The SEEA as a conceptual model and tool for 'Ridge-to-Reef' management

Paper for the

29th Meeting of the London Group on Environmental Accounting

11-15 September 2023

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Questions to London Group

The purpose of this document is to generate understanding and discussion to guide the development of a doctoral research proposal by Michael Vardon, Australian National University (ANU) and potentially Nicholas Conner, New South Wales Department of Planning and Environment on the application of SEEA to ridge-to-reef management.

To aid the development of the research we would appreciate comments or answers to the following questions:

1. Do you know of any research completed or underway relevant to linking SEEA to ridge-to-reef management?
2. Do you have any comments on the conceptual map of ridge-to-reef management and how this relates to SEEA? (See Fig.1 and Table 1)
3. Which ecosystem services and ecosystem assets are most relevant to ridge-to-reef management? (See Fig.1 and Tables 1 and 3)
4. What are possible data sources, methods, and models for account production? (See Section 3.2)
5. What valuation approaches are most suitable for particular ecosystem services? (See Section 3.4)
6. Do you think that there is a way to record 'two-way' ecosystem service flows in line with the perspectives of First Nations People? (See Fig. 7)

We thank you in advance for reading our paper and considering our questions.

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1. Introduction

The concept of ridge-to-reef management and the System of Environmental-Economic Accounting (SEEA) were separately developed by distinct stakeholder groups. Both synthesise a broad range of theories and practices that can contribute towards the ongoing global effort of achieving sustainable development.

Marine and coastal ecosystems are typically managed as separate entities, with limited knowledge or consideration of their interactions. In most cases, the ecosystems are managed independently, often by multiple levels and agencies of government, each using their own economic and environmental information. There is a *prime facie* case that the SEEA could provide the integrated information needed for ridge-to-reef management. To test the suitability of SEEA for 'ridge-to-reef' management, a case study is proposed.

1.1 Research aims

The preliminary aims of the research are:

1. Determine the potential usefulness of SEEA-based accounts for ridge-to-reef management
2. Work with land and sea managers and accountants to co-design SEEA-based accounts for ridge-to-reef management
3. Use available data sources and methods to produce SEEA-based accounts for ridge-to-reef management
4. Identify theoretic and practical issues with designing, producing, and using SEEA-based accounts for ridge-to-reef management

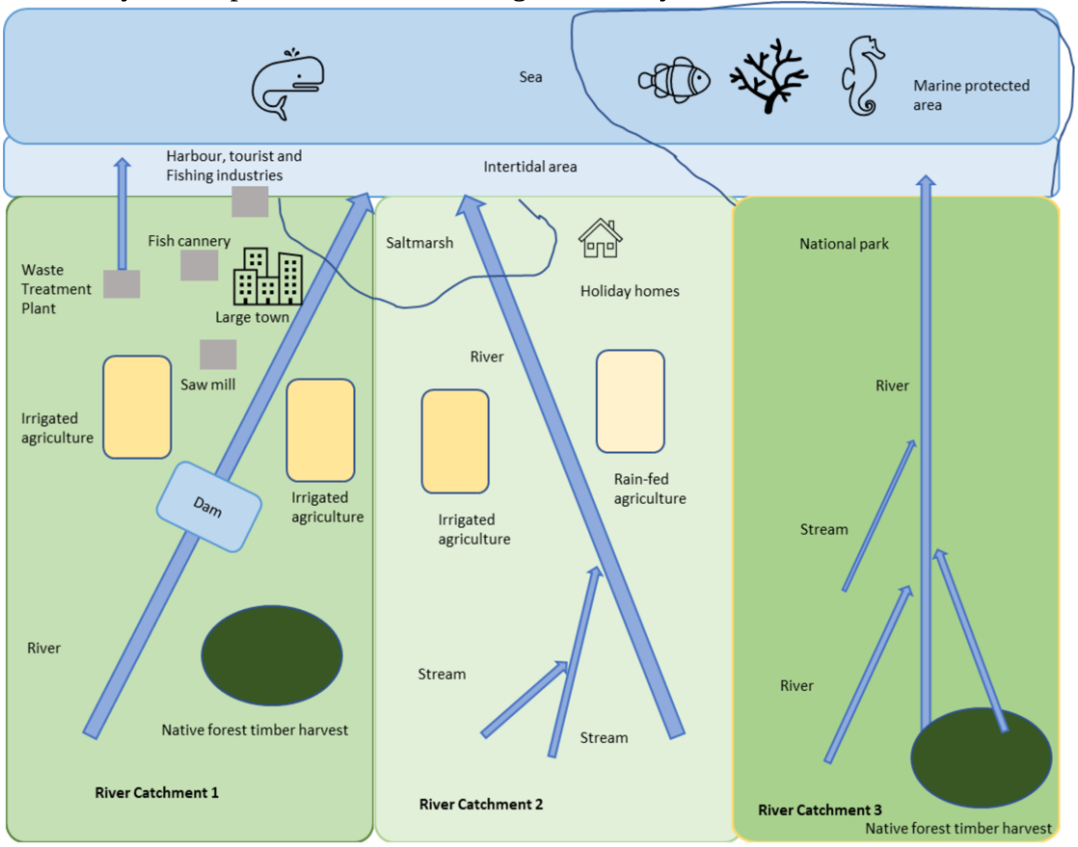
These aims are preliminary, as the purpose of this document is to generate understanding and discussion to guide the development of a doctoral research project to be supervised by Michael Vardon, Australian National University (ANU) and potentially Nicholas Conner, New South Wales Department of Planning and Environment.

