DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS
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System of Environmental Economic Accounting

SEEA Central Framework 2028 update

Draft Guidance Note

Issue A.4: How SEEA CF accounts can be made spatially explicit

Version for discussion at the SEEA CF Technical Committee meeting on 17-21 November 2025.

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1 Introduction

1. The aim of this guidance note is to provide guidance on the treatment of issue A4 in the update of the SEEA CF. This Guidance note addresses **Issue A4** "Some modules of the SEEA CF could be extended to be more spatially explicit, for example in accounts for flows of residuals (covered under B2). Exploring this approach could harness synergies between the SEEA CF and SEEA EA.".
2. A definition of spatially explicit could be "spatially explicit refers to a model or representation where variables, inputs, or processes have specific locations that are significant to the context being analysed. This means that geographic features have a defined location on a landscape that can be recorded and found on a map. In such models, entities are often associated with precise coordinates in space, emphasising the importance of location in the analysis" (AI-generated definition).
3. Some modules of the SEEA CF could be extended to be more spatially explicit, for example in accounts for flow of residuals (covered under B2). Exploring this approach could harness synergies between the SEEA CF and SEEA EA.
4. The detail provided in national accounts and international reporting can be useful in determining overall objectives for environmental management at the national and global level. However, use of a smaller spatial scale can help to better understand local trends and, in some cases, reveal where issues are hidden in national summaries.
5. Reviewing the paragraphs where spatial accounts are referenced, one can note:
    1. The concepts of regional, disaggregated and spatial are used interchangeably throughout SEEA CF.
    2. Most of the references to spatially explicit accounts are an addendum to the key point of each paragraph.
    3. There is not a clear distinction between regional in a sub-national sense and regional in the sense of a group of countries, and what this means for spatial analyses.
    4. There is a dedicated section on spatial and temporal detail for natural assets (paras 5.495 to 5.497) however this is intended for water assets only.
6. There are a good number of references to spatially explicit accounts or reporting of accounts throughout the SEEA CF. However, these could be made more consistent, highlighted more prominently and have a stronger emphasis on accounts compilation.
7. One point to note is that there is no conceptual definition of a spatial or spatially explicit account in SEEA CF, nor any guidance on methods for spatial accounts.
8. Task Team A agreed to the following changes to be incorporated into a guidance note:
    a. **Issue A4.1** ***Revising chapter 2 commentary***,
    b. **Issue A4.2** ***Having consistent terminology*** throughout chapter 2, 3, 4 and 5 and any analytical references;
    c. Issue A4.3 ***Linking the discussion of spatial accounts to ecosystem accounting***
    d. **Issue A4.4** ***Discussing the roles of tabular and mapping concepts*** for spatial accounting including considering recent material on spatial analysis from Measuring Sustainable Tourism.
    e. **Issue A4.5** ***Discussing the integration of the global commons*** into SEEA CF

f. **Issue A4.6** ***Discussing the different representations of spatial data***[1], including the use of established standards from the UN (Global Geospatial Information Management) and geospatial community.

g. **Issue A4.7** ***Discussing how spatial accounting can assist informing and supporting disaster risk management*** and the link to environmental expenditure accounting.

h. **Issue A4.8** ***Establish the relationship between bottom up construction of accounts such as from a global grid and top down disaggregation*** including the use of socio-economic boundaries (including legislative boundaries).

9. This issue is related to a wide range of others under consideration for the review:
    1. Issue A1 - Providing a broad overview of links between SEEA CF and SEEA EA. Ecosystems and environment are interlinked at a spatial level and ecosystem accounting is inherently spatially explicit. Explanation of the linkages between the two should include reference to explicitly spatial accounts.
    2. Issue A6 - Introduction of thematic accounts and strengthening the link to policy. The link to policy highlights the rationale behind the development of spatially explicit accounts for use in national policy.
    3. Issue A7 - Links to social domain. SEEA CF already mentions the usefulness of linking spatially explicit accounts to social information, for example demographic information from the population census, eg "…linking of health status to data on air emissions in particular regions." (para 2.76)
    4. Issue B6 - Inclusion of residual flows to ecosystem type. This information will need to be predominantly spatial to link to ecosystem accounting.
    5. Issue D1 - Inclusion of the carbon stock account in SEEA CF. Most countries will draw on spatially explicit ecosystem accounts to produce carbon stock accounts (especially as different ecosystem types in different locations have different characteristics in relation to carbon storage).
    6. Issue D4 - Consideration of water as a produced asset. Water will need to be measured spatially and as a produced asset.
10. The following process was used to prepare and finalise the GN (This will be drafted by UNSD for inclusion ahead of Global Consultation).

11. The remainder of this Guidance note is structured as follows:

    a. Sections 2 - 9 discuss each of the eight topics listed above with each section providing a description of the current treatment of the relevant issues and proposals for discussion.
    b. Subject to further discussion of the issues and proposals, Section 10 and 11 will be drafted providing recommendations for updates to the SEEA CF and a description of other considerations in advancing the issue.

2 Issue A4.1 Revising chapter 2 commentary

2.1 Discussion

1. The current SEEA CF considers spatially explicit accounting as an analytical extension to the core set of accounts in chapter 2. For example, water accounts suggest that compilation for river basins for the purposes of water resource management (para 3.185). Over time and the development of the SEEA EA this relationship has become more explicit as these methods for ecosystem accounting are intrinsically spatial and linked back to the core accounts. Soulard (2022) highlights the usefulness of a georeferenced ecosystem and other environmental accounts for the purposes of policy and even determining ecosystem extent in the first place.

[1] 'Representations of spatial data' may not be the best way to frame this issue. This might be more appropriate to be called 'how geospatial information standards relate to spatial accounts in SEEA CF'.

2. Land accounts are a special case in SEEA CF. Land accounts are spatially explicit accounts in that they represent space set aside for economic and environmental activities (para 5.239). They are uniquely required to be compiled from detailed geographic information (para 5.244) and will often be reported in different ways (para 5.241). Given the spatial nature of land accounts, these are often seen as baseline or reference data for other accounts. For example, land accounts are largely seen as the link between CF and Ecosystem accounting (Wentland et al, 2020).

3. The SEEA CF has two key paragraphs from chapter 2 that lead the discussion of the spatial application of the SEEA CF accounts:

   "2.76 Examples of the application of such data include the incorporation of employment data on the production of environmental goods and services, the use of socioeconomic groupings of households to assess water and energy use and access to resources, and the linking of information on health status to data on air emissions in particular regions.

   2.80 Combining physical and monetary data is governed at its core by the logic of recording physical flows in a manner compatible with economic transactions as presented in the SNA. This linkage ensures a consistent comparison of environmental burdens with economic benefits, or environmental benefits with economic costs. It can be examined not only at the national level but also at disaggregated levels, for example, in relation to regions of the economy, or specific industries, or for the purpose of examining the flows associated with the extraction of a particular natural resource or the emissions of a particular material."

