

Land Cover (Topic 1.2.1) and Land Use (Topic 2.3.1) statistics



Taller Nacional de Estadísticas Ambientales y de Cambio Climático en Perú

Lima, 13-15 Diciembre 2022



Land Cover (Topic 1.2.1) and Land Use (Topic 2.3.1)

1. Objectives
2. Level 0 Concepts
3. Level 1 Compilers
4. Level 2 Data providers
5. Conclusions





What are land cover and land use statistics?

Land is a unique resource and asset, that delineates the space in which economic activities and environmental processes take place and within which environmental resources and economic assets are located (*FDES p. 43, also in SEEA-CF p. 174*).

Land is finite, and is under pressure to serve the growing demands for human needs

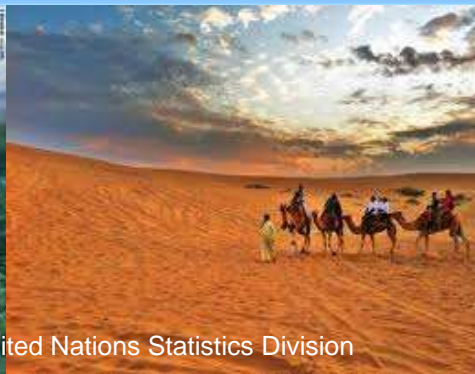
The two primary aspects of land, land cover and land use, are separate but related concepts. **Land cover** is the 'observed biophysical cover on the earth's surface (FAO, 2005) e.g., lakes, wetlands, forests, etc.; while **land use** refers to the **socioeconomic or functional aspects of land**, hence describing the activities, management and institutional arrangement put in place e.g., timber, fuelwood, commercial, recreation.

Statistics on land cover record systematically the areas defined by types (also termed extents with their characteristics). Land use statistics cover both land in use and land not in use.



Why are land statistics needed?

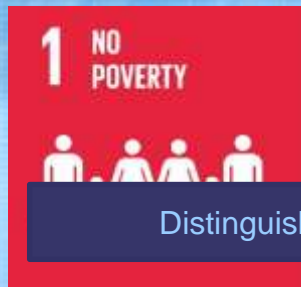
- Spatial foundation for all national administrative data and policies: spatial planning (urban, rural, nature); Land & resource management, conservation and restoration policies (biodiversity loss, desertification), land tenure
- Climate change and desertification: land use change, critical for understanding GHG emissions and removals
- Links to SEEA-CF (Forest, Soil); SEEA-Agriculture, Fisheries & Forests; Foundation for SEEA-EEA (Ecosystem Accounting)
- Indicators:
 - Land cover change - where are changes occurring?
 - Land cover by land use - who manages it?





Land statistics support many SDGs

Land cover & change



1 NO POVERTY

Distinguish urban/rural



4 QUALITY EDUCATION



6 CLEAN WATER AND SANITATION

Distinguish freshwater areas

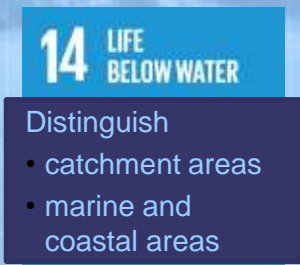


9 INDUSTRY, INNOVATION AND INFRASTRUCTURE



11 SUSTAINABLE CITIES AND COMMUNITIES

Provide detail within urban



14 LIFE BELOW WATER

Distinguish

- catchment areas
- marine and coastal areas



15 LIFE ON LAND

Distinguish

- forest area
- degraded land
- mountain areas

Land use



2 ZERO HUNGER

Distinguish agricultural areas



14 LIFE BELOW WATER

Distinguish marine and coastal protected areas



15 LIFE ON LAND

Distinguish forestry areas

Land ownership



1 NO POVERTY

Agree on land tenure (who owns?)



5 GENDER EQUALITY



How do land cover and use statistics look like?

