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

National Workshop on Environment Statistics and Climate Change Statistics

St. George’s, Grenada, 12-14 November 2019
1. Learning objectives
2. Review of Level 0 (5m)
3. Level 1 (Compilers)
   • Concepts (10m)
   • Group exercise & Discussion (30m)
4. Level 2 (Data providers)
   • Data options, examples & issues (10m)
   • Group exercise & Discussion (15m)
5. Closing Discussion
**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 by defined 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
- Land & resource management, conservation and restoration policies (biodiversity loss, desertification), land tenure
- Climate change: 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**
- Distinguish urban/rural
- Distinguish freshwater areas

**Land use**
- Distinguish agricultural areas
- Distinguish marine and coastal protected areas

**Land ownership**
- Agree on land tenure (who owns?)
- Distinguish forest area, degraded land, and mountain areas

Provide detail within urban
- Distinguish catchment areas, marine and coastal areas
- Distinguish forestry areas
How do land cover and use statistics look like?

<table>
<thead>
<tr>
<th>Component 1: Environmental Conditions and Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subcomponent 1.2: Land Cover, Ecosystems and Biodiversity</td>
</tr>
<tr>
<td>Topic 1.2.1: Land cover</td>
</tr>
</tbody>
</table>

Statistics and related information

- **Bold text**—Core Set/Tier 1;
  - **Regular text**—Tier 2;
  - **Italicized text**—Tier 3

<table>
<thead>
<tr>
<th>Category of measurement</th>
<th>Potential aggregations and scales</th>
<th>Methodological guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Area under land cover categories</td>
<td>Area</td>
<td>- By location</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- By type of land cover (e.g., artificial surfaces, including urban and associated areas; herbaceous crops; woody crops; multiple or layered crops; grassland; 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; and coastal water bodies and inter-tidal areas)(^a)</td>
</tr>
<tr>
<td></td>
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<td>- National</td>
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<td>- Subnational</td>
</tr>
</tbody>
</table>

- FAO Land Cover Classification System
- System of Environmental-Economic Accounting (SEEA) Central Framework (2012) land cover categories
- European Environment Agency (EEA)
### Component 2: Environmental Resources and their Use

#### Subcomponent 2.3: Land

#### Topic 2.3.1: Land use

<table>
<thead>
<tr>
<th>Statistics and related information</th>
<th>Category of measurement</th>
<th>Potential aggregations and scales</th>
<th>Methodological guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bold text—Core Set/Tier 1; regular text—Tier 2; italicized text—Tier 3</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| a. Area under land use categories | Area | • By type of land use (e.g., agriculture; forestry; land used for aquaculture; use of built-up and related areas; land used for maintenance and restoration of environmental functions; other uses of land not elsewhere classified; land not in use; inland waters used for aquaculture or holding facilities; inland waters used for maintenance and restoration of environmental functions; other uses of inland waters not elsewhere classified; inland water not in use; coastal waters (including area of coral reefs and mangroves); Exclusive Economic Zone (EEZ))
• National
• Subnational | • FAO
• UNECE Standard Classification of Land Use (1989)
• SEEA Central Framework (2012) Annex 1 |
| b. Other aspects of land use | | | |
| 1. Area of land under organic farming | Area | • National
• Subnational | • FAO Inter-departmental Working Group on Organic Agriculture |
| 2. Area of land under irrigation | Area | | • Forest Stewardship Council |
| 3. Area of land under sustainable forest management | Area | | |
| 4. Area of land under agroforestry | Area | | |
| c. Land ownership | Area | • By ownership category
• National
• Subnational | • FAO |
How do land cover and use statistics look like?

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

Environment Statistics Section, United Nations Statistics Division
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
Welcome to
Level 1: Land statistics
Level 1: learning objectives

Basic spatial data analysis concepts

- Thinking spatially: maps to data to statistics
- Classifications: SEEA CF, LCCS, IGBP, CORINE
- Boundaries
- 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 products, even when the same term is used.

- A legend is the application of a classification in a specific area using a defined mapping scale and specific data set.

- Most relevant classifications:
  - Environment Statistics Section, United Nations Statistics Division
  - Land Cover Classification System (LCCS) v.3 developed by FAO
  - SEEA Land cover classification (SEEA-CF, Table 5.12, p.178; and Annex p. 299)

1. **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
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 products even when the same term is used.

