# Does coal mining benefit local communities in the long run? A sustainability perspective on regional Queensland, Australia

*Galina Williams, Jeremy De Valck, Ruth Nikijuluw*

## 1 Introduction

The Australian State of Queensland has a long history of coal mining. The Bowen Basin area in Central Queensland is particularly active, featuring most of the state's coal mines and including some of the largest ones by export volume (Huleatt and Jaireth, 2009; Queensland Government, 2016). The Bowen Basin contains the largest reserves of bituminous (or "black") coal in Australia (BBUGS, 2016), which have attracted a lot of extraction companies over the past decades. Coal mining is therefore a significant contributor to Queensland's economy and has often been a favoured option for land use over agricultural land or nature conservation.

However, coal mining is a mature industry in the region and a general decline in that industry's productivity is being observed (Lovell and Lovell, 2013; Queensland Government, 2013). This phenomenon raises concern about long-term economic sustainability in this area. Increasing rates of mine closure over the next decades will require attention from industry and policy-makers to ensure there is a well-defined process for closure and change of land use. In addition, coal mining is a lucrative option but that comes at substantial social and environmental costs. For instance, coal mines generate air, water and land-based pollution while in activity, and mine lands may remain unsuitable for other uses long after their exploitation period due to the level of disturbance and the risk of subsidence. The economic impacts borne locally can be significant and may leave local communities even worse off than before the exploitation of those mines.

The local positive impacts of coal mining that contribute to favouring this option to support regional economic development may look vastly different when additional factors are considered. A large proportion of coal mining workers are FIFOs/DIDOs (Fly In-Fly Out/Drive In-Drive Out), which means that the higher wages paid by the mining industry will not necessarily result in local economic development as workers simply live elsewhere. Another argument is that coal mining only offers short-term economic development, whereas traditional industries like beef production offer more modest, but long-term revenues. To ensure that local communities truly benefit from economic development in the long run, we argue that a sustainability perspective should be taken. This implies considering all detrimental costs associated with coal mining and the many benefits of other land use options not traditionally accounted for in land use planning decisions.

This paper suggests a method that can be followed to approximate the true impact of coal mines to the economy relative to other land use management options, and when the many externalities generated by that industry are correctly internalised. Our approach considers grazing and nature conservation as two alternative land use scenarios to coal mining. The different costs and benefits of each of these three options are identified for the study area and used in a cost-benefit analysis (CBA). The objective of this CBA is to highlight the pros and cons of various land use scenarios to advise future land management policy-making in that area.

## 2 Case study

This case study covers three natural resource management regions –Burdekin, Mackay Whitsunday and Fitzroy– along the Great Barrier Reef in Central Queensland, Australia. Figure 1 shows current land use patterns in the study area and stresses the growing area covered with coal mines. Queensland land use data (Queensland Government, 2019) were combined with three coal mining datasets, each of them corresponding to a stage in the coal mining expansion:

1. Figure 1.A.: Information on current land use types (2016) was combined with data about coal mining leases (Queensland Government, 2018d);
2. Figure 1.B. combines information from Figure 1.A. and data about “nominated coal mines” (Queensland Government, 2015), i.e. additional mining leases for which applications were launched in 2009-2010;
3. Figure 1.C. combines information from Figure 1.B. and data about “coal exploration permits” (Queensland Government, 2018b), i.e. a third source of information about newly approved coal mining leases in that region.