1.2 Ridge-to-reef management

Ridge-to-reef management is an integrated management approach that encompasses the entire ecosystem from upland ridges and mountains to coastal and marine areas. It is aimed at protecting and managing natural resources, habitats, and biodiversity within a specific geographic area. It emphasizes the need for collaboration between various stakeholders, including government agencies, local communities, and non-governmental organizations (NGOs). It also recognises the need for expertise in the physical and social sciences, economics, and natural resource management.

The concept of ridge-to-reef management reflects the need to understand the impacts of activities in upland areas on downstream coastal and marine ecosystems. It recognises the linkages between land, water, and the ocean and seeks to address the negative effects of deforestation, agriculture, urbanization, and pollution on downstream ecosystems (Fig. 1).

Figure 1. A stylised representation of the ridge-to-reef system



Overall, ridge-to-reef management provides a framework for sustainable development that recognizes the interconnectedness of ecosystems and promotes the conservation and wise use of natural resources for the benefit of both present and future generations. The main features of ridge-to-reef management are:

Biodiversity conservation in terrestrial and marine ecosystems: Protecting and restoring natural habitats, biodiversity, and ecological processes, ensuring the long-term sustainability of both land and marine ecosystems.

Sustainable natural resource management: Promoting practices that minimize soil erosion, sedimentation, and pollution, reducing the negative impacts on downstream water bodies, coastal water, and reefs.

Integrated planning and decision-making: Developing and implementing management plans that consider the entire watershed, integrating land and water management strategies.

Stakeholder engagement and capacity building: Involving local communities, indigenous groups, and other stakeholders in the decision-making process, fostering participation, and building their capacity to manage and protect ecosystems.

Climate change adaptation and mitigation: Addressing the risks posed by climate change to ecosystems, communities, and economies through an adaptive management process.

Impacts on the ridge-to-reef ecosystems can be natural or human. Human drivers included the expanding urban area, the use of natural resources (fish, timber, water), aquaculture production, and pollution. Key natural drivers include climate change, storms, and fire.

2. Proposed research components

The proposed research will have four distinct components

1. Systematic literature review linking the SEEA to ridge-to-reef management concepts
2. A co-design accounting process using a case study area
3. Account production and potential applications using a case study
4. Identification of opportunities and barriers for the general use of the SEEA in ridge-to-reef management

2.1 Case study area

The proposed case study site is Clyde River Catchment, approximately 250 km south of Sydney, New South Wales (NSW) (Fig. 2). The study area comprises the tidal waterway, foreshore, and adjacent land of Batemans Bay and the Clyde River including the entrance, the major tributaries, and the river catchment. The town of Batemans Bay is located at the mouth of the Clyde River. The town's population is approximately 8,500[1].The town is a tourist centre and supports a seafood industry, including oysters from marine aquaculture.

Figure 2. Location of the study region, Clyde River, New South Wales, Australia.

[1] https://abs.gov.au/census/find-census-data/quickstats/2021/101041017

2.2 Linking ridge-to-reef and SEEA

A systematic literature review will be done based on existing protocol (e.g., Moher et al., 2009[2]; Sarkis-Onofre et al., 2021)[3] and following the five steps of scoping, searching, screening, citation tracking, and analysis guided by the Collaboration for Environmental Evidence Synthesis Appraisal Tool (CEESAT) (Woodcock et al., 2014)[4].

The systematic review literature is planned to determine:

1. If the SEEA has been used in ridge-to-reef management
2. The key concepts and components of ridge-to-reef management and how they can be linked to the SEEA concepts and accounts
3. The metrics, data sources, and methods (including models) used to measure the physical inter-ecosystem flows (intermediate ecosystem services) between the riverine, estuarine, and marine ecosystems
4. The metrics, data sources, and methods (including models) used to measure the final ecosystem services supplied by the riverine, estuarine, and marine ecosystems to the economic units
5. The metrics, data sources, and methods (including models) used to measure the riverine, estuarine, and marine ecosystems ecosystem extent and condition
6. Comparison of valuation techniques recommended in the SEEA and those used in ridge-to-reef management

2.3 Co-design of accounts for ridge-to-reef management

As part of the research planning, key stakeholders for the co-design of accounts will be identified and the potential roles of stakeholders in the co-design process described. Initial work has already identified many relevant stakeholders (See section 3.3).

The accounts will aim to inform an adaptive management cycle specifically designed for reef-to-ridge management. This concept is illustrated in Figure 3.