A legend is the application of a classification in a specific area using a defined mapping scale and specific data set.

Most relevant classifications:

1. Environment Statistics Section, United Nations Statistics Division
2. IGBP Classification: used in NASA's MODIS land cover

- 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
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 products even when the same term is used.

A legend is the application of a classification in a specific area using a defined mapping scale and specific data set.

Most relevant classifications:

- Environment Statistics Section, United Nations Statistics Division
- European CORINE Land cover

### Classifications

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

1. GIS platform: ArcGIS, qGIS, R, Python

2. EO instruments: ESA Sentinels, NASA MODIS, Landsat

3. Maps

   Land cover: vegetation, water bodies, dry areas, built and crop areas

   Use and ownership: cadastre, urban plans, public/private land

   Admin. units, boundaries: country boundary, coast and islands

   Other helpful spatial data: e.g. deforestation, protected areas, infrastructure

3. Ground truthing and statistics: forest plots etc. (EU Lucas)
Think Spatially: maps to data

- What you see…
- and generalized to a grid (raster)
- …where cell value is “predominant” land cover type
Boundaries and objects …

…don’t always match because of different:

- projections
- scales
- sources
- methods

...and need some adjustment before overlaying
Land cover change

- Now we can compare the two!
- What has changed?

- 2ha Crops to artificial
- 2ha Grassland to crops
- 3ha Tree covered to crops
## Land cover timeseries – basic statistics

### Land cover, ha

<table>
<thead>
<tr>
<th>Land cover</th>
<th>2000</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Artificial surfaces</td>
<td>22</td>
<td>24</td>
</tr>
<tr>
<td>2 Crops</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>3 Grasslands</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>4 Tree covered areas</td>
<td>43</td>
<td>40</td>
</tr>
<tr>
<td>5 Regularly flooded ar</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>6 Inland waters</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>7 Baren lands</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

### Legend

- Artificial Surfaces
- Crops
- Grassland
- Tree covered areas
- Regularly flooded
- Inland waters
- Barren land
Land cover timeseries – calculate SDGs

Indicator 15.1.1: Forest area as a proportion of total land area

\[
\text{Forest area (reference year)} / \text{Land area (2015)} \times 100
\]

Indicator 15.3.1: Proportion of land that is degraded over total land area

\[
A(\text{Degraded})_{i,n} = \sum_{j=1}^{n} A_{\text{recent},i,n} + A_{\text{persistent},i,n}
\]

\[
P_{i,n} = \frac{A(\text{degraded})_{i,n}}{A(\text{total})_{i,n}}
\]

<table>
<thead>
<tr>
<th>SDG 15.1.1</th>
<th>% forest</th>
<th>2000</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDG 15.1.1</td>
<td>% forest</td>
<td>43</td>
<td>40</td>
</tr>
<tr>
<td>SDG 15.3.1</td>
<td>% degraded</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

SDGs metadata source: https://unstats.un.org/sdgs/metadata/
Land cover timeseries – calculate stocks and flows

<table>
<thead>
<tr>
<th>Physical account for land cover</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Opening</td>
</tr>
<tr>
<td>Additions</td>
</tr>
<tr>
<td>Reductions</td>
</tr>
<tr>
<td>Closing</td>
</tr>
</tbody>
</table>

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

Changes:
- Artificial surfaces +2
- Crops -2
- Grassland -2
- Crops +2
- Tree covered -3
- Crops +3
Level 1 - Group Exercise (30m)

- Validation (ground data) preferably more than 30 points per class, larger classes with larger validation samples
- Develop an error matrix to validate a land cover map
- Estimate commission and omission errors
- Estimate Kappa
- Discuss reliability of validation results

The Kappa statistic varies from 0 to 1, where:
- 0 = agreement equivalent to chance.
- 0.1 – 0.20 = slight agreement.
- 0.21 – 0.40 = fair agreement.
- 0.41 – 0.60 = moderate agreement.
- 0.61 – 0.80 = substantial agreement.
- 0.81 – 0.99 = near perfect agreement.
- 1 = perfect agreement.
### Grid/Classified land cover data

