Land cover definitions

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Outline

• Examples
• What is Land Cover
  – Origins of Uncertainty
• Challenges
• Suggestions
  – Overcome issues of portability / integration
Example: what is a forest?
Example: what is a forest?


Does not include species, area, strip width.
Example: Siberian Land Cover

An example of three land cover maps of the same area but ...
Example: Siberian Land Cover

Data Set #1

- Bare soil, rock
- Prostrate shrub tundra
- Sedge tundra
- Shrub tundra
- Deciduous needle-leaf forest
Example: Siberian Land Cover

Data Set #2

- Barren
- Tundra lichen-moss
- Tundra heath
Example: Siberian Land Cover

Data Set #3

Barren or sparsely vegetated
Open shrub lands
Example: United Nations FRA

Spatial characterization can change.
Example: Bog

- Land cover data from remote sensing in 1990 & 2000
  - Same research institute (Research Institute: CEH)
  - Same government department (Government: Defra/ DoE)
Example: Bog

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• In 1990 ‘Bog’ was defined as
  • permanent waterlogging
  • permanent or temporary standing water
  • Myrica gale and Eriophorum species
  • water-logging, perhaps with surface water
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Consequences in one 100 x 100km square:
  1990  12 pixels of ‘Bog’ (<1 ha);
  2000  120,728 pixels of ‘Bog’ (~75 km²)
Example: Sea Level

Source: BKG
Example: sea level

*Fact:* A bridge collapsed!

*Where:* Town of Laufenburg in the canton of Aargau located along the river Rhine

*Why:* The already completed bridge on the Swiss side but with a difference of 0.54 meters compared to the German counterpart

*How:* The two neighbouring countries use varying different measuring methods

*Source:* [http://www.laufenburg.ch](http://www.laufenburg.ch)
What is Land Cover

• Imagine you have some land cover data
• You have not been involved its creation
• You want to use it in your analysis
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- You want to use it in your analysis
- What data aspects do you need to think about?
  - Scale
  - Classification / Classes
  - Original / Primary data
  - Others such as MMU, Object vs Pixel, etc
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Issues
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• Classes
• Original data
• MMU, Object vs Pixel, etc

Your intended Analysis / Problem
What is Land Cover

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**Issues**
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- Classes
- Original data
- MMU, Object vs Pixel, etc

**Uncertainties**

External land cover data

Your intended Analysis / Problem
What is Land Cover

• Origins of Uncertainty – *before* classification

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood</td>
<td>~~~~~~~~~~~</td>
</tr>
<tr>
<td>Grass</td>
<td>~~~~~</td>
</tr>
<tr>
<td>Water</td>
<td>~~~</td>
</tr>
<tr>
<td>Urban</td>
<td>~~~~~~~~~~~</td>
</tr>
<tr>
<td>Arable</td>
<td>~~~~~~~~~~</td>
</tr>
<tr>
<td>Moor</td>
<td>~~~~~~~</td>
</tr>
</tbody>
</table>
What is Land Cover

• Origins of Uncertainty – before classification
• Data: choices of RS imagery
• Pre-processing algorithms:
  – Atmospheric correction
  – Geometric correction
  – Rarely reported
What is Land Cover

• Origins of Uncertainty – classification
• Differences in
  – Conceptualisation, semantics ... meaning
• Examples as above

• But social forces as well
What is Land Cover

1990 field survey

Remote Sensing community

BNOSC

DoE

ITE / CEH EOS (Monkswood)

Input

Accountable Actors

Output

Network of actors and their links:
money information skills control

LCM1990

Users

Accountable Actors

Network of actors and their links:
money information skills control

ITE EOS / Clevermapping

Laserscan

Policy


LCM1990 Issues

LCM2000 Methodology

LCM2000

LCM2000 Steering Group

DETR / DEFRA

2000 Field survey

Input

Accountable Actors

Output

Network of actors and their links:
money information skills control
What is Land Cover

- Origins of Uncertainty – *classification x scale*
- Interaction also contributes to uncertainty
What is Land Cover

- Other considerations
  - Land cover (incl. habitats) are assemblages of plant species
    - Same species present in different land covers
  - Pixel vs object
    - Aggregating from pixels to objects is complex
    - Guided by rules
Phase I Habitats

Objects
(data primitives)

Knowledge Base
(Membership functions)
Phase I Habitats

Objects (data primitives)

Knowledge Base (Membership functions)
Phase I Habitats

Objects (data primitives)

Knowledge Base (Membership functions)

Molinia
Bog Moss
Calluna
Bogs
Cotton Grass
Heathy Bog

Dry Acid Heath
Blanket Bog
Wet Heath
Raised Bog

RS Data: SPOT
RS Data: Aster
RS Data: LISS
RS Data: Landsat
DEM: NextMap
Other considerations

- Land cover vs Land use
  - Do not have direct relationship

- Many land covers contribute to any one land use
- More than one land use can be composed of the same suite of land covers
- Not all instances of the same land use type will have the same land covers
Challenges

• Many sources of uncertainty in land cover definitions
• Most of them are known but un-reported
• Have profound implications for analyses
• Current metadata standards don’t help
• This situation is not unique to land cover
  – But is well exemplified
Challenges

• Land cover used for all kinds of applications
• Easy to share / obtain data
• One the most complex types of spatial data
  – cf Census data, geological point data, etc
  – (maybe land use tops it)
• Includes the full set of uncertainties
  – Scale, semantics, social construction, pre-processing, classification
• Need to help users understand the impacts of uncertainties on their applications
Challenges

• These problems play out at local, national and global scales
  – Huge differences between global LC data
    • As much as 20% in arable / cropland
  – The uncertainties are so great that their input into climate models is problematic
  – Cannot be used for land cover change detection

• Uncertainty in land cover is not a new issue
Figure 2. Variations in estimates of global land-cover classes based on calculations from cartographic sources. Differences in the total cover relate to the inclusion or exclusion of categories such as ice fields and deserts (Townshend, 1992).
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Suggestions

• Understand the uncertainties for any given analysis

• Suggests moving beyond the static layer
  – Scene specific, hides knowledge

• Producers can provide measures of ‘belief’
  – *distances* for each object to each class: Fuzzy memberships, in *n-band* space, probabilities, possibilities, etc
  – raw data, training data, classification and aggregation algorithms (rule base) with the land cover layer

• Data Primitives
Data Primitives

• Reconceptualise what we record
• Data primitives: orthogonal measurements
  – Allow land cover classes to be constructed
• Data primitives for land cover with potential quantitative and qualitative measures

<table>
<thead>
<tr>
<th>Primitives</th>
<th>Quantitative</th>
<th>Qualitative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>Metres</td>
<td>None, short- tall</td>
</tr>
<tr>
<td>Photo synthetic activity</td>
<td>g of carbon per area per year</td>
<td>High-low</td>
</tr>
<tr>
<td>Wetness</td>
<td>Soil-moisture-deficit</td>
<td>Wet-arid</td>
</tr>
<tr>
<td>Disturbance</td>
<td>Insurance value or management costs</td>
<td>High value - low value</td>
</tr>
<tr>
<td>Seasonality</td>
<td>Length of growing season</td>
<td>Short-long</td>
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