ACARP Project C25032

Supplementary Report S2

An evidence based proposal for stakeholder engagement in planning post-mining land uses

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Research Ethics

This study was approved by the CQUniversity Human Research Ethics Committee (Approval H16/11-305) according to the National Statement on Ethical Conduct in Human Research.

Reports in the C2503 series:

Stakeholder involvement in planning to maximise the benefits and acceptance of land packages post-coal-mining in Central Queensland. ACARP Project C2503. Final Report

S1: Processes to transfer post-mining lands to agricultural uses in the Bowen Basin: issues, economics and analysis
S2: An evidence based proposal for stakeholder engagement in post-mining land uses
S3: Models for stakeholder engagement in land use change decisions in the Bowen Basin.
S4: Assessing the convergence of stakeholder views on post-mining lands uses in the Bowen Basin
S5: Using workshop processes to generate stakeholder agreement about post-mining land uses

Abstract

In Queensland's Bowen Basin, areas of post-mining land are increasing. These properties have been subject to decades of coal-mining and, without appropriate transfer to alternative use, may remain as vacant land unable to be used for grazing or other productive uses. Research that informs new and revised policies and processes to optimize rehabilitation and post-mining land use planning is critical in assisting regional economies to transition to post-mining contexts. This paper is the second supplementary report for ACARP project C 25032, *Stakeholder involvement in planning to maximise the benefits and acceptance of land packages post-coal-mining in Central Queensland*. It explores the potential for panels of stakeholders to agree on a beneficial land use, which is one of the four goals of mine rehabilitation and closure specified by the Queensland regulator. Whilst current guidelines require stakeholder consultation, there is little real evidence that rehabilitation and closure planning processes incorporate the perceptions of potential future land-users in terms of the utility of examining leases, socio-economic value and associated opportunities and risks. In contrast, existing literature does reveal the range of influencing factors that landholders, especially graziers, may consider in determining the utility and value proposition of land packages – including physical, agronomic, ecological, economic, aesthetic and recreational characteristics.

This gives rise to two questions: (i) what role can input from stakeholders and potential future landusers play in considering the opportunities and barriers to incorporating ex-mine land into grazing properties; and (ii) what are the characteristics of an appropriate model for engaging and empowering a stakeholder panel to play that role? This research provides a narrative on both questions and proposes a re-conceptualisation of rehabilitation goals. It also identifies a potential role for stakeholders in adaptive management in collaboration with regulators and mining companies, and a process of long-term engagement of a cross-section of predominantly local people using visual models of an authentic case as the basis for reaching agreements about the land use challenge and reconciling ecosystem, social and economic functions and values.

Keywords: Post-mining land use; Mine rehabilitation; Mine closure; Grazing; Stakeholder engagement; Collaborative adaptive management; Visual landscape representations

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A proposal for stakeholder engagement in planning post-mining land uses.

1. Introduction

Attaining and maintaining for future generations an acceptable post-mining land use is integral to the concept of responsible mining. In Australia, mining activities are regulated by the various state governments. For example, in Queensland, mine closure and completion involves a two-step process of first achieving environmental certification and then relinquishing the mine lease to the satisfaction of the relevant state government departments: Department of Environment and Heritage Protection (DEHP) and the Department of Natural Resources and Mines (DNRM). Initial planning for mine closure is defined much earlier, at the mine-planning stage, with project proponents (companies) nominating a post-mining use aligned with prior uses, surrounding uses and pre- and post-mining site characteristics and land suitability in an environmental impact statement (EIS) which they submit for approval with the mining lease application (White et al, 2012, p. 246).

Currently government's approvals and environmental authority are designed around the future land use proposed by the mining company in the EIS and related documents. Conditions specified at that early stage are used to eventually certify satisfactory achievement of rehabilitation outcomes and endorse suitability for subsequent uses. This process has rarely gone full circle in Queensland with very few examples of mines achieving closure (Lamb, Erskine, & Fletcher, 2015) and many historic examples of abandoned mines (Unger et al, 2012). Current estimates suggest there are 20,000 hectares of land disturbed by mining and that by 2021, on current trends, there will be 12 times as much ex-mining land remaining disturbed as there is land that is rehabilitated and supporting alternative uses (Queensland Government Interdepartmental Committee on Financial Assurance for the Resource Sector, 2017). Hence the state faces the prospect of large tracts of mined land in various stages of rehabilitation (Lechner, Kassulke, & Unger, 2016) that remain forever in the custody of mining companies.

There are four goals of rehabilitation: land should be non-polluting, safe, stable and able to support an agreed use (DEHP, 2016). The favoured rehabilitation strategy to achieve these on about half of the rehabilitated land in the dry, sub-tropical region of central Queensland is pasture-based revegetation with grazing commonly nominated as the post-mining land use (Grigg, Shelton, & Mullen, 2000). However, considerable biophysical research has identified threats to sustainability of grazing on rehabilitated land suggesting that scientifically there are unanswered questions and obstacles to rehabilitating for this subsequent land use in Australian conditions (Baumgartl & Glenn, 2013; Doley & Audet, 2013; Lechner et al, 2014; Perring, Standish, & Hobbs, 2013).