<table>
<thead>
<tr>
<th>M</th>
<th>M</th>
<th>C</th>
<th>A</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>R</td>
<td>C</td>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>R</td>
<td>R</td>
<td>C</td>
<td>C</td>
<td>C</td>
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<td>T</td>
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</tr>
</tbody>
</table>

### Land cover Error Matrix

<table>
<thead>
<tr>
<th>Classified data</th>
<th>Reference data</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>C</td>
</tr>
<tr>
<td>A (Artificial Surfaces)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C (Crop)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M (Mangrove)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T (Forest)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R (Regularly flooded)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Point/Reference land cover data

<table>
<thead>
<tr>
<th>M</th>
<th>C</th>
<th>C</th>
<th>A</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>C</td>
<td>C</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>R</td>
<td>R</td>
<td>C</td>
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<td>T</td>
<td>T</td>
<td>T</td>
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</tr>
</tbody>
</table>

### Step 1: Transcribe the number of agreement and disagreement pairs of data (left down) from the classified (left top) and reference (left middle) data in the error matrix (shown above).

Record the number of agreements in diagonal
Record the number of disagreements in rows

### Step 2: Estimate overall accuracy

Overall accuracy = total agreements / total samples

### Step 3: Estimate omission errors (Producers accuracy)

By column class = incorrectly classified / total reference samples by class

### Step 4: Estimate commission errors (Users accuracy)

By row class = incorrectly referenced / total classification samples by class

### Step 5: Estimate Kappa

Kappa = (total agreements - agreements by chance) / (total samples - agreements by chance)

Estimate agreements by chance per class (total by column*total by row/total)
Estimate sum of agreements by chance
Estimate total agreements (sum of diagonal counts)
Welcome to
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

**Statement 1.23: Land use and land cover classes - India**

<table>
<thead>
<tr>
<th>L</th>
<th>L 2</th>
<th>Area (Sq. Kms.)</th>
<th>1985</th>
<th>1995</th>
<th>2005</th>
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<tbody>
<tr>
<td>S. No</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Agriculture</td>
<td></td>
<td></td>
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<td>Crop land</td>
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<td>1,556,346</td>
<td>1,614,921</td>
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<td>Current Shifting cultivation</td>
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<td>Fallow</td>
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<td>266,671</td>
<td>221,136</td>
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<td>Plantation</td>
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<td>78,560</td>
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</tr>
<tr>
<td>1</td>
<td><strong>Sub Total -1</strong></td>
<td><strong>1,888,278</strong></td>
<td><strong>1,900,973</strong></td>
<td><strong>1,914,617</strong></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Barren/un cultivable/Wastelands</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Barren Rocky</td>
<td>65,484</td>
<td>71,250</td>
<td>69,855</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Gullied/Ravinous Land</td>
<td>84,414</td>
<td>78,649</td>
<td>74,355</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Rann</td>
<td></td>
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</tr>
<tr>
<td>2</td>
<td>Salt Affected Land</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2</td>
<td>Sandy Area</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2</td>
<td>Scrub Land</td>
<td>182,800</td>
<td>188,342</td>
<td>192,873</td>
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</tr>
<tr>
<td>2</td>
<td><strong>Sub Total -2</strong></td>
<td><strong>332,758</strong></td>
<td><strong>338,241</strong></td>
<td><strong>337,083</strong></td>
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</tr>
<tr>
<td>3</td>
<td>Built up</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3</td>
<td>Mining</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Rural</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Urban</td>
<td>34,019</td>
<td>40,090</td>
<td>47,239</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td><strong>Sub Total -3</strong></td>
<td><strong>34,019</strong></td>
<td><strong>40,090</strong></td>
<td><strong>47,239</strong></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Forest</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>4</td>
<td>Deciduous</td>
<td>317,429</td>
<td>294,777</td>
<td>280,684</td>
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<tr>
<td>4</td>
<td>Evergreen/Semi evergreen</td>
<td>208,063</td>
<td>205,160</td>
<td>197,992</td>
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<tr>
<td>4</td>
<td>Forest Plantation</td>
<td>150,163</td>
<td>149,523</td>
<td>147,284</td>
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</tr>
<tr>
<td>4</td>
<td>Scrub Forest</td>
<td>84,388</td>
<td>91,388</td>
<td>98,723</td>
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<tr>
<td>4</td>
<td>Swamp/Mangroves</td>
<td>4120</td>
<td>4525</td>
<td>4573</td>
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<td>4</td>
<td><strong>Sub Total -4</strong></td>
<td><strong>764,143</strong></td>
<td><strong>745,173</strong></td>
<td><strong>729,262</strong></td>
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<tr>
<td>5</td>
<td>Grass/Grazing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Grass/Grazing</td>
<td>54,553</td>
<td>56,604</td>
<td>61,595</td>
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<tr>
<td>5</td>
<td><strong>Sub Total -5</strong></td>
<td><strong>54,553</strong></td>
<td><strong>56,604</strong></td>
<td><strong>61,595</strong></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Snow and Glacier</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Snow and Glacier</td>
<td>97,152</td>
<td>91,636</td>
<td>92,522</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td><strong>Sub Total -6</strong></td>
<td><strong>97,152</strong></td>
<td><strong>91,636</strong></td>
<td><strong>92,522</strong></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Wetlands/Water bodies</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>7</td>
<td>Inland Wetland</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>7</td>
<td>Coastal Wetland</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>7</td>
<td>River/Stream/Canals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Water bodies</td>
<td>116,119</td>
<td>121,148</td>
<td>114,856</td>
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<tr>
<td>7</td>
<td><strong>Sub Total -7</strong></td>
<td><strong>116,119</strong></td>
<td><strong>121,148</strong></td>
<td><strong>114,856</strong></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td><strong>Grand Total</strong></td>
<td><strong>3,287,022</strong></td>
<td><strong>3,293,865</strong></td>
<td><strong>3,297,174</strong></td>
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</tr>
</tbody>
</table>