2.2 Proposals

4. Remembering that the emphasis for chapter 2 is the description of the accounting structure and general coherence with the remaining suite of accounts and accounting principles, there are a number of options here in regards to explicit spatial accounts.
5. **Option 1.** Create a section on the spatial accounting as a set of principles, outlining terminology and options, and the purpose of spatially explicit accounts. The benefits of this approach would be to raise the profile of spatial accounts, set out some standard terms and definitions and be a useful reference for linking to relevant accounts (rather than repeating the same message over and over). For example,
   1. 2.3.X Spatial accounting
   2. Spatial accounting refers to the allocation of environmental economic accounts to areas within economic ownership. Environmental Economic Accounts can be compiled and represented through spatial accounting, in map or tabular formats.
   3. Fully spatial accounting, in which all data used in the accounts are georeferenced to fine-scale geographic locations, allows for maximum flexibility on how the accounts can be spatially disaggregated and reported. Partially spatial accounting can support disaggregation by certain sub-national areas (which ones will depend on how the data were collected
   4. One of the key features of spatial accounting is the use of geographic boundaries that enable links to other datasets such as population or economic series. There is no recognised global spatial data infrastructure as this is left for countries to build based on their needs. However, there are guidelines from the UN Global Geographical Information Management, that enable the construction of good spatial data infrastructure through adherence to four key principles:
      i. Use of fundamental geospatial infrastructure and geocoding
      ii. Geocoded unit record data in a data management environment
      iii. Statistical and geospatial interoperability

iv. Accessible and usable geospatially enabled statistics

5. In addition to geographical boundaries such as administrative boundaries, fully spatial accounting requires an agreed national spatial frame or spatial data structure, such as a grid of fine-scale spatial units with a fixed point of origin, to which accounting data and other relevant data can be georeferenced.
6. Some SEEA CF accounts lend themselves to spatially explicit accounting more than others. The intention is not necessarily that all SEEA CF accounts should be made spatially explicit but rather that consideration should be given in compiling the accounts to whether it is possible in principle to make them spatially explicit and, if so, whether the additional work required to do so would add sufficient value to the use of the accounts to be worthwhile.

6. **Option 2** could be to just reword what is in chapter 2 and then reword relevant parts as shown in issue 4.2 above. In this case, SEEA CF could have the following reworded paragraphs for chapter 2:
7. "2.76 Examples of the application of such data include the incorporation of employment data on the production of environmental goods and services, the use of socioeconomic groupings of households to assess water and energy use and access to resources, and the linking of information on health status to data on air emissions ~~in particular regions~~ ***by using spatially explicit accounting***.
8. 2.80 Combining physical and monetary data is governed at its core by the logic of recording physical flows in a manner compatible with economic transactions as presented in the SNA. This linkage ensures a consistent comparison of environmental burdens with economic benefits, or environmental benefits with economic costs. It can be examined ~~not only at the national level but also at disaggregated levels~~ ***using spatially explicit accounting and statistical disaggregation techniques***, for example, in relation to regions of the economy, or specific industries, or for the purpose of examining the flows associated with the extraction of a particular natural resource or the emissions of a particular material."

3 Issue A4.2 Having consistent terminology

3.1 Discussion

9. References to spatial data are inconsistent throughout SEEA CF. For example:
    1. Para 1.12. "… geospatially referenced data…"
    2. Para 2.76. "… in particular regions."
    3. Para 2.80. "Not only at the national level but also at disaggregated levels, for example, in relation to regions of the economy…"
    4. Para 3.185. "… available for such geographical areas, corresponding economic data will generally be available only for administrative regions; therefore, these two geographical boundaries may not align."
    5. Para 3.221. "…for regions within a country…"
    6. Para 3.82. "…between the national environment and another environment…"
    7. Para 3.132. "… between the national environment and another environment… resources caught in non-national waters…"
    8. Para 5.268. "…To undertake this type of analysis, the data must be based on spatially referenced data sources."
    9. Para 5.333. "… data that are spatially referenced."

10. Para 5.495. "…at many geographical levels, ranging from local levels and the level of river basins, to national and multinational levels… choice of spatial scale is important, as countries may experience significant geographical variation…"
11. Para 5.496. "… be appropriate spatial references…"
12. Para 5.497. "…for specific spatial scales… at relevant spatial levels… available spatial detail for economic data (which are more commonly compiled based on administrative boundaries…"

3.2 Proposals

10. There are a couple of options considering consistent terminology.
11. **The first option** is to consider any sub-national or regional analysis as 'spatial accounting' for example, spatial accounting principles should be used when representing water accounts.
12. **The second option** is to use the term 'geographical' when applied to sub-national accounts, for example, 'geographical representation of water accounts'.
13. **The third option** is the have a spatial typology or glossary where terms can be flexibly used but have clear definitions. For example:
    1. Spatial Accounting – Using spatially explicit data to compile accounts, thus enabling aggregation or disaggregation of the accounts at various geographical levels and spatial representation of the accounts in various forms.
    2. Spatial units – a defined area that is used as a building block for collecting, organising and analysing location specific data and information (Bordt, 2015), SEEA EA uses the concept of a basic spatial unit as a part of the compilation process.
    3. Geographical boundaries – Sub-national areas that are usually defined by a national geographic classification system or other administrative purposes such as government areas.
        i. Administrative boundaries – regions that are recognised by governments for the purposes of planning, public services and management.
        ii. Economic boundaries – these are defined by SNA 2025 as either the territory in which economic activity takes place or where the residents of a country undertake economic activity.
        iii. Demographic boundaries – are determined by the areas use to collect data from populations for example, Australia uses a meshblock and statistical area classification which allocates smaller population groups into boundaries which can be aggregated for the purposes of population statistics. These are also used to define economic regions.
        iv. Natural boundaries – boundaries based on, for example, ecoregions, biomes or catchments. For example, SEEA EA which can be aggregated to biomes, catchments or other ecoregions.
    4. Spatial disaggregation – use of methods to allocate aggregated data to spatial areas.
    5. Spatial aggregation – use of methods to aggregate data from finer scale spatial units to broader scale spatial units.
    6. Geographical level – specific spatial unit or scale used to group geographical information such as countries, states, regions, provinces, municipalities. International geospatial guidance recommends a consistent, interoperable approach such as a nested hierarchy, with each level containing a larger or smaller extent of geographical area than the one above or below it.
    7. Spatial scale – the physical size, extent, or level of detail at which a phenomenon or process is observed, measured, or analysed in space. In the context of

accounting, spatial scale refers to the spatial resolution at which the data used to compile the accounts has been georeferenced.