While there are few examples in the peer reviewed literature of long-term monitoring studies demonstrating successful rehabilitation for pastoralism in Australia, one study of a north Queensland copper mine rehabilitation areas (1–7 years post-rehabilitation) and nearby comparison sites within surrounding grazed and un-grazed agro-ecosystems undisturbed by mining, suggested a sustainable post-mining land use was achievable with careful, locally attuned, management strategies (Vickers, Gillespie, & Gravina, 2012). Likewise, Maczkowiack and colleagues (2012) profiled risk factors for grazing in the Bowen Basin and suggested that where land is managed by local graziers and productivity will support commercial cattle grazing, this is likely to be a low risk post-mining land use. Other positive examples can also be found in the grey literature (Grigg et al, 2006; Melland et , 2014; Mulligan, 2003).

While the environmental science continues to explore the factors determining the sustainability of grazing in these post-mining landscapes, researchers have acknowledged that science and technology will not provide all the answers any more than regulation and a legal frameworks can (Limpitlaw &

Briel, 2014). Mines and the nascent post-mining landscapes being developed by rehabilitation activities are embedded within rural communities and there has been insufficient consideration of what that means for rehabilitation and closure planning (Collier, 2011). Besides evidence of the bio-physical condition and productivity of post-mining landscapes, data about preferences and needs of stakeholders such as potential land users are also relevant. This means that it is valuable to consider input from those living on the land in determining the specifics of postmining land uses because "what is 'best' depends for a large part on the perception of farmers" (Milestad et al, 2012, p. 368; see also Palmer, 2012). In other land use contexts, research recommends combining socio-economic insights from practitioners with bio-physical modelling of potential productivity to achieve robust and practical development solutions (Alves-Pinto et al., 2017). With specific regard to post-mining land-use projects, it is argued that many suffer more from "lack of due diligence in assessing the markets, communities' livelihood systems, experiences and knowledge base, and … an absence of community participation" than from insufficient consideration of the science (Mborah, Bansah, & Boateng, 2016, p. 15).

Until recently, land-use planning in rural regions of Queensland has been mostly a top-down, technocratic, rationalist approach that paid little attention to wider land-use values and stakeholder interests. However, it is land-users who are expected to manage and eventually own privately, these post-mining landscapes. Other directly affected stakeholders are local and state government, businesses and civil society groups in proximate communities as well as NRM groups, environment protection groups and Indigenous interests. While in other land-use planning contexts participatory decision making is regularly advocated (Lawrence & Deagen, 2001; Renn, 2006), within the context of land use planning for mining landscapes there are limited examples.

In this paper we consider the argument for including potential land users and local community members with a stake in responsible stewardship of these land areas in contributing to some of the decisions; opportunities that may be realised by adopting inclusive and participatory stakeholder approaches to decision-making for post-mining land; and how such approaches may help address barriers to incorporating ex-coal-mining land into grazing properties in central Queensland's Bowen Basin. This involves a focus on the potential for involving stakeholders in considering suitable postmining land use as one of the four goals of the guideline that drives rehabilitation practices and programs in Queensland as suggested in Figure 1.

To explore these issues, we review and critically analyse the current mining, rural development and natural resource management literature in relation to two questions: 1) what role can input from stakeholders and potential future land-users play in mine closure processes in Queensland? and 2) what are the key characteristics of an appropriate model for engaging a stakeholder panel to play that role? Our review focuses on coal mining in central Queensland, but is applicable to post-mining land-use decision making in general. We conclude by proposing an alternative approach to postmining land use decision-making based on a goal of "utility" and then describe three focus areas for future research.