2.4 Valuation

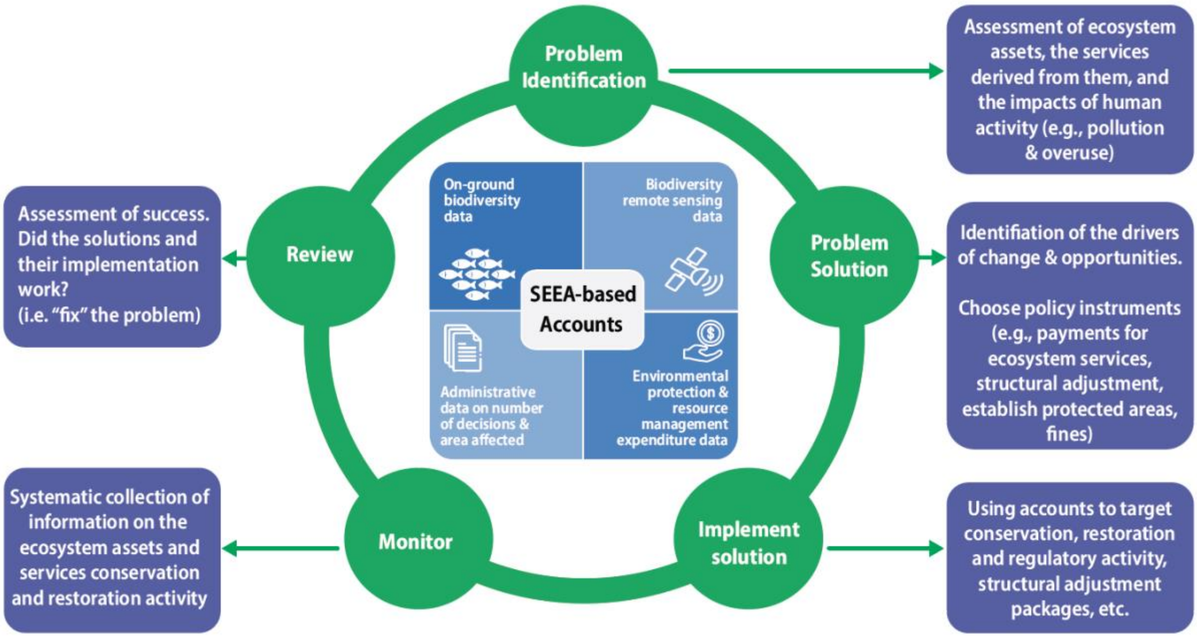
An assessment of the valuation techniques used in ridge-to-reef cases will be compared to those recommended in SEEA. It is noted that not all ecosystems or ecosystem services relevant to ridge-to-reef management will involve monetary valuation. A list of services and potential valuation methods is found in Section 3.4.

[2] Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., 2009. Academia and Clinic Annals of Internal Medicine Preferred Reporting Items for Systematic Reviews and Meta-Analyses. Ann. Intern. Med. 151 (4), 264–269. https://doi.org/10.7326/0003-4819- 151-4-200908180-00135

[3] Sarkis-Onofre, R., Catal´a-Lo´pez, F., Aromataris, E., Lockwood, C., 2021. How to properly use the PRISMA Statement. Syst. Rev. 10 (1), 13–15. https://doi.org/10.1186/s13643-021-01671-z

[4] Woodcock, P., Pullin, A.S., Kaiser, M.J., 2014. Evaluating and improving the reliability of evidence syntheses in conservation and environmental science: a methodology. Biol. Conserv. 176, 54–62. https://doi.org/10.1016/j.biocon.2014.04.020

Figure 3. Ridge-to-reef adaptive management cycle using SEEA-based accounts.



Source: After Vardon et al. (2016)[5]

3. Preliminary findings

Initial research and thinking have already produced some preliminary findings and "shell" tables. These are provided to prompt discussion and to test our thinking.

3.1 Linking ridge-to-reef to SEEA

Table 1 is a preliminary assessment of how ridge-to-reef management can be related to the SEEA accounts. To date, the only SEEA accounting addressing ridge-to-reef management is the Experimental Environmental-Economic Accounts for the Great Barrier Reef[6].

The preliminary assessment indicates that the priority SEEA accounts for ridge-to-reef management are: ecosystem extent, ecosystem condition, ecosystem services, environmental and natural resource management actions and expenditure, water emission, and fish (and other harvested marine species).

The ecosystem assets and services most relevant to ridge-to-reef management will be identified via the co-design process outlined below. The ecosystem assets will be listed according to the Global Ecosystem Typology recommended by SEEA, and the SEEA reference list of ecosystem services will be used. A summary list of each will be compiled and a diagram produced to represent the assets and flows and economic activity (Figure 1). In this, the flows missing from the SEEA frameworks can be identified.

[5] Vardon, M., Burnett, P. and Dovers, S. (2016). The accounting push and the policy pull: balancing environment and economic decisions. *Ecological Economics*, 124: 145-152. http://dx.doi.org/10.1016/j.ecolecon.2016.01.021

[6] https://www.abs.gov.au/statistics/environment/environmental-management/experimental-environmental-economic-accounts-great-barrier-reef/latest-release

Table 1. Preliminary assessment of the links between ridge-to-reef management and the SEEA