Topic	Statistics and Related Information (Bold Text - Core Set/Tier 1 ; Regular Text - Tier 2; <i>Italicized Text - Tier 3</i>)		Area (ha) 2000	Area (ha) 2018
	Topic 2.3.1: Land use	a.	Area under land use categories	Area
		1. Agriculture	Area	Area
		2. Forestry	Area	Area
		3. Aquaculture	Area	Area
		4. Built up and related area	Area	Area
		5. Land used for maintenance and restoration of environmental functions	Area	Area
		6. Other land use not elsewhere classified	Area	Area
		7. Land not in use	Area	Area
		8. Inland waters used for aquaculture	Area	Area
		9. Inland waters used for maintenance and restoration of environmental functions	Area	Area
		10. Other uses of inland waters not elsewhere classified	Area	Area
		11. Inland water not in use	Area	Area
		12. Coastal waters (includes area of coral reefs, mangroves, etc.) (also in 1.1.3.b)	Area	Area
		13. Exclusive Economic Zone (EEZ) (also in 1.1.2.e)	Area	Area
		b. Other aspects of land use	Area	Area
		1. <i>Area of land under organic farming</i>	Area	Area
		2. Area of land under irrigation	Area	Area
		3. Area of land under sustainable forest management	Area	Area
		4. <i>Area of land under agroforestry</i>	Area	Area
		c. Land ownership - private land	Area	Area
	c. Land ownership - public land	Area	Area	



How do land cover accounts look like?

Table 5.13
Physical account for land cover (*hectares*)

	Artificial surfaces	Crops	Grassland	Tree-covered area	Mangroves	Shrub-covered area	Regularly flooded areas	Sparse natural vegetated areas	Terrestrial barren land	Permanent snow, glaciers and inland water bodies	Coastal water and inter-tidal areas
Opening stock of resources	12 292.5	445 431.0	106 180.5	338 514.0	214.5	66 475.5	73.5	1 966.5		12 949.5	19 351.5
Additions to stock											
Managed expansion	183.0	9 357.0									
Natural expansion			64.5								1.5
Upward reappraisals			4.5								
<i>Total additions to stock</i>	183.0	9 357.0	69.0								1.5
Reductions in stock											
Managed regression		147.0	4 704.0	3 118.5	9.0	1 560.0	1.5				
Natural regression					1.5	64.5					
Downward reappraisals						4.5					
<i>Total reductions in stock</i>		147.0	4 704.0	3 118.5	10.5	1 629.0	1.5				
Closing stock	12 475.5	454 641.0	101 545.5	335 395.5	204.0	64 846.5	72.0	1 966.5		12 949.5	19 353.0

Note: Crops include herbaceous crops, woody crops, and multiple or layered crops.



What do you need to compile land statistics?

1. GIS platform

2. Maps

3. Expertise (EO, vegetation)

4. Ground truthing and statistics

**Assess inputs,
Confusion matrix, Kappa**

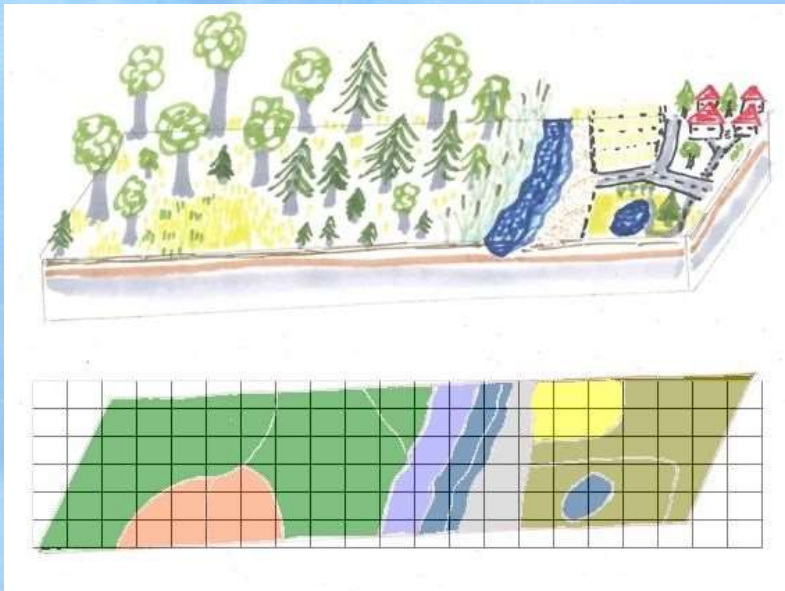
5. Classification(s) and units

**International ones
Re-classify
Harmonize inputs**

6. Compilation template

**At least 2 time periods
Changes in additions and reductions
Aggregate and allocate statistics**

**Review available data
sources**



Level 1: Land statistics





Level 1: objectives

Basic spatial data analysis concepts

- Definitions
- Classifications: SEEA CF, LCCS
- Thinking spatially: maps to data to statistics
- Land cover/use change
- Data quality
- Error matrix

