

System of Environmental Economic Accounting



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Environmental
Economic
Accounting

SEEA Technical Note: Land Accounting

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SEEA Technical Notes

This note is a part of a series of Technical Notes prepared to support the development of data based on the System of Environmental Economic Accounts (SEEA) Central Framework, the first international standard in environmental economic accounting. Since SEEA is not a single account but a series of modules, the accounts in each of the various modules can be developed separately in accordance with the priorities and the resource availability in each country.

The series of Technical Notes is comprised of a) a note addressing general issues that cut across domains focusing on institutional arrangements and institutional processes that encourage efficient implementation of the standard and associated data compilation exercises (see *Institutional Arrangements and Statistical Production Processes for the Implementation of the SEEA-Central Framework*) and b) a number of notes on specific modules. It is recommended that those wishing to develop data related to any of these specific modules should read the cross cutting note in conjunction with the note on the specific modules to be developed.

The notes on modules summarize the data requirements and other operational considerations in 10-15 pages designed to provide sufficient guidance to initiate the development of the accounts. The notes also provide reference information for additional publications that will support the full development of the accounts and provide information on extensions and linkages that can be exploited once the accounts and tables are in place.

I. Introduction to land accounting

1. Land is a unique asset that delineates the space in which human activities and environmental processes take place, and within which environmental assets and economic assets are located. Land is central to economic and environmental accounting. Beyond an assessment of the ownership and use of land as part of economic production, some of the issues that can be considered in the context of land accounts include the impacts of urbanisation, the sustainability of agriculture and forestry, the use of inland freshwater resources, and biodiversity conservation.
2. This technical note provides an overview of land accounting according to the System of Environmental Economic Accounting 2012 Central Framework (SEEA CF) which was adopted by the United Nations Statistical Commission in 2012 as the international statistical standard for environmental economic accounts.
3. The general purpose of SEEA Technical Notes is to summarize the key features of accounting for a given topic to support countries in the implementation of the SEEA, and describe what might be a minimum set of information to guide initial efforts in compilation. This technical note will describe the main features of the SEEA accounts for land, and present a set of core accounts which comprise an adapted version of the SEEA Central Framework accounts to focus and guide initial compilation.
4. The core accounts represent a minimum set of information which countries should aim to compile and report, explicitly identifying the most important data items for the module at hand. While the core accounts represent a minimum set, countries may often wish to extend the level of detail in areas deemed particularly policy relevant. The Technical Notes provide highlights of such possible extensions in the explanatory text. The level of detail and industry disaggregation of the core accounts is relatively uniform across the set of module-specific technical notes. For the modules where industry disaggregation is relevant, five broad industry classes are identified.
5. Land area can be analysed in many different ways and as such land accounts can be prepared from several points of view. From a spatial point of view, land accounts can be compiled for the country as a whole or for regions within countries. For example, accounts can be compiled by administrative boundaries or by land cover characteristics.. From an economic point of view, land accounts can be constructed by the area of land owned by different institutional sectors, land used by different industries and land zoned for different activities (e.g. residential, industrial, conservation).
6. Land also constitutes an important component in the assessment of national and institutional sector wealth. Land is bought and sold in combination with physical attributes of the land (e.g. soil) and the produced assets that may be located on the land (e.g. buildings) and, thus, the composite value will incorporate these values as well as a value of the space itself (the location).
7. In addition, land accounts also help unlock the power of Geographic Information Systems (GIS) to locate areas of change and map a wide range of social, economic and environmental information. While the focus initially is to build environmental-economic information at the

national level, local environmental conditions can vary widely across a country resulting in the need for analysis and policy action that differ by local area. GIS can be very important in integrating data sets organized by administrative regions and others organized by bio-physical or topographic regions.

8. National assessments of the changing shares of different categories of land use and land cover within a country can provide useful indicators of change. For example, how changing shares of land cover and land use relate to income generation over time. Such information can be used to assess how factors interact in particular regions and help to target policy action appropriately.

9. The development of core accounts was requested by the UN Statistical Commission at its 44th session in February 2013. The core accounts for land, along with other core accounts such as those for energy, forests, and others, constitutes the starting point in the development of common reporting tables in close coordination with international agencies. They will be submitted to the UNCEEA after extensive consultations with experts, including the London Group on Environmental Accounting, international organizations and national statistical offices.

10. The information presented in the core accounts for land is data which can be used to produce a range of indicators identified in international initiatives. For example, the Commission for Sustainable Development¹ has indicators for land use change, land degradation, arable area, and forest area. Furthermore, land accounts are the central to ecosystem accounting. Land areas may be used to provide a measurement basis for ecosystem accounting in a similar way to which statistical units, such as establishments, provide a basis for measurement in economic statistics. SEEA Experimental Ecosystem Accounting develops these ideas in more detail.

11. Section II briefly describes the SEEA accounting system for land and introduces the core accounts for land, along with and classifications for land cover and land use. Section III describes some important indicators that can be derived from the core accounts for land. Section IV deals with the data sets required to produce the land accounts including the main concepts, data sources and compilation methods. Section V describes how the land accounts and related datasets may be extended to address broader issues and linked to other data sets. Section VI provides references and links to supporting material.

II SEEA-CF accounts – land

A. Core Accounts - land

12. Land accounts can be prepared in both physical (e.g. hectares) and monetary (\$, €, ¥, etc.) terms. There are three core accounts that are most fundamental for land; namely the physical asset accounts for land, first with land classified by land cover and secondly, classified by land use, as well as the monetary asset account for land use.

¹ See <https://sustainabledevelopment.un.org/csd.html> for more information on the Commission's work.

13. At its most basic level, land cover comprises all of the individual features that cover the area within a country. For the purposes of land cover statistics the relevant country area includes land and inland waters. The area of coastal waters is generally excluded from land accounts but provision is made to extend the coverage to include coastal waters and the Exclusive Economic Zone (EEZ) if there is a need (e.g. because fish or other marine resources are harvested).

14. The SEEA definition of land cover and the full classification are presented below:

Land cover *refers to the observed physical and biological cover of the Earth's surface and includes natural vegetation and abiotic (non-living) surfaces².*

15. Current land cover is a function of natural changes in the environment and of previous and current land use, particularly in agricultural and forestry areas. Thus, a clear and systematic description of classes of land cover allows the land cover classification to be compared with that for types of land use, while maintaining pure land cover criteria.

16. The 14 classes in Table 1 constitute a set of land cover types with clear boundaries based on definitions from the Land Cover Classification System (LCCS) of the FAO. This land cover classification can be used at all scales, independently of the method of observation, thus allowing cross-referencing of local and regional maps with continental and global maps without loss of information. Extended descriptions of the classes are provided in Annex I.³

² Definition from the SEEA Central Framework, paragraph 5.257

³ As part of the SEEA Central Framework research agenda (see annex II), the interim land cover classification presented in table 5.12 will be further tested to ensure its suitability for the standardization of statistical data sets at the international level. Note that wetlands may be part of multiple classes. Work is underway to identify secondary classes to address this issue. In the meantime, if wetlands are a subject of interest, it may be desirable to separately identify them within each class.

