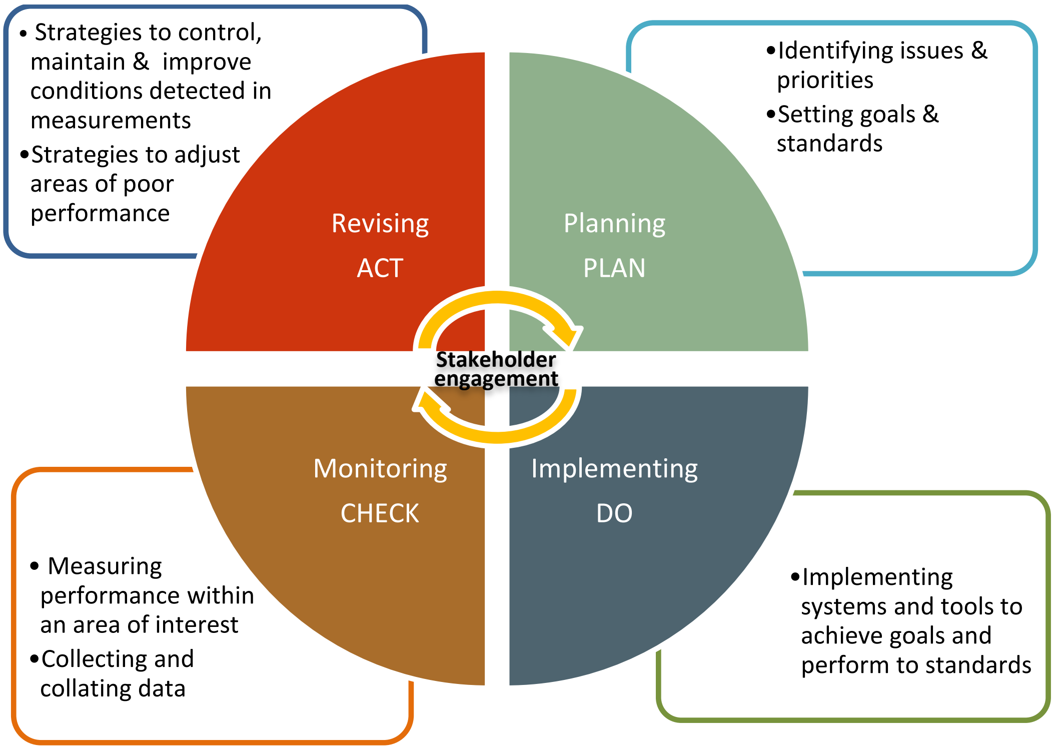
Adaptive management is a systematic and iterative process to achieve continual improvement and accommodate dynamic, unpredictable contexts. It involves exploring alternative ways to achieve desired objectives; predicting the outcomes of alternatives based on best available current knowledge of various kinds, and clear understandings of risks involved and how much can be tolerated, as guided by a strong values base; and it requires transparent reporting. The adaptive management cycle is commonly understood as a four-phase cycle of Plan, Do, Check, Act as represented in Figure 4. It is complemented by another framework familiar to the mining industry involving monitoring, evaluation, review and improvement (MERI).

Stakeholder engagement is central to all phases because an adaptive management approach explicitly identifies the full range of perspectives in terms of the alternatives available and the risks and trade-offs associated with each. Stakeholder engagement is discussed further in section 5.7.1.

Planning that is thorough, thoughtful, and suitably consultative can be a time-consuming process involving identifying the important issues and priorities, determining the spatial and temporal boundaries (and hence the system or receiving environment) and identifying assets or resources with environmental, social, cultural and economic value (in consultation with affected communities and stakeholders). This will direct attention to the present condition of each. It will also highlight impacts of concern and relative magnitude of risk to the resources considering all past present and predicted developments, and external, natural and social stressors as well as associated contributory actions and actors affecting the valued resources. There may be evident cause-effect links, but it will also be necessary to try to assess how the effects of various stressors are aggregating and interacting as part of developing alternatives/ options for achieving agreed goals and standards for the system condition.

Implementing adequate strategies, systems, tools and procedures to manage cumulative impacts, achieve goals and perform to standards is necessary throughout the life-of-mine. Such strategies apply the mitigation hierarchy: anticipate and avoid, or, if not possible, minimise impacts and risks. Options for minimising include reducing, rectifying, repairing, and restoring. Where residual impacts remain, compensate or offset for them[9].

Figure 4: The Adaptive Management Cycle



Monitoring and learning from experience are inherent to an adaptive management approach. This in turn needs effective oversight/ supervision mechanisms. Rigorous monitoring involves measuring performance about priority impacts with appropriate monitoring indicators. It is reliant on collecting and collating accessible, trusted and relevant information and is complemented by regular, open communication and transparent reporting.

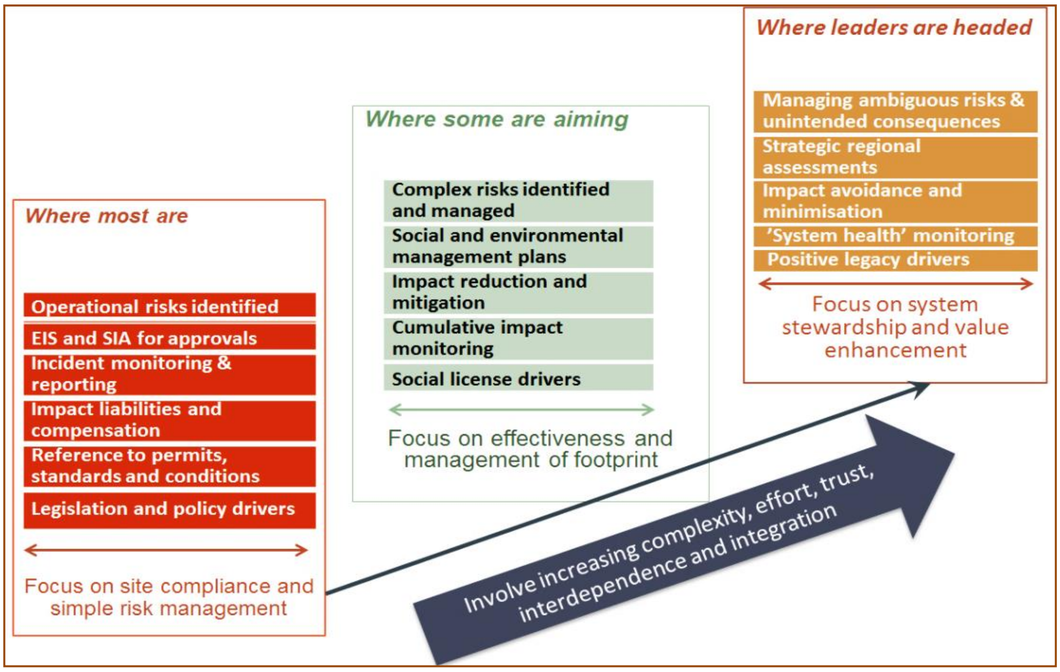
Revising strategies in response to the evidence collected through rigorous monitoring is also part of the continuous improvement that adaptive management entails. In this phase, modifications to practices to control, maintain and improve conditions detected in measurements and to adjust areas of poor performance are introduced.

[9] IFC (2013) Good Practice Handbook. Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets. www.ifc.org/sustainability

5.2 Models of assessing and managing impacts

Examining the data we gathered in terms of the adaptive management cycle shows different approaches to common impact assessment, systems, monitoring and management activities – from conducting an ESIA to arrangement of air and water quality monitors – that are embodied in both policies and practice. Furthermore these suggest that impact assessment and management are similar to other areas of industry practice in that there has been a gradual evolution in the nature and style of such activities. In terms of occupational health and safety and risk assessment, this has been regarded as a "maturity journey"[10] and in mining industry practice more generally a similar "sustainability journey"[11] is espoused. Three models are evident from our study and characteristics of these three models are represented in Figure 5.

Figure 5: Models of Impacts Management [12]



The three models are outlined below and are not mutually exclusive.