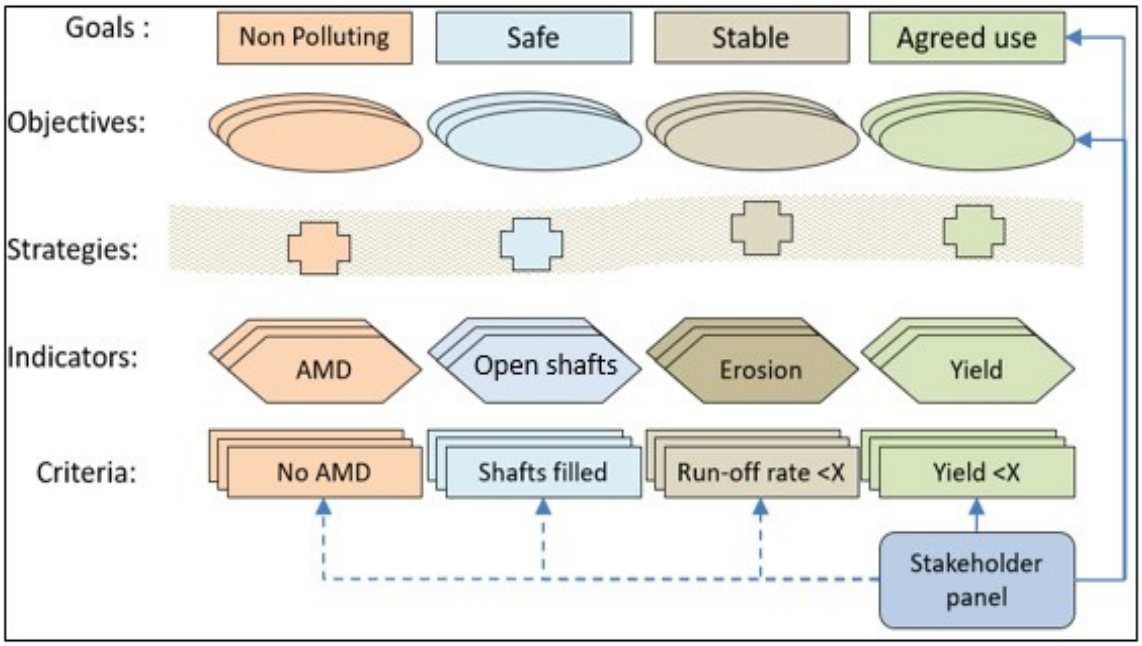

Figure 1: Potential for stakeholder input under Guideline 18 (adapted from Minserve Group & CQU, 2007 p. ii). Note AMD = Acid Mine Drainage

2. Opportunities from and barriers to incorporating mined land into a grazing property in central Queensland

The potential benefits from incorporating post-mining lands into grazing properties relate to restoring productive, social and aesthetic functions of the land as well as ecological ones. In some cases this may mean returning the land to an alternative productive use once mining is completed (Harvey, 2016; Unger, 2017). There is additional value in ensuring ongoing stewardship of parcels of disturbed land that could otherwise become wildfire risks or pose challenges to control of weeds and pests (Maczkowiack & Smith, 2012). Incorporating land into the surrounding land uses also minimises the impact of closure on local character and the regional economy (Pavloudakis, Galetakis, & Roumpos, 2009).

Nevertheless, there are several challenges associated with incorporating mined land into grazing properties. The major issue is that currently, there is no specific process for transferring mining lands to agriculture and little guidance about what process and criteria to use for determining that such new land uses are 'acceptable'. While pasture-based revegetation is a common target for rehabilitation, and, like bushland, a preferred subsequent land use among stakeholders in one survey (Maczkowiack & Smith, 2012) the hierarchy of rehabilitation goals outlined by the Queensland regulator prioritises environmental outcomes ahead of the social and economic dimensions of sustainability (Njeru, Kragt, & Banning, 2015). Thus the bulk of attention of both companies and government is on defining and meeting the environmental criteria.

There are also difficulties in quantifying and managing the residual risk associated with the potential for rehabilitation to fail though eliminating all risk may be a long-term and near impossible task. It appears inappropriate that residual risk should be assigned to future land owners, and the State Government is unlikely to accept the transfer of large residual risks to the Crown/State. However, there are opportunities for mechanisms to cover the residual risks and manage their incidence, such as bond or insurance instruments, or tenure mechanisms and conditions that clearly specify any responsibilities beyond those regarded as standard in a grazing enterprise.

A third challenge is that mining companies may sometimes be discouraged from undertaking unclear or unrewarding processes or be reluctant to seek land use change and relinquishment in case it interferes with operations or they want to reopen the site in the future. Alternatively, they might get certification and relinquishment, but keep exploration rights. In parallel there is the potential reluctance of agricultural producers to take on post-mining land where remaining coal resources are not sterilised and there may therefore be some risk of renewed mining interest in the sites.

The following sections outline evidence about how potential opportunities may be realised and the challenges outlined above addressed to some extent by participatory approaches.

3. A role for input from stakeholders and grazing 'experts' in mine closure processes

Despite concerns about the capacity or responsibility of stakeholders in deliberations about complex and uncertain situations such as satisfactory use of mined land, one survey of more than 200 cases of stakeholder participation in making environmental and natural resource decisions demonstrated the quality of such decisions and that the stakeholder groups have access to adequate scientific and technical knowledge (Beierle, 2002).

Farming Systems Research similarly endorses landholder participation in rural land management that is holistic and multidisciplinary (Norman, 2002). Such research may contain some lessons relevant to the value and means of involving graziers and land users in management of post-mining lands. For instance there is evidence that potential landholders may "assume some degree of risk *so long as they have control* over the land and over decisions about what business to conduct on it and how to manage it" (Milestad et al., 2012, p. 375 italics added). There are also indications that farmer participation in multi-stakeholder initiatives ensures that land management options are acceptable from multiple perspectives, not only from the perspective of productivity (de Krom, 2017). Additionally, stakeholder input facilitates assessment of direct consequences of the choice of landuse on the potential future farmers and of indirect consequences from the proposed economic activities, including on access to public utilities and on amenity.

