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Peak Minerals: Mapping Sustainability Issues at Local and National Scales

Category – Limits to growth

ABSTRACT

Peak minerals adopts the Hubbert metaphor for peak oil to highlight issues associated with initial mining of 'cheaper, more accessible and higher quality ores' pre-peak, to 'lower grade, more remote, complex and expensive ores' post-peak. In doing so, it prompts focus on the 'services' provided by the resource in-use as well as the transition strategy to supply those services following the decline of production post-peak.

This paper applies the peak minerals metaphor as a basis for examining the social and environmental implications pre- and post-peak production across spatial scales. Using document review and stakeholder analysis from a National Peak Minerals Forum held in Australia, social and environmental impacts are mapped at local and national scales.

This innovative mapping found that currently, consideration is given to local social and environmental issues and global economic issues, however, triple bottom line issues at the national scale are currently overlooked. As minerals resources belong to the people of a nation, this finding will inform future approaches to transition strategies seeking to maximise long term value for the use of the resources.

1. INTRODUCTION

Demand for Australian non-renewable mineral resources is rising, in large part driven by demand from China. Production increases by 2020 needed to meet demand range from between 50% for copper and iron or to more than 100% for zinc and nickel (Access Economics, 2008). However, the ores being mined to supply this demand are of increasingly lower grade and are more complex to process (Giurco, Prior, Mudd, Mason, & Behrisch, 2010; Mudd, 2007) and whilst Australia will not physically run out of these resources – economic, social and environmental constraints can hasten the onset of peak minerals (Mudd & Ward, 2008). Declining ore grades also significantly increase environmental and social impacts (Giurco & Petrie, 2007; Norgate & Haque, 2010) and for mining regions, the issue of cumulative impacts from multiple mines is also of concern (Franks, Brereton, & Moran, 2009). Currently, little consideration is being given to how environmental and social impacts change through time – over the life of the peak production curve – at local and national scales (Giurco, et al., 2010).

This paper uses the Hubbert model developed for peak oil (Hubbert, 1971) as metaphor for peak production in minerals, highlighting the need to better understand:

- social and environmental impacts at different stages of the peak, and
- how understanding impact profiles along the peak production trajectory can inform sustainable minerals management and deliver long term benefit to regionally and nationally.

2. PEAK MINERALS METAPHOR

Hubbert (Hubbert, 1956) proposed a forecast for the timing of peak production of oil from mainland US states as shown in Figure 1Figure 1. Whilst the 'peak' concept has been subsequently associated with 'when will production peak' as highlighted by (Hemmingsen, 2010) whilst giving lesser focus to other aspects of Hubbert's work, namely, that irrespective of the exact year of peak production post-peak extraction will be more difficult, prompting the need to focus on developing a transition technology to provide the energy services. Additionally, supply disruption during transition could cause economic impacts.