Efficient: There is a general acceptance of the need for efficient identification and management of cumulative impacts. Hence most companies are operating efficiently and many policy reforms seek to reduce inefficiencies and encourage compliance to standards. This model is characterised by reactive management of individual activities and impacts.

Effective: There are cases of more proactive policies, practices and approaches that are focussed on effectively assessing and managing cumulative impacts. Such approaches not only manage efficiently but in addition seek to protect a social license to operate and involve more integrated activities that tailor standards, measurements and controls to a broader context usually giving some consideration to other nearby mines.

[10] Foster, P., & Hoult, S. (2013). The Safety Journey: Using a Safety Maturity Model for Safety Planning and Assurance in the UK Coal Mining Industry. *Minerals*, 3(1), 59-72.
[11] Sustainable Minerals Institute http://www.smi.uq.edu.au/Capabilities/SustainableIntegration.aspx
[12] Adapted from: PWC: http://www.slideshare.net/PWC/integrating-environmental-social-and-governance-esg-issues-in-deals-and-valuing-their-impact

Sustainable: Leading practice extends the management goals further and is headed to sustainable and resilient operations that optimise economic, community and environmental outcomes now and into the future by embedding continuous improvement. This model is characterised by considerations of system stewardship and value enhancement over multiple scales, spatial areas and timescales.

Some measures are fundamental to management of impacts (cumulative and otherwise) in every operation. For instance, mines in Australia have an Environmental Impact Statement (EIS) and an EMP. However, as illustrated in section 5.3, the style of these plans may differ depending on where the focus and management goals are directed and which model is applied.

Similarly the central activities at all stages of the mine life cycle will be approached somewhat differently by the various models. For example in the closure stage, rehabilitation and re-vegetation can be treated as risk-containment measures, or a restoration project or a value-adding opportunity.

In the sections below a brief example of a current measure is provided in a box before the characteristics of the different approaches to that phase for each model are described. Comparing three different models and the approaches to each of the phases of the adaptive management cycle that they might apply shows how consideration of cumulative impacts can be incorporated into each phase (planning, acting, monitoring and revising). It also demonstrates the specific conditions under which different approaches may be more appropriate.

5.3 Planning

Companies' approaches to planning vary and the issues, goals and risks they address or express in plans such as their EMPs or SIMPs will differ accordingly. EMPs have explicit objectives. Some, for instance, adopt license conditions and regulator standards as their reference points and focus on stand-alone actions, monitoring and reporting by the mine. Those conditions and standards may relate to concentrations of a pollutant in the operation's emissions and/or discharges at source/site boundaries. Alternatively, the EMP may exceed conditions and standards that take a narrow perspective and voluntarily relate to overall concentrations of the pollutants in the receiving environment relative to ambient standards.

The different goals adopted in an EMP or a government's offset policy can make a significant difference to management strategies and to outcomes. These could, for example be: (i) no net loss of a species or (ii) no change to the current trajectory of the species' condition (which may, for example, be increasing, stable or declining numbers), or (iii) enhancement of the species condition or numbers.

An example of an approach to planning with respect to traffic impacts based on a SIMP of a company in Queensland – edited and de-identified – is provided in Box 1.

Box 1: Planning to manage cumulative impacts on traffic

The potential cumulative impacts of project X and other proposed projects when added to the existing traffic and after taking into account proposed management and mitigation strategies was assessed using the table below. It identifies that traffic associated with the project may impact three main traffic and road transport values.

Traffic/ Transport Value	Efficiency	Safety	Amenity
Potential Impact	Reduced efficiency from increased traffic volumes and reduced pavement condition and intersection control	Reduced safety related to bridges, cattle grids, rail crossings, school bus routes, driver fatigue and composition of traffic	Reduced amenity related to stock route co-location, sensitivity of adjacent land uses, dust nuisance and light glare
Relevance factor			
• Probability	L/M/H	L/M/H	L/M/H
• Duration	L/M/H	L/M/H	L/M/H
• Magnitude/ intensity	L/M/H	L/M/H	L/M/H
• Sensitivity of receptor	L/M/H	L/M/H	L/M/H
Significance by road type			
• Highway	L/M/H	L/M/H	L/M/H
• Regional connecting road	L/M/H	L/M/H	L/M/H
• Rural connecting road	L/M/H	L/M/H	L/M/H
• Rural access road	L/M/H	L/M/H	L/M/H
Overall significance		**Medium**	

The planned strategies to manage impacts on traffic and transport include:

- agreements with infrastructure providers about company obligations re road works
- a Regional Rules code of conduct for the workforce and contractors
- collaboration with the Queensland Coal Infrastructure Strategic Plan e.g. providing workforce numbers and routine traffic movements to government agencies to aid planning
- participate in Road Action Group and lobby QPS to increase highway traffic patrols

The assessment of the relevance and significance points to a moderate impact warranting application of further specific management practices and monitoring.

The general characteristics of each approach to planning are outlined below.

5.3.1 The Efficient Model

As a minimum, companies aim to operate as efficiently as possible in ***compliance*** with permits, conditions and standards of the regulator and specifically their license limits. Their plans will deal with identified operational risks and ways to minimise reasonably avoidable adverse impacts. They will therefore follow detailed ***site plans*** focused on specific separate impacts associated with mining activities – especially those identified in their EIS, SIA or license conditions.

An example of regulations aligned with this model is a system of development applications revolving around project site plans and fixed zoning categories.

5.3.2 The Effective Model

Some companies seek to plan for the whole life-of-mine on the basis of goals related to the industry as a whole and its future. The standards they adopt will be ***defined*** in relation to the context as well as multiple dimensions of each stressor. Hence, dust criteria, for instance, will relate to size and also chemical and physical properties. This model of planning also proactively addresses complex risks and satisfies diverse stakeholders beyond the regulator. Such plans will therefore be based on substantial ***predictions and forecasting*** as well as best available technical expertise from a range of disciplines.

An example of government planning aligned with this model is Queensland's *CoalPlan 2030*[13], which details infrastructure requirements to support potential growth in the state's coal industry and proposes coordinated approaches to fulfilling rail, port and water infrastructure needs based on commercial arrangements between "coal chain stakeholders".

5.3.3 The Sustainable Model

A sustainable approach to planning typically involves multidisciplinary company teams addressing priorities that are consistent with broader visions. Multiple criteria are used to assess ***alternatives*** and plan the ***optimal*** management of uncertain and ambiguous risks. This style of planning explores diverse aspects of alternatives for achieving priorities at levels from general to detailed drawing on varied information and expertise. Resultant plans express how the specific industry or operation/s contribute to long-term development for all stakeholders.

Both state governments have some aspirations for multi-year integrated regional planning covering economic development, natural resource management, land use, infrastructure and other aspects. In this vein, the Upper Hunter Strategic Regional Land Use Plan (SRLUP)[14], prepared as part of the New South Wales Government's Strategic Regional Land Use Policy, is an example of analysis of the region in terms of a range of matters to balance agriculture – especially critical industry clusters – and resource development.

[13] Queensland Department of Infrastructure and Planning (2010) *CoalPlan 2030: Laying the Foundations for the Future*. http://www.dlg.qld.gov.au/resources/plan/cg/coal-plan-2030.pdf

[14] NSW Department of Infrastructure and Planning (2012) *Upper Hunter Strategic Regional Land Use Plan*. http://www.nsw.gov.au/sites/default/files/initiatives/upperhunterslup_sd_v01.pdf

5.4 Implementing

Each of the three models approaches implementation differently using different systems and tools. There is considerable diversity of the kinds of knowledge that inform these systems and tools and those regarded as relevant, reliable and rigorous are different for the various approaches. The approaches also differ in terms of the standards applied and the risk mitigation goal they pursue: improving, maintaining, avoiding, mitigating or offsetting.

An example of implementation of biodiversity management is provided in Box 2[15].

