Towards Experimental Ecosystem Accounts for the Great Barrier Reef

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Summary

The Australian Bureau of Statistics (ABS) in collaboration with a range of institutions is developing a set of experimental ecosystem accounts for the Great Barrier Reef. The accounts will cover both the marine and terrestrial environments of the region and include information on biodiversity, land cover, water pollution and a selection of ecosystem services and natural capital. The project will test the ability of already available data on the environment and the economy to populate selected components of the United Nations System of Environmental-Economic Accounting – Experimental Ecosystem Accounting framework.

The work builds on earlier work undertaken by the ABS and is being undertaken in collaboration with the Great Barrier Reef Marine Park Authority (GBRMPA), the Australian Institute of Marine Science and the University of Queensland. In addition to the collaboration between the agencies, the work is dependent on the cooperation of many individuals from a range of disciplines, including ecology, economics, statistics, information technology and accounting. The experimental accounts are scheduled for release in April 2015.

1. Introduction and background

1. The Australian Bureau of Statistics (ABS) is developing Experimental Ecosystem Accounts for the Great Barrier Reef region, in Queensland Australia. The accounts will be based upon the System of Environmental-Economic Accounting (SEEA), using both the SEEA-Experimental Ecosystem Accounting and the SEEA Central Framework. This project is being undertaken to test the application of the SEEA to one of the world's iconic natural assets and to share the learnings from the process with the wider environmental and ecosystem accounting communities.

2. Ecosystem accounting may be particularly valuable to areas like the Great Barrier Reef Marine Park and the six Natural Resource Management (NRM) Regions that drain into it. This type of accounting can help to identify and quantify the different uses occurring in the region, who this use benefits and how these uses impact on the environment. As well as being a World Heritage listed area and being protected by the Great Barrier Reef Marine Park Act of 1975, it is, along with the surrounding NRM regions, used for a variety of economic and recreational activities. With these activities come pressures in the form of sediment and nutrient loads in runoff, coastal development and direct use, adding to pressures from changing oceanic temperature and chemical composition due to Earth's changing climate.

3. An ecosystem account of the area will help to highlight the relationship of environmental condition to the economic and other benefits that are provided by the region. The account could become an important tool to help make informed decisions to allow ecologically sustainable use of the Great Barrier Reef region for purposes including recreational, economic and cultural activities.

4. Successful compilation of the accounts will depend on a wide variety of data and expert input which in turn depends on the strength of partnerships with key stakeholders. The ABS is developing the accounts in conjunction with Great Barrier Reef Marine Park Authority (GBRMPA), the body legislated to manage the Marine Park, as well as with input from a range of institutions including: The Australian Institute of Marine Sciences (AIMS, custodians and collectors of a significant amount of bio-physical data); Tourism Research Australia (TRA); and the University of Queensland.

1.1 The Great Barrier Reef

5. The Great Barrier Reef is globally significant. It is the world's largest coral reef ecosystem and is listed on the register of World Heritage sites. The Great Barrier Reef Marine Park covers 344,400 km^2 in area and extends from the northern tip of Queensland in north-eastern Australia to just north of Bundaberg.

6. The Reef is also one of the richest in terms of faunal diversity, with over 450 species of hard corals, about 150 species of soft corals and sea pens, about 40 species of sea anemones, over 100 species of jellyfish, over 5 species of marine spider, 1,625 fish species (including 1,400 coral reef species), 133 species of sharks and rays, 6 species of threatened marine turtles, over 30 species of marine mammals, over 3,000 species of molluscs, about 500 species of worms, around 1300 species of crustaceans, 630 species of echinoderms, 14 breeding species of sea snake, and 215 species of birds. Among these species, the Great Barrier Reef provides habitat for a range of threatened or iconic species including major

feeding grounds for the dugong, nesting grounds for two threatened marine turtles, and is an important breeding ground for whales.

7. The Great Barrier Reef marine ecosystem is also closely linked with the 28 terrestrial river catchments that drain into the sea in the area. Those catchments cover over 38 million hectares and have a population of over one million people. The 28 river catchments are grouped into six Natural Resource Management areas (NRMs): Cape York, Wet Tropics, Burdekin, Mackay Whitsunday, Fitzroy and Burnett Mary.

8. Threats to the condition or health of the Great Barrier Reef include climate change, declining water quality (from catchment run off), and the loss of coastal habitats (from coastal development and fishing impacts). Many of the threats are the result of regional or global actions, beyond the boundaries of the Great Barrier Reef Marine Park (GBRMP).