14. Some definitions that will need some clarity before adding to a glossary of spatial accounting:
    1. Regions, where the terminology is used for multiple countries (supranational, macro regions) are represented compared to regions which are sub-national. Potentially this could be remediated through the use of geographical levels.
    2. Geospatially referenced – doesn't seem to exist in current definitions, 'georeferenced' is more specific as it is tied to a coordinate system and regularly used to transform aspects or conic projections. However it is needed for fully spatial accounting so needs a firm definition and term.
    3. Spatially referenced – also doesn't largely exist in geographic definitions, 'spatial reference' is a metadata term used by Geographic Information Systems to refer to a set of parameters that defines how geographic features and their coordinates are related to real world space. Put in the context of 'use of a spatial reference' would make more sense.

4 Issue A4.3 Linking the discussion of spatial accounts to ecosystem accounting

4.1 Discussion

15. Issue A1 discusses the links SEEA CF and SEEA EA in depth, though this issue will discuss the spatial nature of these accounts.

16. The SEEA EA on the use of spatial accounting states "(para 2.7) **Spatial**: a comprehensive measurement base of statistical units is formed through use of the ecosystem concept to establish the number of occurrences of ecosystems within a defined territory that can be classified in mutually exclusive ways" and notes "(para 2.12) … The EAA (Ecosystem Accounting Area) is the geographical territory for which an ecosystem account is compiled."

17. The inherent flexibility of the EAA concept could be applied to SEEA CF as it would allow for bespoke approaches to measuring environmental assets, "(para 2.20) Key spatial properties of an ecosystem's location are its extent, size or area; its spatial configuration (the way in which its various components are arranged and organized); the landscape or seascape forms (e.g. mountain regions, coastal areas) within which the ecosystem is situated…" and "(para 2.21) Ecosystems can be identified at different spatial scales; for instance, a small pond and a tundra stretching over millions of hectares may both be considered an ecosystem."

18. A systems-based approach for ecosystems accounting, noted in Bagstad (2025) and UN (2022a), is advised for an interoperable approach to ecosystems modelling which holds promise for application in explicit spatial SEEA CF accounts. That is, at least, the use of common spatial units, and common metadata to describe biotic and abiotic functions within national ecosystems.

19. It is worth noting at this point that SEEA EA uses a consistent approach to the term 'spatial' to describe most geographic concepts.

20. SEEA CF land accounts are inherently spatial and may be seen as linked to (terrestrial) ecosystem extent accounts in SEEA EA. However, land accounts are not equivalent to ecosystem extent accounts, as ecosystem types and land cover or land use classes have a different conceptual basis. Further clarity is needed on differentiating land accounts from ecosystem extent accounts, with land accounts remaining within the scope of SEEA CF. This will be covered in Issue A1.

4.2 Proposals

21. This issue needs to be combined with Issue A1 (Linking SEEA CF and SEEA EA). Data sources used in CF accounts are often used to in the compilation of ecosystem extent and condition accounts. It would seem logical that there should be a degree of consistency between the spatial elements of SEEA CF and SEEA EA. SEEA EA has spent more time considering the spatial elements of environmental economic accounting. At a conceptual level some basic spatial identity is needed that is consistent with other spatial data series. This links to the proposal referenced in issue A4.1, option 1, new paragraph 5 recommending an approach for a national spatial frame or spatial structure.
22. **The first option** is to ensure that terminology is consistent between any new references to spatial accounts and the spatial concepts discussed in SEEA EA. For example, for spatially explicit statistics, concepts such as a grid (Discrete Global Grid[2]) and a basic spatial unit (SEEA EA) seem to be coherent.
23. One useful tool to adopt from SEEA EA is to adopt the concept of an ecosystem accounting area. In the SEEA CF context this would be an 'Environmental Accounting Area'. So the adjustment to text in Chapter 2, and following on from option 1 in Issue A4.1, could be:
    1. 2.3.x An Environmental Accounting Area is the geographical territory for which an environmental account is compiled. The EAA therefore determines the location of environmental assets and the source of flows to the economy.
24. **A second option** may be to highlight the link between SEEA CF and SEEA EA for spatial accounting, but also consider a SEEA - Spatial Accounting technical paper which can focus on compilation examples and guide compilers through the process of creating georeferenced data sets for the purposes of aligning SEEA CF and SEEA EA accounts. The land account technical paper (UN 2016) is a useful base for expanding to a more detailed compilation guide to explicit spatial accounts.

5 Issue A4.4 Discussing the roles of tabular and mapping concepts

5.1 Discussion

25. There are overlapping concerns between this issue and Issue A4.8, in regards to the principles of reporting using spatially explicit accounts. There are overlaps with compiling the SEEA CF accounts using some of the concepts from spatially explicit accounts.
26. Several countries present spatially explicit accounts in the form of maps and/or tables with a breakdown of subnational areas, for example:
    1. Statistics Sweden publish regional air emissions estimates (tabular), land accounts (tabular), regional environmental economic accounts (tabular and mapping).
    2. Australian Bureau of Statistics publish land accounts (tabular and mapping), water accounts (tabular).
    3. Instituto Brasileiro de Geografia e Estatística publish land accounts (mapping and tabular) and water accounts (mapping and tabular).
    4. Statistics Canada publish plastic material accounts (tabular), environment taxes (tabular), and selected natural resource reserves (tabular).
27. The tabular references above from the selected NSOs feature sub-national administrative areas in their output. The mapping outputs are also based heavily on socio-economic

[2] Discrete Global Grid - a spatial reference system that partitions the Earth into a hierarchical set of nested cells, providing a way to digitally organize and address the entire globe (Béjar etal, 2023).

boundaries. Australia for instance uses a classification of statistical geography for mapping and tabular representations of their land accounts. Interestingly Brazil uses cross tabulations with ecoregions in their land accounting, while these are not necessarily established reporting or standard geographical regions, they are combinations of homogeneous regions.

28. The final draft of measuring sustainable tourism (MST) has a few notable points worth mentioning here:
    1. Early identification of a systematic approach to sub-national regions is useful for attributing environmental data to other information. For example the use of a consistent set of sub-national boundaries. In the MST case, this was the use of defined tourism regions.
    2. Seek more disaggregated data, below that of any specified region when considering a coordinated approach to data collection.
    3. That connections between environmental boundaries and administrative ones are important to note or manage when using these data for management purposes.
29. MST also considers a useful starting point for a range of accounts that are suitable for sub-national reporting:
    1. Water accounts
    2. Solid waste accounts
    3. Emissions accounts (and including air quality accounts)
    4. Land and ecosystem accounts
    5. Environment protection expenditure accounts
30. Global Geospatial Information Management (UN-GGIM) recognises spatial data and standards in a broad context, “Geographic information is also referred to as geospatial information, geodata, geoinformation, location-based data, or spatial information. Standards facilitate the integration of all kinds of geographic information to enable more effective policies and decision-making. They form part of the architecture by which such information can be discovered, collected, published, shared, stored, combined, and applied. Standards also enable collaborative geospatial information management across organizations and levels of government.” (UN, 2022)
31. GGIM also introduces the concept around sharing geospatial data, which is critical for EEAs, “ Interoperability is the ability to access, exchange, integrate and cooperatively use data in a coordinated manner, within and across organizational, regional, and national boundaries.” (UN, 2022)
32. GGIM introduces the need for defining national standards for geospatial information, including domain specific (by topic, eg land cover reflectance) and technology specific metadata. However, it does not go on to specifying a global standard.
33. A countries approach to deciding on and designing spatial accounts is often driven by the end user. In the cases where this is driven by the compiler the end result can be mixed (Vardon etal, 2016). One of the gaps is a logical process for determining use and the types of accounts that would suit, for example, where spatial accounts are needed.