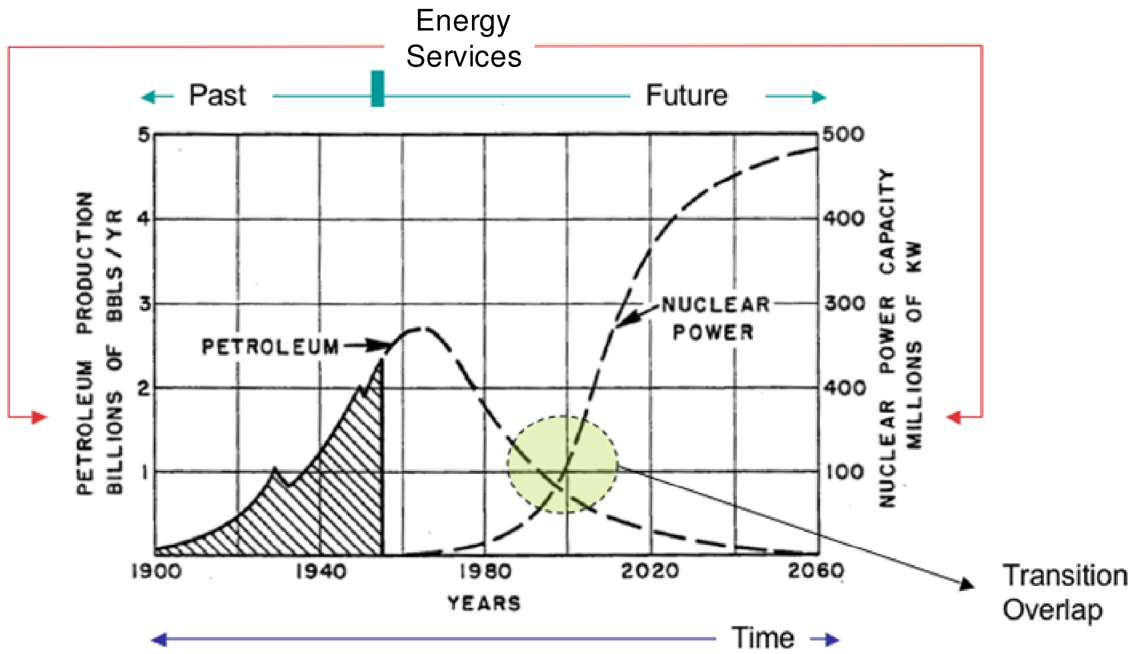

Figure 1: Hubbert's prediction for peak oil production in the lower 48 states of the USA and a potential transition to nuclear power to supply the energy services (adapted from (Hubbert, 1956))

The applicability of the peak oil metaphor to minerals is described more fully in other literature (Giurco, et al., 2010; May, Prior, & Giurco, 2010), including the differences with respect to understanding discovery, production, ultimately recoverable reserves and the fact that metals from minerals are recyclable and therefore potentially available for reuse (when not tied up in in-use stocks). The generic peak minerals metaphor used in this paper is shown in Figure 2.

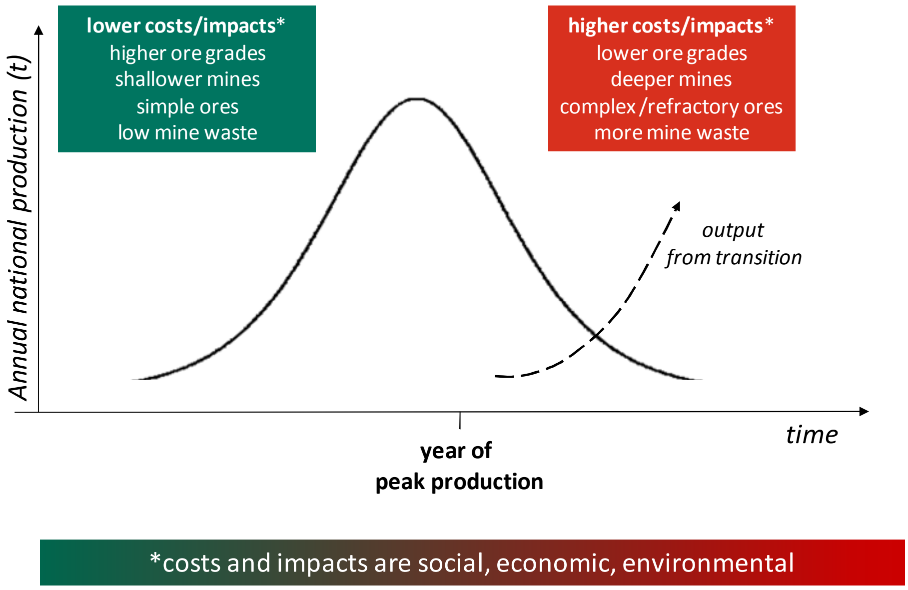

Figure 2: Generalised peak minerals metaphor

Figure 2 highlights that production post-peak is characterised by higher costs and impacts, arising from lower ore grades (as higher grades become exhausted), deeper mines (as shallower deposits are exploited), more mine waste (from obtaining the same amount of product from lower grades or deeper mines) and more complex/refractory ores (for example the move to processing nickel laterites following the decline in available sulfide deposits). The generalised transition (dotted line) indicated can be interpreted in different ways, depending on what the peak production curve is taken to represent; for example:

- if the peak curve represents aggregate national (or local) minerals production, the transition could prompt the question of what (other) sector could underpin the prosperity of the nation (or local area) following the decline of the mining sector;
- the second way in which the metaphorical peak can be used is to focus on assessing the disruptiveness of the transition – this is explored further by (Mason, Prior, Mudd, & Giurco, 2010).
- finally, if the peak curve is for a specific commodity such as copper, then it could prompt consideration of what transition material will supply the services to which copper is currently integral following peak production (recycled copper, another metal as aluminium for carrying electricity or non-metal such as plastic water pipes).
    - this line of argument is more pertinent to a commodity approaching a global peak – such as oil – than a national peak, as following a decline in Australian copper production it is likely to be sourced from other countries overseas (e.g. Chile). Whilst an Australian peak would not be a problem for global supply, the economic, social and environmental consequences of declining national production must be managed.
    - by focussing on a single commodity, the role which future technologies could play in moderating the current peak, or, in unlocking a transition to a second new peak for the commodity (such as occurred with the use of the carbon in pulp process for gold, see (D. Giurco, et al., 2010) (G. M. Mudd, 2007).
    - the remainder of this current paper seeks to explore the role which social and environmental constraints could play in limiting supply or changing demand, by mapping them at different scales across the peak production curve.

3. SOCIAL AND ENVIRONMENTAL IMPACTS ACROSS SCALES

This section explores how the social and environmental impacts map across a generalised peak production curve (i.e. not for a specific commodity or location) and discusses the connections between them with a view to identifying connections and areas of further investigation required to understand their potential influence on peak minerals and in the longer term, to sustainable resource management.

3.1. Social impacts at the local scale

When examining the influence of peak minerals on society, it is clear that impacts vary at different scales: local, regional/national and global. At an international scale, (Clark & Cook Clark, 1999) identified tenure and social issues as the two most important factors that would impact on global mining operations in the future. More locally, in a survey of mining industry representatives, namely, members of the Australian Institute of Mining and Metallurgy, (Moffat, Mason, & Littleboy, 2009) it was found that although social issues were not considered of primary importance as future drivers in the Australian industry (with economic and environmental drivers rated more highly), they were nonetheless considered significant. That these concerns vary merely demonstrates the variability inherent in the social dynamics of the minerals industry.

Figure 3 shows the mapping of local social considerations to the peak production curve and further descriptions and references are given in Table 1. National and global considerations are explored further in (Giurco, et al., 2010).

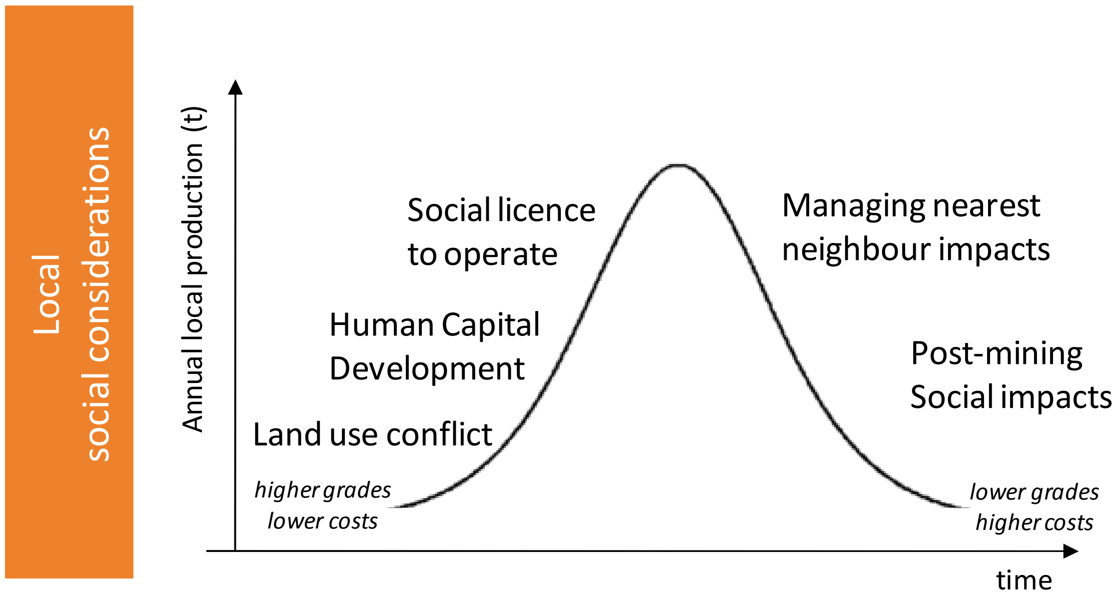

Figure 3: Local social considerations consideration mapped to the peak production curve (D. Giurco, et al., 2010)