Changes in life-style and economic prosperity make the selection of a post-mining land use a complex, multi-faceted decision requiring consideration of many factors associated with a viable future for potential landusers and the affected community (Pavloudakis et al., 2009). Mine closure planning needs to be consistent with wider understanding that "Systems should be tested with respect to their ability to meet community goals" (Star, 2016: 243). Participatory approaches are argued to be beneficial in both farming and mining contexts in developing relevant and acceptable principles and practices based on local understanding of natural processes, available resources, farming systems and planning regimes (Glass, Scott, & Price, 2013; Pavloudakis et al., 2009). Accordingly, Worrall, Neil, Brereton and Mulligan (2009) suggest that management of post-mining land parcels should be attuned to local context and "should ultimately be the responsibility of the relevant government agencies, developed through a participative process with local stakeholders and private enterprise" (p. 1433).

Proposed future land uses may be, like farm management decisions and suitability to agricultural uses, more readily evaluated with landholder participation in the formative stages as well as in the evaluation of outcomes (Chataway, 2006; Norman, 2002). Future land use can be evaluated in terms of the farmer's financial situation, likely impacts on farm profitability, non-financial incentives and costs involved, and alignment with the farmer's current farming system, skill set and personal values

(Boardman, Bateman, & Seymour, 2017; Burton, 2004; Kragt et al., 2014; Morgan, Hine, Bhullar, & Loi, 2015; Page & Bellotti, 2015; Pannell et al., 2006). According to Roche (1999, p. 49), such stakeholders "have a special position or experience that gives them unique insights... in this sense, what may be

seen by others as 'anecdotal' becomes critical data because of the source's value". Despite considerable variation and context-dependence (Knowler & Bradshaw, 2007), generally, rural producers will adopt changes that perform well against these criteria and provide (or are perceived to provide) private production benefits (Morgan et al., 2015; Page & Bellotti, 2015) or lifestyle benefits (Burton, 2004).

The research shows that a complex mix of considerations is relevant to key decisions of rural producers and the same would likely apply to decisions about the suitability of post-mining land to a grazing enterprise with considerations proposed to include alternative values of utility, safety, beauty and integrity (Harvey 2016). For example, the focus of rehabilitation in Europe is said to have become more multi-functional – with attention to restoring productive functions as well as consideration of ecological, aesthetic and social aspects of the landscape (Svobodova et al 2012; Unger, 2017). Stakeholders need to evaluate options for land uses and identify potential management strategies to avoid known rehabilitation risks while satisfying the productivity, efficiency and other criteria of graziers. While environmental experts in mining companies can provide details of the likely landscape and site conditions, local graziers will be the prime source of details of grazing systems and practices and both groups can pool their knowledge with scientists from various disciplines to identify key opportunities and threats with respect to long term production and sustainability. There are a number of different domains of an ex-mine site (such as pit, tailings, spoil heaps, revegetated areas, off-set zones and locations of decommissioned infrastructure). They pose varying degrees of risk and would likely be considered separately when considering post-mining land use (Doley & Audet, 2013; Grigg et al., 2006). Not all of these domains may be suitable for grazing, and the suggestion is that graziers may be best positioned to assess that and explain their reasons.

Greater community engagement is actually endorsed in current mine relinquishment requirements and processes. For instance Queensland's guideline on *Rehabilitation requirements for mining resource activities* states that,

> [Completion criteria] [1] should be developed in consultation with stakeholders (e.g. the landowner, local government, indigenous groups, community groups and various State departments). The criteria are of importance to landowners because they may set limitations on the agreed future land use and expose the landholder to risks and potential costs associated with maintaining the former mine site in a safe and productive condition (Department of Environment and Heritage Protection, 2014, p. 18).

Certification and relinquishment come late in the mine life-cycle, however input from stakeholders is advocated from early in the life of mine,

> The expectation created by mining legislation, self-regulation statements and guidelines is for early, transparent stakeholder engagement, detailed closure planning at feasibility stage, exemplary environmental practices and performance reporting during the operational phase, and that land disturbed by mining will be progressively returned to a useable postmining condition, of a similar or better land-use than existed prior to mining (White et al., 2012, p. 67).

[1] Completion criteria "provide a clear definition of successful rehabilitation for each domain at the mine site in the form of a set of measurable benchmarks against which the rehabilitation indicators can be compared to determine whether the objectives are being met." (DEHP, 2014, p. 17)

Table 1: Roles of regulator, mining company and potentially stakeholders in the mine rehabilitation process (Modified from DEHP 2014: 7)

