Land Degradation Analysis by multi-scalar approach

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Land Cover Change → Negative land cover change, Loss of vegetation → Loss of Ecosystem Services → ***Soil erosion***

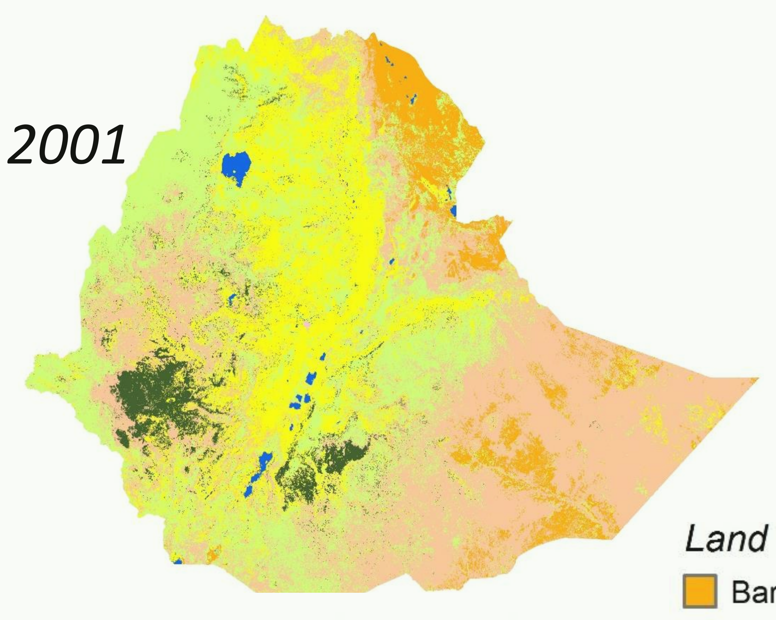
Introduction - framework
Inside Land degradation dynamics, Land cover change (LCC) and soil erosion are the most evident phenomena. LCC could be considered as one of the most important reach factors of global change (Turner et al., 1990), determining rapid changes in erosion rates. The land cover reflexes socio-economic, demographic, and environmental situation of a country. Often LCC represents a loss of ecosystem services defining areas most prone to erosion process (Foley et al., 2005), and area more vulnerable to the hazard phenomena. Considering this framework, a land degradation analysis has been performed to provide a contextualization of environmental risk. The main goal of this work is to provide a global land degradation overview detecting chronic areas at regional level. The workflow has been developed for humanitarian support. The land degradation analysis confirms to be an asset during the Disaster Risk Reduction (DRR) process.

Objective – our objectives match to perform LCC-Erosion analysis by a GLOBAL approach, detecting hot spot areas in which apply a successive sub-regional analysis.

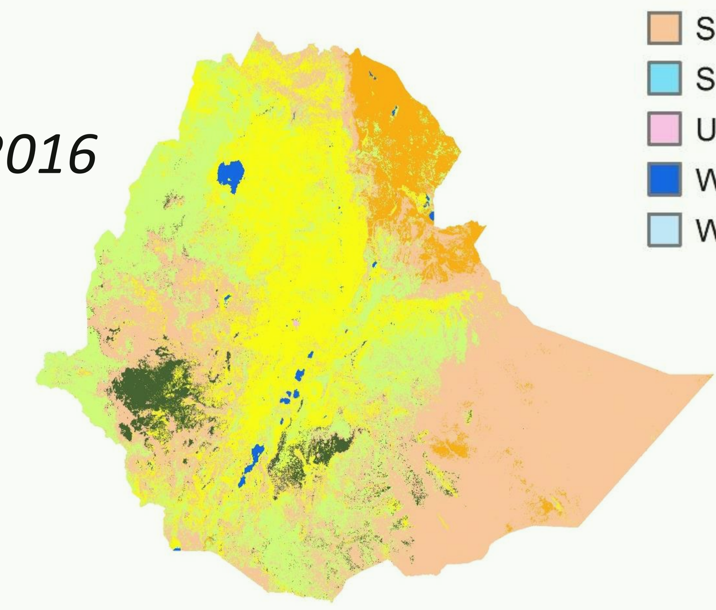
Methods – The analysis has been composed from three main steps: (i) Global Land cover change analysis considering the years between 2001-2015; (ii)Global erosion analysis by Revised Universal Soil Loss Equation (RUSLE); (iii) Regionalization analysis considering the spectral signature behavior of Landsat-Sentinel images to detect bad lands.
The land cover analysis has been performed by global approach considering MODIS-MCD12Q1 V006 data. According to the loss-gain of the most vegetated land cover classes it has been possible to define 'negative' or 'positive' land cove change dynamics. By statistical analysis the information has been than extracted by administrative 2 level boundaries.
On the second step an erosion analysis has been calculated considering the land cover information proceeding from the previous step and considering an adaptation of others variable as Slope, Lithology factor, Rain factor.
On the latest step, for the hot spot areas, the author suggests a regionalization of the analysis considering Landsat or Sentinel data to detect bad-lands and gully areas.

