GOFC-GOLD
Global Observation of Forest Cover and Land Dynamics
Land Cover Project Office

esa

Time Series Data Analysis with BFAST Spatial for Forest Cover Change Detection

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REDD+ “Training the Trainers” Regional Workshop

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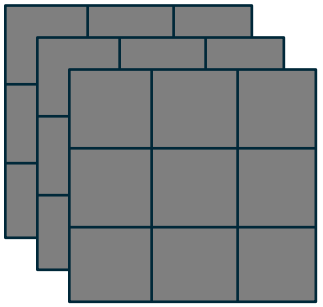
BFAST Spatial

Background

- Developed by Loic Dutrieux, Ben DeVries, Jan Verbesselt, at Wageningen U.
- Includes a set of utilities and wrappers to perform change detection on satellite image time-series spatial gridded-data (Landsat and MODIS).
- Includes pre-processing steps and functions for spatial implementation of BFASTmonitor change detection (pre-processing raw surface reflectance Landsat data, inventorying and preparing data for analysis, production and formatting of results).
- Package available on GitHub repository: https://github.com/dutri001/bfastSpatial



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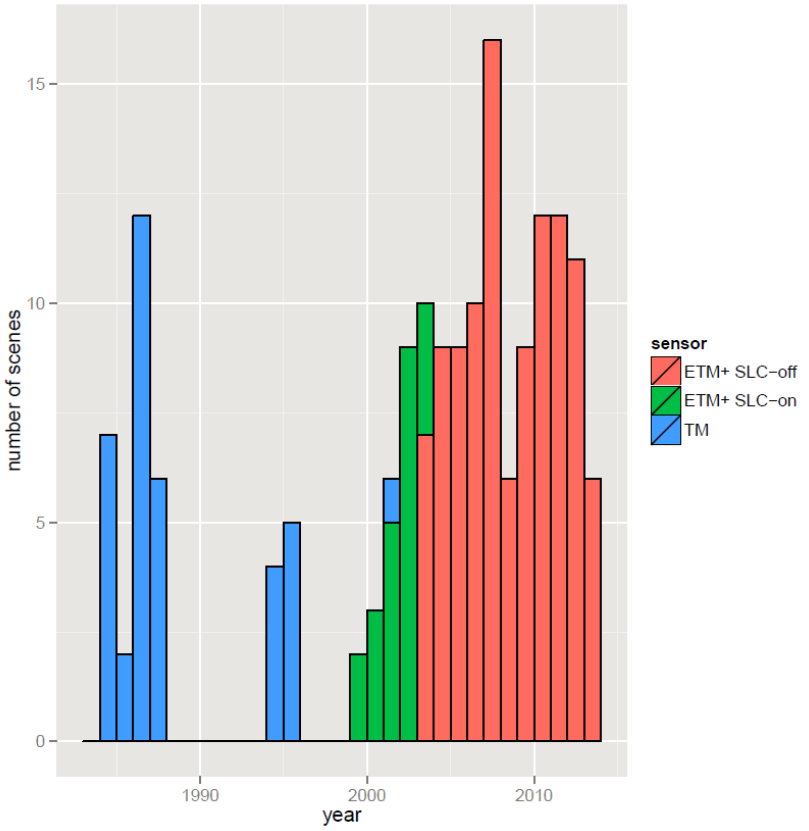
Utilities

- Pre-process Landsat surface reflectance data and prepare them for subsequent analysis
- The overall Landsat pre-processing requires to:
  - Extract data from the tar.gz archive
  - Calculate Vegetation Indices from surface reflectance bands (when not provided by USGS)
  - Crop the data to a desired spatial extent
  - Apply one of the cloud/land mask supplied with the data
  - Create a spatio-temporal object to be used in subsequent analyses

BFAST Spatial

Utilities

- Data inventory (lists Landsat scenes and provides information such as acquisition date, sensor, path, row, ...)