Main features of ridge-to-reef management	Relevant SEEA accounts	Notes
Biodiversity conservation in terrestrial and marine ecosystems	Ecosystem extent Ecosystem condition Ecosystem service Biodiversity Environment protection expenditure	SEEA Ecosystem accounting SEEA Central Framework
Sustainable natural resource management	Land cover Land use Land zoning Forest Solid waste Natural resource management expenditure Water Emission accounts (water pollution) Agriculture, Forestry	SEEA Central Framework SEEA Water SEEA Agriculture, Forestry, and Fisheries
Integrated planning and decision-making	-	Linking of SEEA to the adaptive management cycle
Stakeholder engagement and capacity building	-	The need to co-design accounts has been recognised as important for SEEA uptake. Links to human and social capital, outside of the scope of SEEA
Climate change adaptation and mitigation	CO_2 emissions Land Carbon Climate regulation service	SEEA Central Framework SEEA Central Framework SEEA Ecosystem Accounting

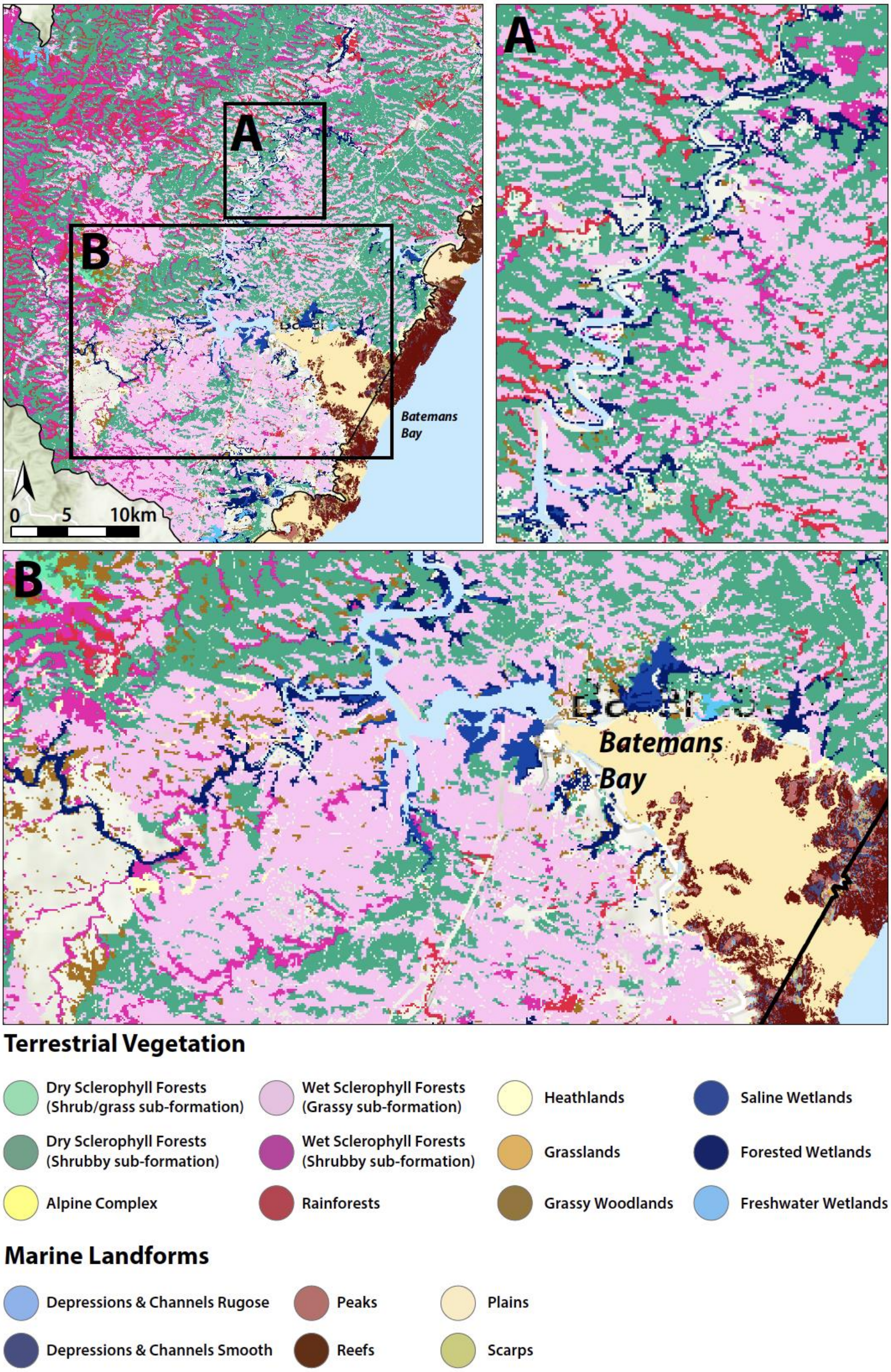
3.2 Data sources and method for account production

A range of data sources have been identified for account production including from the NSW Government, Australian Bureau of Statistics and Geoscience Australia. The first consideration is to define the ecosystem accounting area (i.e., the boundary of the ridge-to-reef). At present it is simply called the Clyde River area. The data available may be "cut" to any spatial boundary.

Information on terrestrial ecosystems and marine landforms is shown in Figure 4. The terrestrial ecosystems are mostly Sclerophyll forests dominated by gum trees (*Eucalyptus* spp.) (76% of vegetation extent), with patches of freshwater and marine wetlands (3% of vegetation extent). The marine landform is most comprised of plains (sandy bottom) (42% of marine landform) but with a large amount of reef (35% of marine landform). Time series information is available for land cover[7]. At this stage, no attempt has been made to link the existing ecosystem and land cover classes for the region to the Global Ecosystem Typology.