1.2 Management and Great Barrier Reef Marine Park Act

9. The Australian Government established the Great Barrier Reef Marine Park Authority (GBRMPA) to better manage the Great Barrier Reef and to meet environmental, economic and social objectives. The Great Barrier Reef Marine Park Act 1975 provides for the establishment, control, care and development of the marine park.

10. The relevant objectives of the Act are to:
- provide for the long term protection and conservation of the environment, biodiversity and heritage values of the Great Barrier Reef Region;
- allow ecologically sustainable use of Great Barrier Reef Region for various purposes;
- encourage engagement in the protection and management of the Great Barrier Reef Region; and
- assist in meeting Australia's international responsibilities in relation to the environment and protection of world heritage.

11. The Great Barrier Reef Marine Park is a multiple use area that supports a range of communities and industries (such as tourism, fishing, and shipping), and a zoning plan covers the marine park and separates potentially competing uses. For example, around a third of the Marine Park has marine national park status which prevents fishing and collecting.

1.3 SEEA and ecosystem accounting

12. The SEEA Central Framework (UN et al 2012) was adopted as an international statistical standard by the United Nations Statistical Commission in 2012. The SEEA Experimental Ecosystem Accounting (UN et al 2013) was endorsed by the same Commission in 2013.

13. The SEEA Experimental Ecosystem Accounts is a summary of the state of knowledge on ecosystem accounting and merges with the SEEA Central Framework. Ecosystem accounting is an approach to the assessment of the environment through the physical measurement of ecosystems and of the flows of services from these ecosystems into economic and other human activity. In this the scope of ecosystems includes those ecosystems substantially modified by human activities, such as urban and agriculture areas. The SEEA Experimental Ecosystem Accounting is not a definitive set of concepts, classifications and methods but provides a platform for integrated, multi-disciplinary research programs.

14. An important feature of the SEEA Experimental Ecosystem Accounting is the summary of valuation. Valuation is one of the most contentious areas of environmental and ecosystem accounting. The SEEA Experimental Ecosystem Accounting highlights the distinction between exchange values and welfare values. Exchange values reflect the quantity of services that would have been obtained had they been freely traded. Exchange values are in keeping with accounting approaches in general and with the SNA approach of valuing non-market goods, such as public education and household production (e.g. owner occupied houses). In this approach to valuation, cost of production can be used (e.g. for public schools) or equivalent market price (imputed rents for own occupied houses). Examples in the case of ecosystem services might be the use of access permits, tourism expenditure, insurance premiums, land values, replacement or remediation costs.

15. In addition, welfare values measure the potential consumer surplus value of goods or services. The consumer surplus is the gains obtained by consumers because users are obtaining a product at a market rate less than they would be willing to pay. In the case of ecosystem accounting, current payments (i.e. exchange values) may often be zero so the "willingness to pay" and thus consumer surplus may be substantially higher. Welfare values are not included in national accounting and therefore incompatible in the context of valuation in the SEEA Experimental Ecosystem Accounting.

2. Summary of Past work

2.1 Science

16. There has been extensive scientific work on many ecological and biological topics in the Great Barrier Reef region over many years. Assets such as coral and sea grass are widely monitored.

17. The most recent collation of this work has been two large bodies of work. First, the Draft Strategic Assessment (GBRMPA 2013) identifies existing and emerging risks to the Reef, and assesses current and future policies for their likely direct, indirect and cumulative impacts.

18. Second, Scientific Consensus Statements synthesise existing knowledge to provide advice as part of the Reef Water Quality Protection Plan. In 2013 their report highlighted "key Great Barrier Reef ecosystems are showing declining trends in condition due to continuing poor water quality, cumulative impacts of climate change and increasing intensity of extreme events".

2.2 Economics

19. Deloitte Access Economics (2013) provided a study of the economic contribution of the Great Barrier Reef World Heritage Area to the Australian economy to the Department of Environment and the GBRMPA. The study estimated the economic contribution of the Great Barrier Reef World Heritage Area to the Australian economy in 2011-12 was $5.68 billion while generating nearly 70,000 full-time equivalent jobs.

20. The ABS produces accounts according to the SNA for Australia and the State of Queensland. These provide measures of consumption and production as well as balance sheets showing net wealth. National data on the value of environment assets is presented in

the ABS publication *Australian Environmental-Economic Accounts 2014* (cat. no. 4655.0). The value of rateable land in Queensland is available from the *Land Account: Great Barrier Reef Region, Experimental Estimates* (cat. no. 4609.0.55.001) and the data underpinning this can be used to generate estimates of the value of land for the terrestrial areas of the Great Barrier Reef.