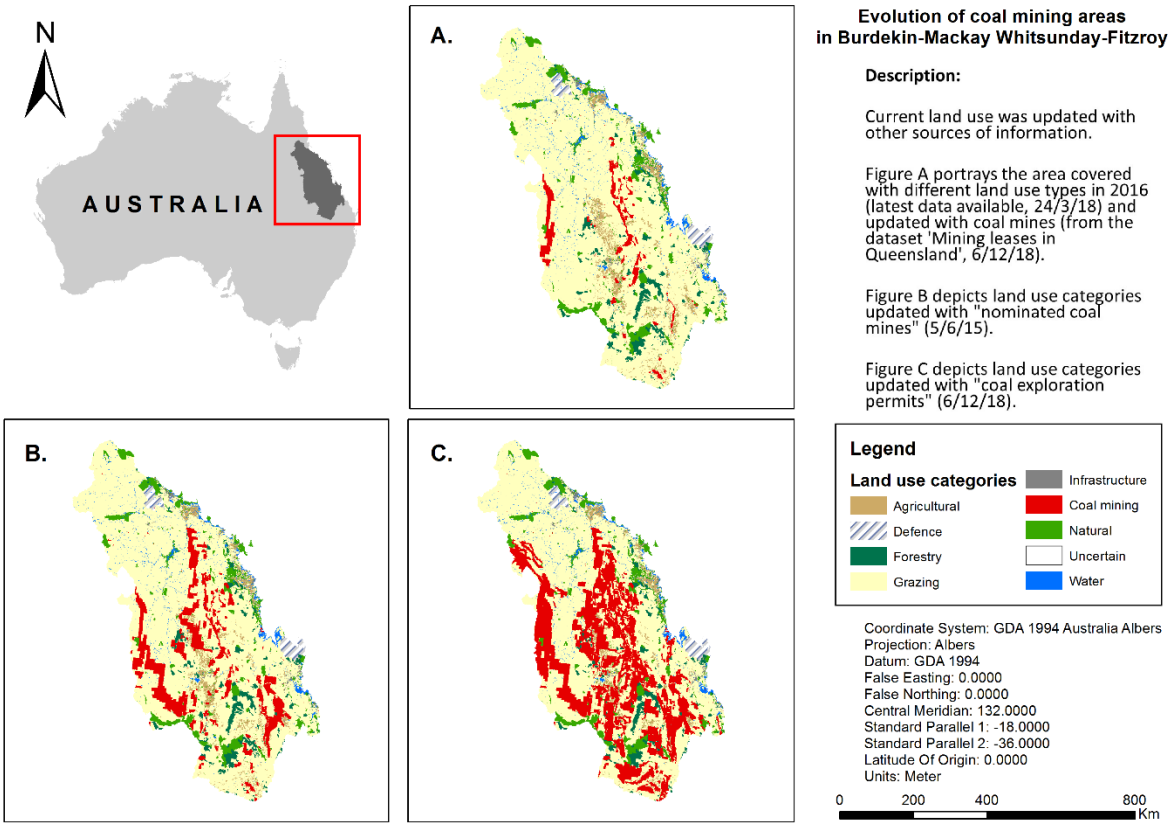


*Figure 1. Evolution of coal mining areas (in red) in the study area*

Figure 1.A. represents the area currently covered with coal mines and Figure 1.C. the total area potentially devoted to mining by 2047. Figure 1.B. represents a partial expansion scenario. It should be noted that only a small fraction of mining leases will be exploited eventually, making Figure 1.C. less likely than Figure 1.B.

Table 1 presents the changes in total area covered with each land use type in the study area from the current situation (Figure 1.A.) to partial (Figure 1.B.) and full expansion of coal mines (Figure 1.C.). Table 2 summarises the relative changes in area for three land use types: grazing (pastures), coal mining and nature. The increasing dominance of coal mines over other types of land use appears inevitable and could reach 2.3 to 7 times its current cover. This transition will likely have significant impacts on local communities and the environment.

*Table 1. Changes in total area covered with each type of land use in the study area and for the projected period (2016-2047)*