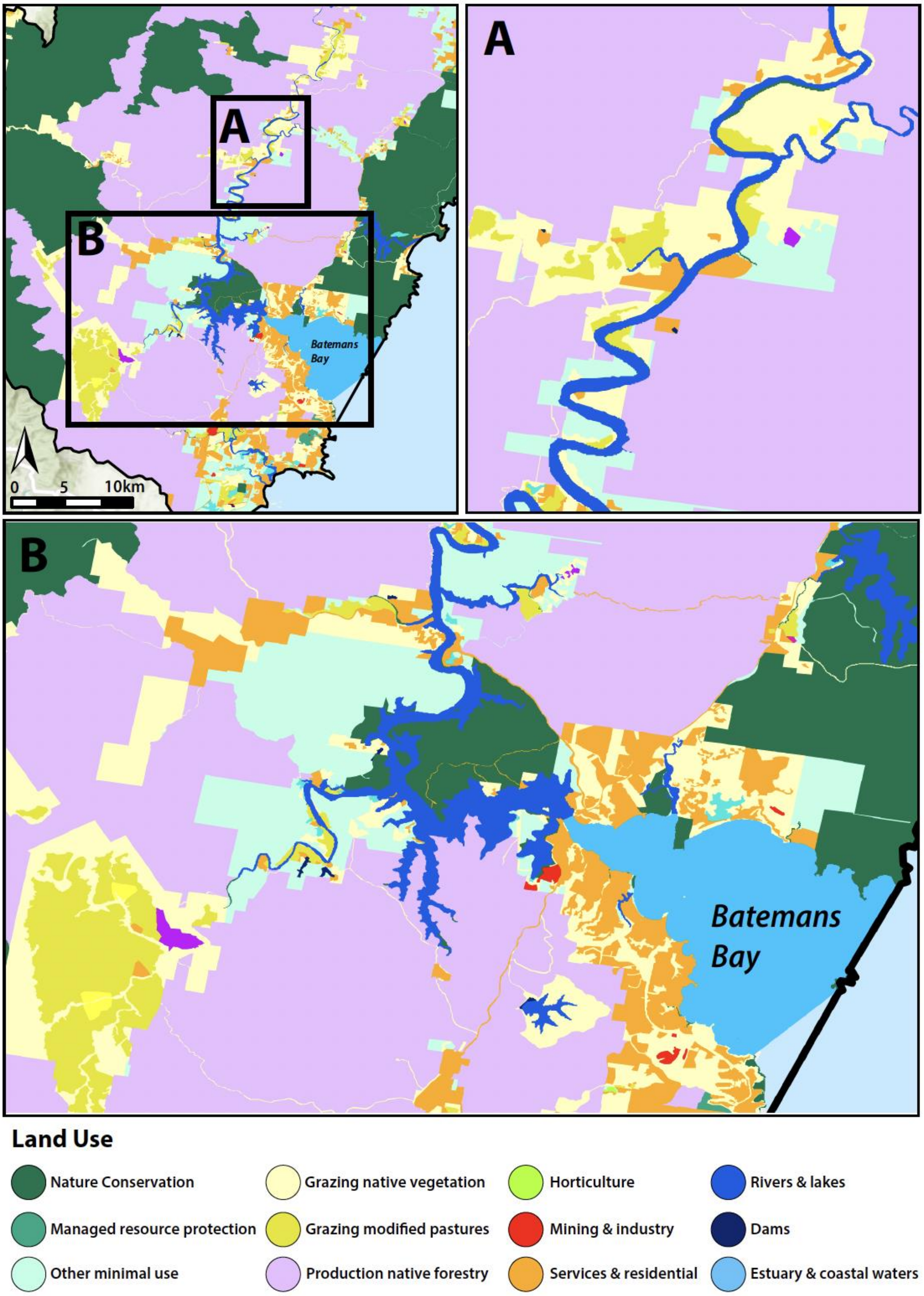
[7] https://www.dea.ga.gov.au/products/dea-land-cover

Figure 4. Vegetation and marine landforms in the Clyde River area. Also see Tables A1, A2.