5.2 Proposals

34. This issue should be collapsed into one issue with A4.6 and A4.8.

35. **Option 1.** The treatment of spatial accounts should be considered in two distinct ways, and should be consistent throughout the SEEA CF:
    1. Accounts that are compiled spatially from the ground up or using georeferenced data are ideally 'fully spatial accounts', or those with the distinct responsibility of being related to domestic or regional geography. These accounts could be: Land accounts, water accounts, timber asset accounts, though this is not an exclusive list. Typically these are aggregated from natural or environmental boundaries, or through the use of basic spatial units that are the basis for gridded measurements.
    2. Accounts that are composed of some spatial data, data modelled from from national or regional totals or a mix of both sources should be referred to as 'partial spatial accounts' reflecting the nature of their compilation.
    3. As mentioned in para 27, above, aggregation geographies are largely country specific, examples include socio-economic, administrative, ecological and so on. Usually a geography is chosen for analysis, eg choosing socio-economic boundaries may not make sense ecologically, but can be useful to explain consequences of environmental change or economic impact.
36. **Option 2.** A table could be presented in Chapter 2 (table 2.x, below) describing the relationship between environmental economic accounts and spatial accounting. This table would most likely suit option 1 in Issue A4.1 (construction of a new section in chapter 2 on spatial accounting).
37. Table 2.x, Suitability of Central Framework accounts for spatial accounting

		Fully spatial accounts	Partially spatial accounts
	Energy		
	Water		
	Material Flow		
Emissions	Air		
	Water		
	Land		
	Waste		
Assets	Minerals		
	Water		
	Timber		
	Biological		
	Carbon		
	Cover		
	Use		
	EPE		
	NRM		
	Taxes		
	EGSS		
	Other		

	Difficult to compile
	Would require siginifcant collection activity
	Suitable for spatial accounting

38. As mentioned in para 30 above, any use of geospatial metadata should be consistent with Global Geospatial Information Management Framework (UN GGIF). Capturing the four elements of standards:
    1. Use of fundamental geospatial infrastructure and geocoding
    2. Geocoded unit record data in a data management environment
    3. Statistical and geospatial interoperability
    4. Accessible and usable geospatially enabled statistics
39. The decision to construct spatial accounts should follow a logical process that is driven by the likely end users of the product. An option here would be to build a logical chain of events or decision tree that can assist countries to decide. In this case an example or demonstration spreadsheet could be developed to lead the discussion of accounts with end users to determine a suitable outcome. The logic chain product in the SEEA EA is an example of this type of product.

6 Issue A4.5 Discussing the integration of the global commons

6.1 Discussion

40. Global commons are defined as:
    1. Vogler (2012) defined the global commons as "…areas and resources defined as being beyond sovereign jurisdiction." Then goes on to provide examples such as the high seas, deep seabed, Antarctica and the global atmosphere.
41. The SNA, SEEA CF and SEEA EA do not mention global commons directly as a feature of Environmental Accounting. Oceans and atmosphere are excluded from environmental assets in SEEA CF (para 30). The last SEEA guidelines to mention global commons specifically was SEEA 2003 (UN, 2003).
42. It is useful to consider the three elements of what is considered to be a global commons as referred to in the current SEEA CF.
43. Atmosphere has two features in SEEA CF:
    1. It is excluded from environmental assets (para 30) and
    2. is excluded in transboundary flows (para 3.33, "…or air emissions transferred into the atmosphere of other countries.").
44. The author notes that the atmosphere is seen as an infinite sink for water vapour and air emissions and an infinite source for inputs into the economy from Economy Wide – Material Flow Accounting perspectives. Para 5.16 notes that the volume of air in the atmosphere is also not in scope of environmental assets.
45. SEEA CF refers to the high seas where a country has harvesting rights in the high seas and mineral and energy resources rights on the ocean floor (para 2.102, 5.16).
46. The volume of water in the sea is excluded in measurement of national stocks. Seabed is included in environmental assets where there is a recognised claim for example, para 5.13, " … and any other water or seabeds in international waters over which the country has a recognized claim.".
47. SEEA CF Section 5.9.2 details the distinguishing characteristics of residency when taking into account of the Economic Exclusion Zone:
    1. "5.398 The aquatic resources for a given country comprise those resources that are considered to live within the exclusive economic zone (EEZ) of a country throughout their life cycles, in both coastal and inland fisheries. Migrating and

straddling fish stocks are considered to belong to a country during the period when those stocks inhabit its EEZ.

2. 5.399 When exploitation control over migrating and straddling fish stocks, and fish stocks that complete their life cycle in international waters (high seas), has been established and the access rights of a country to them are defined in international agreements, that portion of agreed access rights to those aquatic resources can be considered to belong to the country.
3. 5.400 In some cases, international agreements specify explicitly the share of total catches that should be allocated to each country. When this is the case, each country's share of the stock of the common aquatic resource can be determined on the same basis. In the absence of specific information about the share of the common aquatic resource, the catch realized by a given country can be used as an indicator of the country's share.
4. 5.401 These aspects of the measurement boundary are defined with reference to the United Nations Convention on the Law of the Sea, and in particular to the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (United Nations, 2004) and the Code of Conduct for Responsible Fisheries (FAO, 1995). Together, these agreements create a legal framework for international fisheries management."

48. SEEA CF considers high seas for total catch of aquatic resources: para 5.434, "…For the purposes of accounting for the national aquatic resource, the focus must be on the total catch from the country's aquatic resources, including any resources on the high seas over which ownership rights exist, regardless of the residency of the harvesting operation.".
49. High seas are taken into account when considering valuation of aquatic resources through the use of quota: para 5.445, "… and may apply both to harvesting within the waters of the country's EEZ and to fishing on the high seas."
50. Residual flows are not explicitly mentioned in relation to the high seas or seabed in SEEA CF. Water emissions deflect any treatment to the solid waste account: para 3.260 "… The direct dumping of waste into water bodies is not covered in water emissions accounts but in solid waste accounts.". The solid waste accounts however only discuss these flows in very general terms:
    1. para 2.68 "… Solid waste accounts are useful in organizing information on the generation of solid waste and the management of flows of solid waste to recycling facilities, to controlled landfill or directly to the environment.", and
    2. para 3.274 "… It also shows the flow of solid waste to the rest of the world as exports and the flow of solid waste direct to the environment.".
51. SNA 2025 refers to a similar treatment to high seas as SEEA CF.
52. SEEA EA considers the global commons components in a similar fashion to SEEA CF:
    1. Para 3.26, "Common forms of EAAs include: … Other areas of policy or analytical interest such as protected areas; areas owned by specific industries or sectors (e.g. government-owned land); and areas outside national jurisdiction (e.g. open oceans and high seas)."
    2. Para 3.84 "… As not all ecosystems are owned (e.g. some remote natural areas and the high seas beyond the EEZ), various accounting conventions have been established."