Key definitions

- Area under land cover categories (FDES 1.2.1.a): The area of land cover is the area under each land cover category of the classification used. Land cover change is an equally important statistic and indicates the changes occurring to the land cover over time
- Area under land use categories (FDES 2.3.1.a): The area of land use is the area under each land use category of the classification used. Land use change is an equally important statistic and indicates the changes occurring to the land use over time.
- Area of land under organic farming (FDES 2.3.1.b.1): Organic agriculture (farming) is a specific and precise standard of production which aims at achieving optimal agroecosystems that are socially, ecologically and economically sustainable.
- Area of land under irrigation (FDES 2.3.1.b.2) ...
- Area of land under sustainable forest management (FDES 2.3.1.b.3)
- Area of land under agroforestry (FDES 2.3.1.b.4)
- Land ownership (FDES 2.3.1.c)





Classifications and legends

- ❖ Land use or land cover products develop their legends based on a classification. There is often a lack of comparability between products as land use or land cover classification definitions can vary between dataset or map.

- ❖ A legend is the defined mapping

- ❖ Most relevant

SEEA CF Land cover classification

- 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 intertidal areas

1. Land Cover Classification (SEEA Land cover p. 299)



Classifications and legends

- ❖ Land use classification as land use dataset
- ❖ A legend defined
- ❖ Most relevant

2. IGBP Classification






































	0 Water
	1 Evergreen Needleleaf Forest
	2 Evergreen Broadleaf Forest
	3 Deciduous Needleleaf Forest
	4 Deciduous Broadleaf Forest
	5 Mixed Forests
	6 Closed Shrublands
	7 Open Shrublands
	8 Woody Savannas
	9 Savannas
	10 Grasslands
	11 Permanent Wetlands
	12 Croplands
	13 Urban and Built-Up
	14 Cropland/Natural Vegetation Mosaic
	15 Snow and Ice
	16 Barren or Sparsely Vegetated



Classifications and legends

- ❖ Land use or land cover products develop their legends based on a classification. There is often a lack of comparability between products as land use or land cover classification definitions can vary between

3.

 111: Continuous urban fabric	 222: Fruit trees & berry plantations	 331: Beaches, dunes, sands
 112: Discontinuous urban fabric	 223: Olive groves	 332: Bare rocks
 113: Diffuse constructions	 224: Lavender	 333: Sparsely vegetated areas
 121: Industrial or commercial units	 231: Pastures	 334: Burnt areas
 122: Road & rail networks	 241: Ann. crops assoc. with peren.	 335: Glaciers & perpetual snow
 123: Port areas	 242: Complex cultivation patterns	 400: Undifferentiated wet areas
 124: Airports	 243: Agriculture + natural veg.	 411: Inland marshes
 131: Mineral extraction sites	 244: Agro-forestry areas	 412: Peat bogs
 132: Dump sites	 311: Broad-leaved forest	 421: Salt marshes
 133: Construction sites	 312: Coniferous forest	 422: Salines
 141: Green urban sites	 313: Mixed forest	 423: Intertidal flats
 142: Sport & leisure facilities	 321: Natural grassland	 511: Water courses
 211/212: Arable land	 322: Moors & heathland	 512: Water bodies
 213: Rice fields	 323: Sclerophyllous vegetation	 521: Coastal lagoons
 214: Greenhouses	 324: Transitional woodland-scrub	 522: Estuaries
 221: Vineyards	 325: Moors	 523: Sea & ocean

Land cover timeseries – basic statistics

Land cover 2000



Land cover 2018



LEGEND

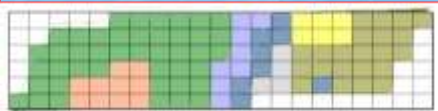
	Artificial Surfaces
	Crops
	Grassland
	Tree covered areas
	Regularly flooded
	Inland waters
	Barren land