Table 1 Land cover classification (interim)

Category	
1	Artificial surfaces (including urban and associated areas)
2	Herbaceous crops
3	Woody crops
4	Multiple or layered crops
5	Grassland
6	Tree covered areas
7	Mangroves
8	Shrub covered areas
9	Shrubs and/or herbaceous vegetation, aquatic or regularly flooded
10	Sparsely natural vegetated areas
11	Terrestrial barren land
12	Permanent snow and glaciers
13	Inland water bodies
14	Coastal water bodies and inter-tidal areas

17. The SEEA definition of land use and the full classification are presented below:

Land use reflects both (i) the activities undertaken and (ii) the institutional arrangements put in place; for a given area for the purposes of economic production, or the maintenance and restoration of environmental functions⁴.

18. In effect, an area that is “used” implies the existence of some human intervention, including active management. Land in use therefore includes protected areas which are under the active management of institutional units of a country for the purpose of excluding most economic or human activity from that area.

19. Not all land in a country is used following the definition above. Some areas are “not in use”, although they may have a use in supporting ecosystems and biodiversity. In order to provide a complete accounting for land use within a country, both land in use and land not in use must be included.

20. The complete classification for land use comprises 46 basic classes and is presented in full in Annex I of the SEEA-CF, with a summary presented in Annex II of this note. The higher level classes for land and the classes for inland water are presented below. Classes for coastal water and the EEZ are parallel to those for inland water.

⁴ Definition from the SEEA Central Framework, paragraph 5.246

Table 2 Land use classification

1	Land
1.1	Agriculture
1.2	Forestry
1.3	Land used for aquaculture
1.4	Use of built up and related areas
1.5	Land used for maintenance and restoration of environmental functions
1.6	Other uses of land n.e.c.
1.7	Land not in use
2	Inland waters
2.1	Inland waters used for aquaculture or holding facilities
2.2	Inland waters used for maintenance and restoration of environmental
2.3	Other uses of inland waters n.e.c.
2.4	Inland waters not in use

21. Data from remote sensing (either aerial photography or satellite images) are increasingly available for the entire area of a country and can form the basis of preliminary land cover accounts. Remote sensing images can provide some indication of land use but these data can also be difficult to interpret in some cases. Additional precision can often be found in a range of administrative datasets (e.g. those of local governments) associated with the regulation of land use. Constructing preliminary datasets based on remote sensing data can identify where additional administrative data are most needed. Ultimately, classification in the most challenging cases may require on site verification.

22. Account 1 shows the Physical asset account for land cover from the SEEA Central Framework. It shows the opening and closing areas for different land cover types and the additions and reductions for each class of land.

Core Account 1: Physical Account for Land Cover (hectares)

	Category of Land														TOTAL	
	Artificial surfaces	Herbaceous crops	Woody crops	Multiple or layered crops	Grass-land	Tree covered areas	Mangroves	Shrub covered areas	Shrubs and/or herbaceous vegetation, aquatic or regularly flooded	Sparsely natural vegetated areas	Terrestrial barren land	Permanent snow and glaciers	Inland water bodies	Coastal water bodies and inter-tidal areas		
Opening Stock	12293	271517	117295	56619	106181	338514	215	66476		73.5	1966.5	0	1657.3	11292.2	19351.5	1003449
Additions to Stock	183	4677	3119	1561.5	69										1.5	9611
Reductions in Stock		147			4704	3118.5	10.5	1629		1.5						9610.5
Closing Stock	12476	276047	120414	58181	101546	335396	204	64847		72	1966.5	0	1657.3	11292.2	19353	1003449

23. Account 2 is the Physical asset account for land use and has the same rows as the physical asset account for land cover as described above. The columns are based on the Land use classification described above.

Core Account 2: Physical asset account for land use

	Type of Land Use					TOTAL
	Agriculture	Forestry	Use of built up & related areas	Land used for maintenance & restoration of environmental functions	Other*	
Opening stock	531650	317800	10630	10000	133369	1003449
<i>Additions to stock</i>	8130	340	150	0	0	
<i>Reductions in stock</i>	0	7720	0	900	0	
Closing stock	539780	310420	10780	9100	133369	1003449

24. Land cover and land use are interrelated. For example, land uses associated with agricultural production are closely aligned to crop area. However, while land use and land cover can be closely related, this is not always the case. For example, tree covered areas can be used for forestry, for the maintenance and restoration of environmental functions, or may not be used at all (i.e. land not in use). Another common example is grazing land which constitutes agricultural land use but shows up as grasslands or sparse trees when considering land cover.

25. With data structured in an accounting format based on common statistical units, it is possible to link land cover to land use. This allows for the preparation of accounts showing land cover by land use as well as matrices showing the changes in both land cover and land use over an accounting period. In assessing land cover and land use change, it may be useful to determine the proportion of the opening stock of land whose cover or use has remained unchanged. To undertake this type of analysis the data must be based on spatially referenced data sources.

26. The basic land accounts are very important for establishing the ability to describe and analyse data in varying geo-spatial configurations in the long run. This foundational aspect of these accounts and associated datasets needs to be a primary consideration from the outset of developing the SEEA based information for land. Before developing a GIS system (or modifying an existing one) for environmental-economic accounts, one should consider the full breadth of potential bio-physical and economic datasets that one might want to eventually integrate. It must also be kept in mind that land accounts are at the core of ecosystem accounting. This link should be carefully considered when developing land accounts in a country where ecosystem accounting may be a priority.

27. The third core account for land is the monetary asset account for land use which requires the separation of the value of land from other attributes that contribute to the market value of the combined asset – land plus, for example, produced assets that may be located on the land (e.g., buildings). As monetary valuation of land is required for the national accounts, it is not specifically addressed in this note. However, it should be pointed out that the information on land use contained in the SEEA accounts may be useful in improving the estimates of the value of land for the national accounts balance sheet.

Core Account 3: Monetary Asset Account for Land Use

	Type of Land Use				TOTAL
	Agriculture	Forestry	Use of built up & related areas	Land used for maintenance & restoration of environmental functions	
Opening value of stock of land	420000	187500	386000	2000	995500
<i>Additions to stock</i>	3500	200	2500		6200
<i>Reductions in stock</i>		4750		200	4950
<i>Revaluations</i>	18250	15350	65000		98600
Closing value of stock of land	441750	198300	453500	1800	1095350

28. Another important characteristic of land is that of ownership, which generally requires access to administrative records. Ownership information can allow the creation of datasets by economic activity or economic sector which may be very useful in some policy applications.

29. Land may in some cases support more than one use. While the basic classification should reflect the dominant use, capturing information on secondary uses may be important in some environmental contexts, for example land primarily used for agriculture may also support animal habitats in peripheral areas such as wind breaks and hedge rows.