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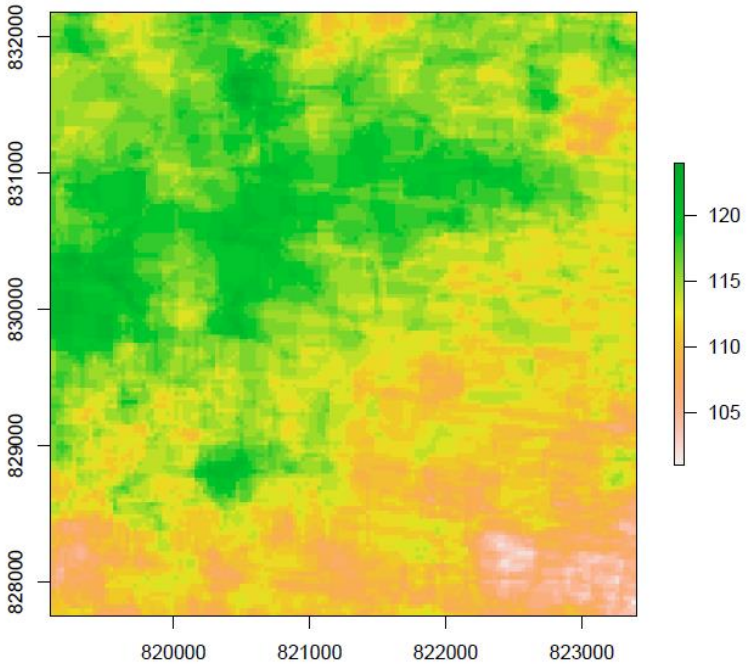
Utilities

- Number of valid observations (cloud cover)

```
## layer
## Min. 101
## 1st Qu. 112
## Median 114
## 3rd Qu. 117
## Max. 124
## NAs 0
```