Table 1: Social considerations at different stages of the peak minerals cycle

Issue	Description / Example	Reference
Land use conflict	Conflict between farmers and miners in Liverpool Plains, New South Wales	(Hilson, 2002; Smith, 2009)
Social and human capital development	The level of dependence between mining and the community varies between communities, in relation to the mined commodities, and as a result of the way mining companies operate in different localities.	(Solomon, Katz, & Lovel, 2008; Stedman, Parkins, & Beckley, 2004; Warhurst & Mitchell, 2000)
Social licence to operate	Social licence refers to the demands on industry from citizens to going beyond compliance with respect to corporate responsibility	(Gunningham, Kagan, & Thornton, 2004)
Managing nearest neighbour and cumulative impacts	The resource rich nature of some localities means they are likely to experience the cumulative impacts of several mining operations.	(Brereton, 2003; Franks, Brereton, & Moran, 2009)
Post-mining social impacts	Post-mining social impacts can arise from job losses, economic impacts and health impacts post-mine closure.	(Marcello, Malcolm, & Mary Louise, 2001; Otchere, Veiga, Hinton, Farias, & Hamaguchi, 2004)

Figure 3 is a generalised representation of the issues with respect to the production cycle. Mapping the issue through time from the perspective of the community is shown in Figure 4 with specific identification of mediating processes.

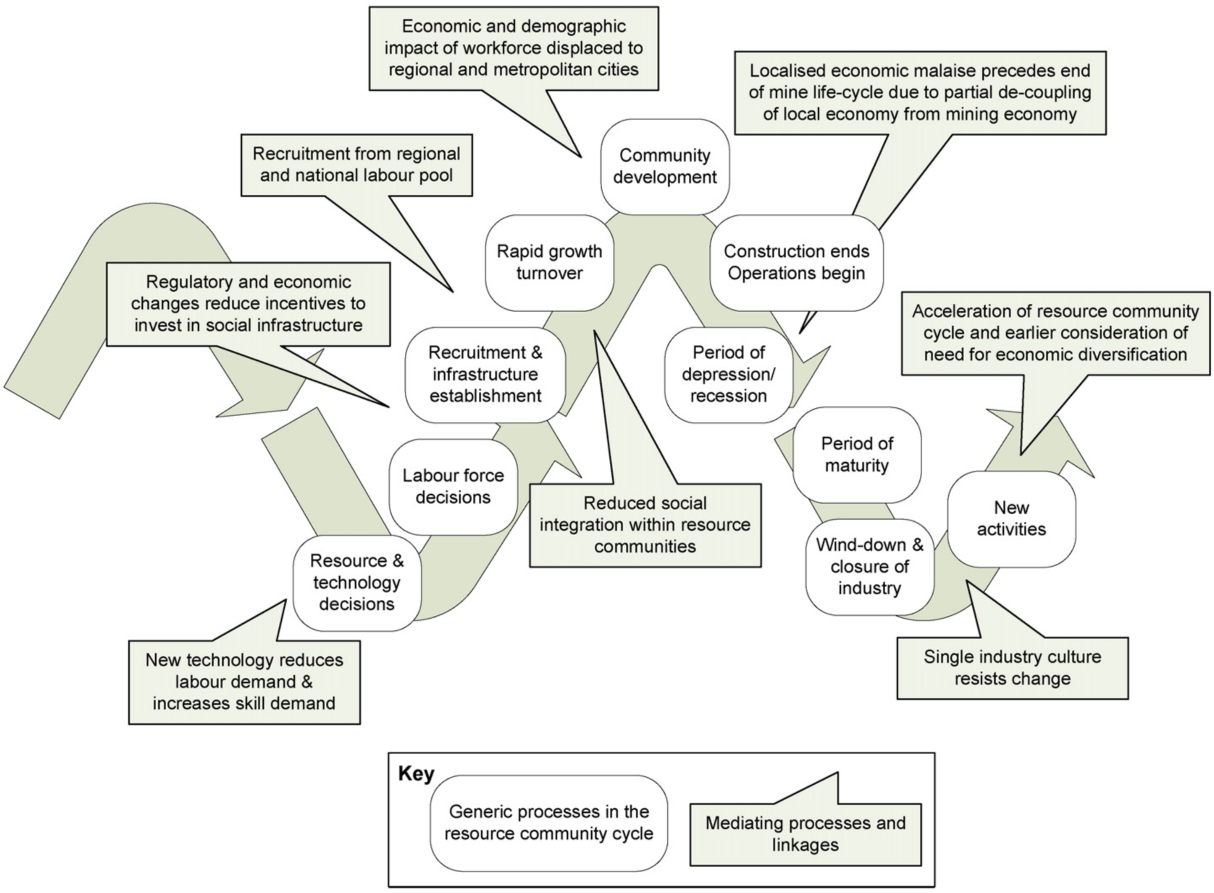

Figure 4: The resource community cycle (Lockie, Franettovich, Petkova-Timmer, Rolfe, & Ivanova, 2009)

3.2 Environmental considerations and local and national scales

External environmental factors affect mining and processing production patterns, including climate change and input constraints (such as water and energy). However, mining and minerals production also gives rise to its own environmental impacts as shown in Figure 5 for local scale considerations.