30. It should be noted that generally the total area of land for a country will remain unchanged from one period to the next and so the total opening and closing stock of land in physical terms (hectares) will be unchanged. However, there are situations where the area of land for a country may change. It may increase, for example due to reclamation of land through the construction of dykes and other barriers. It may also decrease, for example due to land subsidence or higher water levels. Changes in the total area of land may also occur due to political factors. For example, the total area may increase or decrease due to war and associated events and or possibly resolution of areas of disputed territory⁵.

B. Other land accounts

31. The accounts described to this point provide opening and closing balances by type of land classification, based either on cover or use. An extension of this would be to present information on changes which cross classifies the opening and closing classes for basic observation units and identifies those that have changed. This allows one to present a change matrix showing how land units evolved from one classification to another during a given period.

32. The Land cover change matrix shows the area of different land cover types at the beginning of the reference period (opening stock), the net increases and net decreases according to the land cover type it was converted from (in the case of increases), or what it was converted to (in the case of decreases). Summing the rows will give the net overall change for each class of land cover during the period, which is shown in the second last column. Finally, the area covered by different land cover types at the end of the reference period (closing stock) is shown on the right. The table shows, for example, that between opening and closing stocks the area of

⁵ If total land area changes due to any of these rare circumstances, all data outputs and the associated metadata should clearly indicate the size and reason for the change.

herbaceous crops grew from 271,217 to 276,047 thousand hectares, comprising additions to crop area from grassland (4,677,000 ha) and a loss of (147,000 ha) to artificial surfaces.

Account 4 - Land Cover Change Matrix (hectares)

	OPENING STOCK	Net Increase (+) and decrease (-) from other land covers (1,000 ha)														NET CHANGE	CLOSING STOCK
		Artificial surfaces	Herbaceous crops	Woody crops	Multiple or layered crops	Grass-land	Tree covered areas	Mangroves	Shrub covered areas	Shrubs and/or herbaceous vegetation, aquatic or regularly flooded	Sparsely natural vegetated areas	Terrestrial barren land	Permanent snow and glaciers	Inland water bodies	Coastal water bodies and inter-tidal areas		
Land Cover Classifications	Artificial surfaces	12292.5		147			27		9							183	12475.5
	Herbaceous crops	271517	-147			4677										4530	276047
	Woody crops	117295					3119									3118.5	120414
	Multiple or layered crops	56619							1560	1.5						1561.5	58180.5
	Grass-land	106180.5	-27	-4677					69							-4635	101546
	Tree covered areas	338514		-3118.5												-3118.5	335396
	Mangroves	214.5	-9												-1.5	-10.5	204
	Shrub covered areas	66475.5		-1560		-69										-1629	64846.5
	Shrubs and/or herbaceous vegetation, aquatic or regularly flooded	73.5		-1.5												-1.5	72
	Sparsely natural vegetated areas	1966.5															1966.5
	Terrestrial barren land	0															0
	Permanent snow and glaciers	1657.3															1657.3
	Inland water bodies	11292.2															11292.2
	Coastal water bodies and inter-tidal areas	19351.5							1.5							1.5	19353

33. It is important to understand that the matrix shows net changes, which may mask some important information. For example, if natural forest is lost in one place but an equal amount of plantation forest is added elsewhere, then no net change of tree covered area would be shown. Similarly, when agricultural land is converted into built-up land, but, at the same time, agricultural land is created through deforestation, total crop or grassland (used for agriculture) may not change. Where these phenomena are relevant, the format of Table 1 can be extended to show increases and decreases in separate tables and thus allow more detailed analysis⁶.

34. A land use change matrix showing physical changes in land use could also be developed with the same structure as the the land cover change matrix (above). The rows and columns showing land cover classification in Account 4 would be replaced with the land use classification presented in core account 2.

35. Countries should look at the full classification structure when determining to what level it will classify land use in its own systems. It should consider the extent and degree of variation of specific land covers and uses, along with the analytical and policy requirements. Given there are only a total of 34 basic classes for land and four each for inland water, coastal water and EEZ, it is recommended that countries consider coding at the lowest level of the classification.

⁶ Presenting the data in maps can be very useful in setting out gross changes in land uses.

III Indicators for land

36. As observed at the beginning of this note, “Land is a unique asset that delineates the space in which human activities and environmental processes take place, and within which environmental assets and economic assets are located.”

37. Thus information on land cover and land use often provide basic information needed for many of the indicators being developed for monitoring environmental change. In particular land use has an important role in linking human activity and economic activity to environmental data such as in ecosystem accounts.

38. The level of classification of land use will determine the extent of indicators that can be prepared based on the land asset account information. The more detailed the initial classification the more detailed the indicators that will be potentially available to address policy needs.

39. The land accounts information is important in informing at least four of the proposed indicators for the Sustainable Development Goals currently under discussion for the post 2015 agenda. The four currently identified as potential indicators are:

- i. Proposed Indicator for Target 15.1: Forest area as a percentage of total land area
- ii. Proposed Indicator for Target 6.6: Change in wetlands extent over time (% change over time)
- iii. Proposed Indicator for Target 2.4: Emissions of greenhouse gases in agriculture (per hectare of land and per unit of output, separately for crop and livestock sectors).
- iv. Proposed Indicator for Target 15.1: Coverage of protected areas broken down by ecosystem type, including total area of forests in protected areas (thousands of hectares)

40. While the first indicator comes directly from the Physical Account for Land Cover, the other three require information from other SEEA accounts or extensions to the accounts.

41. For example, the second indicator requires the separate identification of wetlands which can be found in more than one of the basic classes of the interim Land Cover Classification. If this indicator is required, then separate identification of wetlands within these classes should be undertaken in the initial preparation of the data.

42. The third indicator requires additional information from the Air Emissions Accounts identified by ISIC classes⁷. It would also require the identification of land use by industry. Linked land use to industry would be an extension to the core table information that should be considered for the development of these sort of indicators.

43. The fourth indicator requires information on ecosystem accounts. Land accounts are the fundamental link between the accounts in SEEA-CF and the Ecosystem Accounts. In building

⁷ See the separate Technical Note being prepared on the Air Emissions Account for additional guidance on this subject.

the land accounts, it will be important to assure that the foundations for this important linkage are put in place.

44. The land accounts are also specifically linked to two of the OECD's proposed Green Growth Indicators (numbers 7, and 10) and would be useful in delineating areas for a third (number 11) :

- Indicator 7. Forest resources (area and volume of forests; stock changes over time);
- Indicator 10. Land resources (land cover types, conversions and cover changes; land use state and changes);
- Indicator 11. Soil resources (erosion of topsoil, particularly on agricultural land)

45. The generation of indicators of various types for regions within a country will depend on the level and quality of spatial coding available within the systems used to produce SEEA accounts. As noted earlier, the Land accounts form the foundation for such efforts and consideration of the full range of desired indicators should be undertaken at an early stage.

IV Compilation

46. The compilation of SEEA accounts should be founded on the GSBPM as outlined in the first note in this series "Statistical Production Processes for Implementation of the SEEA-Central Framework".

