Global changes in landscapes between 1992 and 2015

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Introduction

Land-cover change is a pervasive phenomenon caused by changing the climate, and, in recent decades, by the rapid population growth and accelerated industrialization. As a part of a positive feedback loop, land cover changes in turn directly impact climate change and environmental conditions and have a close relationship to population migration and economic conditions. Thus, **the assessment of land-cover changes is of prime importance for the effective planning and management of resources**. It provides necessary information for making decisions on a trade-off between development and conservation.

The release by the European Space Agency (ESA) of **a set of worldwide annual land cover maps covering the 1992-2015** period makes possible a quantitative assessment of land change on the global scale. While ESA land cover mapping effort was motivated by the need to better characterize global and regional carbon cycles, the dataset may benefit a broad range of disciplines.

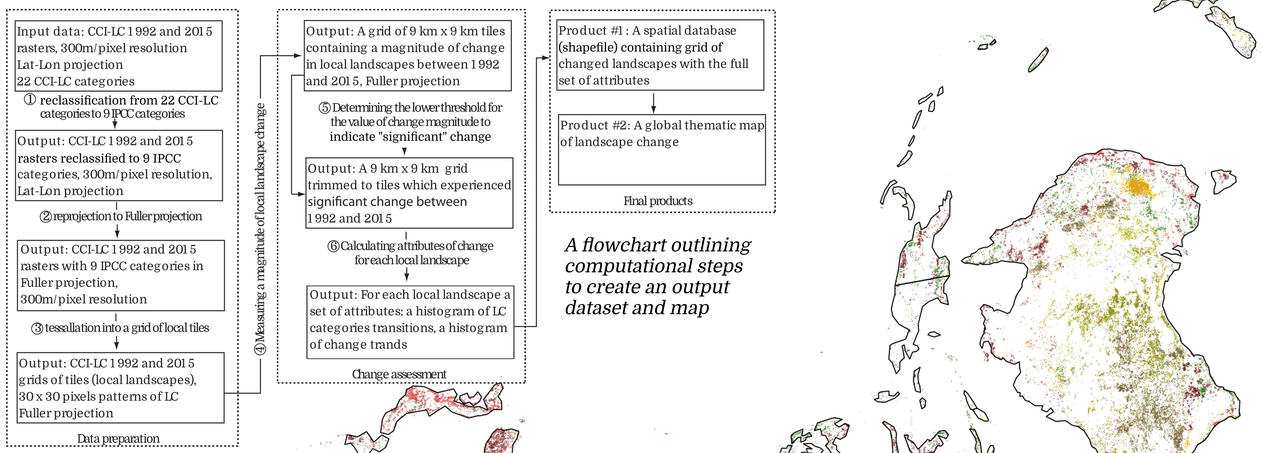
We focus on alternative, **pattern-based approach to assessing land change using the CCI-LC.** This approach stems from the perspective of landscape ecology and environmental studies where frequently it is a spatial pattern of land cover categories rather than categories themselves which is of interest.

Every landscape is assigned one of several possible change trends which makes this information mappable on the global scale. The result is a global thematic map of change which visualizes **a global spatial distribution of different land changes in a single map** – a compact summarization of what, where, and to what degree has changed between 1992 and 2015.