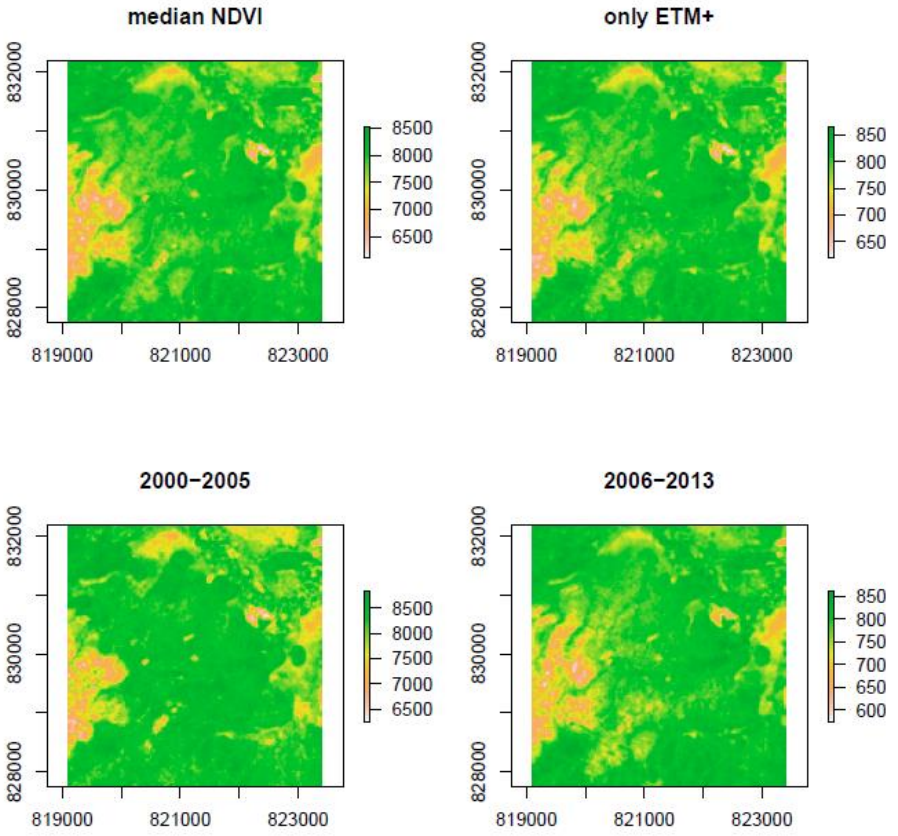


BFAST Spatial

Utilities

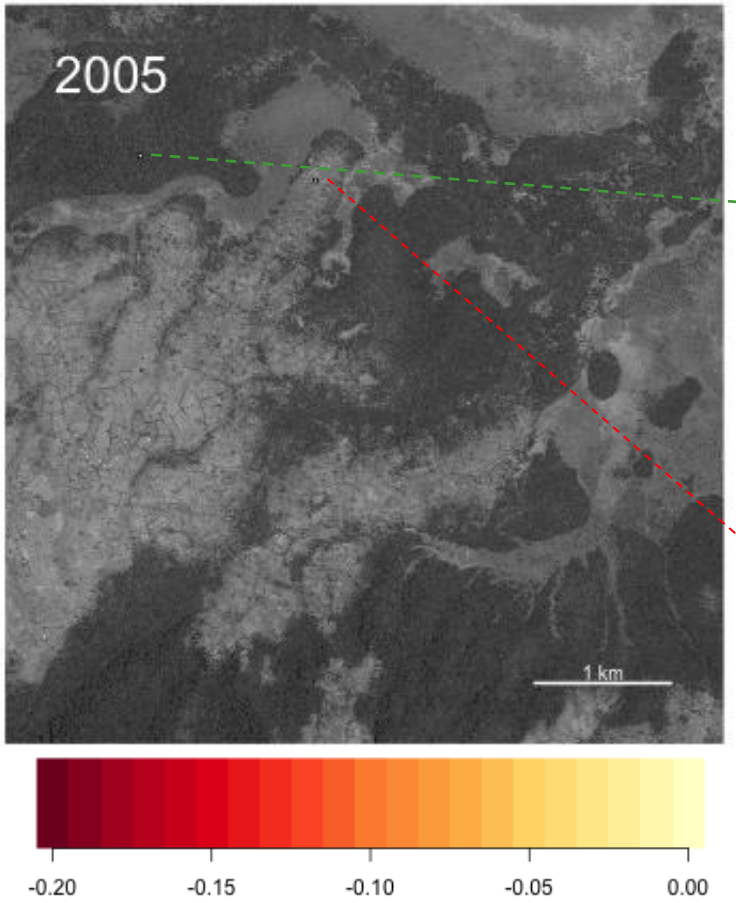
- Summary statistics of the dataset (NDVI, other spectral index)

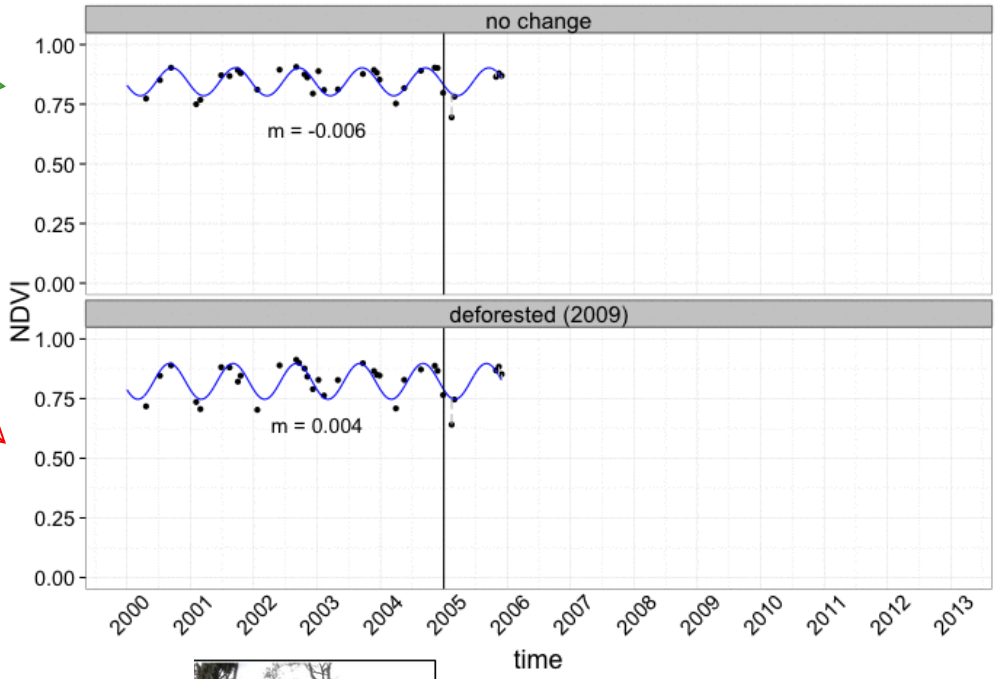
```
## layer
## Min. 101
## 1st Qu. 112
## Median 114
## 3rd Qu. 117
## Max. 124
## NAs 0
```