| Land use | Burdekin | | | Mackay Whitsunday | | | Fitzroy | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2016 - Current area ($km^2$) | 2047 – Partial expansion ($km^2$) | 2047 – Full expansion ($km^2$) | 2016 - Current area ($km^2$) | 2047 – Partial expansion ($km^2$) | 2047 – Full expansion ($km^2$) | 2016 - Current area ($km^2$) | 2047 – Partial expansion ($km^2$) | 2047 – Full expansion ($km^2$) | 2016 - Current area ($km^2$) | 2047 – Partial expansion ($km^2$) | 2047 – Full expansion ($km^2$) |
| **Agricultural** | 2,556 | 1,861 | 1,548 | 1,551 | 1,551 | 1,551 | 8,875 | 7,153 | 4,580 | 12,982 | 10,565 | 7,679 |
| **Defence** | 2,140 | 2,140 | 2,140 | 0 | 0 | 0 | 2,833 | 2,833 | 2,833 | 4,974 | 4,974 | 4,974 |
| **Forestry** | 893 | 853 | 611 | 737 | 730 | 730 | 9,493 | 9,037 | 7,214 | 11,123 | 10,619 | 8,554 |
| **Grazing** | 119,277 | 111,196 | 95,528 | 3,018 | 3,018 | 3,018 | 117,037 | 104,495 | 76,845 | 239,333 | 218,710 | 175,392 |
| **Infrastructure** | 574 | 566 | 555 | 379 | 379 | 379 | 672 | 651 | 583 | 1,625 | 1,597 | 1,518 |
| **Coal mining** | 4,706 | 13,724 | 30,276 | 7 | 14 | 14 | 5,890 | 21,239 | 54,000 | 10,632 | 35,007 | 84,320 |
| **Natural** | 7,201 | 7,142 | 7,028 | 2,748 | 2,747 | 2,747 | 8,938 | 8,646 | 8,119 | 18,887 | 18,535 | 17,895 |
| **Water** | 3,300 | 3,166 | 2,960 | 644 | 644 | 644 | 1,985 | 1,903 | 1,783 | 5,928 | 5,7120 | 5,388 |
| **Total** | 140,648 | 140,648 | 140,648 | 9,084 | 9,084 | 9,084 | 155,724 | 155,958 | 155,958 | 305,485 | 305,719 | 305,719 |

*Table 2. Relative change in total area covered with pastures (grazing), coal mines and nature in the study area over the projected period (2016-2047) – Partial (P) and full (F) coal mining expansion scenarios*

| | Burdekin (P) | | Burdekin (F) | | Mackay Whitsunday (P & F) | | Fitzroy (P) | | Fitzroy (F) | | Total (P) | | Total (F) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Land use change** | Area ($km^2$) | Relative (%) | Area ($km^2$) | Relative (%) | Area ($km^2$) | Relative (%) | Area ($km^2$) | Relative (%) | Area ($km^2$) | Relative (%) | Area ($km^2$) | Relative (%) | Area ($km^2$) | Relative (%) |
| **Grazing** | -8,081 | -7 | -23,749 | -20 | 0 | 0 | -12,542 | -11 | -40,192 | -34 | -20,623 | -9 | -63,941 | -27 |
| **Coal mining** | 9,018 | 192 | 25,570 | 543 | 7 | 104 | 15,349 | 261 | 48,110 | 817 | 24,375 | 229 | 73,688 | 693 |
| **Natural** | -60 | -1 | -173 | -2 | 0 | 0 | -292 | -3 | -819 | -9 | -352 | -2 | -992 | -5 |

# 3 Methods

We use a CBA approach to gather relevant information to compare the costs and benefits of three land use scenarios: i. coal mining, ii. grazing, and iii. nature conservation. The three options are compared on a spatial basis, i.e. the study area defines the extent of the market. A base case, corresponding to the current situation described in Section 2, is used as the starting point for this analysis. The duration of the project covers the period 2016-2047 as determined by available data about current coal mining leases. It assumes the continued exploitation of all currently granted coal mining leases with no further addition.

The objective is to estimate the net public benefit or cost of each scenario. For doing so, the net cost/benefit of each scenario must be compared with the net social and environmental costs that it generates during the project duration and possibly after the project time (here, the mining exploitation period). The identification of all impacts can be complex and once assessed, their conversion to economic values is not always straightforward. Due to data availability, each land use requires the collection of different types of values, which we describe in the sub-sections below.