Land Cover change analysis

2001



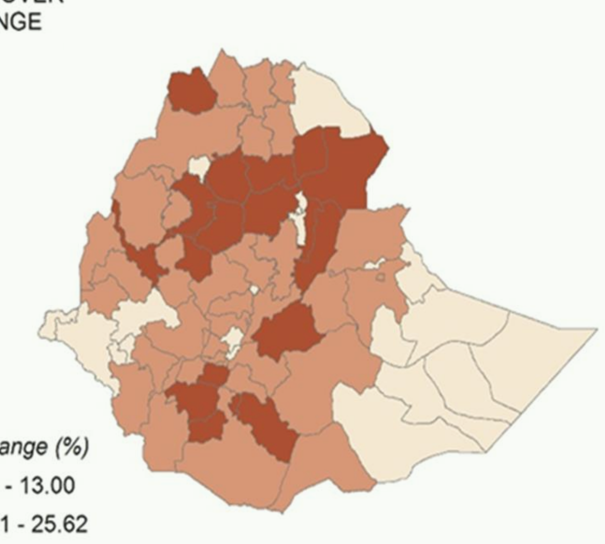
2016



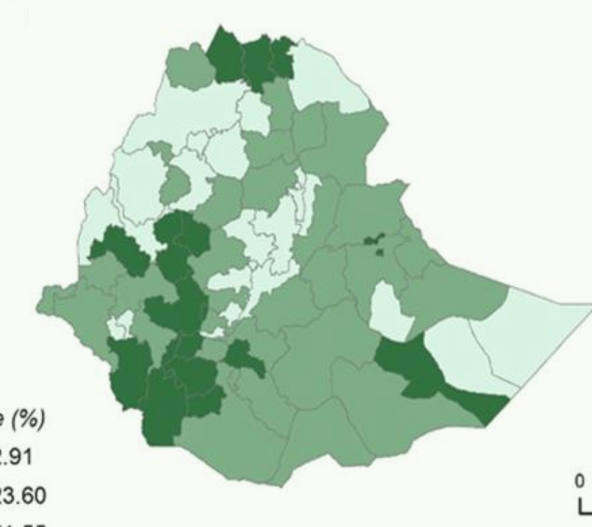
MODIS Land cover (500m)

- Land cover classes generalization
- Add an 'Ecological value' according to vegetation cover
- Regrouped in:
  - *Time1*: 2001-2007
  - *Time2*: 2010-2016
- Temporal comparison T1 Vs. T2
- Zonal Statistics