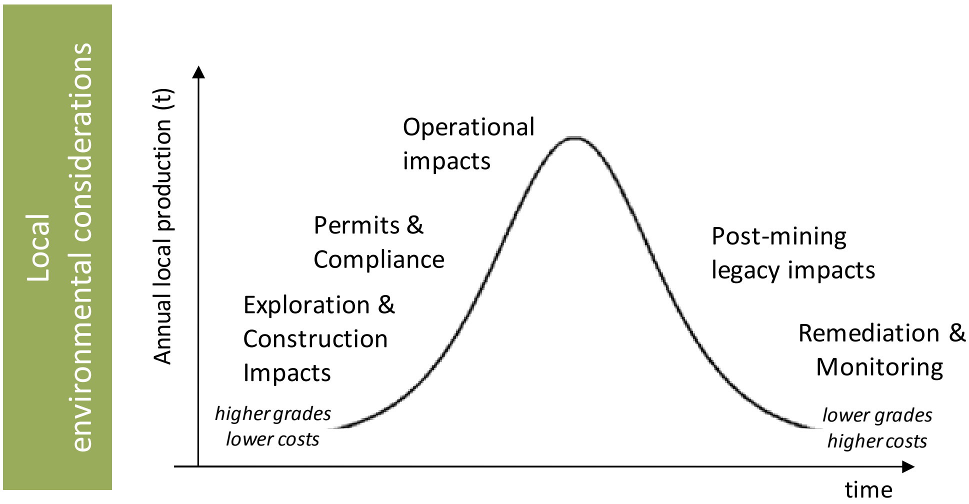

Figure 5: Environmental impacts mapped along peak production curve at the local scale

Considerations for the national scale are shown in Figure 6, with a particular focus on the environmental issues states or the nation as a whole would need to consider in relation to peak production from any given mining sector. Whilst there are similar themes when compared with local environmental (exploration and construction permits, impacts and governance) there are distinct ones such as strategic assessment and the environmental regulation of post-mining issues (who pays for cleanup of abandoned mines or contaminated rivers?). Strategic assessment here refers to the question – if as a nation we have depleted our own stocks of particular metals and mining revenue streams, how will this affect our ability to respond to environmental challenges in the economy more broadly, especially if environmental and social externalities were inadequately incorporated into the revenue streams obtained from resource extraction (Prior, Giurco, Mudd, Mason, & Behrisch, 2010).

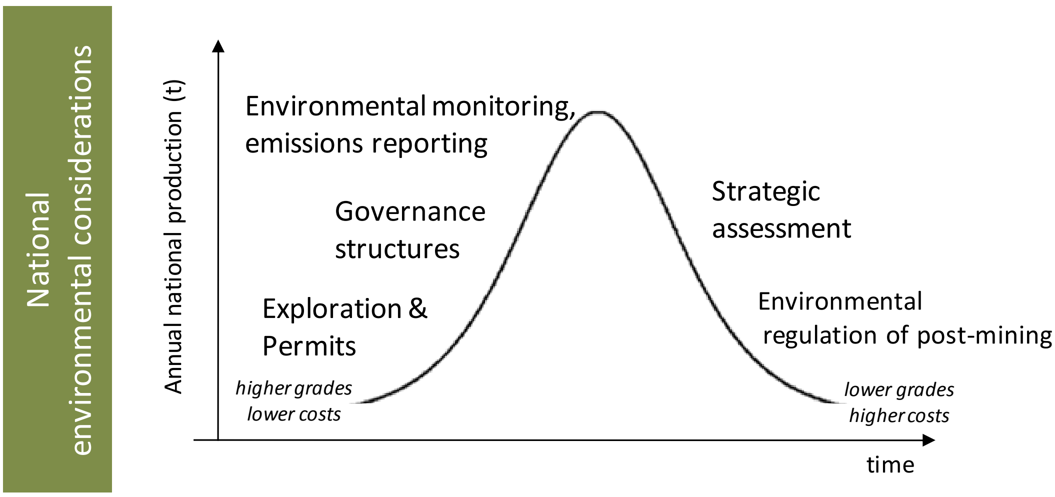

Figure 6: Environmental impacts at the national scale mapped along the peak production curve