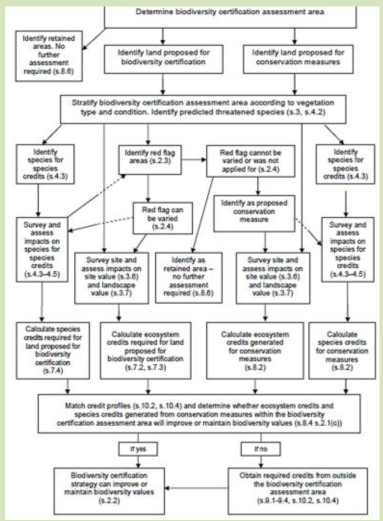
Box 2: Implementing systems and tools to protect biodiversity

Biodiversity conservation is enshrined in both state and federal legislation, and management of cumulative impacts on biodiversity has also received much scientific attention. In New South Wals for instance there has been a multi-pronged strategy involving:

- Preparation of a Biodiversity Plan for Coal Mining in the Upper Hunter Valley and conduct of a strategic assessment of implementing the plan as a cooperative exercise by the New South Wales and Federal Governments
- Transitional implementation of the Biodiversity Offsets Policy for Major Projects since October 2014
- Introduction of a Biodiversity Banking and Offsets Scheme (or 'BioBanking') – a market based scheme where credits required to offset impacts are purchased from BioBank (offset) sites to help address the loss of biodiversity values, including threatened species.
- Development of a number of offsetting tools including Native Vegetation Assessment Tool (NVAT), BioBanking Assessment Methodology (BBAM) and Biodiversity Certification Assessment Methodology (BCAM) (illustrated below). These help assess impacts on a range of biodiversity values and allow application of a sophisticated credit calculator.

However, the principles underlying such tools cannot be reduced to flowcharts and equations. They vary with the management model adopted. Some questions inherent to offset systems include:

- Like for like or better?
- Does improvement in condition balance loss of extent?
- What are the relative values of revegetation of degraded land versus protection of intact land? Is protection of a non-threatened species and offset?
- Are fixed rations preferable to 'Black box' calculations?
- How much is enough?



[15] NSW Department of Environment Climate Change and Water (2011) *Biodiversity Certification Assessment Methodology*. http://www.environment.nsw.gov.au/resources/biocertification/110170biocertassessmeth.pdf

The general characteristics of each approach to implementation are outlined below.

5.4.1 The Efficient Model

Most companies exercise independent control of their own **activities** harnessing their own resources and information. For such activities, their performance targets are defined by feasible limits to practices and the most cost-efficient methods. Some common practices therefore include watering of roads with pit water to settle dust and recycle an otherwise waste product as well as fitting ‘governors’ on company vehicles to control speed and improve road safety. They act promptly and efficiently when a problem arises and in other ways adopt reactive strategies and operational systems.

A number of recent initiatives of both state governments have espoused a goal of efficient management of the industry and its impacts. Hence there have been administrative changes aimed at ‘reducing red tape and green tape’. It is too soon to judge the effect of such changes on the systems and practices implemented to control cumulative impacts.

5.4.2 The Effective Model

Some companies are seeking to share information and coordinate activities for controlling (effectively reducing and mitigating) **impacts**. To this end their performance targets relate to containment of nett effects for specific impacts). An example of companies proactively trying to anticipate and prevent or avoid adverse impacts is the coordinated blasting schedules of companies in the Hunter Valley. Another is the coordinated Isaac River Cumulative Subsidence Impacts Project which implemented multiple waterway management techniques both in individual mine plans and collaboratively – predominantly soft-engineering, timber and riparian vegetation – to manage risks of erosion, suspended sediment generation and damage to river banks and beds. These drew upon expertise from within the companies and external researchers and scientists.

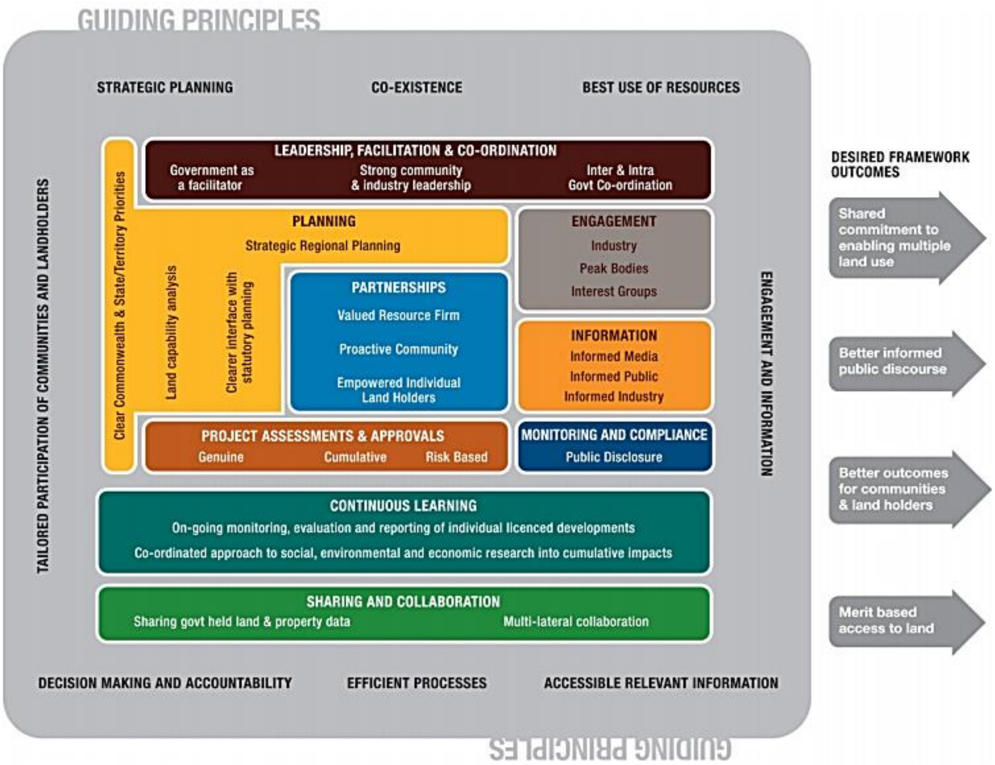
Queensland’s Regional Planning Interests Act and accompanying regulation identify and protects areas of the state that are of regional interest to manage the impact and support the coexistence of resource activities and other regulated activities in areas of regional interest. They aim is to strike an appropriate balance between various priority land uses: regional living/ residential areas; high-quality agricultural areas; strategic cropping land; and areas with important environmental value.

5.4.3 The Sustainable Model

Sustainable operations share resources, risks, rewards and responsibilities to build collective capacities for stewarding the **receiving environment.** Their performance targets are determined by the absorptive capacity and resilience of receptors. They implement proactive initiatives to achieve mutual benefit and enhance or add value to local assets and avoid compromising human health and safety or causing irreparable harm to the social system or ecosystem. Company initiatives in this vein have identified opportunities for synergies because of geographic proximity to other industries or resources. For example by-products from one operation can be used as alternative input for another operation. This concept is known under different names, including industrial ecology. There are examples of coal companies using waste water from nearby urban plants to avoid tapping surface or underground supplies and collaborative training and skilled labour utilisation.

The Federal Government's Standing Council on Energy and Resources (SCER) has proposed a Multiple Land Use Framework that defines nine areas of action, systems and processes (especially by regulators) to facilitate sustainable simultaneous and sequential uses of land for different purposes. It couches these within a framework of four desired outcomes and eight guiding principles. The implied style of operating recognises the whole adaptive management cycle and the whole mine life-cycle in building in consideration of project assessments and approvals, planning, monitoring and compliance and continual learning. It places strong emphasis on engagement, coordination, partnerships, sharing and collaboration. The conceptual model as represented in Figure 6 has strengths, but we found little evidence of its influence on practice to date.

Figure 6: Representation of Multiple Land Use Framework[16]



5.5 Monitoring

The three models will also approach monitoring in different ways and undertake different forms of assessment and measurement of impacts. This is evident in the considerations and contingencies companies incorporate into decisions about monitoring options.