NEGATIVE LAND COVER CHANGE



POSITIVE LAND COVER CHANGE

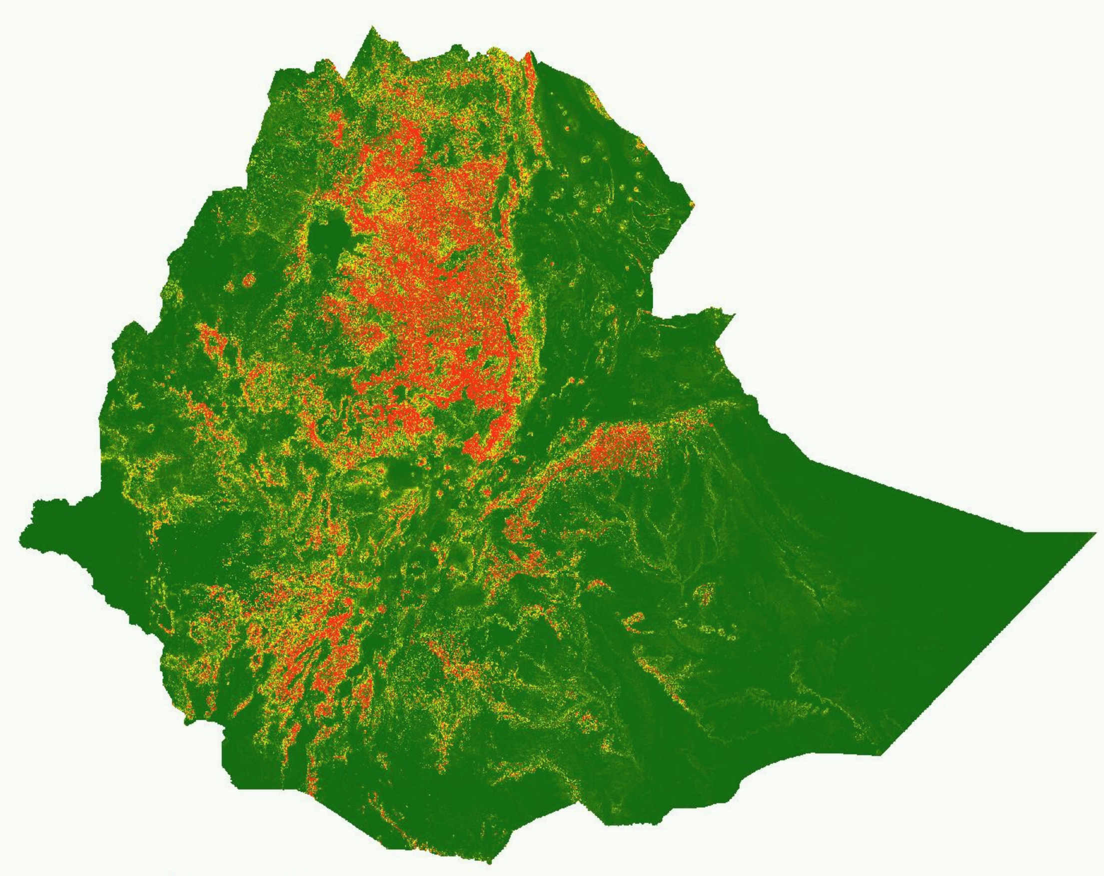


Erosion propensity analysis

Revised Universal Soil Loss Equation
R x C x Sl x K

- WorldClim 1970-2000 → Monthly Rainfall → R
- MODIS MCD12Q1 (500 m) → Land Cover → C
- DEM NASA (500 m) → Slope Length → Sl
- Global Soil Map FAO GEO-network → Lithology nature → K