## 3.1 Coal mining

To assess the range of costs and benefits associated with coal mining, we follow the valuation framework illustrated in Figure 2. First, the benefits of coal mining must be listed. They take place at different scales (from local to national) and take various forms such as income tax, jobs or royalties. Second, the externalities generated by that industry must be identified and their value must be estimated. For instance, they can take the form of social issues such as traffic, health impacts, increased real estate prices or loss of community identity (Lockie et al., 2009; Petkova et al., 2009). Externalities can substantially reduce the net public benefit of coal mining projects if factored in as project costs. However, because of their indirect nature and the difficulty to assess them accurately, they are traditionally not considered in standard project appraisal and decision-making processes.

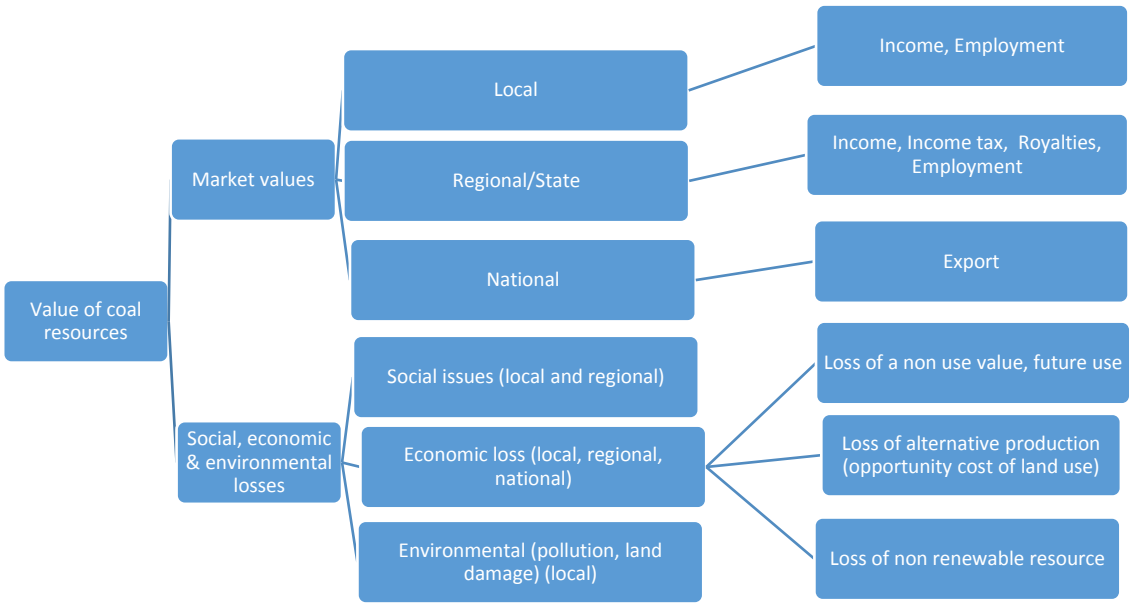


*Figure 2. Valuation framework for the coal mining land use scenario*

Environmental impacts of coal mining can take different forms. First, land itself is degraded through the exploitation of the mine, creating risks of soil erosion, landslides and subsidence. As part of the *Mineral and Energy Resources (Financial Provisioning) Act 2018 (MERFP Act)*, which amends Queensland Government's *Environment Protection Act 1994*, mining companies are now required to rehabilitate the mining site after the mine closure (Queensland Government, 2018c). Second, surface water and aquifers can also be affected: a large amount becomes unavailable for other purposes, and water may become contaminated due to acid mine drainage. Third, air quality may deteriorate (e.g. coal ash) in the area because of mining activities.

## 3.2 Grazing

Grazing remains the main land use in Central Queensland's rangelands, currently covering 78.3% of the study area (Queensland Government, 2019). Low annual rainfall and poor local conditions for cropping make grazing the most suitable agricultural activity in this region. The quality of land for agriculture varies from high quality farming land and improved pastures for cattle, to poor quality land that has marginal grazing capacity. Mixes of land types may often be found on the same property. The scale and ownership of agricultural operations vary, but most can be classified into three groups:

- family owned and operated enterprises (on a single site);
- consolidated large-scale family operations over several properties; and
- agricultural companies.