Land cover, ha		2000	2018
1	Artificial surfaces	22	24
2	Crops	6	9
3	Grasslands	10	8
4	Tree covered areas	43	40
5	Regularly flooded ar	8	8
6	Inland waters	8	8
7	Baren lands	3	3
Total		100	100

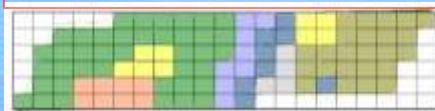


Land cover timeseries – calculate stocks and flows

Land cover 2000



Land cover 2018



LEGEND	
	Artificial Surfaces
	Crops
	Grassland
	Tree covered areas
	Regularly flooded
	Inland waters
	Barren land

•Artificial surfaces +2

•Crops -2

•Grassland -2

•Crops +2

•Tree covered -3

•Crops +3

Physical account for land cover

	Artificial surfaces	Crops	Grassland	Tree covered	Regularly flooded	Inland waters	Barren land	Total
Opening	22	6	10	43	8	8	4	101
Additions	2	5						7
Reductions		2	2	3				7
Closing	24	9	8	40	8	8	4	101

Level 2: Land statistics



Level 2: Learning objectives

- More conceptual issues – one official map, multiple uses
- Examples from other countries
- Input data options and sources
 - International data
 - Multiple sources, metadata
 - Differing class definitions
 - Limitations of remote sensing



One official map for multiple uses

- Different departments often use different classifications and sources
- Key objective is to agree on one map able to serve multiple purposes
- Consistency with international sources will facilitate reporting obligations



European example: CORINE Land cover and LUCAS

- CORINE land cover is an example of harmonized and decentralized production of land cover data
- Customized software tool ensures complete comparability between countries and time periods although input data differs
- LUCAS is a network of sample points for which land data is regularly observed and recorded





Examples from countries

EnviStats India 2018

Compendium of Environment Statistics; Ethiopia, 2016

Statement 1.23 : Land use and land cover classes - India

S. No.	L 1	L 2	Area (Sq. Kms.)		
			1985	1995	2005
1	Agriculture	Crop land	1,558,712	1,556,346	1,614,921
		Current Shifting cultivation			
		Fallow	252,073	266,671	221,136
		Plantation	77,493	77,956	78,560
		Sub Total -1	1,888,278	1,900,973	1,914,617
2	Barren/unculturable/Wastelands	Barren Rocky	65,484	71,250	69,855
		Gullied / Ravinous Land	84,414	78,649	74,355
		Rann			
		Salt Affected Land			
		Sandy Area			
		Scrub Land	182,860	188,342	192,873
		Sub Total-2	332,758	338,241	337,083
3	Builtup	Mining			
		Rural			
		Urban	34,019	40,090	47,239
		Sub Total-3	34,019	40,090	47,239
4	Forest	Deciduous	317,429	294,777	280,684
		Evergreen/Semi evergreen	208,063	205,160	197,992
		Forest Plantation	150,163	149,523	147,284
		Scrub Forest	84,368	91,188	98,723
		Swamp / Mangroves	4120	4525	4579
		Sub Total-4	764,143	745,173	729,262
5	Grass / Grazing	Grass / Grazing	54,553	56,604	61,595
		Sub Total-5	54,553	56,604	61,595
6	Snow and Glacier ²	Snow and Glacier	97,152	91,636	92,522
		Sub Total-6	97,152	91,636	92,522
7	Wet lands / Water bodies ¹	Inland Wetland			
		Coastal Wetland			
		River/Stream/Canals			
		Water bodies	116,119	121,148	114,856
		Sub Total-7	116,119	121,148	114,856
Grand Total			3,287,022	3,293,865	3,297,174

¹ Includes Aqua Culture, Water bodies, and Permanent Wetlands;

² Includes Salt Pan, Snow and Ice.