Overarching Management Functions							
1 Specify Needs	2 Design	3 Build	4 Collect	5 Process	6 Analyze	7 Disseminate	8 Evaluate

47. It is often the case when building accounts (SEEA or SNA for example) that one of the goals is to use existing data sources as much as possible. In such a case, the 'Specify Needs', 'Design' and 'Build' phases will often need to be undertaken simultaneously and iteratively, as one evaluates the capacity of existing data sets to meet needs relative to the potential costs of initiating new data development.

Specify Needs, Design & Build

48. The initial compilation of a land account will require several steps that may not need to be undertaken for each data cycle but should be revisited periodically in conjunction with periodic budget and planning cycles:

Setting out the specific land accounts and the dimensions of each account that would best respond to the information needs of the country should be done at this stage. This will provide a basis to

examine the adequacy of the existing data and assess where additional information may be required. Particular attention should also be given in the initial stages to whether these land accounts will be linked to the ecosystem accounts and the national accounts. In particular, compiling the Ecosystem Accounts will likely require the integration of spatial data from many sources (e.g., land cover, hydrology, land use, ownership, etc.). It is suggested that important national data holders are engaged in the initial process of compiling the land accounts.

49. Data on land use and ownership is desirable. Integrating these data would support a better linkage with the other physical and monetary accounts. For example, a given forest area may appear homogenous from a land cover map and yet it may be partly owned by government (as a park) and partly owned by a forestry concession. The forest area will have two different owners and at least two different uses. These differences will result in different conditions and ecosystem services.

50. Land accounts will be important in constructing a number of the indicators being proposed to support the SDGs. These indicators may require additional detail beyond that in the core tables such as the separate identification of wetlands within classes 6 and 9 of Land Cover.

51. The integration and arrangement of this information requires skills and knowledge of GIS in addition to statistical skills and knowledge of accounts and information about land. A prerequisite to the successful ongoing production of land accounts is GIS information technology.

52. At this point if sufficient basic data are not available to produce one or more of the accounts, it may be necessary to initiate a project to generate the missing data. This may well mean that account development splits into two paths one for the accounts that can be initiated with existing data and one where development will have to await the availability of basic data.

53. In some cases where partial data exist but there are some important data gaps it may be a good idea to construct a preliminary account filling in missing data with the best available estimates. While such an exercise may not produce a viable account, it may well reveal more about the extent and importance of data gaps thus providing a better foundation for the development of these missing basic data.

54. In the case where basic data must be developed, it is recommended that a separate project be initiated to develop the necessary data. This project should follow the GSBPM steps and generic principle as set out in the first note in this Technical Note series. Depending on the organization of responsibilities within the statistical infrastructure of the country this step may involve additional agencies or sectors of the NSO.

55. In cases where the existing data is in another agency the establishment of institutional and operational arrangements governing the shared use of these data may need to be put in place before the data can be secured. Again this may require that development of different accounts proceed along different time paths.

56. EEA compilers will at an early stage need to assure access to these data if it does not already exist. A key consideration is the terms of access under current institutional

arrangements. These should support cooperative working arrangements and the release of the land accounts with sufficient detail to address the policy issues which are important for the country.

In cases where institutional arrangements are not yet established, it should be noted that this step can take considerable effort and time as it will be important for all agencies involved to clearly appreciate the mandate of the other agencies and associated constraints. Establishing and maintaining good working relations with the agencies that are the source for basic data can pay dividends later in the production process when estimation challenges can benefit from expertise in all concerned agencies.

57. While data sources for particular countries will vary, data are typically available from government agencies concerned with: agriculture; forestry; fishing; environment; geological survey; urban planning and land administration. Statistical offices may also have data on agricultural, and/or natural resource management practices more generally, based on surveys. The operators of satellites, such as the European Space Agency (ESA) and National Aeronautics Space Administration (NASA), international agencies such as the Food and Agricultural Organisation (FAO) as well as conservation organisations (such as Artificial Intelligence for Ecosystem Services ARIES) also provide information on land cover, land use and other data related to land.

58. In developing land accounts a particular need is to understand the means by which the underlying data on land cover and land use are collected and the original purpose of the collection when using administrative data. Working closely with the originating agencies and fully considering the associated metadata will be important to insure the appropriate integration of such alternate data sets.

59. Data on land values and land ownership are often to be found in administrative data sets. These characteristics often require particular attention to confidentiality constraints. Also, as mentioned earlier, separating the value of land from other attributes such as structures is a complex task. Attention should be paid to what attribute information is available from any datasets that are to be used. The most up to date guidance on estimating land value can be found in a land Compilation Guide published by Eurostat and the OECD⁸.

60. When considering the key data to be used for land accounting, scale, resolution and accuracy are important. However it is essential that data sets that are well established and likely to be produced and updated on an ongoing basis are used. This will enable repeated reporting of change over time. In some instances it may be necessary to consider trading-off quality and continuity.

Collect

61. One of the major constraints in constructing land accounts is the lack of data from a single source. Accessing relevant information on land requires data collection from a large number of

administrative entities or agencies and thus require considerable initial effort. Actual data sources will be different in each country. It is suggested that important national data holders are engaged in the process of compiling the accounts. They will be able to advise on data availability and quality. They will also benefit from having their data assessed and used.

62. Broadly, three sources are used; – administrative sources, collection sources and satellite images sources. Increasingly, data based on combinations of administrative sources, collection sources and satellite images sources are being compiled.

- Administrative sources – cadastre maintained by a land registry office, tax authorities, or land information centre
- Collection sources – population and housing census, Agriculture survey and census, business survey, other type of survey and census data, and other governmental organizations information on land
- Satellite images sources – Images of Earth collected by satellites

63. Administrative data (cadastre, land registry, tax data) usually provide detailed physical data including type of land, location, and owner and can provide more precise information for some land areas. A cadastre is a comprehensive register of the property within a country. It is commonly maintained to record the physical status and legal ownership of land. It includes very detailed maps showing the location of the parcels of land and dimensions of land, and typically includes the use of the land, ownership and value of the individual parcels of land. Many times the ownership of the land is maintained through the use of land title registry that records the change in ownership and could be combined with cadastral information. Cadastral data sets that bring together administratively based information on all or significant portion of a country's land are available for many countries. These may provide sufficient information for the initial classification of various land uses with the reference to a single dataset.