Regulator (DEHP/DNRM)	Mining company	Potential stakeholder engagement	Questions/problem to collaboratively solve
Pre-mining			
	Exploration and feasibility studies – including baseline studies and planning of possible rehab objectives	Identify acceptable future land uses – whether pre-mining, natural or novel ecosystem/ land use. Signal what factors they consider in calculating the value proposition and identify requirements to make land suitable for end use/s (i.e. to make land safe, stable and non-polluting for those uses and meet other functional requirements e.g. viability, lifestyle etc) - i.e. propose completion criteria for goal 4. (These would not override the ecological criteria but may add new information e.g. about (i) acceptable residual risk (ii) acceptable trade-offs and balances or (iii) whole-of-enterprise/ landscape assessment versus isolated domains.	What land use/ mosaic of land uses would be acceptable/ appropriate on this mining lease area once mining has finished? What factors do you take into consideration to determine suitability of land to grazing? – (e.g., site conditions and characteristics? Financial viability/ business considerations? Personal values and circumstances? External conditions (markets, drought etc)? Proposed indicators of land being suitable, safe, stable and non-polluting for the multiple functions envisaged and to meet other functional requirements?
	Pre-design conference	Participation of stakeholders - as orientation so they are informed of options being considered and can provide 'insider' perspective on those	What completion criteria (standards re the indicators) would you apply to say 'a grazing proposition'? Acceptable levels of residual risk?
EIA requirement decision	Prepare EIS and/or application for site-specific EA for a prescribed ERA	Closely engaged in preparation of EIS including social impact assessment (SIA) and	What are the possible impacts and what is their significance?

	(environmentally relevant activity)	in mine planning and risk assessments.	What level of risk (likelihood and consequences) is associated with mining activities? What are the pros and cons of various mitigation options?
Prepare draft Environmental Authority (EA) Objection hearing if required Issue EA – including conditions re rehab			Do stakeholders have any objection or suggest any conditions to feed in during statutory public consultation periods?
During mining			
	Progressive rehab and monitoring	Participation in monitoring and adaptive management of rehab.	Are targets and conditions being met?
	Apply for progressive certification		Endorsing 'readiness' to be (partially) certified (by their standards for goal 4) as one perspective for authorities to consider. Also input about acceptability of residual risk
Assess progressive rehab report Decide the application			
	Adjust financial assurance		
Post-Mining			
	Apply for surrender of EA – including final rehab report and residual risk calculation	Contribute to consensus on acceptable residual risk or areas where more science is needed	Is specialist expertise about likely risks advisable (if so, what sort?)
Assess final rehab report (PRAC) Decision on application	Lodge any residual risk payment Post closure management (if required)	Potentially involved through covenants, land access agreements etc	Are any long-term management arrangements needed and how would they work for future landholders and neighbours?

4. A panel model for engaging stakeholders in planning post-mining land uses

The widespread endorsement of participatory approaches and stakeholder engagement in closure planning does not mean there is consensus about effective ways of doing that. In other fields such as Natural resource management and urban planning, approaches include citizen's juries, reference panels, stakeholder advisory committees, world cafés, deliberative polls, focus groups, field days, surveys, Delphi rounds, choice experiments, action research and participatory monitoring (ÁlvarezFarizo, Gil, & Howard, 2009; Bell, Morse, & Shah, 2012; Carson & Gelber, 2001; Harding &

Macdonald, 2001; Renn, 2006; Solomon, 1999; Strand, Carson, Navrud, Ortiz-Bobea, & Vincent, 2017). Rauschmayer and Risse (2005) propose that the choice of an appropriate participatory approach should be based, on consideration of their information management, legitimacy, social dynamics and costs. An alternative set of criteria are scope, representativeness, timing, comfort and convenience, and influence (Eiter & Vik, 2015). The existence of different criteria is a recognition that participatory approaches offer differing opportunities for incorporating diverse and equally valuable perspectives, co-producing knowledge and ideas, generating dialogue and fostering an open and positive future-focus.

In this section we outline and provide a rationale for one structured model of participatory planning highlighting the key qualities of such an approach suited to engaging stakeholders in the context of post-mine planning. We do not aim to provide a comprehensive review of participatory techniques (for reviews see Rauschmayer & Risse, 2005; Reed, 2008; Rowe & Frewer, 2005; Warburton, 1997; Webler, 1999). Nor are we comparing or evaluating models of participatory processes (for approaches to comparative evaluations see Eiter & Vik, 2015; Hassenforder, Smajgl, & Ward, 2015). Here we build on the findings of other researchers to specifically identify an approach that seems appropriate for the mining context concentrating on the dimensions of *who* to engage and *how* in a process that may extend over years, even decades, and will involve potentially conflicting judgements of economic opportunity, risk and responsibility.

A stakeholder panel is an established means of natural resource management and catchment management that involve group deliberation of relevant factors from various perspectives and identification of potential areas of conflict and of consensus. We suggest that a stakeholder panel (or participatory advisory committee or reference group) is a useful and appropriate approach for participatory decision-making about agreed land uses in the mining rehabilitation context. While there are limited examples in the mining context (Minserve Group & CQU, 2007; Owen & Middlin, 2010), in other settings, such a panel is often advocated as a robust strategy for managing shared land since it provides a forum for managing risk and supporting stakeholder assessments, analysis and decision-making as a basis of adaptive management in dynamic and uncertain situations where questions of sustainability are an issue (Doelle & Sinclair, 2006; Glass et al., 2013; Leys & Vanclay, 2011). A stakeholder panel, which involves a limited number of participants, is particularly appropriate in the context of planning in central Queensland where the number of potential landholders and viewpoints are fewer than for other decision making contexts such as regional planning or developments in urban areas. Stakeholder panels can participate in a process of adaptive interaction and decision making at intervals throughout the mine life-cycle. The panels would involve different roles for the regulator, proponent, graziers and other stakeholders with some of the challenges at each stage collaboratively tackled to ensure effective and lasting strategies. Table 1 proposes the role stakeholders could play at various points throughout the mine life cycle to complement the roles and responsibilities of the relevant state government departments and mining companies and provides samples of questions relevant to all parties.