3. Para 4.8 " … Also, it is possible to compile accounts covering areas outside national jurisdiction, for example, ocean areas including the high seas."

4. Para 11.45 " Treatment of the atmosphere and the high seas. The scope of ecosystem assets excludes the atmosphere and generally for national-level accounting purposes marine areas beyond the EEZ would also be outside the EAA that defines the scope of the extended balance sheet. The values of these environmental assets are therefore not captured in the value of ecosystem assets…"

5. Para 13.12 "…Further, for some themes (for example, climate change or assessment of environmental and economic outcomes on the high seas beyond national jurisdiction), compilation of global scale accounts may be of relevance."

53. SEEA 2003 referred to the global commons as:

    1. "2.27 Just as there is an interaction between the national economy and the economies of the rest of the world, so there is an interaction between the national economy and the environment of the rest of the world. This includes not only the environment of other countries but the open seas, the upper atmosphere and so on (often referred to as the global commons). Such flows take place when units belonging to the national economy operate abroad. National airlines flying to another country consume oxygen from and discharge residuals to the rest of the world environment. Tourists consume ecosystem inputs and leave residuals behind. Flows between the rest of the world economy and the national environment also take place and need to be registered." (UN, 2003)

6.2 Proposals

54. The current concept for 'global commons' in the SEEA CF is divided into three components and referred to individually. These are:
    1. Marine areas beyond the Economic Exclusion Zone
    2. Seabed beyond the Economic Exclusion Zone, and,
    3. Atmosphere.
55. Global commons are defined as: "areas and resources defined as being beyond sovereign jurisdiction" (Vogler, 2012). These exist outside of Exclusive Economic Zone, and have a few treaties managing them: United Nations Conferences on the Law of the Sea (UNCLOS), Antarctic Treaty System (ATS) (Buck, 1988).
56. SEEA CF also expresses that parts or at least the harvesting rights in the global commons that are owned are to be included in a countries economic assets.
57. Global commons, with the exception of harvesting rights for natural resources claimed by a economy, are generally excluded from spatially explicit accounts. However, there is a need to measure these commons in a spatially explicit account, but ownership of these accounts is not clear.
58. **One option** is to refer to rights consumed in the global commons to be an 'extranational' geographic level activity or transaction. For example, adjusting para 5.398: "The aquatic resources for a given country comprise those resources that are considered to live within the exclusive economic zone (EEZ) of a country throughout their life cycles, in both coastal and inland fisheries. Migrating and straddling fish stocks from extranational sources are considered to belong to a country during the period when those stocks inhabit its EEZ."
59. **The second option** is to define global commons in the context of the high seas, seabed and atmosphere, then leave the current descriptions of how SEEA CF approaches these in place.
60. A **subsidiary to this option** is to define global commons in Chapter 2 in a similar way to SEEA 2003 such as:

1. " 2.xxx There are interactions between national economies and the environment of the rest of the world. This includes the open seas, the upper atmosphere, deep seabed and so on (often referred to as the global commons). Such flows take place when units belonging to the national economy operate abroad. National airlines flying to another country consume oxygen from and discharge residuals to the rest of the world environment. Nations have harvesting rights on the high seas. These flows between the rest of the world economy and the national environment also take place and need to be registered."

7 Issue A4.6 Discussing the different representations of spatial data

7.1 Discussion

61. There are two main representations of spatial data. 1) mapping – where data are translated to a number of defined vectors or shapes with country boundaries and represented by cartography. 2) tabular data – where data from different areas within a country are represented in a written form, usually as a table or as a graphic such as an infographic or a statistical graph.

62. Uptake of spatial representations of SEEA CF are currently typically limited to accounts of land and sometimes water. Some air emissions accounts by region are available, Statistics Sweeden is the notable stand out here. Regional environment protection expenditure accounts are feasible (Osborn 2002). Asset accounts by region are feasible but are likely to have confidentiality and market sensitive information.

63. There is flexibility in reporting on spatial data as both mapping and tabular data approaches can be compiled on either:

    1. from spatially detailed or georeferenced sets of information, for example satellite imagery or regionally designed survey data, or

    2. from disaggregating based on spatial variables to a particular set of boundaries.

64. Other definitions of regional or sub-national scales have been suggested, for example, Balej etal makes an interesting point that in respect of land cover there are two main spatial scales, macroregional and mesoregional and two types of region, formal and informal. Linking accounts through spatial accounting is also an option for example, Soulard (2020) notes the linkage between a grid spatial data infrastructure and other variables needed for ecosystem accounts link through land accounts. For the moment these are left out of scope of spatially explicit accounting approaches.

7.2 Proposals

65. The two main representations of spatial accounts are tables and maps, with derivations based on these two approaches such as infographics, time series GIFs and analytical tools. This doesn't tend to be a conceptual need, but a useful representation of these data.
66. **One option** is to refer to the tabular or mapping nature of spatial outputs in chapter 2. As an addition to option one in Issue A4.1:
    1. 2.3.x Spatially explicit accounts can be represented in SEEA CF as either as tables or as maps depending on the geographic scale chosen and what analysis will be useful in that context. For example, sub-national tables of energy accounts may be sufficient, but land accounts are ideal for both tables and maps since they are likely to have a stronger connection to finer geographical scales.
67. **The second option** is to go into more detail about the types of spatial inputs that would be needed, with examples in each of the accounts of SEEA CF where spatial outputs are sensible, that is, add an extra table in each of the relevant accounts with a representation of a spatial

account. This will take a degree of work to cover all the accounts. This should be an annex to chapter 2.

68. **The third option** is as suggested in A4.3 that we should create a spatial accounting technical note, using the land account and SEEA EA as a basis for the note, which would include a section on links to principles of geographic information management including the development of a representative spatial data infrastructure for the purposes of environmental accounts.

8 Issue A4.7 Discussing how spatial accounting can assist informing and supporting disaster risk management

8.1 Discussion

69. The Sendai Framework for Disaster Risk Reduction is seen as the key set of indicators driving a global response to disasters. The Sendai Framework has seven global targets:

    1. Reduce Global disaster mortality
    2. Reduce Number of affected people
    3. Reduce Economic loss in relation to GDP
    4. Reduce Damage to critical infrastructure and service disruption
    5. Increase Number of countries with national and local DRR strategies by 2020
    6. Increase International cooperation to developing countries
    7. Increase Availability and access to warning system and DRR information

70. Vardon (2023) presented on the links between SEEA and disaster related statistics with a focus on ecosystem accounts. Some of Vardon's key messages were in context of using the relationship between SEEA CF stocks and SNA stocks, especially non-produced assets; as well as the ability for SEEA, especially SEEA EA to produce detailed maps of extent and condition of ecosystems, with the potential to produce overlays of the services they may provide for the benefit of disaster reduction. Vardon's final point was the use of environment accounts in most planning cycles for disaster risk and management.