1 Includes Aqua Culture, Water bodies, and Permanant Wetlands;
2 Includes Salt Pan, Snow and Ice.


#### Compendium of Environment Statistics; Ethiopia, 2016

**Figure 17: Land Use Area and Category by Year**

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

- All Crop Area
- Fallow Land
- Wood Land
- Other Land Use
- Grazing Land
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.

For more information on the products, go to: http://maps.elie.ucl.ac.be/CCI/viewer.
LAND USE/LAND COVER MAP FOR GRENADA

Location

Legend

Interpretation
This product shows a 2 m resolution land use/land cover map of Grenada. Land use/land cover was primarily maps through a combination of automated classification and visual interpretation of high-resolution Pleiades satellite imagery acquired in 2013 and 2014. RadarSat-2 satellite imagery (2011-2014) and existing land use/land cover data were used to map areas obscured by significant cloud cover in the Pleiades imagery.

Local projection: WGS84 UTM Zone 16 North
Geographical system: WGS84 Geographic (NMS)

Data sources
This product was derived from Pleiades satellite data acquired between 2013-2014 (includes material © CNES 2014, distribution Airbus Military Services / ACI Image S.A., France, all rights reserved) and Radarsat-2 satellite data acquired between 2011-2014 (includes material © 2014. MacDonald, Dettwiler and Associates Ltd. All rights reserved). The product was derived upon the 2001 land cover map developed by The Nature Conservancy’s Mesoamerica and Caribbean Region project.

The aim of EO WORLD is to produce, deliver and access the centers of EO-based geo-information services in support of ongoing World Bank project activities. This work forms part of SAAs efforts to raise awareness within the World Bank of European and Canadian EO missions (both ESA and national), and the capacities of EO service providers to provide information customized to the needs of individual projects. The World Bank together with ESA has identified 12 specific EO WORLD Actions for which EO-based information has significant potential.

This product was produced by the British Geological Survey as part of Annex 3 of the EO WORLD 2 project. Risk information services in the Caribbean.
Input data options and sources

- International data: FAO data, Deforestation map
- Multiple sources of imagery, metadata
- Differing class definitions
- Limitations of remote sensing
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
Take home 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!

For more information please contact the Environment Statistics Section at the UN Statistics Division:

E-mail: envstats@un.org
website: http://unstats.un.org/unsd/ENVIRONMENT/