The composition, structure and modus operandi of panels suited to rural change vary considerably. As one example, for rural producers, Chataway (2006) outlines a process of identifying 'hosts' of primary study sites and then using existing industry discussion groups, of which the host landholders were members, as reference groups. In the case of mine rehabilitation the appropriate 'hosts' would be underlying landowners and neighbours, with industry groups such as the Queensland Farmers' Federation and Agforce, or resource groups like Landcare, or Catchment Associations potentially acting as the reference groups. This would allow consideration of different scales of interest – both localised, regional and statewide. Other examples are commonly used for regional and landscape level planning notably multi-sectoral committees and community management boards (Eberhard, Johnston, & Everingham, 2013; Kellert, Mehta , Ebbin, & Lichtenfeld, 2000; Robins & Dovers, 2007).

As well as considering different forms, scales and functions, it is also valuable for group decision processes to include strategies to focus the discovery, dialogue and decision making and to bridge boundaries between the different perspectives of the ecologist, mine technical experts, regulators and various community stakeholders. Each of these stakeholder groups has its own body of knowledge, values, priorities and standards which often result in apparently incompatible positions. Arguably a key purpose for engaging different perspectives will be to explicitly address the lack of certainty about some issues such as the residual risks associated with mined land. Groups who participate in the stakeholder panel need to draw on diverse forms of knowledge and be able to understand not only basic biophysical data but also the drivers and barriers affecting land managers and the impacts of land management practices on key regional assets and ecosystems (Byron & Lesslie, 2008).

For a stakeholder advisory panel working on rehabilitation and closure planning at a landscape level, to "incorporat[e] different viewpoints in a fair and flexible manner" (Star, 2016, p. 246) requires holistic consideration of multiple interlocking social, economic and ecological systems involving a range of stakeholders. Each stakeholder group has a "local view that includes information about only a subset of the tasks" (Star, 2016, p. 246). Participatory approaches for choosing post-mining landscapes assume that stakeholders are well-positioned to define the varied challenges and opportunities they face and that they have the capacity to respond effectively to their own life circumstances. These may not always reveal conflicting interests. Collier (2011) demonstrated that stakeholder engagement in open planning and decision-making without prior prescriptions, brought stakeholders to a desire for multiple land uses and similar rehabilitation conclusions and goals as ecological practitioners, academics, and NGOs.

An advantage of group situations is that they facilitate stakeholders' learning from one another and provide the basis for understanding of landscape-scale effects and intersections with policy decisions. Rather than top-down application of formulaic regional development strategies, these situations rely on "learning the specifics of a particular setting and enabling participants to learn from their own experience and that of others" (Ostrom, 2005, p. 275). Considering the perceptions of groups of stakeholders in aggregate is appropriate because landholders are not isolated decisionmakers and the role of collective processes and group dynamics in farm management choices should be recognised and incorporated into engagement processes (Milestad et al., 2012). Group settings stimulate greater reflexivity and allow participants to explain and qualify their responses or identify important contingencies associated with their answers – important elements of exploring hypothetical scenarios or projecting the future (Stewart, Shamdasani, & Rook, 2007).

Although stakeholders may seek out additional expertise and technical information, deliberative decision making amongst the stakeholder panel is most productive if it happens in a dialogical and

interactive way and the stakeholders are empowered. Rather than information being obtained from various parties as the basis for separate synthesis or 'ajudication' by 'experts' about the best solution or trade-off, knowledge and understanding are co-produced by engaged parties with the assistance of facilitators. The facilitators "open up spaces for dialogue between these contrasting modes of knowledge construction built upon different life experiences, expectations and identities" (Long & Beierle, 1999, p. 19). Menconi, Grohmann and Mancinelli (2017) conducted a systematic review of participatory processes involving farmers. They identified both strengths and weaknesses in the involvement of farmers in decision-making, for example, often in such processes farmers were engaged only as a source of information rather than as active participants in the choices for the protection, management and transformation of the rural territory. Thus genuine empowerment through a deliberative process, especially of potential future landholders, is consistent with the general literature about agricultural innovation, sustainable farming systems and responsible land use management which designates the role of the landholder as crucial to successful farm management (Grigg et al., 2006; Milestad et al., 2012). Such an approach also recognises Australian farming as a multifunctional management exercise with production, consumption and protection objectives. Graziers are those who routinely manage central Queensland's rural spaces but opportunities for them to collaborate with those making decisions about the transformation of these territories after mining have been limited.