21. A range of academic studies relating directly to the economics or value of the Great Barrier Reef or coastal and marine ecosystems more generally are also available.

2.3 Ecosystem Accounting

22. While ecosystem accounting is still in the early stages of development in Australia, a range of activity has occurred or is occurring. These include:

- Victorian Department of Environment and Primary Industry have produced a set of experimental ecosystem accounts, including an estimate of condition using the metric *habitat hectares*;
- Department of Environment published a report on ecosystem services key concepts and applications in 2010;
- The Department of Agriculture published a discussion paper on ecosystem services in 2012;
- The Wentworth Group of Concerned Scientists is conducting trials in the Natural Resource Management areas of Australia using measurement of the physical characteristics of ecosystems (e.g. biodiversity, soil, carbon and water) ; and
- South East Queensland Catchment Management Authority produced an Ecosystem Services Framework in 2012.

23. The starting point for accounting for terrestrial ecosystems at the ABS has been determining the extent of different land cover types, which are a proxy for ecosystems, and can be measured using remote sensing techniques and hence are amendable to large scale estimation and regular production (i.e. annual).

24. In 2011 the ABS released the *Land Account: Great Barrier Reef Region, Experimental Estimates* (cat. no. 4609.0.55.001) which presented data beyond the range of land account tables described in the SEEA Central Framework. As well as land cover and value, the account presented other economic, social and environmental data, all at the common spatial unit of the Natural Resource Management (NRM) region. An updated version was released in July 2014, which showed change in these variables. In doing so, the ABS took a step towards an experimental ecosystem account of the area and developed significant insight into the processes involved in assembling such multi-dimensional accounts.

3. Project outputs

3.1 Scope and coverage

25. The Great Barrier Reef accounts will cover marine and terrestrial area. The area of Great Barrier Reef marine region, which includes the area proscribed in the Great Barrier Reef Marine Park Act, will define the marine area. The terrestrial region included will be that area adjacent to marine region.

26. The terrestrial region will be defined as the six mainland Natural Resource Management (NRM) regions that wholly or partially drain into the Great Barrier Reef marine Park (Burnett Mary, Fitzroy, Mackay Whitsunday, Burdekin, Wet Tropics and Cape York). While Cape York and Burnett Mary NRMs do not wholly drain into the marine park, the management plans are NRM specific and an analysis of (terrestrial) ecosystem response to interventions in management practices over the whole area of management may give a more complete picture of the results of intervention.

27. The ecosystem assets to be accounted for will depend on the ability to detect and differentiate them, and to measure change. Marine assets will include all ecosystems found within the Great Barrier Reef Marine Park such as coral reefs, sea grass beds and sand areas. The terrestrial assets included will be all ecosystems in the NRM regions adjacent to the park. The ecosystems will be approximated by the land cover types identified in the Dynamic Land Cover classification, which is managed by Geoscience Australia.

3.2 Proposed Accounts

28. The proposed accounts can be characterised by their physical location (terrestrial or marine) and by their units of measurement (physical or monetary). For some accounts, only physical measures will be possible, but the aim will be to value and therefore monetize as many assets and flows as possible. In this, expert input will be required on the available data, existing valuations and valuation techniques.

Table 1. Prioritised list of accounts for the Great Barrier Reef

Number of tables	Account	Publication Priority	Physical outputs	Monetary Outputs
1	Land Cover	1	Yes	Yes
2	Land Condition	1	Yes	No
3	Land Use	1	Yes	Yes
4	Terrestrial biodiversity	1	Yes	No
5	Marine Condition	1	Yes	No
6	Marine Biodiversity	1	Yes	No
7	Provisioning – food/nutrition LAND	1	Yes	Yes
8	Cultural – tourism LAND	1	Yes	Yes
9	Physical flow – sediment loads in rivers	1	Yes	No
10	Provisioning – food/nutrition MARINE	1	Yes	Yes
11	Cultural – tourism MARINE	1	Yes	Yes
12	Cultural – indigenous cultural (Written commentary only)	1	No	No
13	Cultural - Recreational	2		
14	Marine Use	2		
15	Provisioning – water	2		
16	River condition	2		
17	Provisioning – timber	2		
18	Provisioning – fibres/materials	2		
19	Regulatory – carbon sequestration	2		
20	Provisioning – biomass energy	2		