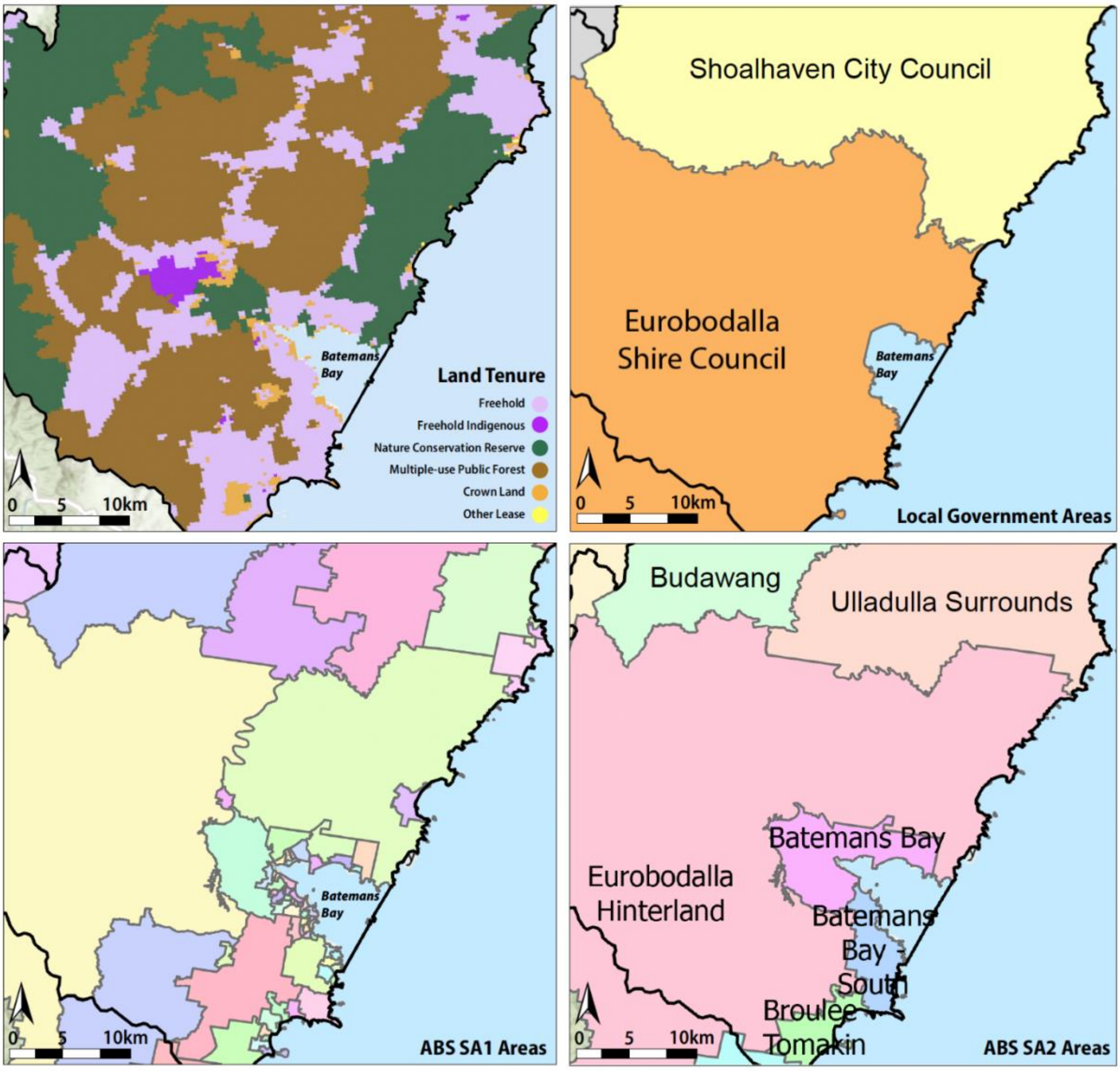
Information on land use is shown in Figure 5. Land use in the area is dominated by forestry (48% of the region's land use), followed by conservation (24% of the region's land use). Residential areas are clustered mainly around the Batemans Bay township (4% of land use). A preliminary land cover land use table for the study area has also been prepared as shown in Table A4.

Figure 5. Land use in the Clyde River area. Also see Table A3



The land zoning information (Fig. 6) includes land tenure information, as well as information on the spatial boundaries used by the Australian Bureau of Statistics. The Eurobodalla Shire Council has the largest proportion of land in the Clyde River area (61%), but the Shoalhaven City Council has a significant area in the north (37%). Figure 6 also highlights the overlap and misalignments of statistical boundaries, which will be a consideration in the study.

Figure 6. Land zoning in the Clyde River area. Also see Table A5



A search for data on ecosystem condition has not yet begun.

Information Tools being considered for modelling ecosystem services include Data4Nature[8], ARIES for SEEA[9], and InVEST[10].

8 https://www.data4nature.com.au/
9 https://seea.un.org/content/aries-for-seea
10 https://naturalcapitalproject.stanford.edu/software/invest

3.3 Account co-design

An indicative list of stakeholders is found in Table 2. Co-design with regional stakeholders is yet to begin, although a list of potential stakeholders has been prepared. The co-design process would involve meetings with stakeholders and workshops. A Steering Committee for the project may be established.