5.Tools and techniques to focus and facilitate stakeholder panel decision-making

This section identifies from the literature specific techniques that may assist and add value to stakeholder panel deliberations drawing on the considerable interest in developing tools and techniques to focus and facilitate the participatory decision-making including the use of visual prompts, spatial representations, GIS visualisation methods and interactive modelling (de Groot,

Alkemade, Braat, Hein, & Willemen, 2010; Minserve Group & Central Queensland University, 2007; Owen & Middlin, 2010; Svobodova, Sklenicka, & Vojar, 2015; Voinov & Bousquet, 2010). Such methods are particularly useful for mining landscapes where the dramatic changes to the landscape may be hard to visualise without aids. Research about some of these and their application to mining landscapes is outlined in this section.

Research evidence suggests there is potential for interdisciplinary groups and stakeholders with different areas of expertise to cooperate successfully despite having different goals, time horizons and methods of working with data and not fully understanding the models of others (Star, 2016). The success of such efforts is facilitated by the development of bridging social capital if very disparate social groups are involved (de Krom, 2017) and by the use of what has been called a "boundary object" (Star, 2016). An abstracted map is a prime example of a boundary object to be a hypothetical but authentic representation for all parties to communicate and cooperate over tackling a multifaceted task (Star, 2016).

The use of GIS, mapping and visual representations have potential for engaging landholders (Minserve Group, 2007; Owen & Middlin, 2010). These tools facilitate realistic consideration of landholding-scale sites and can lead to better understandings of relationships among topography, ecosystems, economics and other dimensions (Andrews, McMullen, & Grimshaw, 2007; Teutsch, Collins, & Ditsch, 1999). Spatial tools allow rural land use decisions to be attuned to a particular landscape context as well as based on the specific needs of the agricultural sector and the socioeconomic and environmental consequences (Tassinari, Torreggiani, & Benni, 2013). Spatial mapping, for example, is a powerful tool for understanding the socio-cultural realities of landscapes and ecosystems. It enables

the localization of potential conflict areas and the representation of multiple dimensions including intangible ones that may not readily be quantified.

Visual representations have been used in some stakeholder group contexts as suitable analytical and design tools and techniques to aid decision-making and identify preferences and perceptions. Visual indicators can give strong representation of a range of physical, chemical and biological properties and conditions that are readily assessed by the practised eye (Tongway & Hindley, 2004). Various tools appropriate to land use change decisions combining ecosystems and restoration targets have been researched (see de Groot et al., 2010 for an overview). For instance, Byron and Lesslie (2008) report using GIS to integrate remotely sensed information, land parcel boundary information, forest and reserve mapping, land cover, and local government zoning with data from a social survey of landholders about their values, perceptions and practices. This demonstrates the potential of spatial methodologies to provide material to aid group deliberations. Other researchers have compared qualitative assessments of biophysical and socioeconomic parameters obtained in focus groups of local stakeholders with resource management categories and decisions based purely on GIS data (Mehra, Singh, Abrol, & Oinam, 2017). Though this research did not advocate synthesis of different data it provides an assurance of the authenticity of the GIS representations. Visual landscape preferences and judgements on the basis of realistic configurations of visual clues and attributes are established techniques in some planning situations (Svobodova, Sklenicka, Molnarova, & Salek, 2012). Typical attributes of a post-mining landscape can be identified and used in an assessment of post-mining options as demonstrated by Svobodova and colleagues (2012). They found seven variables were significant to acceptance of mining land rehabilitated to agricultural or forestry uses to restore productive functions.

Along with static GIS maps, time-series land use mapping at various scales can be developed using diverse information sources to track significant trajectories in land use change and understand the interaction of variables. It also allows comparisons of different scenarios and improves transparency about trade-offs and costs as well as integration of local knowledge (Ungaro, Häfner, Zasada, & Piorr, 2016). One suggestion in this vein is representing a small number of alternatives spatially, with maps or photographs as shared information to stimulate dialogue among a range of viewpoints. This is seen as appropriate for multi-dimensional decisions especially ones that can have wider public good implications and also to "induce participants to assume a longer-term and more socially-oriented position" (Bunse, Rendon, & Luque, 2015, p. 90).

Multi-criteria analysis in combination with GIS mapping is a common analytical decision making approach to reach agreement about different land use planning decisions. Logan, Murphy and Beale (2007), describe a hybrid assessment technique based on multi-criteria analysis, risk analysis and cost-benefit analysis in which alternative closure configurations are scored on an integrated set of weighted criteria. They suggest the advantages of the technique are its ability to be customdesigned to accommodate meaningful environmental, social and economic criteria and the userfriendliness that facilitates the engagement of stakeholders. Applications of the multi-criteria approach to particular sites in central Queensland have been described by Grimshaw (2007) and Welsh, Bianco and Roe (2007). Other techniques that show promise are using "spatial units" to support syntheses of land-use, economic, agricultural, and landscape planning (Tassinari et al., 2013) and employing a hypothetical grazing land management scenario to explore, through choice modelling, graziers' reasons for and the costs of particular patterns of decision making on rangeland properties (Gregg & Rolfe, 2016) as well as game-style challenges under various scenarios (Lamarque et al., 2013). The importance of assessment methods involving economic aspects besides physical, agronomic, and ecological ones is being increasingly advocated in rural land-use planning (Tassinari et al., 2013). The

inclusion of the economic criterion is appropriate since efficiency is a key priority for graziers. However, producers may have multiple values in addition to the profit-maximising criterion especially when they are confronted with considerable uncertainty and constantly changing circumstances. For farm managers to achieve higher enterprise and environmental efficiency the limits and associated costs need to be understood (Gregg & Rolfe, 2016).