Source: Remote Sens. 2015, 7(3), 2401-2430; doi:10.3390/rs70302401 Article "Development of Decadal (1985-1995-2005) Land Use and Land Cover Database for India"

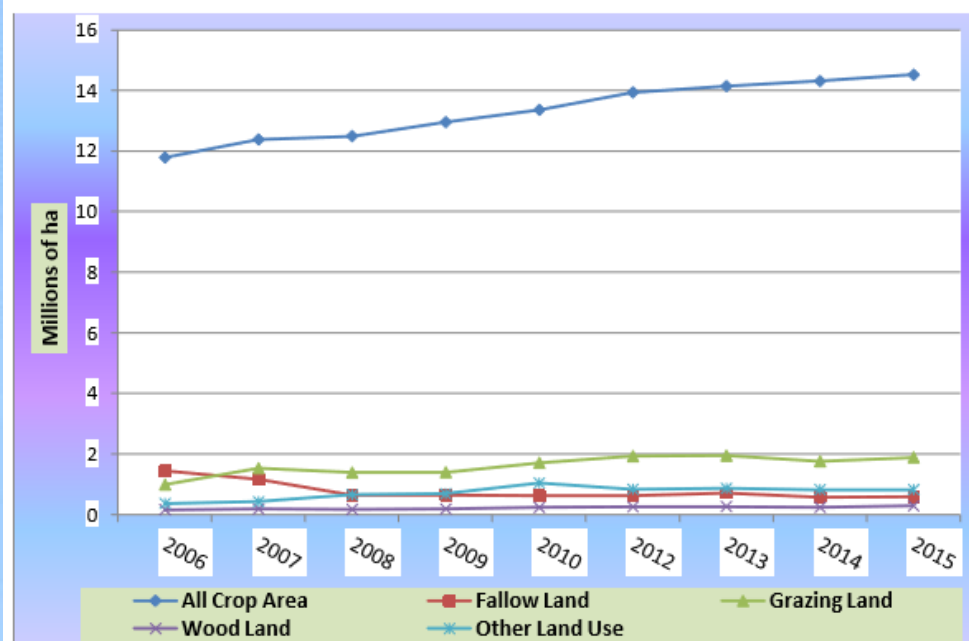


Figure 17: Land Use Area and Category by Year

Source: AgSS main season reports of CSA 2006/07-2015/16



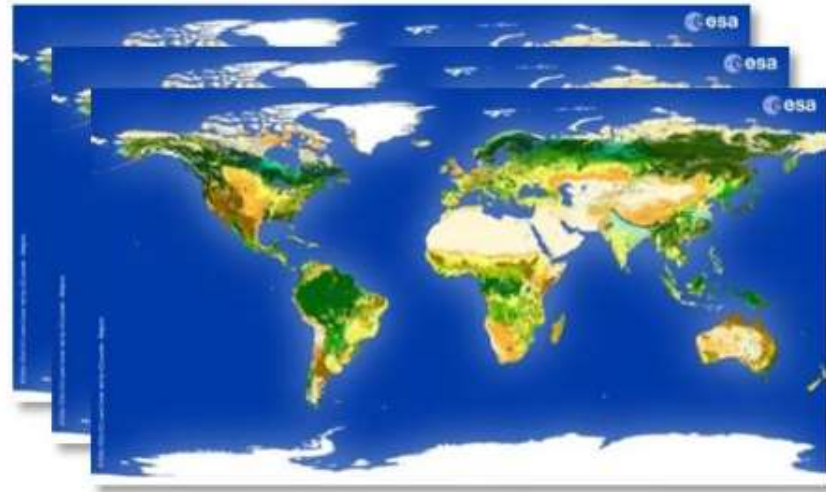
Input data options and sources

International data sources

- European Space Agency
- NASA
- Many more

Three global LC maps for the 2000, 2005 and 2010 epochs

The CCI-LC team has successfully produced and released its 3-epoch series of global land cover maps at 300m spatial resolution, where each epoch covers a 5-year period (2008-2012, 2003-2007, 1998-2002). These maps were produced using a multi-year and multi-sensor strategy in order to make use of all suitable data and maximize product consistency. The entire 2003-2012 MERIS Full and Reduced Resolution (FR and RR) archive was used as input to generate a 10-year 2003-2012 global land cover map. This 10-year product has then served as a baseline to derive the 2010, 2005 and 2000 maps using back- and updating techniques with MERIS and SPOT-Vegetation time series specific to each epoch.



In order to meet the user requirement set in this project, the map proposes a legend based on the UN Land Cover Classification System (LCCS) with the view to be as much as possible compatible with the GLC2000, GlobCover 2005 and 2009 products. The level of thematic details was found to be improved with respect to previous global LC products. Each map is characterized by a set of quality flags.