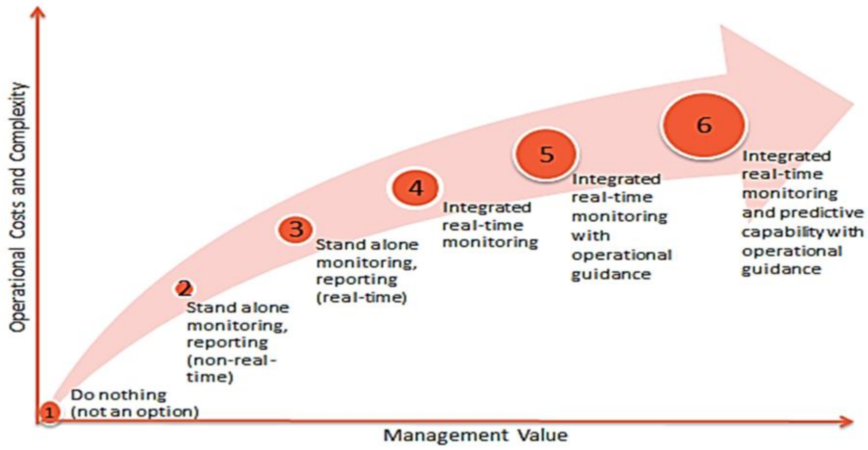
An example of the many decisions involved in monitoring of dust is provided in Box 3[17] to illustrate how different approaches might implement systems meeting different specifications depending on the compliance, social license and management imperatives they face. The criteria by which they choose between the many dust monitoring options will relate to the management value of available dust monitors and dust monitoring practices and the implications of each option in terms of cost and complexity.

[16] SCER (2013) Multiple Land Use Framework. http://www.scer.gov.au/workstreams/land-access/mluf/

[17] Robin Ormerod of Pacific Environment Ltd, "Dust Management Options" presented to Moranbah Cumulative Impacts Group 3 August 2011. Included with kind permission.

Box 3: **Options for measuring dust impacts** (Robin Ormerod - Pacific Environment)

Dust is a common problem, especially for open-cut coal mines. And, in places like Moranbah and the Hunter Valley there is considerable attention to monitoring cumulative airborne particulate matter from mines. Historically, individual mines have largely decided the make-up and siting of monitoring systems.



To fit the solution to the scale and nature of the situation and assess the monitoring system with the desired management capacity, mines now consider a number of specifications and criteria: Does it facilitate reporting of compliance with relevant standards? Does it provide real-time monitoring? Can readings be integrated with others? Will readings guide operational decisions? Does it have predictive capability? Are costs to install and operate proportionate to functional value?

Instrument		Measures	Real-time?	NEPM Standard?	Cost	Comment
TEOM continuous direct mass measurements of particulates		PM_{10}	Yes ≥10 min average	Yes	High	High quality. For compliance & management
Hi-Volume Air Sampler		TSP PM_{10}	No 24 hr average	Yes	Medium	For compliance. Collected dust can be analysed.
E-BAM (Beta radiation attenuation) continuous ambient particulate monitor		PM_{10}	Yes 1-hr average	Yes	Medium	Moderately useful for management. OK for compliance.
Osiris / DustTrak (Light attenuation)		PM_1 $PM_{2.5}$ PM_{10} TSP	Yes ≥1 min average	No	Low-Medium	Ideal for reactive management. Not for compliance.
Dust Gauge		Dust Deposition	No 30 day average	Yes	Low	Data quality issues. For compliance. Little management value. OK for long-term trends

In locations with intensive mining there are examples of real-time and predictive data from multiple sites all integrated in a database with reporting and warning functions and feedback to operations allowing revision of activities. Where the database is web-enabled, multi-site and public access are possible thus able to serve management, compliance and social licence functions.

The characteristics of each approach to monitoring are outlined below.

5.5.1 The Efficient Model

Most mines monitor their ***site emissions and extractions*** and also monitor complaints and grievances. The systems and tools they adopt to do so primarily serve ***compliance*** functions. For instance, monitoring of achievements in terms of indigenous employment will consider number of Aboriginal employees; air and water quality will be monitored using point source and perimeter monitors for dust and river outlet monitors that measure in terms of fixed standards or license conditions; social impacts are often judged by the number of complaints and grievances. The monitoring relies primarily on the scientific and technical expertise of site specialists and regulators.

Regulations aligned with this model include environmental authorities, project approval conditions or development consent conditions issued to resource companies which specify site-specific criteria for such things as volumes of mine-affected water that can be released regularly, or annual (or 24 hour) ceilings on PM_{10} particulate matter emitted.

5.5.2 The Effective Model

Companies focussed on the effectiveness of their activities also monitor ***sensitive receptors*** for multiple impacts with some ***sharing of monitoring data*** (including with public reporting and perhaps participation in the monitoring). For instance, when assessing their achievements with respect to Indigenous employment, companies might monitor retention, training, and look beyond their employees for any changes in employability and employment opportunities and increase in the overall pool of qualified Indigenous people who are potential workers. When focussing on an impact like dust, they might consider pooled-data from other local mines and include monitors based in the receiving environment (such as the neighbouring town or by the local school) rather than on the lease perimeter. This is now the practice in Moranbah for instance.

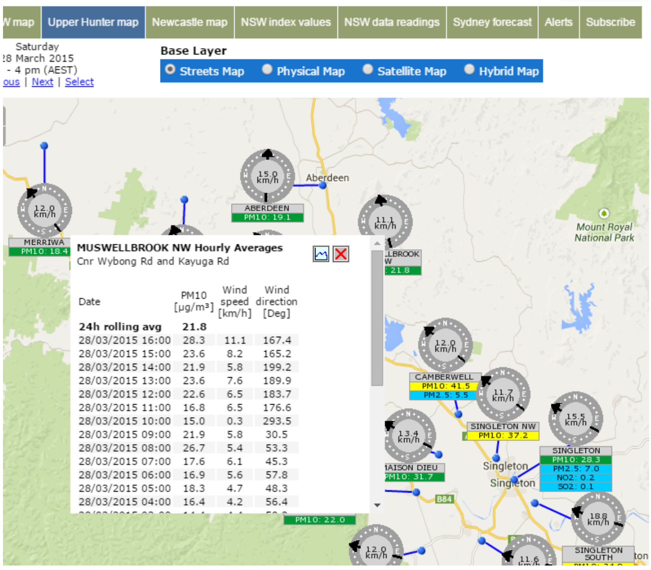
Governments and regulatory authorities can play an important role in effective monitoring notably in coordination and synthesis of multiple data sets, the sharing of government data, and facilitating public disclosure. The coordination and consolidation role is especially significant in the case of cumulative impacts where simple aggregation gives an inadequate representation. For instance, the Queensland Government Statistician's Office collates data from multiple companies and temporary accommodation providers to monitor overall non-resident worker numbers in the main mining regions of the state. This is valuable since individual company reports, including their SIAs usually provide detailed projections of workforce needs through various phases (construction, operations and so on), but rarely overlay these to identify overall peaks. In the Surat Basin, for instance, recent SIA's have acknowledged cumulative impacts could result from numerous construction projects and operations including as many as six underground and seven open cut coal mines, four gas projects, gas pipelines, a gas-fired power station, a dam and water pipeline and multiple electricity sub-stations and transmission lines. It is rare for the prediction of impacts on population numbers and employment to gather data from such disparate sources and consider the temporal and spatial overlap of so many developments.

5.5.3. The Sustainable Model

Sustainability-focussed approaches use comprehensive ***integrated*** monitoring of whole ecosystem or social system 'health' in ways that serve compliance, social license *and* ***system management*** functions. To do this, the system needs to collect a comprehensive array of meaningful and recognised metrics. It also needs to interface with information of a range of contingent factors, and have predictive capabilities so as to inform and guide management strategies. As well as drawing from a range of authoritative sources, it must facilitate timely public reporting. Such complex systems may be appropriate when important elements of the decision that are difficult to quantify or compare, or where communication and coordination among team members with different specialisations is required.