This type of land is primarily dedicated to beef production. Expected returns from production of beef cattle grazing can be estimated from either a herd modelling approach, gross margin analysis, or an asset valuation approach. We used the asset valuation approach as the simplest to present because it essentially represents the returns after all variable costs of cattle management have been accounted for. This approach involves two steps:

i. Convert sale prices for grazing land in the Bowen Basin into livestock equivalents (value per beast area)
ii. Convert the values per beast area into annual equivalents (AE).

The annualised beast area values provide an indication of what buyers of agricultural land consider to be the annual return after operating costs have been accounted for.

## 3.3 Nature conservation

A nature conservation scenario virtually implies no cost at all but generates a number of benefits through ecosystem services (MEA, 2005). Ecosystem services (ES) refer to the goods and services that human societies benefit from natural ecosystems and that contribute to human well-being (Daily, 1997; de Groot et al., 2002). The Common International Classification of Ecosystem Services (or CICES) is probably the most exhaustive ES classification to date (Haines-Young and Potschin, 2018). CICES lists ES according to their biophysical properties (biotic or abiotic) and according to three categories:

i. Provisioning (e.g. water, timber),
ii. Regulation and Maintenance (e.g. flood regulation, carbon sequestration),
iii. Cultural (e.g. recreation, inspiration).

One way to approach the benefits generated by ES in a nature conservation scenario is to identify the most important ES associated with natural ecosystems in the study area and attach an economic value to each of them (Barbier, 2007; Costanza et al., 1997, 2014). While doing so, one must be careful about risks of double-counting that may exist between different ES categories (Fu et al., 2011). Most provisioning services can be valued using market-based techniques but most of other ES are not traded in any market (Pearce and Turner, 1990). Non-market valuation techniques may be used then to estimate their economic value (Hanley and Barbier, 2009).

# 4 Results

## 4.1 Coal mining expansion scenario

Queensland Governments' Department of Natural Resources and Mines reported the production of 47 operating mines in 2015-2016 (Queensland Government, 2017). Forty of these mines (85.1%) were in the Bowen Basin. We restricted our estimation to these mines. The total production was 242.2 Mt for Queensland, of which 217.3 Mt (89.7%) originated from the Bowen Basin (Table 3). Assuming a similar ratio export/production for Bowen Basin as for Queensland (i.e. 91.5%), we estimated total export to be 194.9 Mt for the Bowen Basin. Based on export values for Queensland, we inferred that the total value of coal exports for the Bowen Basin was about $19.6 billion in 2016. This figures does not account for domestic coal sales (24.7 Mt in 2016) (Queensland Government, 2018a), nor does it account for royalties and indirect benefits (e.g. jobs) consequential to coal mining in this region.

*Table 3. Estimation of the total value of coal exports in the study area (2016) (Source: Queensland Government, 2017)*

| | **Queensland** | **Bowen Basin (study area)** |
|---|---|---|
| **Total production (tonnes)** | 242,177,187 | 217,276,894 |
| **Total export (tonnes)** | 221,500,000 | 194,897,374 |
| **Total export value (billion AU$)** | 21.45 | 19.62 |

Coal mining also induces many social and environmental impacts associated with air, water and land pollution. These impacts are difficult to estimate as the causal link with coal mining is complex to establish. Further research is required to estimate these costs. Another type of cost generated by coal mining relates to the post-operating rehabilitation of the site. Lechner et al. (2016) estimated that rehabilitation liabilities ranged from $1.789 to $5.461 billion for coal mines, roughly in the same area (Fitzroy Basin). They applied rehabilitation costs per hectare varying between $30,000 (most conservative) and $145,780. To transpose these figures to our case and the 24,375 $km^2$ (partial expansion) or 73,688 $km^2$ (full expansion) potentially converted to coal mines by 2047, we would need to know the proportion of each mining lease to rehabilitate. We do not have such information, but it is known that mining leases often cover areas vastly larger than the area impacted by mining activities.

## 4.2 Returning land to grazing

For this study the values per beast area for grazing properties on better quality land in Central Queensland have been identified from Herron Todd White (2015, Table 4.1), where there are normally 3-5 hectares per beast area.