64. Additional types of administrative data that may be useful in combination with cadastral data are land registers. Typically a register will include a list of addresses of buildings and dwellings, type of use and sector ownership, size of land area, and other transaction prices

65. On collection sources, various land surveys, conducted either by national statistics office or by other government agencies, can be used to capture various characteristics of land such as how the land is used and the size and provide data on undeveloped areas, forest and other resources. A survey and census of agriculture is a common source of information for various types of land used for agricultural purpose. Population census or housing surveys are common sources for counts of the number of dwellings, and can be used to derive the combined value of the dwelling and the land. Data sources from survey and census are important as they can provide a high level of specificity regarding the land cover and, in particular, the land use in a given area

66. There is often national or international information available on land cover, typically derived from satellite imagery sources. Satellite images are important as they enable a broader assessment of all areas in a country, and as higher resolution images become available permit more

detailed analyses. While sources such as satellite imagery can provide data on the entire country, it should be pointed out that challenges in classification will need to be carefully considered. As with many classification processes one must consider dominance in coverage of a particular area and that may be difficult to ascertain depending on the resolution of images available. Also, in some instances images may hide coverage aspects, for example a tree covered wetland will often from a satellite image simply look like any tree covered area. Assessing the accuracy and uncertainty in the use of remote sensing data for land account will normally require use of ground-truthing (point) data.

67. The following list suggests some generic government departments and the data they may hold:

- Departments of Environment or Parks: Protected areas, habitat types, ecological classifications
- Departments of Natural Resources: Hydrology, remote sensing data (land cover)
- Departments of Agriculture: Agricultural land use, soil type, farm locations
- Departments of Forestry: Forest land use, forest land cover, forest concessions
- Departments of Fisheries: Coastal and marine characteristics (habitat types)
- Departments of Public Works and Transportation: Road networks, power transmission lines, pipelines
- National Statistical Offices: Population and housing census, agriculture survey and census, business survey, settlement areas
- Land registries: Ownership

Process

68. Import data and process data including applying concordances that may be required between the classifications used in the imported data and the classifications to be used in the estimates.

69. As always with administrative data, adjustments may be needed to align administrative sources with the SNA and SEEA concepts.

70. A challenge in geospatial analysis is combining information from various sources according to a common geographical classification.⁹ For this purpose it is necessary to delineate (or mark out) a set of relatively small spatial areas (essentially building blocks). Information can then be attributed to these spatial areas, different types of data may not be easily attributed to the same spatial scale so different methods/techniques may need to be employed in attributing the data to these areas such as area weighting. Each technique will have to be considered relative to increases in uncertainty that it may introduce.

71. Prepare estimates, including the estimation of data for any data gaps. Given the use of proxies to estimate some data and the varying quality and coverage of these, it is likely that different methods will need to be considered for each industry/sector of the economy.

Analyse

72. Analyse tables and graphic representations including undertaking an analysis of time series where possible and recognising the likely need for multiple iterations of this and the previous step. Data quality should be assessed and documented at this stage.

73. The above three steps are the core activities in building the accounts and will be repeated in cycle during each production period. This allows the strength of the accounting approach to be used to confront the various data sources and check for consistency and reasonableness in comparison to other datasets.

74. The first time accounts are estimated for a new program, particular attention needs to be made with regard to adjustments required to the source data to ensure the methods used are appropriate and sound.

75. It is recommended that in cases where significant basic data come from other agencies that staff of those agencies be asked to participate in the analysis of the estimates.¹⁰ These experts often have in depth knowledge that can allow the identification and resolution of inconsistencies.

Disseminate

76. The dissemination of data should always be accompanied by sufficient documentation and metadata to allow users to fully understand the information being disseminated. This is particularly important for the initial dissemination of a new program of data where one might want to identify the initial data as ‘experimental’ or ‘preliminary’ and make it clear that user input is being sought in order to improve future releases.

Evaluate

80. Archive data and related methodological and other documentation. Review estimates, data sources, methods and systems, including actively seeking user feedback.

81. These last two steps are very important for all statistical programs but when initiating a new program of data, seeking user feedback is crucial. This in turn depends on the existence of good documentation on the methods and systems so as to properly inform users and assess their feedback.

¹⁰ In particular, it may be important to assure that confidentiality masks are consistent across agencies such that residual disclosure does not occur.

V Extensions and links

82. Extensions to land accounts can relate to the spatial disaggregation of data contained in other accounts of the SEEA Central Framework and the national accounts, as well as to the SEEA Experimental Ecosystem Accounting.
83. While the Core Accounts presented above for land cover and land use do not call for information on the reasons for land cover or land use change, the standard format for the asset accounts do and basic information on the reasons for change should be sought from the sources used to classify the opening and closing positions.
84. The standard groupings of reasons for additions and reductions are explained in the following paragraphs.
 - a. Managed expansion represents an increase in the area of a land cover type due to human activity. For example, crop areas may be converted to tree covered areas as a result of silvicultural measures such as planting and seeding, or tree covered areas may be converted to crop or grassland following tree clearing. Generally, the managed expansion of one land cover type will also lead to the recording of a matching entry for managed regression of another land cover type or types. In the rare case where there is a managed expansion in the total area of land within scope of the account (e.g. in the case of land reclamation) a matching entry is not recorded.
 - b. Natural expansion is an increase in area resulting from natural processes including seeding, sprouting, suckering or layering. In the case of sparse natural vegetation and terrestrial barren land, the natural loss of vegetation from other vegetation types would lead to increases in these areas. Changes in the extent of permanent snow, glaciers and inland water bodies can also be due to natural variation in, for example, rainfall. Generally, the natural expansion of one land cover type will also lead to the recording of a matching entry for natural regression of another land cover type or types. Again a matching entry is not recorded in rare cases where there is a natural expansion in the total area of land within scope of the account (e.g. in the case when land is created through volcanic activity or landslide).
 - c. Managed regression represents a decrease in the area of a land cover type due to human activity. As for managed expansion, a matching entry is recorded in all cases of managed regression, except in cases where there is a managed regression in the total land area.
 - d. Natural regression should be recorded when the area of a land cover type reduces for natural reasons. As for natural expansion, a matching entry is recorded in all cases of natural regression, except in cases where there is a natural regression in the total land area (e.g. the loss of land due to erosion by the sea).
 - e. Reappraisals can be upward or downward and reflect changes due to the use of updated information that permits a reassessment of the size of the area of different land covers.

For example, new satellite imagery or updated interpretation of satellite imagery or new administrative data sources. The use of updated information may require the revision of previous estimates to ensure a continuity of time series.