•Source:

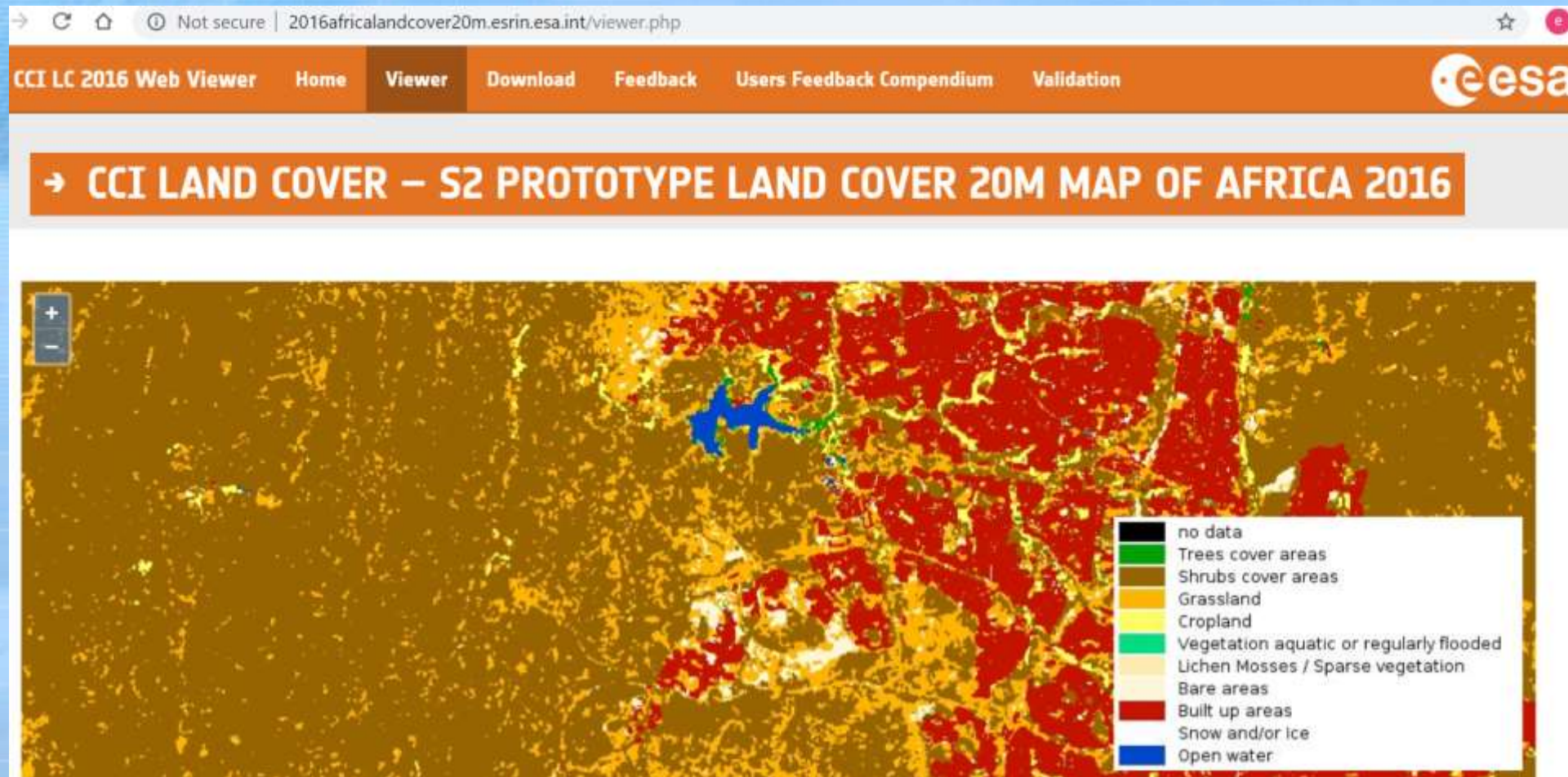
<https://www.esa-landcover-cci.org/?q=node/158>

•Viewer:

<http://maps.elie.ucl.ac.be/CCI/viewer/index.php>

For more information on the products, go to: <http://maps.elie.ucl.ac.be/CCI/viewer>.