*Table 4. Land and beast values for Central Queensland (Source: Herron Todd White, 2015)*

| District and land type | Land value ($/ha) | Annualised land value (5% discount rate) | Beast value ($/AE) | Annualised beast value (5% discount rate) |
|---|---|---|---|---|
| *Moura/Rolleston Scrub* | $1,600 - $1,850 | $128 - $148 | $3,250 - $4,000 | $261 - $321 |
| *Central Highlands Scrub* | $1,250 - $1,600 | $100 - $128 | $3,000 - $3,500 | $241 - $281 |
| *Central Highlands Downs* | $750 - $1,100 | $60 - $88 | $2,500 - $3,000 | $201 - $241 |
| *Alpha Scrub* | $675 - $875 | $54 - $70 | $2,750 - $3,250 | $221 – 261 |
| **Average (2015 values)** | **$1,213/ha** | **$97/ha** | **$3,156/AE** | **$253/AE** |
| **Average (2018 inflated)** | **$1,276/ha** | **$102/ha** | **$3,321/AE** | **$266/AE** |

These results demonstrate that the expected return per beast on grazing lands in the Bowen Basin region are approximately $3,321 or $266 per annum. In area terms, the expected return is $1276/ha, or $102/ha/year. This is the net return, broadly equivalent to average revenues less average operating costs. The implications of these estimates are that if post mining land could be perfectly returned to grazing capability with no additional management requirements or caveats on the title, the expected demand would be approximately $1,276/ha. As the rural property market increases (or decreases) in the Bowen Basin region from those 2015 values, then the values will change accordingly.

A full mining expansion scenario would result in a reduction of 63,941 $km^2$ of grazing land use in the study area, which is equivalent to an opportunity cost of $652.2 M/year. Over the 2016-2047 (32 years) mining exploitation period, this amounts to $20.87 billion, i.e. roughly the same as coal export value in 2016 (Table 3). So, coal mining looks like the better option, but as mentioned earlier, these figures forget to include the social, environmental and land rehabilitation costs of coal mining.

## 4.3 Returning land to nature

Assessing benefits from the entire range of ES provided by natural ecosystems in the study area is very complex. Following De Valck and Rolfe (2018), we assumed that ecosystem biodiversity could be used instead of ES provision to value such ecosystem. ES flows originate from the healthy functioning of ecosystems, enabled by biodiversity. In Central Queensland, Rolfe et al. (2000) conducted a non-market valuation study on the value of preserving rangeland ecosystems. They estimated a willingness-to-pay (WTP) of $11.39/household per species to maintain endangered species in the region, a WTP of $1.69/household to avoid each 1% loss in non-threatened species and a WTP of $3.68/household to avoid each 1% loss of unique ecosystems. These part-worth estimates were then multiplied by the number of households within the Brisbane region (surveyed population) to give an idea of the total value of a change in each of these items.

We applied similar assumptions to calculate the value of nature conservation in Central Queensland (Table 3). We used the most recent census of population and housing to estimate today's total number of households in the Greater Brisbane region: 833,399 households in 2016 (ABS, 2016).

*Table 5. Total benefits of nature conservation in the study area, expressed in terms of willingness-to-pay for biodiversity preservation in Central Queensland*

| | **WTP to avoid each 1% loss in non-threatened species** | **WTP to maintain endangered species in the region** |
|---|---|---|
| $ 1997 value (Rolfe et al., 2000) | $1.69 ($ 1997 value) | $11.39 per species ($1997 value) |
| Inflation-corrected $ 2018 value (Reserve Bank of Australia: https://www.rba.gov.au/calculator/annualDecimal.html) | $2.86 | $19.30 |
| **Part-worth value** | **$2,383,521** | **$16,084,601** |

# 5 Discussion

In this study, we have tried to compare the costs and benefits of coal mining with the ones associated with grazing and nature conservation scenarios. At this stage, we do not possess yet all the necessary information to conclude on the better option for the long-term support of local communities. Further research is needed to improve these results. We are fully aware of the multiple limitations in this study that have to do with the paucity of relevant data, especially to assess the many social and environmental costs of coal mining. At present, this land use option still appears more attractive, but precisely because the large benefits generated by this industry are not weighed against the large costs involved in the long-run. We are also aware that the mining expansion scenarios exposed here may seem very large. Only a small fraction of mining leases is to be exploited eventually. However, we do not have specific numbers at this stage to model this more accurately.