85. Information on reasons for change is more difficult to acquire. Satellite images will not provide such information but it might be possible to infer it in some cases, although confirmation from alternate sources would be encouraged. Administrative or survey sources are more likely to provide such information but again the original purposes of the datasets will need to be considered in interpreting these sources.
86. A starting point for the general approach is the land cover change matrix, (account 4 depicted above). For example, managed expansion can be derived from the changes in land cover related to urban growth and development of infrastructure (through conversion of crops or tree covered area), intensification and industrialisation of agriculture (through conversion of family farming and mosaic landscapes), extension of agriculture in general (through conversion of tree covered land), drainage of regularly flooded areas (wetlands) for crops or artificial surfaces (urban land), and deforestation (of tree covered areas for timber production or agriculture development). Relating land cover and land use is particularly important. The relationship of land cover to land use can be highlighted by preparing accounts showing land cover by land use. If this is done for several points in time, then changes between two points in time can be highlighted. Such change accounts would, for example, show the extent to which forest areas (a land cover) are changing from, for example, maintenance and restoration of environmental functions (a land use) to forestry (another use.).
87. The accounts described in the SEEA-CF generally relate to specific stocks and flows recorded for a country as a whole. However, all materials, substances and resources are found in particular locations and, from a policy perspective, knowledge of the location of various stocks and flows may be of particular relevance. Indeed, national averages usually hide important local variations and spatially disaggregating data can help to better identify environmental spatial patterns.
88. The quality of spatial coding must be assessed carefully as additional datasets are linked and integrated with the land accounts. The original purpose and sources may not provide precise locational information in all cases. For example, data for many economic data programs are gathered by enterprise, usually through the head office, but head offices are often not located where the majority of material flows occur, particularly in large scale manufacturing or mining operations. It may be necessary to pursue more precise locations for some economic activities to fully exploit such data integration.
89. Both land use and land cover accounts can also be presented in monetary terms. That is, while the table structure remains the same, the units of measurement are in monetary units (\$, €, ¥, etc.). Data sources for valuation are generally more aligned with land use and therefore monetary accounts by land use are easier to construct. Land use accounts also generally relate more directly to the existing monetary information on land as an asset in the national accounts.

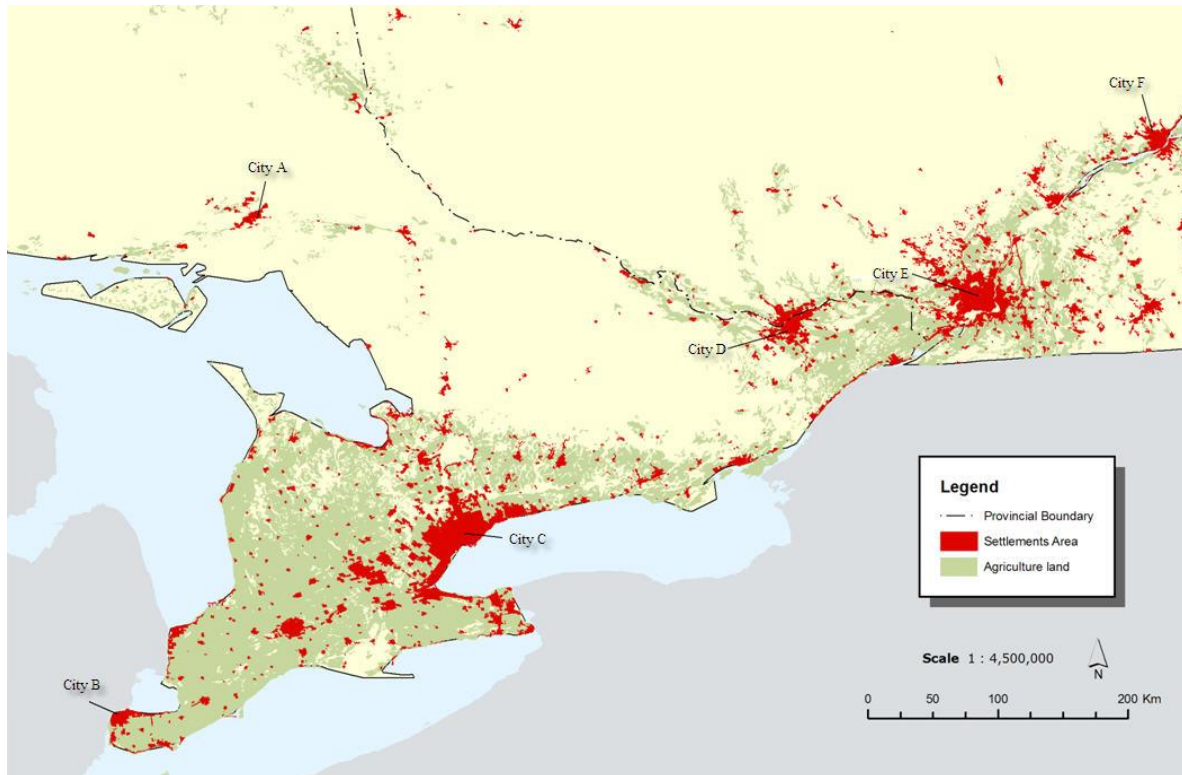
90. Many sources of information on the value of properties have the value for the combined characteristics of the property. This will include the characteristics of the land such as soil, the value of structures such as production plants or buildings and the location. Estimating the value of only the land is a complex and challenging task.
91. A joint Eurostat/OECD Task Force, is developing a compilation manual that provides guidance on this complex issue and it is recommended that countries use this as a basic source for undertaking this task¹¹.
92. The potential of combining geospatial analysis with the data contained in SEEA style accounts is demonstrated by the following example. This example works within the general framework provided and shows measures of land use. The accounts may also be structured to consider land in terms of ownership by economic units, for example by industry or institutional sector. It should be recognised that the completion of geospatial analysis requires strong underlying information systems. A description of the systems, methodologies and best practices in GIS is beyond the scope of the SEEA Central Framework and this note, but this type of information can be found elsewhere¹².
93. A relatively simple example of spatially attributed information is presented in Figure 1. A focus on the use of specific spatial areas enables a stronger, joint consideration of social, economic and environmental implications of various policy choices and options. The expansion in the use of land for housing, for example, requires in turn infrastructure such as roads, sewers, and water supply lines and at the same time can lead to encroachment into high quality agricultural land. Potential environmental impacts include loss of wildlife habitat, increased air pollution and greenhouse gas emissions, and the contamination of rivers, lakes and aquifers. The type or form of expansion may also be significant. For example, is the expansion relatively high or low density in terms of changes in human population?
94. Figure 1 shows a simple presentation of human settlements and agricultural land (Statistics Canada 2010). In this, settlements were defined as tracts of land where humans have altered the physical environment, while dependable agricultural land is land free of severe constraints to crop production. The methodology used to create this map also provides a more detailed, harmonised and comparable suite of data that enables a more complete analysis of settlements and formed the basis for the development of indicators that can be used to track land cover and land use change (Filoso 2011).

¹¹ Specific reference for Eurostat-OECD Task Force document.

¹² For example, see the text books of de Smith et al (2013) or Tomlinson (2005) and a range of on-line information. For example the websites of ESRI, ESA, Geoscience Australia, NASA, and USGS

95. Another example from Australia can be found at [Experimental Land Account for the Great Barrier Reef, 2014](#).

Figure 1. Map of settlements and dependable agricultural land



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VII Annex

Description of land cover classes

The following descriptions of different land cover types are based on the FAO Land Cover Classification System (LCCS).

01 Artificial surfaces (including urban and associated areas)

The class is composed of any type of areas with a predominant artificial surface. Any urban or related feature is included in this class, for example, urban parks (parks, parkland and laws). The class also includes industrial areas, and waste dump deposit and extraction sites.