Both Figure 5 and Figure 6 position selected impacts or issues along the peak production curve. Additionally and critically, one needs to engage with how such issues affect different stakeholder groups, from communities to mining companies and governments (Giurco, et al., 2010). These issues were explored in early 2010 at a National Peak Minerals Stakeholder Forum in Sydney, discussed further in the next section.

3.3 Stakeholder views from National Peak Minerals Forum

The National Peak Minerals Forum (Institute for Sustainable Futures, 2010) was held in Sydney in April 2010, bringing together a range of stakeholders from across sectors to discuss how the issue of peak minerals is understood from different perspectives and how this can link to informing future resource governance strategies.

The forum focused on how peak minerals represents a symbolic change from the current mining of cheap, accessible, easily processed ores, to a future where lower grade, more complex and inaccessible ores remain. Australia's largest mineral exports are iron ore, gold, copper and alumina, and high-grade reserves are being depleted. Whilst estimating the long-term availability of commodities is difficult, rising production rates shorten resource life, and new greenfields discoveries of high quality ores are not being made. Efficiency gains have offset declining grades to date, but water and energy use is rising. The role of new technology being developed by CSIRO was then explored, including in processing iron ore with phosphorus impurities, using bio-char in steelmaking to reduce greenhouse gases, in heap leaching of nickel laterites and in-situ leaching of gold. The impact of the minerals industry on Australia was then discussed, noting the challenges of a stronger dollar and higher interest rates. A sovereign wealth fund was explored as a way to avoid currency appreciation and capture long-term wealth from minerals processing.

There was general acknowledgement that 'peak minerals' in Australia will place increasing pressure on the competitiveness of Australian mining, though for most minerals a peak in production had not yet occurred. Priority actions identified by participants were:

- Establishment of clear incentives that can support industry developments towards sustainability.
  - Extensive R&D into mine site remediation. Development of less intrusive mining techniques (e.g. keyhole mining). Technology designed now that meets the needs of the future
  - More efficient extraction of minerals from co-deposit mines.
  - Legislative or market-based mechanisms to improve production efficiency.
- Development of business models around resource custodianship.
  - Higher use of waste streams; value drawn from waste via reprocessing/recycling.
  - Localisation of society around resource flows.
- Nationally coordinated research to foster ecological analysis, systems thinking, philosophy to guide decision-making.
  - Investment in R&D for technologies to help Australia to out-compete countries whose competitive advantage lies in value adding (e.g. Low-cost labour in China).
  - Sector mind-set change from production to service establishment (e.g. minerals custodianship).
  - Increased government involvement in diversification of the economy.

Turning the discussion toward how best to respond, participants identified four key areas for positioning the minerals industry within a more sustainable Australian economy:

1. Technological advances as key factors in the future sustainability of the mining industry.
2. Structures for long-term decision-making that can assist the development of effective minerals policy.
3. The establishment of Australia as minerals services hub, not simply a quarry for global mineral needs.
4. Ensure impacts from mining are balanced by better and more even distribution of wealth from minerals.

Barriers and enablers for each area were identified, highlighting the link between social and environmental issues at different stages of the peak production curve. For example a barrier to the second area "long term decision making" was the weak structures which exist for including social and environmental considerations in decision making and the Ministerial Council of the National and State governments to facilitate industry and government collaboration on long term planning.

4. DISCUSSION AND CONCLUSION

The concept of resource production peaks has been popularised for many decades following Hubbert's analysis of peak oil. However, there has been much less research directed to understanding the social and environmental issues through time associated with the peak minerals production trajectory is important for raising awareness of these often externalised issues and how they change across scales and through time. This paper has used a conceptual peak minerals model to map these issues across scales and presented resultant stakeholder reflections. Building on the results of the Australian National Peak Minerals Forum, it was found that whilst local and community issues receive attention, monitoring and the development of a coordinated response to national issues is lacking.

Future work will further develop indicators to inform sustainable minerals management that delivers long term benefit to regions and the nation as whole.

5. ACKNOWLEDGEMENT

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