The Hunter Valley Air Quality Monitoring Network provides an example of a combination of data from multiple sites about relevant interacting factors (for example the size and composition of particulate matter in air plus prevailing weather conditions such as wind speeds and directions) to provide actionable information to industry, government and community.

Figure 7: Upper Hunter Air Quality Monitoring Network map



Agreements between the Australian Government, the Queensland Government and the Great Barrier Reef Marine Park Authority have initiated two strategic assessments that will together comprise a comprehensive strategic assessment of the Great Barrier Reef World Heritage Area and adjacent coastal zone. This exercise represents an ambitious measurement effort in terms of scale, collaboration, sourcing of knowledge from informed local, traditional and scientific experts from various disciplinary background – ecological, economic, production and social.

5.6 Revising

The essence of adaptive management is that ongoing monitoring, evaluation and reporting will provide the basis for continual learning and improvement. Different models make different types of adjustments in response to performance measures. Done well, those adjustments are based on systematic consideration of a range of options or alternatives. However the criteria applied to evaluate options are characteristic of different approaches.

Box 4 provides an example of the Hunter River Salinity Trading Scheme[18] which guides regulators in flexibly containing overall discharges to the river within system limits and simultaneously allows mining companies and other license holders discretion about the combination of strategies they use to adjust their discharges to the variable allowances at specified times.

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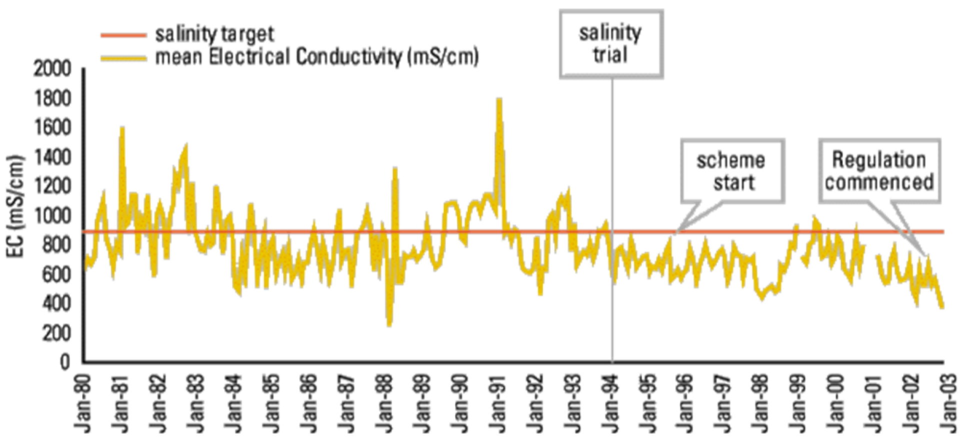
[18] Department of Environment and Conservation NSW (2006). *Hunter River Salinity Trading Scheme: Working together to protect river quality and sustain economic development*. http://www.epa.nsw.gov.au/resources/licensing/hrsts/hrsts.pdf

Box 4: Revising discharge allowances to stabilise and lower water salinity
The Hunter River Catchment supports diverse industries including agriculture, mining and power generation. Prior to the mid-1990s, there was significant conflict and mistrust between these industries. Management and regulation allowed small (minimised) discharges from each mine site at any time. Consequently, in dry times the river became very salty and unusable by farmers when it was most needed.

Electrical conductivity at Singleton 1980 to 2002 (monthly means)



The Hunter River Salinity Trading Scheme is a market-based initiative designed to balance the need for good water quality in the Hunter River for water users with the discharge needs of industry. Overall, salinity (estimated by measuring electrical conductivity) is kept to an appropriate level by only allowing discharges from mines and power stations during high flow or flood events and balancing the amount of salt that industry can discharge with the naturally occurring salt in the river.
Management relies on a network of 21 gauges providing extensive and continuous real-time monitoring of conditions and discharges across the whole catchment. Sophisticated modelling and online reporting facilitates responsive adjustment of saline water management strategies at multiple levels – upper, middle and lower sectors of the catchment, individual numbered blocks of the river and by separate license or credit holders.
Mines can combine pollution abatement technologies with salt credits in the most effective manner for them on the basis of flexibly responding to a range of factors:

- Amount of salt that can be discharged at designated discharge points
- Notified start and end times for releases representing best times for discharge
- Number of salt discharge credits held (of a fixed total of 1000 credits)
- Salinity of their discharge water (and hence volume containing allowed salt)
- Relative economic cost and risks of investing in the credits or in alternatives such as building more on-lease storage for water.

Regardless of diverse strategies of individual mines, the aim is to keep the cumulative salt load of the river below 900EC.

5.6.1 The Efficient Model

Efficient operators commonly rely on compensation**, remedial** measures or interim relaxation of standards to adjust performance within 'legal' limits. These can be temporary measures not linked to changes to the performance standards or operating systems.

For example, Queensland's provision for Temporary Emissions Licenses (TEL) provides a reactive response to extraordinary events that allow for temporary adjustments to discharge nominated volumes of excess mine-affected water over a specified time period (usually of months). This system of rigid permits supplemented by temporary additional emissions lacked the desired resilience to extreme events as the 2011 floods demonstrated. Prior to those floods, discharge quality permit limits for coal mine water discharges under normal operation were judged as inconsistent, varying greatly between mines and not always linked to measures of natural flow. While generally efficient, the system of TELs is essentially **reactive**. Federal policies around water and associated 'make good' provisions in state legislation likewise respond to the symptoms rather than tackling the cause. A further refinement recently introduced in Queensland involves granting a Transitional Environmental Program (TEP) to allow a site some flexibility in emissions while a capital or infrastructure solution to excess saline water is being implemented. This moves beyond the efficient approach in trying to encourage preventative infrastructure solutions where possible – for example a TEP could be granted while a reverse osmosis plant is being built.

5.6.2 The Effective Model

As the example of the revised TEPs in Queensland suggests, an effective approach seeks to develop response plans to **reduce flow-on** effects and modify activities that trigger linked (ill-) effects. Companies have adopted a variety of plans for sourcing and accommodating their workers in line with assessments of the likely cumulative impacts of different options, in an attempt to effectively control negative effects and balance inevitable trade-offs. The lack of a wholly successful approach demonstrates the challenges involved. Housing trusts, joint initiatives by councils and companies, company construction of accommodation including social housing, local government investments in residential development, state government designed housing schemes and various configurations of worker accommodation villages in towns or at a distance have all produced mixed results and had some unintended consequences. An effective solution for all situations remains elusive.

Governments also attempt to reduce and mitigate potential negative impacts. One of the responses both the Queensland and New South Wales Governments have made to the cumulative pressure on infrastructure in mining localities is to introduce a variation of a 'Royalties for Regions' funding program. The design of the scheme varies between states but this has been one of the government strategies viewed positively by stakeholders from all sectors. The schemes were relatively new at the time of our consultations, however there is some evidence they may provide a more flexible way providing crucial local infrastructure at times of rapid change.

5.6.3 The Sustainable Model

Miners and regulators are operating in a highly dynamic environment and it has proved difficult to rigorously develop and consider ***multiple options*** and be truly responsive. **Proactive** re-adjustment of practices on an on-going basis to address unintended consequences demands time and resources as well as coordination of multiple actors. Systems and tools designed to support such activities have, by and large, not become widely used or provided the basis for continual improvement. One example is the Land Use Options Simulator (LUOS) developed a decade ago by the then New South Wales Department of Infrastructure, Planning and Natural Resources as a way to predict outcomes for the future based on present decision making about changes in land use taking into account economic costs, environmental merit and a range of effectiveness criteria. There are other examples of landscape–level adjustments that could be made, to optimise outcomes in multi-industry regions and initiatives with elements of these suggest directions for future improvement.

5.7 Approaches to suit circumstances

Adaptive Management also means tailoring the strategies to suit the circumstance – not being flexible to suit convenience criteria and avoid hard decisions, but certainly considering the specifics of the situation. The appropriate model will vary depending on a range of factors including the materiality of the issue and the nature of the risks involved.