02 Herbaceous crops

The class is composed of a main layer of cultivated herbaceous plants (graminoids or forbs). It includes herbaceous crops used for hay. All the non-perennial crops that do not last for more than two growing seasons and crops like sugar cane, where the upper part of the plant is regularly harvested while the root system can remain for more than one year in the field, are included in this class.

03 Woody crops

The class is composed of a main layer of permanent crops (trees or shrub crops) and includes all types of orchards and plantations (fruit trees, coffee and tea plantation, oil palms, rubber plantation, Christmas trees, etc.).

04 Multiple or layered crops

This class combine two different land cover situations:

Two layers of different crops. A common case is the presence of one layer of woody crops (trees or shrubs) and another layer of herbaceous crop, e.g., wheat fields with olive trees in the Mediterranean area and intense horticulture, or oasis or typical coastal agriculture in Africa, where herbaceous fields are covered by palm trees.

Presence of one important layer of natural vegetation (mainly trees) that covers one layer of cultivated crops. Coffee plantations shadowed by natural trees in the equatorial area of Africa are a typical example.

05 Grassland

This class includes any geographical area dominated by natural herbaceous plants (grasslands, prairies, steppes and savannahs) with a cover of 10 per cent or more, irrespective of different human and/or animal activities, such as grazing or selective fire management. Woody plants (trees and/or shrubs) can be present, assuming their cover is less than 10 per cent.

06 Tree-covered areas

This class includes any geographical area dominated by natural tree plants with a cover of 10 per cent or more. Other types of plants (shrubs and/or herbs) can be present, even with a density higher than that of trees. Areas planted with trees for afforestation purposes and forest plantations are included in this class. This class includes areas seasonally or permanently flooded with freshwater. It excludes coastal mangroves (→07).

07 Mangroves

This class includes any geographical area dominated by woody vegetation (trees and/or shrubs) with a cover of 10 per cent or more that is permanently or regularly flooded by salt and/or brackish water located in the coastal areas or in the deltas of rivers.

08 Shrub-covered areas

This class includes any geographical area dominated by natural shrubs having a cover of 10 per cent or more. Trees can be present in scattered form if their cover is less than 10 per cent. Herbaceous plants can also be present at any density. The class includes shrub-covered areas permanently or regularly flooded by inland fresh water. It excludes shrubs flooded by salt or brackish water in coastal areas (→07).

09 Shrubs and/or herbaceous vegetation, aquatic or regularly flooded

This class includes any geographical area dominated by natural herbaceous vegetation (cover of 10 per cent or more) that is permanently or regularly flooded by fresh or brackish water (swamps, marsh areas, etc.). Flooding must persist for at least two months per year to be considered regular. Woody vegetation (trees and/or shrubs) can be present if their cover is less than 10 per cent.

10 Sparsely natural vegetated areas

This class includes any geographical areas where the cover of natural vegetation is between 2 per cent and 10 per cent. This includes permanently or regularly flooded areas.

11 Terrestrial barren land

This class includes any geographical area dominated by natural abiotic surfaces (bare soil, sand, rocks, etc.) where the natural vegetation is absent or almost absent (covers less than 2 per cent). The class includes areas regularly flooded by inland water (lake shores, river banks, salt flats, etc.). It excludes coastal areas affected by the tidal movement of saltwater (→14).

12 Permanent snow and glaciers

This class includes any geographical area covered by snow or glaciers persistently for 10 months or more.

13 Inland water bodies

This class includes any geographical area covered for most of the year by inland water bodies. In some cases, the water can be frozen for part of the year (less than 10 months). Because the

geographical extent of water bodies can change, boundaries must be set consistently with those set by class 11, according to the dominant situation during the year and/or across multiple years.

14 Coastal water bodies and intertidal areas The class is defined on the basis of geographical features of the land in relation to the sea (coastal water bodies, i.e., lagoons and estuaries) and abiotic surfaces subject to water persistence (intertidal areas, i.e., coastal flats and coral reefs).

Land Use Classification

1 Land

1.1 Agriculture

This category includes tilled and fallow land, and naturally grown permanent meadows and pastures used for grazing, animal feeding or agricultural purpose. Scattered land under farm buildings, yards and their annexes, and permanently uncultivated land, such as uncultivated patches, banks, footpaths, ditches, headlands and shoulders are traditionally included.

1.2 Forestry

Land used for forestry. Excludes land that is predominantly under agricultural or urban use.

1.3 Land used for aquaculture

Aquaculture refers to the farming of aquatic organisms: fish, molluscs, crustaceans, aquatic plants, crocodiles, alligators, turtles and amphibians. Farming implying some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc.

1.4 Use of built-up and related areas

Land affected or adapted by man, under buildings, roads, mines and quarries and any other facilities, including their auxiliary spaces, deliberately installed for the pursuit of human activities. Included also are certain types of open land (non built-up land), which are closely related to these activities, such as waste tips, derelict land in built-up areas, junkyards, city parks and gardens. Land under closed villages or similar rural localities are included.

1.5 Land used for maintenance and restoration of environmental functions This class includes protected areas as defined by IUCN, International Union for Conservation of Nature, i.e., clearly defined geographical spaces, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.

1.6 Other uses of land n.e.c.

Land used for uses not elsewhere classified.

1.7 Land not in use

Areas where there are no clearly visible indications of human activities or institutional arrangements put in place for the purpose of economic production or the maintenance and restoration of environmental functions and where ecological processes are not significantly disturbed.

2 Inland waters

Inland waters are areas corresponding to natural or artificial water courses, serving to drain natural or artificial bodies of water, including lakes, reservoirs, rivers, brooks, streams, ponds, inland canals, dams, and other land-locked (usually freshwater) waters. The banks constitute limits whether the water is present or not.

2.1 Inland waters used for aquaculture or holding facilities Inland water areas that are used for aquaculture facilities including supporting facilities. Aquaculture refers to the farming of aquatic organisms: fish, molluscs, crustaceans, aquatic plants, crocodiles, alligators, turtles and amphibians.

2.2 Inland waters used for maintenance and restoration of environmental functions

Protected inland water areas as defined in 1.5. This class includes enhanced areas (areas with enhancement including stocking, fertilization, engineering, predator control, habitat modifications and/or access limits.)

The class excludes protected wetlands (→1.5) and protected coastal waters (→3.2).

2.3 Other uses of inland waters n.e.c.

Inland water areas used for uses not elsewhere classified.

Examples of data sources

Data on permanent land (accounting unit) features

Data on local and higher level **administrative, statistical and territorial divisions** are usually publicly available from national sources. Global sources of harmonized administrative data can be accessed online, for example ESRI's [World Administrative Divisions](#); and for statistical areas, examples can be consulted from sources like EU's [NUTS](#), Australia's [Statistical Areas](#). Such data is needed for statistical area-units delineation (sometimes following the boundaries of communes, municipalities, provinces, counties etc.), which conforms to principles of confidentiality. Other relevant themes of longer-term land management may be: protected areas (global source - <http://www.protectedplanet.net/>) and other designations (such as water provision, green corridors and belts etc.).