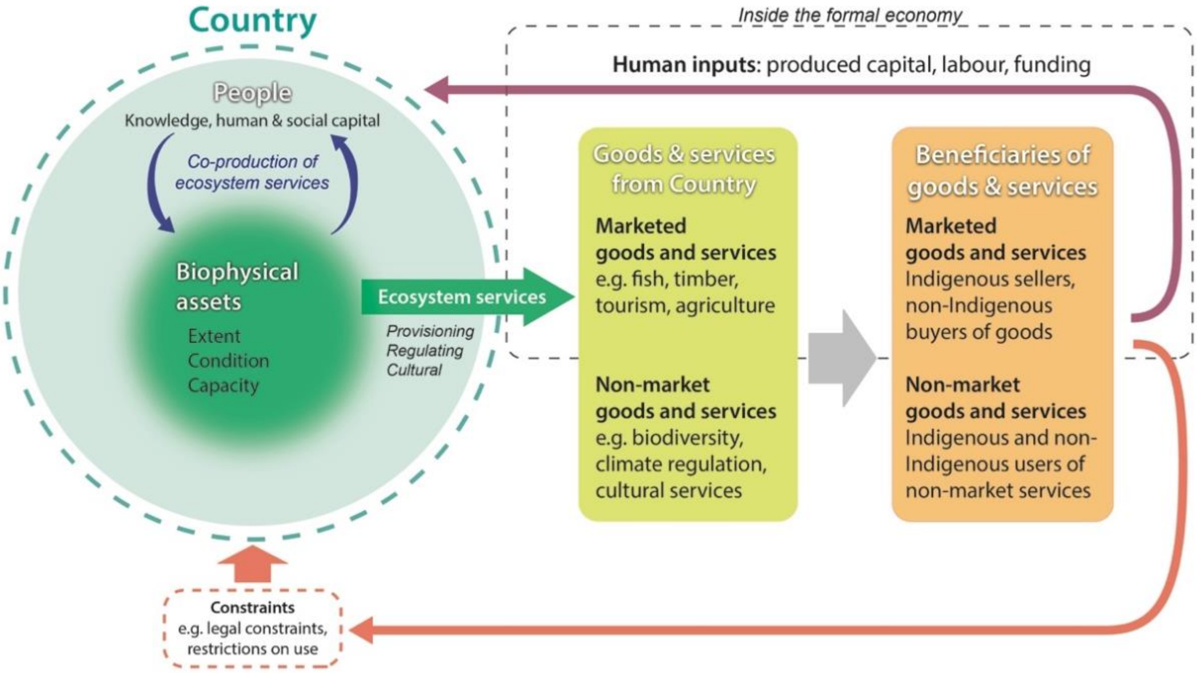
Table 2. Stakeholders in account design for ridge-to-reef management

Stakeholder type	**Identified stakeholders**
NSW State Government agencies	Department of Planning and Environment Treasury Department of Regional NSW Department of Communities and Justice Department of Primary Industries National Parks and Wildlife Service Fisheries NSW Environment Protection Agency State Emergency Service
NSW local government(s)	Eurobodalla Shire Council
Local Land Services	South East Local Land Service
Industry representatives	Tourism Fishing Aquaculture Agriculture Forestry
Australian Government	Department of Climate Change, Environment and Water Department of Agriculture, Forestry and Fishing
First Nations	Yuin
Local landowners	Ratepayers association
Information agencies • National • State	Australian Bureau of Statistics Geoscience Australia Other data providers
Others	Australian National University

A key stakeholder group in the study regions are Indigenous people, representing 8.3% of the region's population[11]. Normyle et al. (2022)[12] found that the relationships that Indigenous people have with the environment is conceptually different from that one-way flow of ecosystem services depicted in the SEEA Ecosystem Accounting[13] and this conception is shown in Figure 7.

[11] https://abs.gov.au/census/find-census-data/quickstats/2021/101041017
[12] Normyle, A., Doran, B., Vardon, M., Mathews, D., Melbourne, J., & Althor, G. (2022). An Indigenous perspective on ecosystem accounting: Challenges and opportunities revealed by an Australian case study. Ambio, 1-13. https://doi.org/10.1007/s13280-022-01746-8
[13] E.g. SEEA Ecosystem Accounting Figure 2.1, page 28

Figure 7. The two-way relationship of Indigenous people to the environment



Source: Normyle et al. (2022)[14]

3.4 Valuation

The work on valuation is yet to begin. Table 3 provides an indication of the ecosystem services and valuation techniques contemplated for use in the study.

Table 3. Valuation techniques for ecosystem services relevant to ridge-to-reef management*

SEEA recommended methods	Ridge-to-reef management
Value directly observed	Provisioning services • Aquaculture licences • Fish licences
Value from the price from similar goods and services	Regulating service • Micro-climate regulation • Water filtration
Value is embedded in market transactions	Provisioning services • Aquaculture • Fish • Timber • Water Regulating service • Coastal protection (insurance)
Value is based on revealed expenditures	Recreation
Value is based on expected expenditures or markets	
Other methods • Contingent valuation • Other	

*Some ecosystem services, such as cultural ecosystem services will not be monetised.

[14] Normyle, A., Doran, B., Vardon, M., Mathews, D., Melbourne, J., & Althor, G. (2022). An Indigenous perspective on ecosystem accounting: Challenges and opportunities revealed by an Australian case study. Ambio, 1-13. https://doi.org/10.1007/s13280-022-01746-8

4. Next steps

This research project is just beginning and is not yet fully funded. The feedback on this paper from the London Group will be used to develop a full research proposal.

At this stage, it is intended that the research will be undertaken as part of a Doctoral study program at the Australian National University. A full-time Doctoral program should be completed in 3.5 years. It is hoped that the project can commence in 2024. A timeline will be produced once the resources for the study are secured and a suitable Doctoral candidate is selected.

Please contact us if you have comments or suggestions on the:

- Conceptual model of reef-to-reef management and its links to the SEEA
- Co-design process
- Data source and methods/models for accounting production
- Application of the accounts to management and planning
- References to other work or;
- Any other matters.