5.7.1 Management strategies tailored to perceived materiality of impacts

Cumulative impact assessments are complex, and cost time and money. For a cumulative impact assessment to be effective in supporting good overall environmental and social risk management, its scope must be properly defined. Because it is unrealistic to think that every environmental and social aspect that can be subject to cumulative impacts can be appropriately factored into a cumulative impact assessment, it is good practice to focus the assessment and management strategies on receptors that are valued environmental and social components, or on the issues judged most material in a specific context. Our consultations revealed that some of the variations outlined above depend on the scale, nature of the impact, the value attached to changing the component of the environmental or social system and the perceived materiality of the issue. The materiality of various kinds of impacts varies in different contexts (and also to different groups of stakeholders).

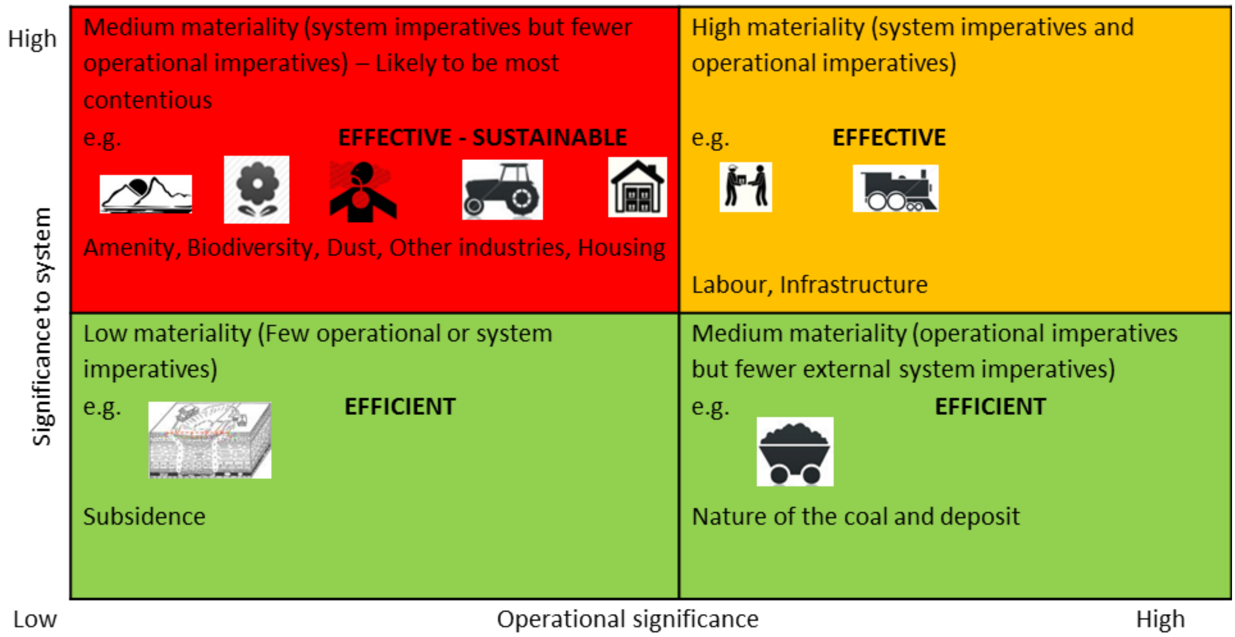
Matrix methods of assessing materiality gather information for review and classification (typically in an excel spreadsheet) from both:

(1) **internal sources** (e.g. risk assessments, strategic plans, performance reports); and
(2) **external sources** (e.g. standards, policies, conditions, audits, engagement and consultation, media, scientific studies and surveys, integrated models).

The matrix in Figure 8 indicates the general assessment of internal and external significance of the main impacts discussed in phase two consultations. For example the impacts on the skilled workforce and on the quality of infrastructure such as roads, rail, power, were of high significance both internally and externally for most of those we interviewed – whereas subsidence was not signalled as a major issue in these contexts. Despite some similarities, these assessments were tailored to specific regions and specific operations and specific production sites.

Materiality assessments of internal significance for instance, varied depending on operational considerations (including stage in the mining life-cycle, type of operation such as open cut v. underground, quality of the coal and so on). Assessments of external significance also varied depending on the conception of the external 'authority' whose priorities were considered: regulator, stakeholders or ecosystem/ socio-economic system (Figure 8 has characterised this as a system focus).

Figure 8: Sample materiality assessment of specific cumulative impacts



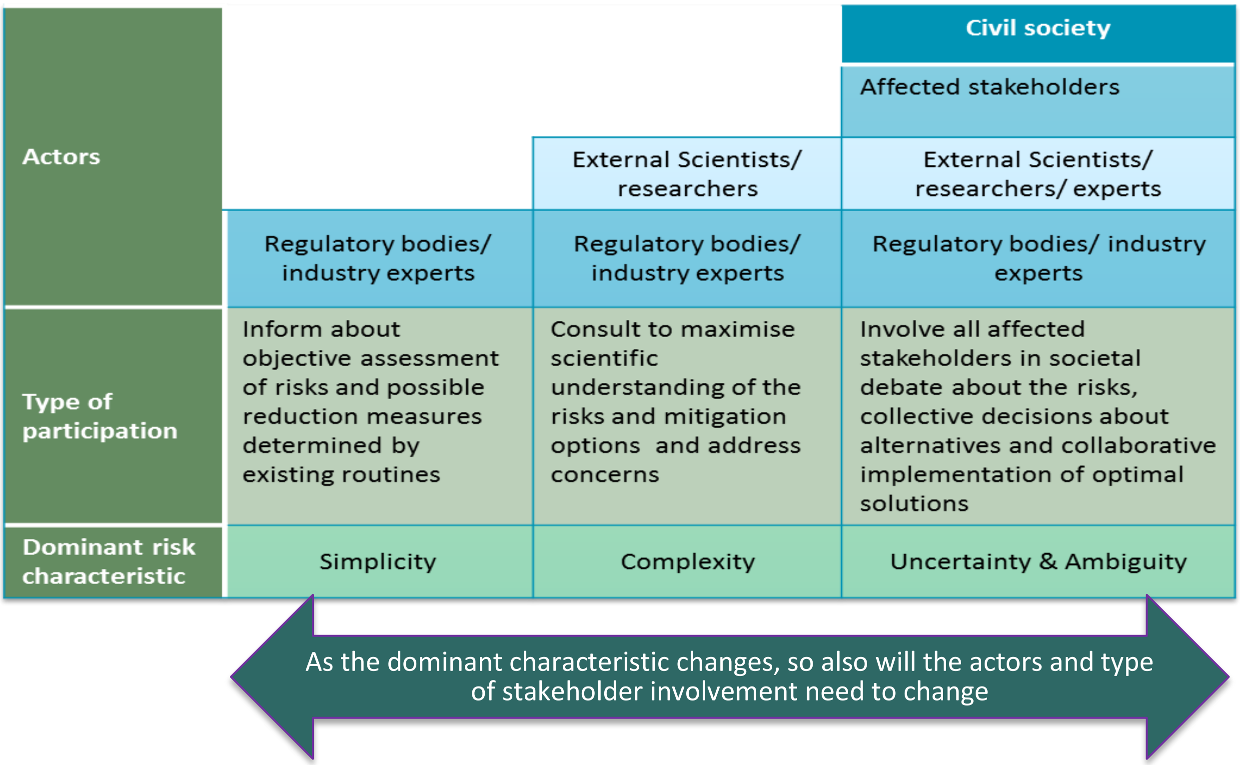
5.7.2 Stakeholder engagement

Both the type of participation and the actors involved may vary depending on the sort of risks associated with particular cumulative impacts. One formulation for showing this has been proposed by the International Risk Governance Council (IRGC)[19]. This can be adapted to incorporate the familiar IAP2 Spectrum of Public Participation as depicted in Figure 9.