Well accepted **ecological and bio-physical classifications** (and datasets) can be accessed from global sources, including [WWF's Terrestrial Ecoregions](#); USGS's [Global Ecosystems](#) (mapped for the Americas and Africa); potential vegetation (that can be used to assess 'pre-settlement' reference conditions, see global source: [Ramankutty and Foley, 1999](#)) etc. Nationally available source may be available in a form derived or different from the globally accepted ones, usually with higher detail, including local and regional geographic features.

Globally harmonized river catchments can be accessed from FAO's [hydrosheds](#), by continent and global soil types from [ORNL DAAC data sets](#) (local or national sources would be preferable if existing).

Data on dynamic (asset) land features

Land use and land cover data will often be the only readily-available source to develop proxy of ecosystem assets over large (complete country coverage) areas and map the places where certain ecosystem services are generated. Despite being subject to error, such data may be sufficient to perform initial analysis, estimate Tier I accounts, and detect subset areas (hotspots of changes) for more detailed ecosystem accounting pilots, and advance towards national Tier II and III accounts.

Land cover may be derived from the following globally available sources:

a. [FAO Global Land Cover-SHARE](#)

The FAO product [Global Land Cover-SHARE](#) (year 2014 Beta-Release 1.0) is constructed using the best quality national and international data sources. 11 land cover classes were harmonized and reclassified according to the LCCS nomenclature and included in the SEEA-CF. The individual classes (layers) can be downloaded [online](#) in quantitative area coverage form, expressed as area per grid-cell (from 0 – 100 ha) and also a composite map of dominant classes. Validation results

indicate overall [Producer's accuracy of 80%](#) (variable between 50 and 100% for the individual classes). The available product has to be tested if possible to apply for multi-temporal analysis (e.g. for countries where the original data source contains more than one year maps).

The 1km grid-maps may be too coarse for spatial analysis, yet the available data may be applied to enhance its quality and spatial detail, as well to reproduce annual time-series using remote sensing imagery.

b. MODIS Land Cover

Modis Land Cover is a set of annual products based on NASA's MODIS imagery, and available at 500m x 500m spatial resolution. The product name is '[Land Cover Type Yearly L3](#)' (version 51 is the latest), metadata can be reviewed, and spatial data downloaded from <http://reverb.echo.nasa.gov/>. The data is distributed as 'granules', which need to be identified by the user ([online](#)) prior to downloading. If the study area is large (e.g. a continent) considerable pre-processing will be needed to ensemble ('mosaic') and harmonize the datasets. MODIS land cover products¹³ are summarised below. See nomenclatures for the five products in Annex 1.

The MODIS Land Cover Type product contains five classification schemes, which describe land cover properties derived from observations spanning a year's input of Terra- and Aqua-MODIS data. The primary land cover scheme identifies 17 land cover classes defined by the International Geosphere Biosphere Programme (IGBP), which includes 11 natural vegetation classes, 3 developed and mosaicked land classes, and three non-vegetated land classes.

The MODIS Terra + Aqua Land Cover Type Yearly L3 Global 500 m SIN Grid product incorporates five different land cover classification schemes, derived through a supervised decision-tree classification method:

- Land Cover Type 1: IGBP global vegetation classification scheme
- Land Cover Type 2: University of Maryland (UMD) scheme
- Land Cover Type 3: MODIS-derived LAI/fPAR scheme
- Land Cover Type 4: MODIS-derived Net Primary Production (NPP) scheme
- Land Cover Type 5: Plant Functional Type (PFT) scheme

V051 Land Cover Type products are produced with revised training data and certain algorithm refinements. For further details, please consult the following paper:

Friedl, M. A., Sulla-Menashe, D., Tan, B., Schneider, A., Ramankutty, N., Sibley, A., and Huang, X. (2010). MODIS Collection 5 global land cover: Algorithm refinements and characterization of new datasets. *Remote Sensing of Environment*, 114, 168–182.

Temporal analysis of land cover change may be obstructed by the data quality and course resolution, however it may be feasible to improve the available data for accounts estimation.

¹³ https://lpdaac.usgs.gov/products/modis_products_table/mcd12q1

c. ESA's GlobCover

The [European Space Agency](#) has produced the [GlobCover](#) maps at 300 m spatial resolution for year 2005-6 and 2009 using MERIS imagery. The two temporal maps are not compatible for land use change analysis however. GlobCover applies a hierarchical classification scheme. Global and regional nomenclatures can be consulted online (see Annex II in ESA's report "GLOBCOVER Products Description and Validation Report" ¹⁴).

d. GlobeLand30

Very high resolution global land cover maps were produced by China, known as [GlobeLand30](#), for years 2000 and 2010, with 10 classes and 30 m resolution, based on the freely available imagery from [NASA's Landsat satellite](#) instruments. The data is available online after registration, and was also [donated to the UN](#).

GlobLand30 classification nomenclature¹⁵

1. Water bodies
2. Wetland
3. Artificial Surfaces
4. Tundra
5. Permanent snow and ice
6. Grass lands
7. Barren lands
8. Cultivated land
9. Shrub lands
10. Forests

GlobLand30 may be the most appropriate dataset for ecosystem accounting, because of its highest spatial detail and the possibility to analyze land cover change; however its quality needs to be well evaluated, since it is the newest source, among other reasons.

Land use data is usually not readily and uniformly available and therefore needs to be assembled from a number of sources, most commonly applicable would be sought from agriculture, forestry, mining, transport, industry and urban planning and administration (including parks and recreation). Protected areas administration and management (including zoning), hunting and fishing areas etc. may provide very relevant land use information too. The subject generally needs much further efforts for developing harmonized inputs (including spatial data) in land and ecosystem accounting. The [European CORINE](#) product introduced land use categories in its combine land cover and use nomenclature (see details in Section 3). Examples of mapping

¹⁴ http://due.esrin.esa.int/files/GLOBCOVER_Products_Description_Validation_Report_I2.1.pdf

¹⁵ <http://www.globallandcover.com/GLC30Download/index.aspx>

ecosystem services with land use include Bateman et al. (2013) and specific tools for the purpose: [LUSI](#), Polyscape (see Jackson et al. 2013) etc.

Administrative data (including maps) on **land ownership** are likely to be available from national sources such as *Official land cadasters* or similar *land administration registers*, for example [UK's Ordinance survey](#). Classification of Land ownerships should be developed, including private and public domains, which may overlap or differ from land use. For example, abandoned cropland may still belong to a farmer, but actually be used for nature restoration.

Land cover, land use and land ownership can change in a very dynamic way independently from each other. Therefore these three properties of land may need to be classified and mapped separately for a complete accounting application at Tier III.

Note that a **number of other themes and sources** of spatial data related to ecosystem functions or components will be very relevant for the accounting purposes (to map condition for example):

- Forest cover and deforestation - University of Maryland product “[Global Forest Change](#)”
- Vegetation types, physiognomy, productivity, habitats etc.