71. For example Vardon (2023) suggests, use of land use mapping for management of response and critical area management; links to land cover (and ecosystem extent) to critical assets; use of environment protection expenditure accounts in recovery management; and evaluation of risks from hazards (emissions).

72. UNESCAP (2023) raise in an issues paper that there is a distinction between SEEA EA and SEEA CF supporting disaster risk management. SEEA CF has a line entry on catastrophic losses, whereas SEEA EA considers losses due to disaster and a part of the natural cycle of ecosystems. The paper does not discuss the use of environment protection expenditure accounts in relation to disaster risk, the key focus seems to be instead on ecosystem services.

73. SEEA CF is a key feature of UNECE's Climate change indicator set (UNECE, 2021), but the use of spatial is to derive key national indicators only. The Task Team did suggest that spatial information would be useful in understanding some of the indicators.

74. Local government environment expenditure accounts are feasible (ABS 2004), though survey techniques are usually needed to gain sufficient information. Oborn (2002) discusses how environmental management can be enhanced through the local development of SEEA EPE accounts, especially when considering mapping local environmental asset, restoration and management as well as allocation of these expenditure with the intent to measure success. This could also be useful in a disaster management context: local environmental accounts,

paired with environment protection expenditure by locations, and understanding the link between population locations and environmental assets.

8.2 Proposals

75. The first observation is that most of the SEEA CF accounts are useful in one way or another for disaster management if they are a detailed enough geographical scale to be used in local disaster risk management. In the case of SEEA EA this was suggested (Vardon, 2023) to be an application for "maps and accounts".
76. The key feature of SEEA CF is the concept that land is considered to be the provision of space (paras 1.49, 5.20). As a consequence any support for disaster management or similar statistics would be to provide a base set of information such as a land account linked to a spatially explicit accounts as described throughout this guidance note. Given that land accounts are the core accounts guidance could be made in SEEA F that the land account, including land cover, land use and land value accounts, are fundamental for linking environmental economic accounts to disaster management exercises. Given the spatial nature of the land account, then there is a link to any spatial representations of population, topography, ecosystems, and to some degree impacts of climate change.
77. On method to defining how useful an account could be in supporting disaster management is if the account can be considered fully spatial or partially spatial (as defined in A4.1). An account considered to be fully spatial would be useful for considering where impacts could be felt from disasters, or with sufficient modelling where disasters could occur. For example in the case of an ecosystem collapsing, ecosystem accounts could determine the likely collapse of relevant ecosystem services leading to a disaster. In this case land use accounts could determine the likely extent of impact on industry and households, with support from other accounts such as water and energy if applicable.
78. **One option** for chapter 2 is to add to the new section proposed in issue A4.1, referring to the usefulness of SEEA CF in Disaster Risk Management:
    1. " 2.3.x The inherent links to spatial accounting go beyond understanding key features of the natural environment. If explicit spatial accounts are available at sufficient detail, then these can be applied to areas of population, economy and ecosystems. The overlay of these accounts and areas with socio-economic statistics can underpin analysis on the impact, pathways to recovery and mitigation of disasters. For example, a detailed set of thematic forest accounts, including land cover, ecosystem assets and services, restoration expenditure, value, and production can indicate the risk of a disaster, say wildfire, the impact of disaster on the economy and nearby population centres, and the likely costs of restoration. With some extra information, say prevailing winds, predictions of direction of disasters and impacts on human health are also feasible."
79. **A second option** is to elaborate the links to disaster management in more depth in a spatial accounting technical note. Some country or locality based case studies would be useful to explain how to coordinate data inputs and consider an entire environmentally enhanced disaster management system.
80. **A third option** is the introduction of a table in chapter 6 that details the links between SEEA accounts (including ecosystem accounts) and disaster management principles (eg protection, impact, location). An example table could look like this:
81. Table 6.x SEEA related accounts and related disaster management options

DRR	Ideal accounts	Spatial?
Reduce Global disaster mortality	Land, ecosystems	Fully

Reduce Number of affected people	Land, ecosystems	Fully
Reduce Economic loss in relation to GDP	Energy, Water	Partial
Reduce Damage to critical infrastructure and service disruption	Land	Fully
Increase Number of countries with national and local DRR strategies by 2020	n/a	
Increase International cooperation to developing countries	n/a	
Increase Availability and access to warning system and DRR information	Land	Fully

82. The same style of table could be used for linking to other frameworks such as Measuring Sustainable Tourism etc.

9 Issue A4.8 Establish the relationship between bottom up construction of accounts such as from a georeferenced grid and top down disaggregation

9.1 Discussion

83. Bottom up construction of accounts enable discrete boundaries to be a feature of the accounting process. For example, in the Australian Land Accounts, data translated from representations given at a national grid where aggregated to statistical boundaries based on population statistics, and commonly used for representing economic statistics. This process also enabled aggregation to state (sub-national) boundaries, which were then coherent with state based totals for land valuation accounts. In this case land valuation accounts were derived from detailed data from a third party, modified to represent the statistical concept at State (sub-national) totals.

84. Bottom up construction of accounts also have different types of input data. For example, UK air emissions accounts have a combination of point sourced data from pollution exceedances and measured using national consumption data. US (Bagstad etal 2020) estimated water accounts using a combination of spatial data sets and industry information, as well as considering good environment accounting to balance out inputs and outputs. Wentland etal (2020) apply vast amounts of data to construct national totals using regression or hedonic techniques.

85. It is expected that, academically, linking spatial accounts together, say timber asset and forest ecosystem accounts with emissions accounts, would be desirable but discovering examples is difficult. Much of the academic literature is focus on case studies of particular regions and their environment, economic, and social interactions.

86. Recognising the importance of land in spatial accounts is a consideration for top down or bottom up concepts. Wentland etal (2020) point out that land is used indirectly for the purposes of ecosystem accounts, Meadows and Khoo (2019) recommend that land is a part of spatial architecture when allocating or recording environmental assets. For spatial accounts, land is a useful baseline set of information as it has relevant characteristics which enable both recording of information, for example via earth observations, and a variable which is vital for the disaggregation of statistics to a regional context.