The IRGC distinguishes particularly between calculable risks that are easily identified, characterised, and managed which they call simple risks, and risks that are more complex, uncertain and/ or ambiguous. Straightforward, essentially technical risks can, by and large be handled by routine processes and trained industry personnel with arms-length oversight by regulators. However when there are multiple contributing factors and it is difficult to identify and quantify causal links and connections or when there is inadequate scientific and technical data or divergent and contested perspectives and values involved, different means are required for risk management as well as for dealing with the knowledge challenge and engaging stakeholders. For instance outside expertise from specialist knowledge holders both researchers and scientists as well as observant locals and Indigenous stewards is needed for more complex and uncertain risks. Affected stakeholders and the wider general public need to be actively involved when there is uncertainty or conflicting views and values to be reconciled and the options considered will need more than technical dimensions.

[19] IRGC 2012 p18 http://www.irgc.org/IMG/pdf/An_introduction_to_the_IRGC_Risk_Governance_Framework.pdf

Figure 9: A structure of stakeholder engagement



Given the interactions and multiplicity of interconnected factors relevant to many cumulative impacts, they usually involve less predictability and will benefit from wider dialogue among a broad group of multidisciplinary experts and affected stakeholders about both understanding the nature of the risk and choosing effective management strategies.

The Upper Hunter Mining Dialogue provides an example of involvement of a broad range of stakeholders in debate, consideration of alternatives and joint implementation of action plans. This initiative was launched in 2012 and brings together the nine coal producers of the Upper Hunter, community, environmental, agricultural and business groups, as well as local government and state government agencies, to address the cumulative impacts of mining and growth in the Upper Hunter region of New South Wales. Joint Working Groups, made up of representatives of participating stakeholder groups are developing and implementing projects to achieve five year goals they have adopted in the areas of: Water; Emissions and Health; Social Impacts and Infrastructure (mainly housing); and Land Management.

Another example from a rural area with processing plants and other industries alongside farmland in California USA is provided in Box 5[20].

[20] London, J. K., Huang, G., & Zagofsky, T. (2011). *Land of Risk, Land of Opportunity: Cumulative Environmental Vulnerabilities in California's San Joaquin Valley*. Davis, CA: UC Davis Center for Regional Change.

Box 5: **Stakeholder engagement in management of cumulative health impacts**

San Joaquin Valley, California is a mixed industry region with:

- highly productive agricultural land (crops and dairies)
- major transportation arteries and logistics centres
- water systems infrastructure
- manufacturing (including refineries, chrome plating)
- power generation.

In social terms, poverty is high, pesticides and effluents are prevalent, air and water quality are poor and there is a high incidence of ill health.

A Cumulative Environmental Vulnerability Assessment considered data about three factors:

Environmental Hazards	Social Vulnerability	Health Conditions
Toxic release inventory sites Hazardous waste facilities Storage and disposal facilities Industrial sites and refineries Active ingredients per unit area for key chemicals (e.g. pesticides) National air toxics	% of population in poverty % of population >25 years without secondary schooling % population under 5 or 60+ % of population in ethnic, cultural or linguistic minorities Access to prevention/ mitigation e.g. how far to safe water/ quality medical care?	Incidence of low birth weight Incidence of select diseases e.g. Asthma hospitalisation rate Life expectancy

Data was accessed from official and scientific sources and 'groundtruthed' with the community by community water sampling and testing and at workshops asking:

- What hazards affect you?
- Where are the 'danger' locations?
- What data is inaccurate or missing from the 'official' record as shown in large maps or aerial images?

The results showed that nearly one-third of the population faced both multiple hazards and had high social vulnerability and that many more hazards were identified by residents than in official records. This evidence-based data allowed decision-makers to identify Cumulative Environmental Action Zones (areas where a combination of hazards and vulnerability are concentrated) as priorities for action

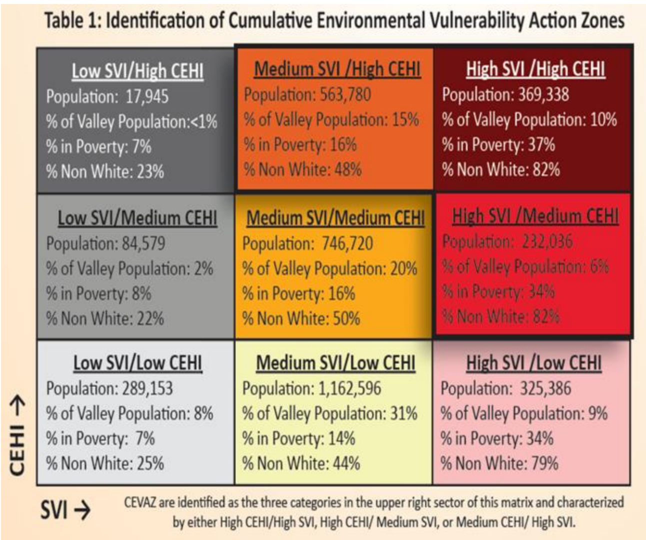


Table 1: Identification of Cumulative Environmental Vulnerability Action Zones

CEHI ↑			
	Low SVI/High CEHI Population: 17,945 % of Valley Population:<1% % in Poverty: 7% % Non White: 23%	Medium SVI /High CEHI Population: 563,780 % of Valley Population: 15% % in Poverty: 16% % Non White: 48%	High SVI /High CEHI Population: 369,338 % of Valley Population: 10% % in Poverty: 37% % Non White: 82%
	Low SVI/Medium CEHI Population: 84,579 % of Valley Population: 2% % in Poverty: 8% % Non White: 22%	Medium SVI/Medium CEHI Population: 746,720 % of Valley Population: 20% % in Poverty: 16% % Non White: 50%	High SVI /Medium CEHI Population: 232,036 % of Valley Population: 6% % in Poverty: 34% % Non White: 82%
	Low SVI/Low CEHI Population: 289,153 % of Valley Population: 8% % in Poverty: 7% % Non White: 25%	Medium SVI/Low CEHI Population: 1,162,596 % of Valley Population: 31% % in Poverty: 14% % Non White: 44%	High SVI /Low CEHI Population: 325,386 % of Valley Population: 9% % in Poverty: 34% % Non White: 79%
SVI →			

CEVAZ are identified as the three categories in the upper right sector of this matrix and characterized by either High CEHI/High SVI, High CEHI/ Medium SVI, or Medium CEHI/ High SVI.

6. Conclusions

Companies and governments sometimes face competing objectives and must constantly make decisions about appropriate approaches to assessing and managing individual effects of enterprises which, when considered together, are considerable or which compound or increase other socio-environmental impacts.

This report provides a common framework and some consistent reference points as a basis for shared understandings among the users of the shared human, natural and infrastructure assets of multi-industry regions. The adaptive management framework is familiar because it also applies to leading practice environmental and social management with preparation of evidence-based plans, application of appropriate systems and practices, systematic monitoring of performance and continual improvement of practices and systems.

Approaches to applying this framework to cumulative impacts management reflect what some regard as a ‘sustainability journey’. Most operations manage their direct site-level impacts efficiently and in compliance with official standards and conditions. However there are examples of industry practices and regulations that aim for more proactive and effective management of contributions to cumulative impacts by considering broader dimensions and assessing risks and monitoring performance differently. With respect to some cumulative impacts a more multi-faceted and integrated approach with a systems focus is emerging.

The specific issues and approaches adopted will vary depending on contextual circumstances, and a range of other factors. Because the configuration of operations, the types of impacts, the data available and other conditions vary, guidelines can only be general. Rather than following a universal ‘formula’, hybrid and flexible approaches will be needed. Some generalisations are reiterated in the list of recommendations below. To meet the distinctive assessment and management challenges that cumulative impacts pose in multi-industry regions as per section 2, and to be consistent with the adaptive management framework outlined in section 5, cumulative impact management should, to the extent possible:

1. **Build in active engagement of relevant stakeholders and a coordinating role for governments.**
   Because of the links between diverse human activities, all industries and resource users both contribute to and experience cumulative impacts and have a role in managing them. Given potentially competing interests, even where an issue falls outside their legislative purview, governments often have a vital coordination role. In addition, when impact areas, activities or responsibilities overlap, collaboration between various stakeholders, including between governments at all levels, may be warranted. *This unites efforts and overcomes any potential lack of coordination that could result from an array of individual initiatives*.