Although simple in theory, this CBA exercise has proven to be very complex to undertake in practice, which is probably why we are not aware of studies of the same magnitude in the literature. Our intention is to improve this analysis in the future by filling up the missing parts of the CBA. In addition, we plan to compare how such assessment may vary based on the scale of analysis. We want to compare costs and benefits at the local scale and at the national scale because some environmental costs may not be easily perceived locally but can sometimes be felt far beyond their source.

# 6 Conclusion

Coal mining is impacting regional Queensland like no other industry. The revenues generated by that industry are huge but limited in time, and they tend not to result in much long-term economic development in Central Queensland. On the contrary, the environmental costs generated by that industry are substantial and may be felt way beyond the mining exploitation period, spatially and temporally. Alternative land uses exist but so far, they are not deemed sufficiently beneficial relative to coal mining.

In this study, we have suggested to apply a cost-benefit analysis to compare a coal mining expansion scenario and scenarios favouring alternative land uses like grazing and nature conservation. At this stage, we have not yet been able to assess the full range of costs and benefits of each of these three options but have suggested several avenues to estimate economic values for the different impacts linked with each land use. Our intention is to pursue this research. We will compute more accurate estimates of the different costs and benefits to demonstrate that less lucrative but also less harmful land use options such as grazing and nature conservation may be better choices to ensure sustainable economic development in regional Queensland.

# References


ABS. 2019. *Census of Population and Housing 2011 and 2016* [Online]. Australian Bureau of Statistics. Available: https://www.abs.gov.au/websitedbs/D3310114.nsf/home/census [Accessed].

BARBIER, E. B. 2007. Valuing ecosystem services as productive inputs. *Economic Policy,* 22**,** 178-229.

BBUGS. 2016. *Bowen Basin Coal Mines* [Online]. Bowen Basin Underground Geotechnical Society. Available: http://bbugs.org.au/bowen-basin-coal-mines/ [Accessed 26/04/2019].

COSTANZA, R., D'ARGE, R., DE GROOT, R., FARBER, S., GRASSO, M., HANNON, B., LIMBURG, K., NAEEM, S., O'NEILL, R. V., PARUELO, J., RASKIN, R. G., SUTTON, P. & VAN DEN BELT, M. 1997. The value of the world's ecosystem services and natural capital. *Nature,* 387**,** 253-260.

COSTANZA, R., DE GROOT, R., SUTTON, P., VAN DER PLOEG, S., ANDERSON, S. J., KUBISZEWSKI, I., FARBER, S. & TURNER, R. K. 2014. Changes in the global value of ecosystem services. *Global Environmental Change,* 26**,** 152-158.

DAILY, G. C. 1997. *Nature's services : societal dependence on natural ecosystems,* Washington, DC, US, Island Press.

DE GROOT, R. S., WILSON, M. A. & BOUMANS, R. M. J. 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological Economics,* 41**,** 393-408.

DE VALCK, J. & ROLFE, J. 2019. Comparing biodiversity valuation approaches for the sustainable management of the Great Barrier Reef, Australia. *Ecosystem Services,* 35**,** 23-31.

FU, B.-J., SU, C.-H., WEI, Y.-P., WILLETT, I. R., LÜ, Y.-H. & LIU, G.-H. 2011. Double counting in ecosystem services valuation: causes and countermeasures. *Ecological Research,* 26**,** 1-14.

HAINES-YOUNG, R. & POTSCHIN, M. B. 2018. *Common International Classification of Ecosystem Services (CICES) V5.1 and Guidance on the Application of the Revised Structure* [Online]. Nottingham, UK: Fabis Consulting Ltd. Available: www.cices.eu [Accessed 16/10/2018].