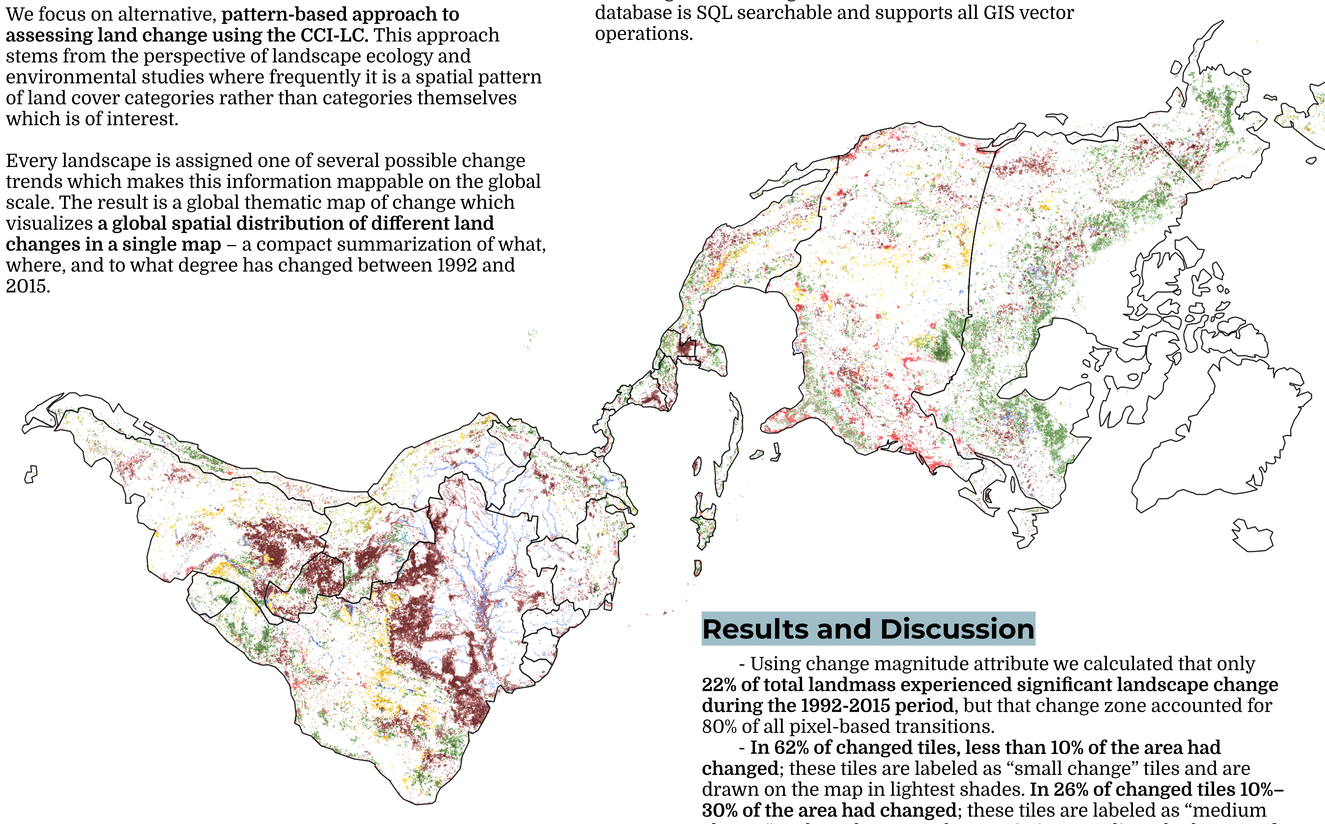
Materials and Methods

To facilitate utilization of ESA maps for broad-scale problems in landscape ecology and environmental studies, we have constructed **a GIS-based vector database of mesoscale landscapes** - patterns of land cover categories in 9km x 9km tracts of land:

1. We reprojected ESA maps to **the Fuller projection** to assure that each landscape in the database has approximately the same size and shape so the patterns of landscapes at different locations can be compared.
2. We calculated each landscape attributes including its **compositions in 1992 and 2015, a magnitude of pattern change, categories transition matrix for detailed characterization of change, and change trend type** - a simple, overall descriptor of the character of landscape change.
3. Combining change trends and change magnitude information we constructed **a global, thematic map of land change**; this map offers a visualization of what, where, and to what degree has changed between 1992 and 2015. The database is SQL searchable and supports all GIS vector operations.



A flowchart outlining computational steps to create an output dataset and map



Trajectories of landscape change 1992-2015

Results and Discussion

- Using change magnitude attribute we calculated that only **22% of total landmass experienced significant landscape change during the 1992-2015 period**, but that change zone accounted for 80% of all pixel-based transitions.
- **In 62% of changed tiles, less than 10% of the area had changed**; these tiles are labeled as “small change” tiles and are drawn on the map in lightest shades. **In 26% of changed tiles 10%–30% of the area had changed**; these tiles are labeled as “medium change” and are drawn on the map in intermediate shades, **In only 12% of changed tiles the area had changed by more than 30%**; these tiles are labeled as ”large change” and are drawn on the map in darkest shades.
- **Dominant land cover transitions were forest -> agriculture, agriculture -> forest, shrubland -> forest, forest -> shrubland, shrubland -> agriculture, and agriculture -> settlement.**
- The largest **net gain** was observed for **agriculture and settlement**, while the largest **net loss** occurred for **forest and shrubland.**
- The entire database of landscape change is **available for download from http://sil.uc.edu**.
- A preprint is available at https://eartharxiv.org/k3rmn/.

More Information

Space Informatics Lab (SIL) focuses on the development of spatial algorithms and datasets, which allows for a better understanding of the environment. It includes:

- **GeoPAT 2 (Geospatial Pattern Analysis Toolbox)** is a suite of modules dedicated to the analysis of large Earth Science datasets in their entirety using spatial and/or temporal patterns.
- **The sabre (Spatial Association Between REgionalizations)** is an R package for calculating a degree of spatial association between regionalizations or categorical maps.
- **Global inventory of landscape patterns and dimensions of landscape spatial configuration** - a GIS database containing the global inventory of land units of cohesive land cover patterns.
- **Ecophysiographic regionalization (ECOR)** - machine ecoregionalization of Earth's landmass using pattern segmentation method.
- For more information visit **sil.uc.edu**

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