87. Top down disaggregation of accounts are in the form of national or sub-national information that may not have a geographic link that are then distributed based on some form of geographic basis such as administrative regions, population centres or even census collection districts. For example, Australia used a five yearly census of agricultural businesses to

distribute water consumption to sub-national reports by modelling consumption forward at a catchment level (ABS 2023). [another example would be useful here]

88. Top down approaches are useful for countries with limited resources, and for detailed accounts for regions. Some of the techniques are: [Other examples would be useful]

    1. Using broad based assumptions for environmental variables when disaggregating to spatial areas (Soil water use model, Australia)
    2. Distributing environmental variables based on demographic or business characteristics by area (Water Account end uses, Australia)

9.2 Proposals

89. This can be addressed as a section in Chapter 2 (as in the first option in issue A4.1 above), where text can be created to cover the relationship between top down and bottom up approaches.
90. **Option 1.** The text is likely to be a guide to compilation rather than a conceptual features. It would be ideal to maintain consistency with the issues above notably:
    1. Use of a spatial data infrastructure that can manage the need for ecosystem level analysis, in particular for highly detailed accounts such as land. Use of spatial referencing or georeferencing to enable detailed analysis on land based features.
    2. Focus on consistent use of terminology around the design of accounts from the top down (spatially disaggregated) and bottom up (spatially aggregated). These methods will need some degree of coherence between the geographies and the spatial referencing need to allocate to these geographies.
    3. Some accounts will need a combination of aggregation and disaggregation techniques when producing spatial accounts.
91. Thus the text needed to be added to Issue A4.1, option 1 above could be:
    1. 2.3.x Compilation of fully spatial accounts are typically georeferenced data or derived from regional data if there is sufficient information to do so. Georeferenced data are often in a grid or based on locations within an economic territory[3]. In some cases explicit spatial accounts will need a combination of data sources both aggregated and spatial referenced, for example in the development of partially spatial accounts.
92. **Option 2** is to propose a Spatial accounting technical note (as described in issue A4.1, which will allow for a more detailed discussion of bottom up and top down approaches to spatial accounts, as well as how to mix the two approaches as a part of standard accounts.

10 Recommendations on conceptual treatments (3-4 pages)

93. **These are in draft pending agreement from the SEEA CF Technical Committee.**
94. A summary of options are presented here:
    1. Include a new section in chapter 2 on Spatial accounting (see text below), OR change wording in paras 2.76 and 2.80.
    2. Change wording In SEEA CF to consider any sub-national accounts as ‘spatial accounting’ or more precisely, ‘fully spatial accounts’ or ‘partially spatial accounts’.
    3. Recommend the production of a post SEEA 2028 technical note on spatial accounting, potentially completing the effort so far on the land technical note.
    4. Create entries in a glossary to reflect the terminology used in spatial accounting (see para 97 below).

[3] In some respects this could overlap with the description of fully spatial accounts in a proposed new section for chapter 2.

5. From an ecosystem accounting perspective, recommend that countries produce a standard geospatial approach to environmental-economic accounts.
6. Using ecosystem accounts as an example, establish a basic spatial unit for SEEA CF accounts such as an Environmental Accounting Area.
7. Include a table on the range of SEEA CF accounts and their application to spatial accounts in chapter 2. (see table at para 37 above)
8. Recommend adherence to the standard processes for establishing geospatial standards from the UNGGIM.
9. Have a decision tree or logic chain to determine the need for spatial accounts based on the Ecosystem accounts example or a decision tree approach.
10. Redraft the concept of global commons into chapter 2, preferably in a new section that is similar to the version in SEEA 2003, noting the inclusions and exclusion to the global commons.
11. Define the representation of accounts in an additional paragraph in chapter 2 or increase the detail in each of the accounts that are suitable for spatial accounting.
12. Include a table in chapter 6 on the links to disaster risk management (and potentially others such as Measuring Sustainable Tourism).
13. Another option is to describe these links in more detail in a technical note for spatial accounting.
14. The discussion on top down and bottom up approaches were considered to be compilation issues. While there is some rationale to introducing these concepts in chapter 2, there would be more impact on the CF community if there was more depth and examples. A technical note on spatial accounting is recommended for this purpose.

95. The terms suggested for inclusion in the SEEA CF glossary are:
    1. Spatial Accounting - practices that incorporate aggregation or disaggregation using spatial data infrastructure in relation to a particular account.
    2. Spatial units - a defined area that is used as a building block for collecting, organising and analysing location specific data and information (Bordt, 2015)
    3. Geographical or administrative boundaries - boundaries that are primarily based on anthropogenic concepts such as population, economic zones and so on. These are usually defined by a national geographic classification system or other administrative purposes such as government areas.
    4. Natural boundaries - boundaries that are largely consistent with ecoregions or areas designated by ecosystem accounting to be contiguous ecosystems (ecosystem assets).
    5. Spatial disaggregation - use of methods to allocate aggregated data to spatial areas.
    6. Spatial aggregation - use of methods to aggregate data from spatial units.
    7. Geographical level - specific spatial unit or scale used to group geographical information such as countries, states, regions or even smaller areas like statistical mesh blocks. These levels form a hierarchy, with each level containing a larger or smaller extent of geographical area than the one above or below it.
    8. Spatial scale - the geographic extent and resolution at which a phenomenon or observation is studied, defining the size of the area and the detail of measurement.
96. Some definitions that will need some clarity before adding to a glossary of spatial accounting:
    9. Regions, where multiple countries are represented compared to regions which are sub-national. Potentially this could be remediated through the use of geographical levels.
    10. Geospatially referenced - doesn't seem to exist in current definitions, 'georeferenced' is more specific as it is tied to a coordinate system and regularly used to transform aspects or Albers projections.
    11. Spatially referenced - also doesn't largely exist in geographic definitions, 'spatial reference' is a metadata term used by Geographic Information Systems to refer to a set of parameters

that defines how geographic features and their coordinates are related to real world space. Put in the context of 'use of a spatial reference' would make more sense.

97. The additional text for a new section in chapter 2 is consolidated here:
    i. 2.3.X Spatial accounting
    ii. Spatial accounting refers to the allocation of environmental economic accounts to areas within economic ownership. Environmental Economic Accounts can be compiled and represented through spatial accounting, in map or tabular formats.
    ~~iii.~~ Fully spatial accounting, in which all data used in the accounts are georeferenced to fine-scale geographic locations, allows for maximum flexibility on how the accounts can be spatially disaggregated and reported. Partially spatial accounting can support disaggregation by certain sub-national areas (which ones will depend on how the data were collected
    iv. One of the key features of spatial accounting is the use of geographic boundaries that enable links to other datasets such as population or economic series. There is no recognised global spatial data infrastructure as this is left for countries to build based on their needs. However, there are guidelines from the UN Global Geographical Information Management, that enable the construction of good spatial data infrastructure through adherence to four key principles:
        1. Use of fundamental geospatial infrastructure and geocoding
        2. Geocoded unit record data in a data management environment
        3. Statistical and geospatial interoperability
        4. Accessible and usable geospatially enabled statistics
    v. In addition to geographical boundaries such as administrative boundaries, fully spatial accounting requires an agreed national spatial frame or spatial data structure, such as a grid of fine-scale spatial units with a fixed point of origin, to which accounting data and other relevant data can be georeferenced.
    vi. 2.3.x An Environmental Accounting Area is the geographical territory for which an environmental account is compiled. The EAA therefore determines the location of environmental assets and the source of flows to the economy.
    vii. 2.xxx There are interactions between national economies and the environment of the rest of the world. This includes the open seas, the upper atmosphere, deep seabed and so on (often referred to as the global commons). Such flows take place when units belonging to the national economy operate abroad. National airlines flying to another country consume oxygen from and discharge residuals to the rest of the world environment. Nations have harvesting rights on the high seas. These flows between the rest of the world economy and the national environment also take place and need to be registered.
    viii. 2.3.x The inherent links to spatial accounting go beyond understanding key features of the natural environment. If explicit spatial accounts are available at sufficient detail, then these can be applied to areas of population, economy and ecosystems. The overlay of these accounts and areas with socio-economic statistics can underpin analysis on the impact, pathways to recovery and mitigation of disasters. For example, a detailed set of thematic forest accounts, including land cover, ecosystem assets and services, restoration expenditure, value, and production can indicate the risk of a disaster, say wildfire, the impact of disaster on the economy and nearby population centres, and the likely costs of restoration. With some extra information, say prevailing winds, predictions of direction of disasters and impacts on human health are also feasible.
    ix. 2.3.x Compilation of fully spatial accounts are typically georeferenced data or derived from regional data if there is sufficient information to do so. Georeferenced data are often in a grid or based on locations within an economic territory . In some cases explicit