HANLEY, N. & BARBIER, E. B. 2009. *Pricing Nature: Cost-benefit Analysis and Environmental Policy,* London, UK, Edward Elgar.

HERRON TODD WHITE 2015. National Rural Market Update - November 2015. Brisbane.

HULEATT, M. B. & JAIRETH, S. 2009. Australian Coal Resources, December 2009. *In:* AUSTRALIA, G. (ed.). Australian Government.

LECHNER, A. M., KASSULKE, O. & UNGER, C. 2016. Spatial assessment of open cut coal mining progressive rehabilitation to support the monitoring of rehabilitation liabilities. *Resources Policy,* 50**,** 234-243.

LOCKIE, S., FRANETTOVICH, M., PETKOVA-TIMMER, V., ROLFE, J. & IVANOVA, G. 2009. Coal mining and the resource community cycle: A longitudinal assessment of the social impacts of the Coppabella coal mine. *Environmental Impact Assessment Review,* 29**,** 330-339.

LOVELL, C. A. K. & LOVELL, J. E. 2013. Productivity decline in Australian coal mining. *Journal of Productivity Analysis,* 40**,** 443-455.

MEA 2005. *Ecosystems and Human Well-Being: Synthesis,* Millennium Ecosystem Assessment. Washington, DC, USA, Island Press.

PEARCE, D. & TURNER, R. 1990. *Economics of natural resources and the environment,* Baltimore, USA, Johns Hopkins University Press.

PETKOVA, V., LOCKIE, S., ROLFE, J. & IVANOVA, G. 2009. Mining Developments and Social Impacts on Communities: Bowen Basin Case Studies. *Rural Society,* 19**,** 211-228.

QUEENSLAND GOVERNMENT 2013. Estimates of Queensland Mining Productivity Performance, 1989-90 to 2011-12. Queensland Treasury and Trade.

QUEENSLAND GOVERNMENT. 2015. *Nominated coal areas - Queensland* [Online]. Department of Natural Resources, Mines and Energy. Available: https://www.business.qld.gov.au/industries/mining-energy-water/resources/geoscience-information/gsq [Accessed 31/01/2019].

QUEENSLAND GOVERNMENT 2016. Geological survey and investment. Business Queensland, State of Queensland.

QUEENSLAND GOVERNMENT 2017. Queensland coal – mines and advanced projects (July 2017). *In:* MINES, D. O. N. R. A. (ed.). State of Queensland.

QUEENSLAND GOVERNMENT. 2018a. *2017 calendar year—Coal sales statistics* [Online]. State of Queensland. Available: https://data.qld.gov.au/dataset/annual-coal-statistics [Accessed].

QUEENSLAND GOVERNMENT. 2018b. *Exploration permits for coal - Queensland* [Online]. Department of Natural Resources, Mines and Energy. Available: https://www.business.qld.gov.au/industries/mining-energy-water/resources/geoscience-information/gsq [Accessed 31/01/2019].

QUEENSLAND GOVERNMENT 2018c. Mineral and Energy Resources (Financial Provisioning) Act 2018 - Act No. 30 of 2018. *In:* COUNSEL, O. O. T. Q. P. (ed.). State of Queensland.

QUEENSLAND GOVERNMENT. 2018d. *Mining leases - Queensland* [Online]. Department of Natural Resources, Mines and Energy. Available: https://www.business.qld.gov.au/industries/mining-energy-water/resources/geoscience-information/gsq [Accessed 31/01/2019].

QUEENSLAND GOVERNMENT. 2019. *Land use mapping - 1999 to current - Queensland* [Online]. Department of Environment and Science. Available: https://www.qld.gov.au/environment/land/management/mapping/statewide-monitoring/qlump [Accessed 31/01/2019].

ROLFE, J., BLAMEY, R. & BENNETT, J. 2000. Valuing the preservation of rangelands: Tree clearing in the desert uplands region of Queensland. *The Rangeland Journal,* 22**,** 205-219.