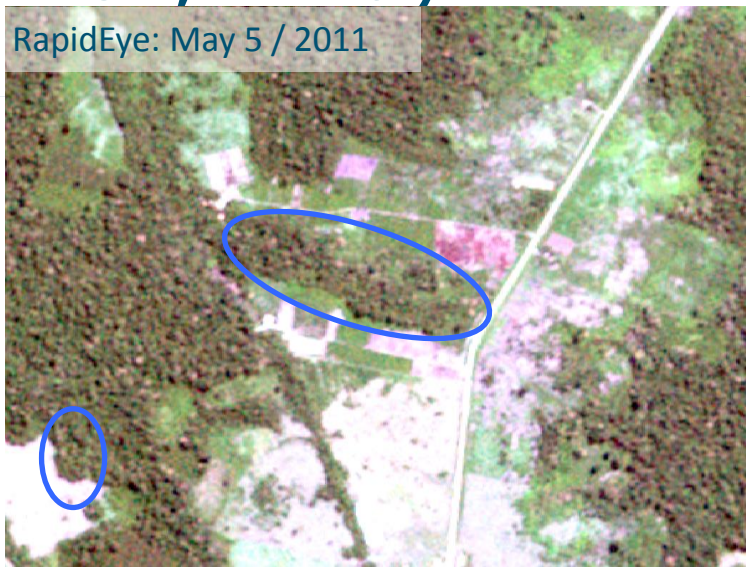
BFAST Spatial: in-Migration (Kafa, Ethiopia)

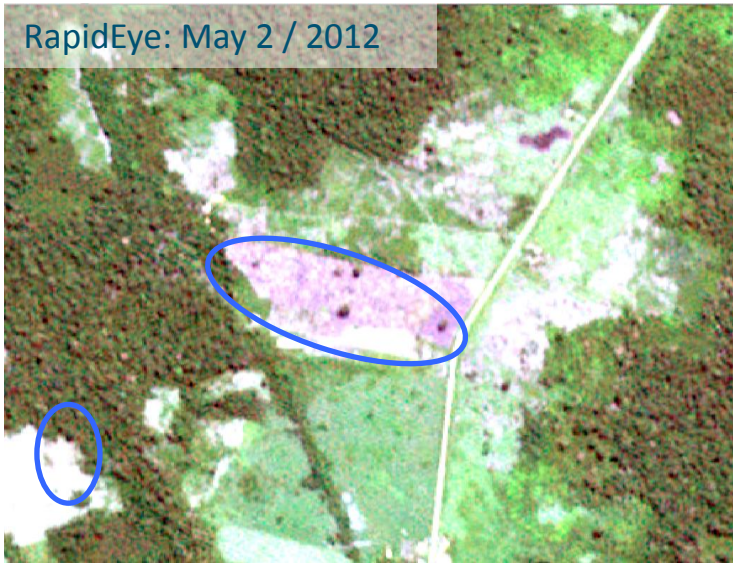
Image background: SPOT5 (Feb 2011, 2.5m)