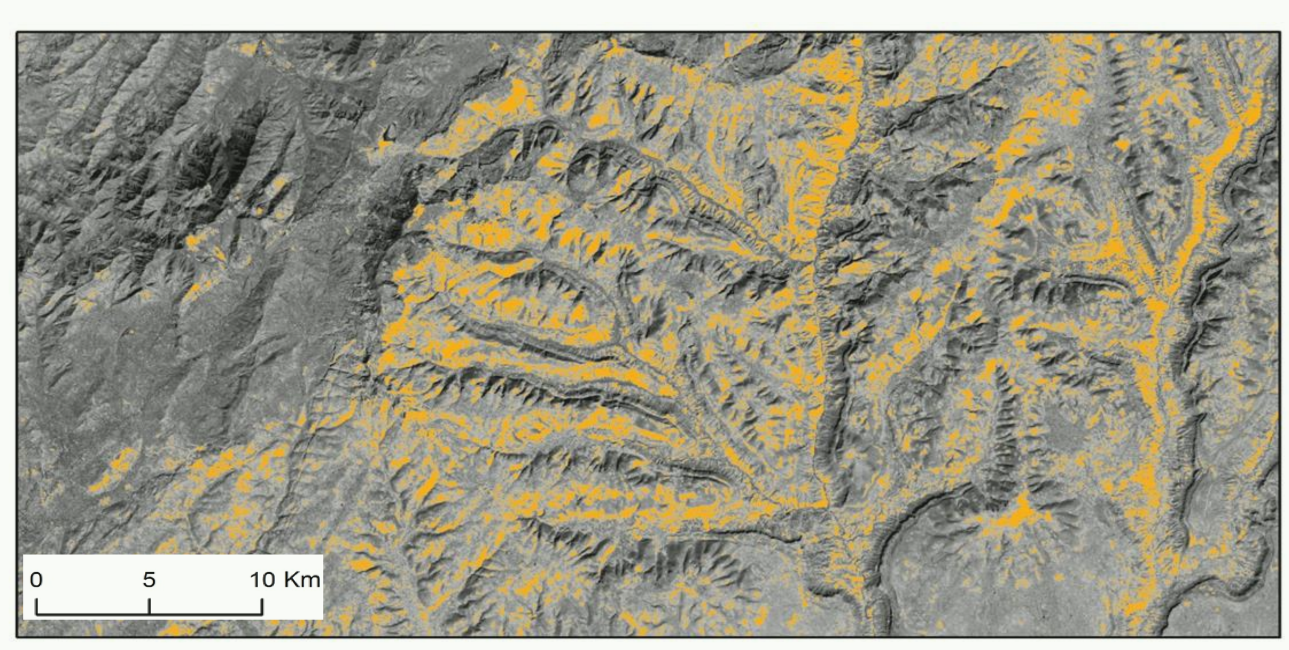
RUSLE → Erosion propensity Map (Tons/ha) →



Regionalization

The land cover detection and the erosion analysis could be performed In hot spot areas considering remote sensing data and local data set.

Considering the spectral response of satellite images as Landsat or Sentinel it is possible detect bad-lands (1.5-1.7; 2.2 μm)



Results – Considering *WFP countries*, we recognized we the following macro areas affected by chronic land degradations problems:
- -Central east and Central and west of Africa (*Ethiopia, Eritrea, Ghana, Nigeria, Sierra Leone*)
- -East cost of *India*
- -Central America (*El Slavador, Haiti, Ecuador, Nicaragua, Guatemala*)
- -Asia (*Philippine, Indonesia, Timor-leste*)

Discussion – In hot spot areas the results have been checked by photointerpretation considering high spatial resolution images (Google Earth, Digitalglobe). From this first overview the outputs seems to have a good match with the current situation.
On the erosion product have also been performed statistics checks (Pearson's correlation) between our results and the European soil erosion map elaborated by Joint Research Center (JRC) (Panagos et al., 2015). This correlation test has been performed considering around 100 random points, and it showed an *(r)* value of 0.65 between the two-erosion data.
We must remember that in our methodologies the protector factor (P factor) on erosion analysis has not been considered. There isn't a global 'P factor' database, indeed these is strictly related with local land management.

Conclusion – The ecosystem services produced by vegetation cover is crucial for the land degradation control. All changes in land cover from forest to other class with a consequent loss of vegetation density produce an increase in erosion rate. The analysis of land degradation represents a crucial step to contextualize environmental risk. The workflow proposed has a multi-scalar approach, so, according to the data set availability it is possible apply this methodology at each scale (from global to sub-regional). Future steps will match with the need to analyze landslide phenomena on the already recognized land degradation hot spot areas.

Major References
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