29. The SEEA Experimental Ecosystem Accounting provides guidance on prioritising accounts in the form of nine criteria to be applied and these criteria were used to assess which accounts will be produced. Priority 1 accounts are those that were assessed to be most central to the overall functioning, both environmental and economic, of the region, and that have good data availability. Time permitting, upon completion of these accounts, Priority 2 accounts will be assessed for production and inclusion in the April 2015 release. Some accounts are not strictly ecosystem accounts but rather physical flow accounts as described in the SEEA Central Framework. For example, the accounts for sediment loads in rivers are water emission (or pollution) accounts. Accounts for other assets or services may also be produced and their feasibility and priority will be assessed with a range of experts.

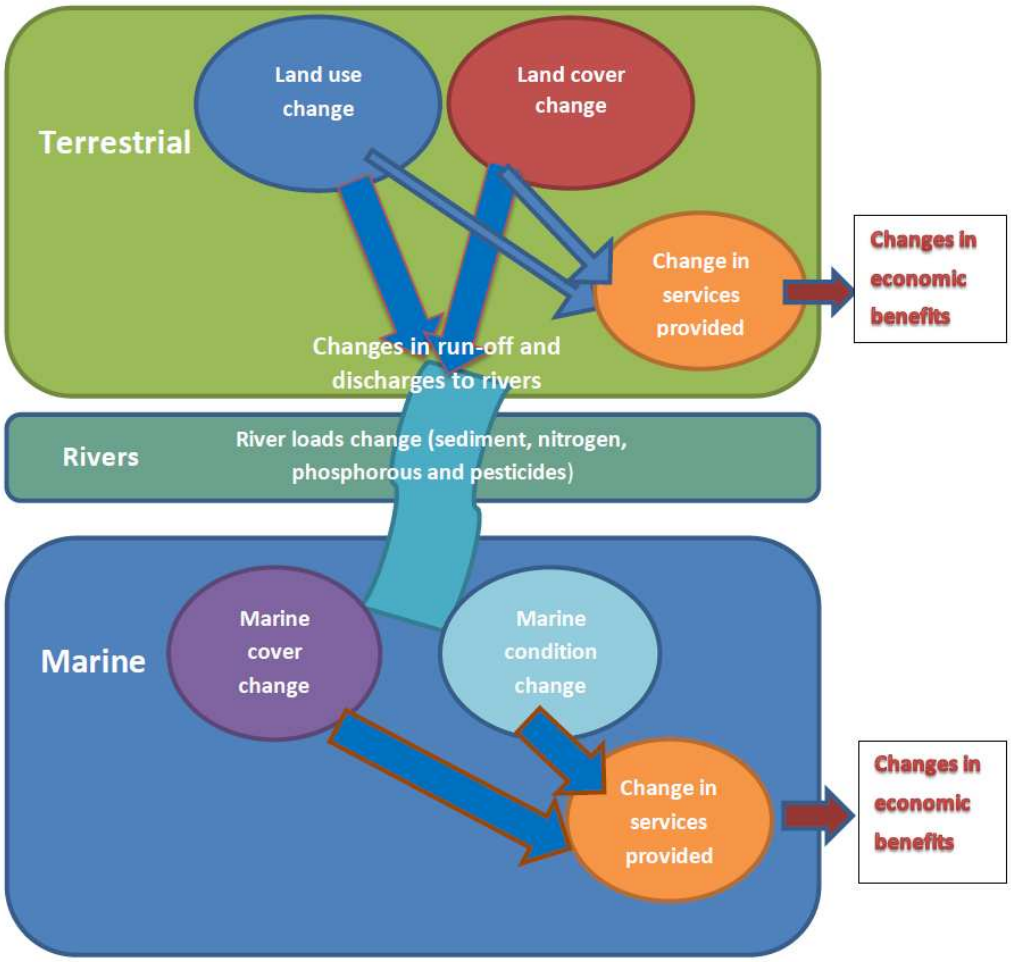
3.3 Linking accounts of assets and flows

30. By presenting a selection of the above accounts in a single publication, it is hoped that users will follow the flow of data to gain insight into possible interventions. For example, the amount of sediment and other loads that rivers discharge into the Great Barrier Reef lagoon

will change over time with changes in land use, land management and land cover. While these changes are occurring, the marine park environment (e.g. coral reef condition) may also experience changes.