2. **Wherever possible adopt a proactive planning based approach.**
   A forward-looking approach that considers various options and predicts and analyses the cumulative impacts of each over time and at various geographic scales is integral to comprehensive management of the potential consequences, benefits and risks of various combinations of activities and industries. *This is preferable to a fragmented and reactive approach*.

3. **Consider the potential cumulative impact of a range of scenarios incorporating past, present and probable future projects.**
   Informed scenarios about the cumulative impacts associated with potential development scenarios in a region will necessarily be based on a number of uncertainties, and flexible judgements. For various reasons not all proposed projects will become operational. Similarly the trajectory for other industries will vary in response to factors such as prolonged drought or macro-economic settings. Hence a range of scenarios from optimistic to pessimistic, radical to conservative, should be considered. They should focus on the areas of impact that are salient in the specific context with its unique combination of industries and assets. Mines, farms, national parks and higher education colleges may all contribute (positively or negatively) to some areas of impact (e.g. traffic and biodiversity) but may not all be significant contributors to other areas of impact (e.g. noise and local employment). Hence it is relevant to identify the areas of impact that should be considered in respect of each project. Existing community and regional plans, economic development plans, natural resource or catchment management plans and similar documents provide a useful resource for such exercises. *This addresses the problem of isolating effects of individual stressors and individual industries*.

4. **Identify and incorporate interactions between the various activities and their impacts.**
   Identifying interactions between multiple land uses poses challenges both conceptual (since our understanding of the way factors interact in complex social and environmental systems is imperfect) and methodological (since the means of calculating of controlling the combination, aggregation and feedbacks of many impacts as well as direct, indirect and induced effects is not well developed). Tools and systems of variable sophistication exist in some areas. This is more the case for some areas of impact (e.g. environmental, economic and health impacts) than others (such as impacts on social fabric and psycho-social impacts). *This addresses the challenge of non-linear impact pathways*.

5. **Draw upon diverse knowledge and multidisciplinary expertise to build system understanding.**
   Some of the knowledge and information required to manage cumulative impacts will be collected in an ongoing way as part of the monitoring activities. As well, a considerable body of relevant material is available in baseline studies, public records and from government and other authorities. Multidisciplinary perspectives are becoming more common and there are innovative examples of incorporating the accumulated wisdom of observant locals from other industries as well as traditional or Indigenous knowledge including through participatory forms of planning, monitoring and evaluation. *This minimises the constraints of incomplete and 'siloed' understanding*.

6. **Standardise and synthesise hard-to-match-data in innovative ways.**
   Available data about different industries may relate to different scales and intervals and be expressed in very different units. Nevertheless many of the factors are interlinked and determine overall system condition as well as the condition of particularly significant components of the socio-economic or environmental system. To relate the data requires, at a minimum, coordination of various data sources – as

has been achieved in some of the networked air and water monitoring programs. There are some tentative initiatives tackling more complex aspects too (for instance by weighting of factors, or monetising ecosystem services), but there is much room for further innovation. *This addresses challenges associated with data inconsistency*.

7. **Consider the various dimensions of the impacts from multiple perspectives.** In the case of cumulative impacts of mines, farms and other industries, there is not a single point in time or spatial scale that is relevant and the multiple stressors and receptors cannot be assumed to be uniform. Some multifaceted dimensions are:

    - Time dimensions – past, present and prospective projects all contribute to the cumulative impact
    - Spatial dimensions – cumulative impacts operate at multiple scales simultaneously from project/ site-specific to regional and system focus
    - Patterns of vulnerability and exposure – differential properties of the receptor influence differential likelihood and consequences of an impact.
    - Known resilience, thresholds and tipping points – cumulative impacts are not simply incremental, but may compound exponentially

Many practical projects to realise many of these recommendations could be best achieved in collaboration including projects to share information, promote continual collective learning and integrate policies and practices across disciplines. One simple example of an initiative that industry and state governments could collaborate on would be refining and maintaining an up-to-date repository of relevant policies as demonstrated with the XMind files in this project.

This study builds on earlier work undertaken by the Centre for Social Responsibility in Mining in collaboration with ACARP[21]. It shows that the cumulative impacts of mining are intertwined with the activities of overlapping and nearby industries based on alternative land uses. These cannot be considered in isolation since they all contribute to the impacts on the same receiving environment. In some cases the cumulative impact of multiple, unrelated projects may exceed that of a number of comparable and more easily aggregated activities. For example, there is evidence that the impacts of agricultural land use are a major contributor to water quality issues in the Fitzroy catchment. Similarly, it seems likely that quarrying, building construction, bush fires and road and rail traffic account for many of the aberrant readings in depositional dust monitors near Moranbah coal mines.

Such situations where a range of combining and interacting human activities must be taken into account pose incrementally greater challenges than identifying and managing the cumulative impacts of a single mining operation, or even of multiple coal mines in a locality. The study has concluded that there are emerging examples demonstrating how the principles and practices of effective management of cumulative impacts of mining can be modified, extended or supplemented to provide sustainable, adaptive management of mining-intensive regions where mining encroaches onto productive agricultural land, co-exists with other industries and abuts urban settlements.

[21] Assessing the Cumulative Impacts of Mining on Regional Communities: An exploratory study of coal mining in the Muswellbrook area of NSW (C14047),
Developing good practice in managing the cumulative impacts of coal mining (C16036), and
Governance Strategies to Manage and Monitor Cumulative Impacts at the Regional Scale (C19025)

7. Selected Toolkits and References

General Guides:

Franks, D. M., Brereton, D., Moran, C. J., Sarker, T., & Cohen, T. (2010). *Cumulative impacts - A good practice guide for the Australian coal mining industry*. Brisbane: Centre for Social Responsibility in Mining & Centre for Water in the Minerals Industry, Sustainable Minerals Institute, The University of Queensland and Australian Coal Association Research Program. https://www.csrm.uq.edu.au/publications/cumulative-impacts-guide

ICMM (2006). *Good Practice Guidance for Mining and Biodiversity*. London, UK: International Council on Mining and Metals (ICMM). https://www.icmm.com/document/13

ICMM (2010). *Good Practice Guidance on Health Impact Assessment*. London, UK: International Council on Mining and Metals (ICMM). https://www.icmm.com/document/792

ICMM (2013). *A practical guide to catchment-based water management for the mining and metals industry*. London, UK: International Council on Mining and Metals (ICMM). http://www.icmm.com/publications/water-management-guide

IFC (2013). Good Practice Handbook: Cumulative Impact Assessment and Management. Washington DC: International Finance Corporation.

Environmental Impact Monitoring sites

Biodiversity assessment New South Wales http://www.environment.nsw.gov.au/biocertification/

Gladstone ambient air quality monitoring http://www.ehp.qld.gov.au/air/data/search.php

Gladstone region air and water quality reports http://www.ehp.qld.gov.au/gladstone/

Moranbah Cumulative Impacts group http://mcig.org.au/issues/air-quality-dust/

Upper Hunter Air Quality Monitoring Network http://www.environment.nsw.gov.au/aqms/upperhunter.htm

Social Impact Assessment data sources (additional to ABS)

Know your community - Aboriginal and Torres Strait Islander Queenslanders and the communities they live in http://statistics.oesr.qld.gov.au/datsip/profiles

Public Health Information Development Unit - Social Health Atlas of Australia - http://www.adelaide.edu.au/phidu/

Regional Australia Institute, 2013. Insight Australia's Regional Competitiveness Index http://www.regionalaustralia.org.au/insight/

8. Appendices

1. XMind Files Instruction Toolkit
2. Western Downs (Surat Basin) Case Study - Queensland
3. Upper Hunter Valley Case Study - New South Wales
4. Isaac Region (Bowen Basin) Case Study - Queensland