This body of research points to the use of a visual 'boundary object' to facilitate stakeholder deliberations given many of the characteristics of the challenges involved in considering post-mining land uses. Stakeholders must come to practical conclusions about hypothetical and hard-to-visualise landscapes that require economic, social and environmental considerations in the public interest as well as self-interest. In such situations, presenting stakeholder groups with a realistic post-mining landscape can stimulate dialogue and elicit people's experiences, values and preferences.

6. An alternative approach to post-mining land use decision-making based on utility

Unclear and unformulated approaches to rehabilitation and mine closure in central Queensland pose environmental risks and economic burdens for mining companies, government and the pastoral industry (Fourie & Brent, 2006). The uncertainty prevailing in this jurisdiction contrasts with other coal mining regions where more guidance is provided (for example the USA see Skousen & Zipper, 2014). To propose a pathway to more functional outcomes, this paper has focussed on exploring the potential for stakeholder input with regard to one of the four sustainability goals of mine rehabilitation and closure as specified under Guideline 18 in Queensland – "Agreed beneficial land use" (Department of Environment and Heritage Protection, 2014). Rather than the various rehabilitation goals being achieved sequentially they are presumed to be iterative. Stakeholders input is represented in Figure 1 as being primarily related to the fourth goal of agreed land use (solid line), however, it will influence deliberation on other goals since they affect agricultural management (dashed line). Agreed beneficial land use has not received the systematic attention that has been directed at the other three goals – safe, stable and non-polluting landscapes. If rehabilitated landscapes are designed and implemented to optimise post-mining utility and with guidance and agreement of stakeholders to prevent poor decisions early in a mine's life, long-lasting negative legacies may be avoided. This paper proposes an approach to decision-making about postmining land uses – or utility – on the basis of its exploration of two questions.

First it concludes that most of what is known about the opportunities and risks of grazing as a postmining land use in central Queensland's Bowen Basin is based on techno-scientific knowledge – notably crucial environmental science about the success factors in rehabilitating to pasture and impacts of grazing on the stability, safety and non-polluting status of land rehabilitated to pasture. However only a handful of studies have considered the opportunities and risks from the perspective of potential future land users and the issues they consider in determining long-term utility of a property. This leaves a major gap in knowledge about production, consumption and protection goals of stakeholders and the critical factors in land management decisions by graziers that affect communities' well-being. The proposition therefore is for stakeholder participation in establishing rehabilitation plans and post-mining land uses.

There are different views about the status of input from stakeholders and potential future land users in formal mine closure processes, and no clear demonstration of how that input on one of the four closure goals would be balanced with scientific and technical understandings in decision-making. A second proposition in the paper is for a collaborative process based on greater understanding of the factors influential in decisions of the wider group of stakeholders. This perspective could inform closure processes and improve confidence in some options. For instance, understanding of land uses

that would be deemed acceptable/ appropriate on mining leases once mining has finished and the factors that stakeholders take into consideration to determine suitability of land to grazing may be of value to proponents in planning their rehabilitation practices and also to regulators in considering whether rehabilitation outcomes satisfactorily maximise residual opportunities of post-mining land and minimise the risks (to the land, the miner, the pastoralist and the Queensland public interest/ government). In line with this, Table 1 suggests potential roles for stakeholders alongside those of proponents and regulators throughout the mine life-cycle and regulatory process. This sort of collaborative governance of multi-dimensional land use changes allows for consideration of the interdependence of environmental, social and economic factors and is emerging in many contexts (Banzhaf et al., 2017).

Third, the review suggests that an appropriate model for engaging and empowering a stakeholder panel to play that role would have the following characteristics:

a. Ideally meaningful engagement of stakeholders would begin early and continue at intervals throughout operations and the rehabilitation and closure processes. This would allow for adaptive management and community preferences and considerations of utility to be built in alongside consideration of more technical and scientific constraints and objectives.
b. The stakeholders involved should be a cross-section of predominantly local people who are potentially affected in some way by closure and by decisions about future land use notably graziers as potential future land-users as well as other 'experts'.
c. The question/ challenge or task set for this group should be very open so as not to constrain innovation and the synergies of harnessing multiple resources and diverse experience and perspectives.
d. Group deliberations focused on an authentic case and with the ability to draw upon a range of expertise should play a major part in the process.

To a large extent that leaves unanswered the question of how decisions reached in such groups and by such processes would be integrated with current evidence and decisions weighed in progressive certification and mine closure processes. Those issues of combining ecosystem, economic and social functions holistically are matters that decision makers and standard setters will need to determine, and a pilot or 'virtual' demonstration of what could be achieved through a process such as that outlined above could suggests options for aligning the regulation of rehabilitation and closure with the public interest and the interests of potential future landusers.

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