31. Alongside the physical measures included in the accounts, users may also consider the economic outcomes associated the changes. For example, the changes in economic activity associated with differing land use and the changes in activity associated with different zoning, cover and condition of the marine park. For example, Figure 1 below shows the connections between the terrestrial and marine environments and how changes may impact on the condition of assets and/or the services derived from the assets.

Figure 1. Example flow of accounts for river loads data.



4. Concepts, sources and methods

4.1 Data Sources

32. The nature of ecosystem accounting dictates that many datasets from many different data sources are required to populate the various accounts. The level of detail in the meta-data

behind the datasets is integral to describing the quality of the accounts. The assessment of the suitability of data sources for accounts will involve consultation with custodians of the datasets.

33. Major sources identified so far include:

- Sediments and pollutant loads, marine condition (water quality, coral and sea grass condition) – Reef Plan 5 (various years) data, AIMS Monitoring Survey;
- Land cover – Geoscience Australia Dynamic Land Cover Dataset (DLCD) of Australia;
- Land use – Queensland Valuer Generals' dataset on land use and land value;
- Marine cover – GBRMPA Spatial Data;
- Marine condition – AIMS Monitoring Survey;
- Fisheries – Queensland Department of Agriculture, Fisheries and Forestry QFISH dataset;
- Tourism – ABS Tourism Satellite Account, 2012-13 (cat. no. 5249.0), Tourism Research Australia Regional Data;
- Biodiversity – Atlas of Living Australia, CSIRO; and
- Socio-economic data – ABS National Regional Profiles (cat. no. 1379.0.55.001).

4.2 Concepts, Standards and Classifications

34. To ensure comparability, the use of standards and classifications is a key feature of ecosystem account compilation. The key concepts are drawn from the United Nations SEEA Central Framework and SEEA Experimental Ecosystem Accounting.

35. Other classifications to be used include:

- ANZSIC – Australian and New Zealand Standard Industrial Classification;
- CICES – (Towards a) Common International Classification of Ecosystem Services;
- DLCD – Geoscience Australia Dynamic Land Cover Dataset of Australia; and
- IUCN Red list and threat types – International Union for Conservation of Nature Red List.

36. This list is not exhaustive and additional classifications may be used. For example, the status of species in the *Environmental Protection and Biodiversity Conservation Act 1999* and the vegetation classes used in the *Native Vegetation Inventory Survey*.

4.3 Spatial boundaries

37. The choice of spatial boundaries is a key consideration in ecosystem accounting and the project will select a small set of spatial boundaries for the accounts. This will necessarily require some compromises to the accuracy of the individual data sources that are attributed to different spatial boundaries. However, if there is access to the primary data source then re-aggregation should not lead to any loss of accuracy.

38. For previous ABS Land Accounts three types of boundary were used: biogeographic regions; natural resource management areas and; ABS statistical geography. For the marine areas the choice is not as clear as the experience with accounting for marine systems is more limited than for terrestrial systems. The project is currently evaluating supporting two-three boundaries.

4.4 Valuation methods

39. Beyond a commitment to test the valuation methods identified in the SEEA Central Framework and SEEA Experimental Ecosystem Accounts, the valuation techniques to be employed have yet to be finalised. Techniques that may be used include:

- Market value (e.g. of land, tradeable fishing licences)
- Replacement Cost
- Net Present Value

40. In this it must be noted that while non-market valuation methods relying on consumer surplus are mentioned in the SEEA Experimental Ecosystem Accounts, they are not recommended and will almost certainly not be included in the valuations included in the experimental accounts for the Great Barrier Reef. Non-market valuations that exclude consumer surplus can be used in the accounts, while methods that involve consumer surplus may be used for comparisons, context, etc.

4.5 Statistical methods

41. Standard statistical methods will be used to generate the estimates included in the accounts. The explanatory notes accompanying the accounts will provide details of the methods used.

5. Process

42. The project was launched in October 2013 with a teleconference including identified stakeholders, namely:

- Great Barrier Reef Marine Park Authority (GBRMPA)
- Bureau of Meteorology (BoM)
- Department of Environment (DoE)
- Geoscience Australia (GA)
- Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES)

43. Initial ABS work covered data acquisition and scoping of the accounts as well as meta-data analysis. Currently, data is being compiled into accounts with information papers being presented to a range of fora. The final information paper on Experimental Ecosystem Accounts for the Great Barrier Reef is scheduled for release in April 2015 with a workshop involving interested parties to be held shortly after.