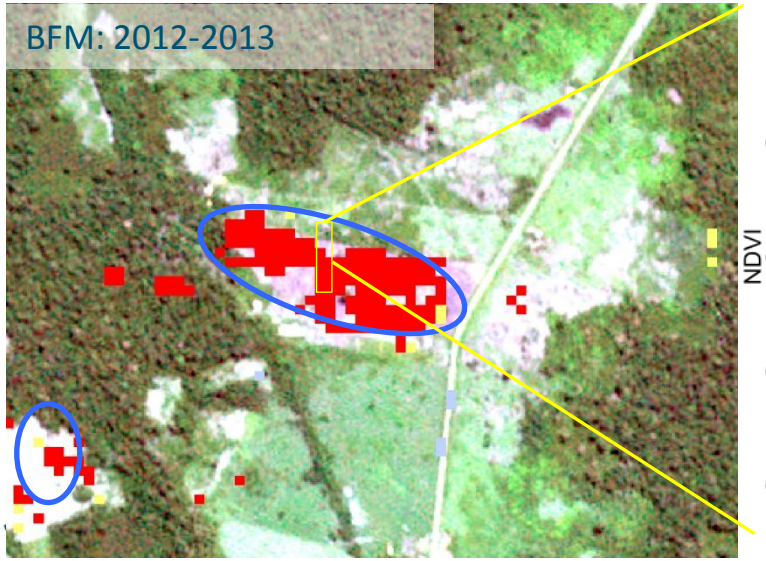


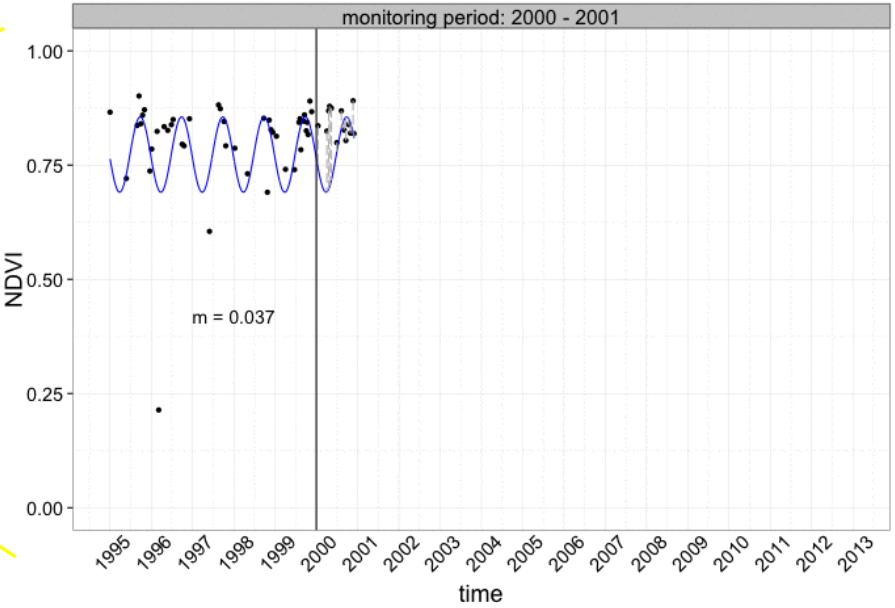


BFAST Spatial: Clear-Cutting (Madre de Dios, Peru)