spatial accounts will need a combination of data sources both aggregated and spatial referenced, for example in the development of partially spatial accounts.

b.

98. Comments from the wiki

    1. Statistics Canada- agreed with the general aims of the guidance note
    2. Mandy Driver (SA) – contributed to key changes for guidance note v2. Advice was given on the naming of spatial accounting types, decision trees for deciding on the use of accounts, guidance on the definition of boundaries, guidance on the connections to ecosystem accounts.
    3. *Comments from TT-A were included in the guidance note.*

11 Other considerations in advancing the issue (1-2 pages)

99.

100.

12 References

Australian Bureau of Statistics (2004), 4611.0 - Environment Expenditure, Local Government, Australia, 2002-03 in https://www.abs.gov.au/AUSSTATS/abs@.nsf/ProductsbyCatalogue/74F47FC0E3BCA4A7CA256C5600057277?OpenDocument

Australian Bureau of Statistics (2022), National Land Cover Account, ABS Website, ABS (2023), https://www.abs.gov.au/methodologies/water-account-australia-methodology/2021-22

Kenneth J. Bagstad, Zachary H. Ancona, Julie Hass, Pierre D. Glynn, Scott Wentland, Michael Vardon, John Fay (2020), Integrating physical and economic data into experimental water accounts for the United States: Lessons and opportunities, Ecosystem Services Volume 45, October 2020.

Kenneth J. Bagstad, Stefano Balbi, Greta Adamo, Ioannis N. Athanasiadis, Flavio Affinito, Simon Willcock, Ainhoa Magrach, Kiichiro Hayashi, Zuzana V. Harmáčková, Aidin Niamir, Bruno Smets, Marcel Buchhorn, Evangelia G. Drakou, Alessandra Alfieri, Bram Edens, Luis Gonzalez Morales, Ágnes Vári, María-José Sanz, Ferdinando Villa, 2025., Interoperability for ecosystem service assessments: Why, how, who, and for whom?, Ecosystem Services, Volume 72, 2025, 101705, ISSN 2212-0416, https://doi.org/10.1016/j.ecoser.2025.101705.

Balej, Martin. Comparing regional differentiation of land cover changes in natural and administrative regions of the Czech Republic using multivariate statistics, in https://www.researchgate.net/publication/254457598_Comparing_regional_differentiation_of_land_cover_changes_in_natural_and_administrative_regions_of_the_Czech_Republic_using_multivariate_statistics

Rubén Béjar, Javier Lacasta, Francisco J. Lopez-Pellicer, Javier Nogueras-Iso,A (2023), Discrete Global Grid Systems with quadrangular cells as reference frameworks for the current generation of Earth observation data cubes, Environmental Modelling & Software, Volume 162, 2023, 105656, ISSN 1364-8152, https://doi.org/10.1016/j.envsoft.2023.105656.

Bordt, M., 2015
https://unstats.un.org/unsd/envaccounting/workshops/eea_forum_2015/98.%20SEEA%20EEA%20Tech%20Guid%208%20Spatial%20units,%20scaling%20and%20aggregation%20(21Jan2015).pdf

Osborn, D. (2002). Looking for Knowledge Management in Environmental Accounting. In: Bennett, M., Bouma, J.J. (eds) Environmental Management Accounting: Informational and Institutional Developments. Eco-Efficiency in Industry and Science, vol 9. Springer, Dordrecht. https://doi.org/10.1007/0-306-48022-0_15

Soulard, F., 2022.
https://seea.un.org/sites/seea.un.org/files/lg28_d1_s1_4_soulard_register_of_ecosystem_assets_for_canada.pdf

UN 2003, SEEA 2003.

UN 2016, Draft Technical note on Land Accounting,
https://seea.un.org/sites/seea.un.org/files/seea_technical_note_-_land_jan_2017_draft.pdf

UN (2021), Conference of European Statisticians' Set of Core Climate Change-related Indicators and Statistics Using the System of Environmental-Economic Accounting.
https://unece.org/sites/default/files/2021-08/CES_Set_Core_CCR_Indicators-Report.pdf

United Nations (2022a). Guidelines on Biophysical Modelling for Ecosystem Accounting. United Nations Department of Economic and Social Affairs, Statistics Division, New York

UN 2022b, https://standards.unggim.ogc.org/unggim_guide.html#_summary

UNESCAP 2023, https://www.undrr.org/sites/default/files/2023-06/IAEG-Disaster-related%20Statistics_03%20Issue%20paper%20-%20Environmental%20and%20ecosystem%20losses%20%28Working%20Paper%29.pdf?startDownload=true

Michael Vardon, Peter Burnett, Stephen Dovers, 2016, The accounting push and the policy pull: balancing environment and economic decisions, Ecological Economics, Volume 124, Pages 145-152, ISSN 0921-8009, https://doi.org/10.1016/j.ecolecon.2016.01.021. 2016

Vardon 2023 in https://www.unescap.org/sites/default/d8files/event-documents/S6_SEEA-Ecosystem_3rdExpertForum_5-7Jun2023.pdf

Vogler, J. (2012) 'Global Commons Revisited', Global Policy Vol3(1)pp 61-71, 27 January 2012, doi.org/10.1111/j.1758-5899.2011.00156.x

Scott A. Wentland, Zachary H. Ancona, Kenneth J. Bagstad, James Boyd, Julie L. Hass, Marina Gindelsky, Jeremy G. Moulton, Accounting for land in the United States: Integrating physical land cover, land use, and monetary valuation, Ecosystem Services, Volume 46, 2020, 101178, ISSN 2212-0416, https://doi.org/10.1016/j.ecoser.2020.101178.