Also please contact us if you would like to be kept updated on the study.

5. Bibliography

This is an indicative reference list based on an initial search of Scopus[15]. Note that the references within the text above are found in the footnotes on each page.

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[15] www.scopus.com

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Nicaragua where downstream water users pay upstream landowners for land conservation and sustainable farming (Corbera et al., 2007; Schomers and Matzdorf, 2013).

6. Supplementary Tables

Table A1. Land cover extent for Clyde River Study Area

	Terrestrial Vegetation												
	Dry Sclerophyll Forests – Shrub Grass sub-Formation	Dry Sclerophyll Forests – Shrubby sub-Formation	Wet Sclerophyll Forests – Shrubby sub-Formation	Wet Sclerophyll Forests – Grassy sub-Formation	Rainforests	Grassy Woodlands	Grasslands	Heathlands	Freshwater Wetlands	Forested Wetlands	Saline Wetlands	Not Classified	**Total**
Area (hectares)	210	34339	13046	27663	5492	1646	18	510	87	1911	632	11939	**97495**
Area %	0	35	13	28	6	2	0	1	0	2	1	12	**100**

Table A2. Marine Landforms extents for Clyde River Study Area

	Marine Landforms						
	Depressions and Channels Rugose	Depressions and Channels Smooth	Peaks	Plains	Reefs	Scarps	**Total**
Area (hectares)	466	280	1176	3816	3156	91	**8985**
Area %	5	3	13	42	35	1	**100**

Table A3. Land use for Clyde River Study Area

Land use	Nature conservation	Managed resource protection	Other minimal use	Grazing native vegetation	Production native forestry	Plantation forests	Grazing modified pastures	Cropping	Perennial horticulture	Manufacturing & industrial	Residential, farm infrastructure	Services	Transport and communication	Mining	Waste treatment & disposal	Lake	Reservoir/dam	River	Marsh/wetland	Estuary/coastal waters	**Total**
Area (hectares)	23455	113	4863	9287	47147	89	2663	88	7	32	3468	188	186	13.03	20	67	23	2158	80	3549	**97495**
Area %	24	0	5	10	48	0	3	0	0	0	4	0	0	0	0	0	0	2	0	4	**100**

Table A4. Land cover by land use for Clyde River Study Area. Area in hectares.

	Terrestrial Vegetation												
Land use	Dry Sclerophyll Forests – Shrub Grass sub-Formation	Dry Sclerophyll Forests – Shrubby sub-Formation	Wet Sclerophyll Forests – Shrubby sub-Formation	Wet Sclerophyll Forests – Grassy sub-Formation	Rainforests	Grassy Woodlands	Grasslands	Heathlands	Freshwater Wetlands	Forested Wetlands	Saline Wetlands	Not Classified	**Total**
Nature conservation	39	11460	5645	3184	2220	165	6	163	50	140	81	302	**23455**
Managed resource protection	0	5	0	76	16	0	0	0	0	13	0	2	**113**
Other minimal use	0	1952	170	1938	43	186	1	42	1	394	11	126	**4863**
Grazing native vegetation	3	2456	985	3188	564	353	3	96	7	627	62	943	**9287**
Production native forestry	169	17835	6038	18117	2489	579	0	168	0	192	27	1532	**47147**
Plantation forests	0	2	0	7	0	1	0	0	0	0	0	78	**89**
Grazing modified pastures	0	88	66	49	53	144	0	2	0	83	0	2177	**2663**
Cropping	0	0	2	0	0	1	0	0	0	1	0	83	**88**
Perennial horticulture	0	0	0	0	0	0	0	0	0	0	0	6	**7**
Manufacturing & industrial	0	0	0	2	0	0	0	0	0	1	0	29	**32**
Infrastructure	0	449	116	916	76	182	3	26	0	116	1	1581	**3468**
Services	0	5	0	11	0	17	0	3	1	35	0	116	**188**
Transport & communication	0	32	1	51	1	6	0	0	0	3	0	91	**186**
Mining	0	2	0	3	0	0	0	0	0	0	0	8	**13**
Waste treatment & disposal	0	0	2	4	0	0	0	0	0	0	0	13	**20**
Lake	0	3	0	7	1	0	0	0	0	0	0	57	**67**
Reservoir/dam	0	0	0	2	0	0	0	0	0	3	0	18	**23**
River	0	42	20	100	29	11	0	1	0	286	431	1237	**2158**
Marsh/wetland	0	6	0	8	0	0	0	0	28	15	19	5	**80**
Estuary/coastal waters	0	1	0	1	0	0	4	9	0	1	0	3535	**3549**
Total	**210**	**34339**	**13046**	**27663**	**5492**	**1646**	**18**	**510**	**87**	**1911**	**632**	**11939**	**97495**

Table A5. Land tenure for Clyde River Study Area

	Land Tenure										
	Freehold	Freehold Indigenous	Other Perpetual Lease	Other Term Lease	Other Lease	Nature Conservation Reserve	Multiple Use Public Forest	Other Crown Purposes	Other Crown Land	No Data Unresolved	**Total**
Area (hectares)	22192	1041	13	9	9	28633	43560	1905	76	58	**97495**
Area %	23	1	0	0	0	29	45	2	0	0	**100**