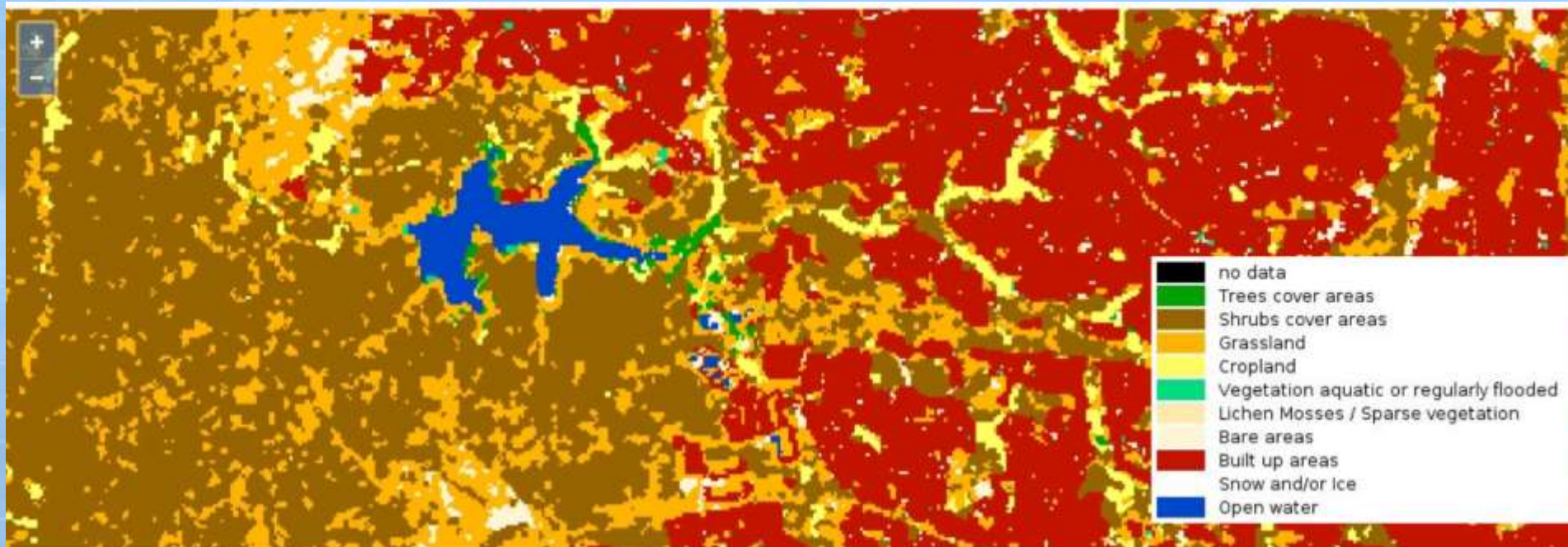
Spatial data: CCI LAND COVER – S2 PROTOTYPE LAND COVER 20M MAP OF AFRICA 2016



Source: <http://2016africalandcover20m.esrin.esa.int/>

Viewer: <http://2016africalandcover20m.esrin.esa.int/viewer.php>





Input data options and sources

- Lots of data from international sources
- Multiple sources of imagery, metadata
- Differing class definitions
- Limitations of remote sensing
- Global Gateway in Latin America and the Caribbean: European Space Agency and the Commission join forces on earth observation (europa.eu)
- ESA - Earth from Space: Lima, Peru



Discussion points

1. What national data and classifications for Land are already available for your country?
2. If there are no national sources, what data could you use to create Land statistics?
3. What would be the priorities (Cover, Use, Ownership; Agreement on “One Map”)?
4. Discuss and report your results



Key points

- Land Cover maps, classified by the SEEA-CF classification are a useful starting point for creating Land statistics and accounts
- Data need to be national and comparable
- Combine satellite data with other data
- An interdepartmental team should agree on “One Map”
- Global data for Land Cover may be used if there is no national alternative
- Mixed land cover and land use will often be practical but consider land cover first before land use



Acknowledgements

- This presentation has been elaborated by the Environment Statistics Section of the United Nations Statistics Division.
- It is based on Chapter 3 of the Framework for the Development of Environment Statistics (FDES 2013).
- It contains materials developed by the Statistics Division of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP): <http://communities.unescap.org/environment-statistics>





Questions and comments?





Thank you for your attention!

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