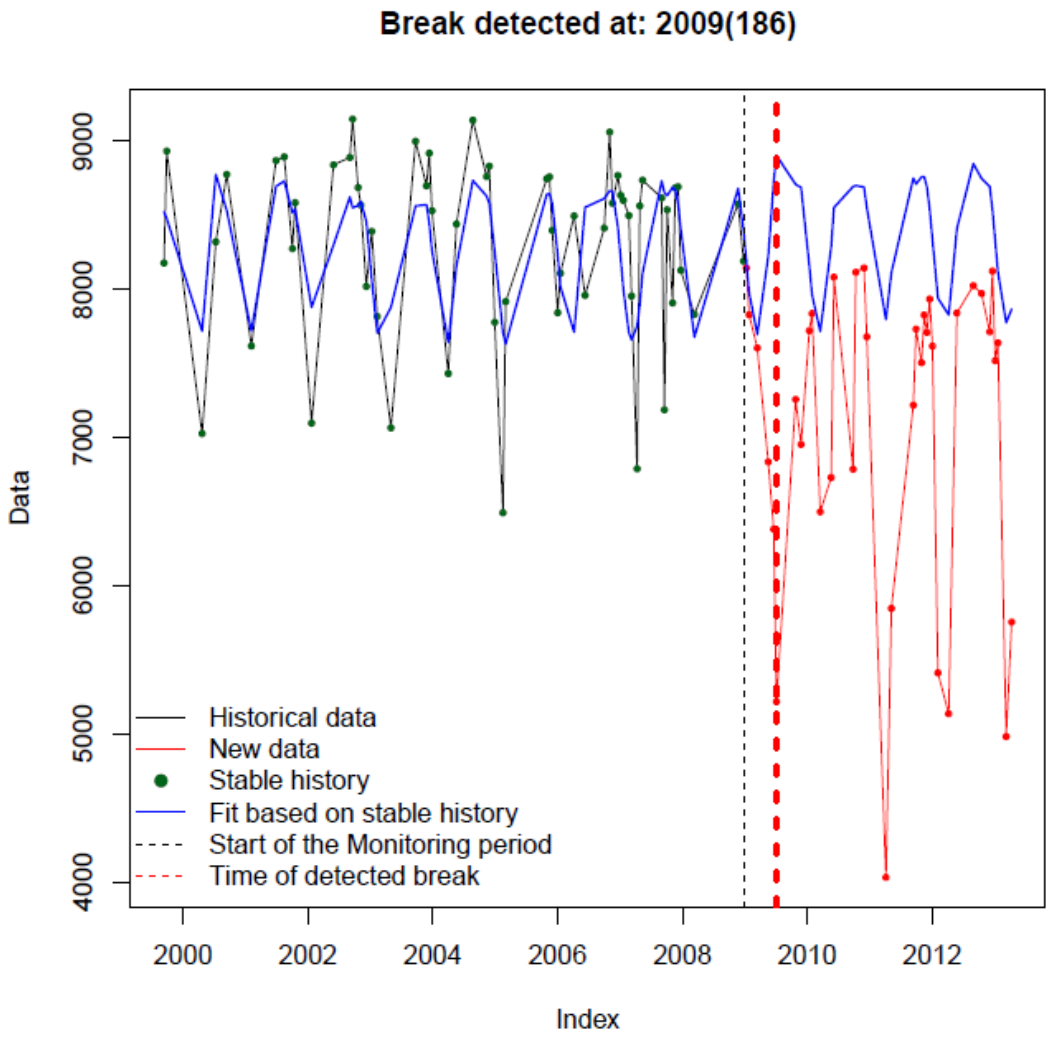


BFAST Spatial

Utilities

- BFASTSpatial monitor

e.g. one pixel trajectory:



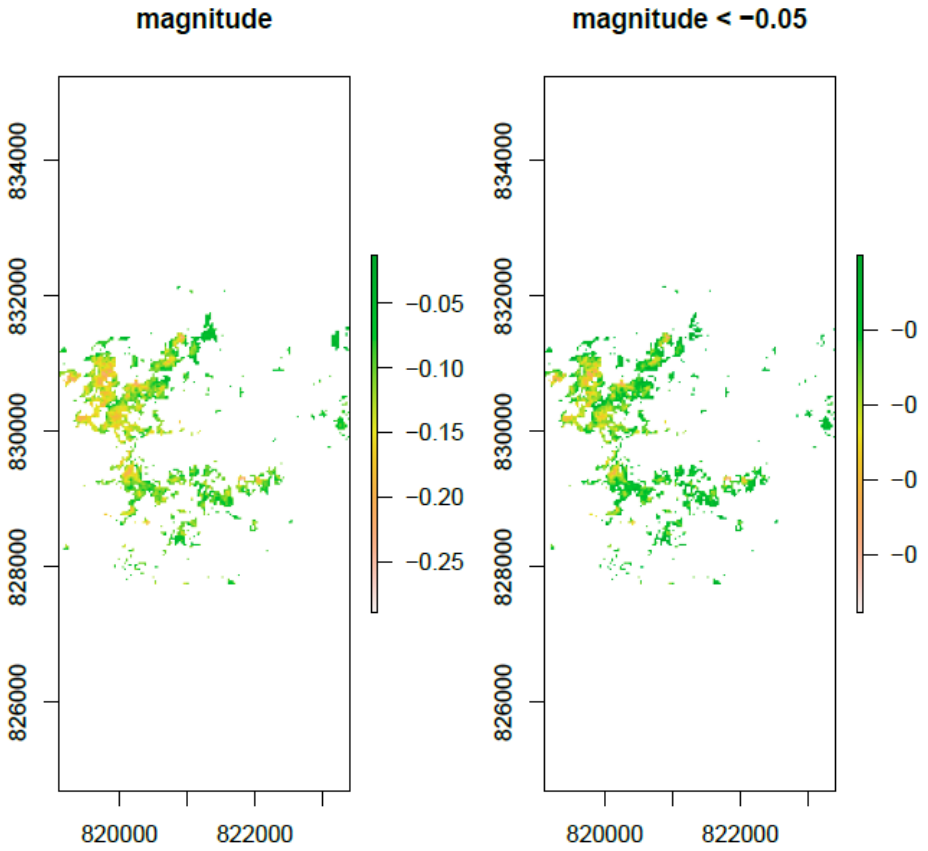
BFAST Spatial

Utilities

- BFASTSpatial monitor

- Can be applied over an entire raster time series

- Allows to pinpoint the location and timing of changes, including magnitude,



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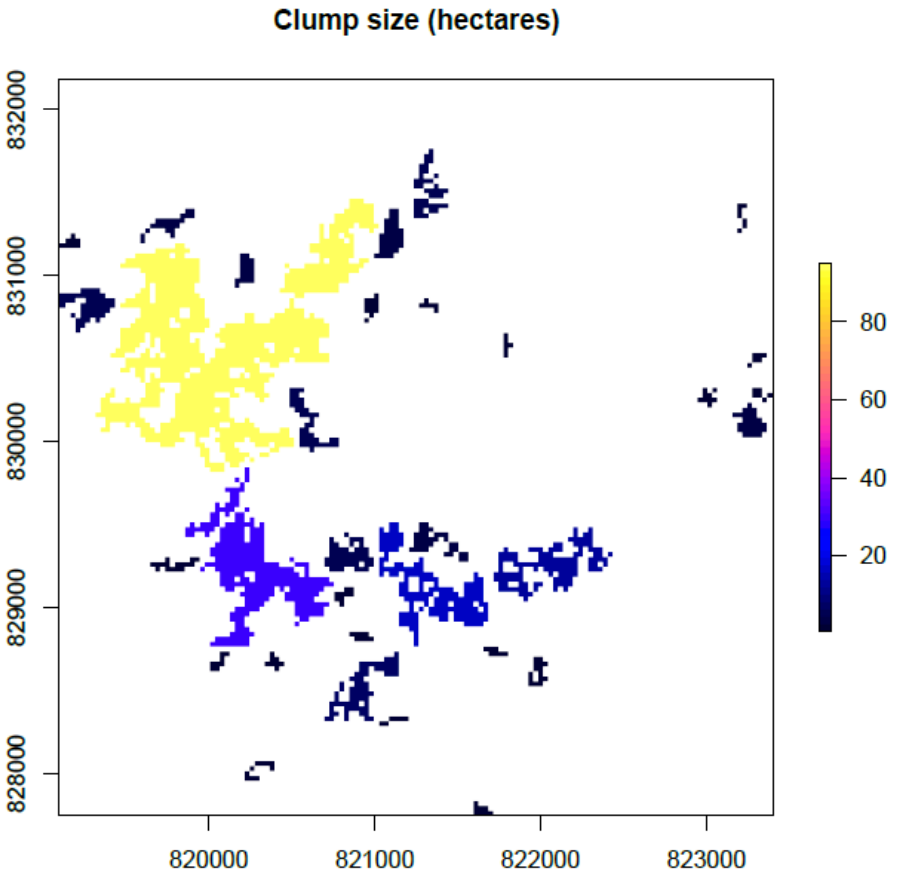
BFAST Spatial

Utilities

- BFASTSpatial monitor

-Can be applied over an entire raster time series

- Allows to pinpoint the location and timing of changes, including magnitude, and area of change



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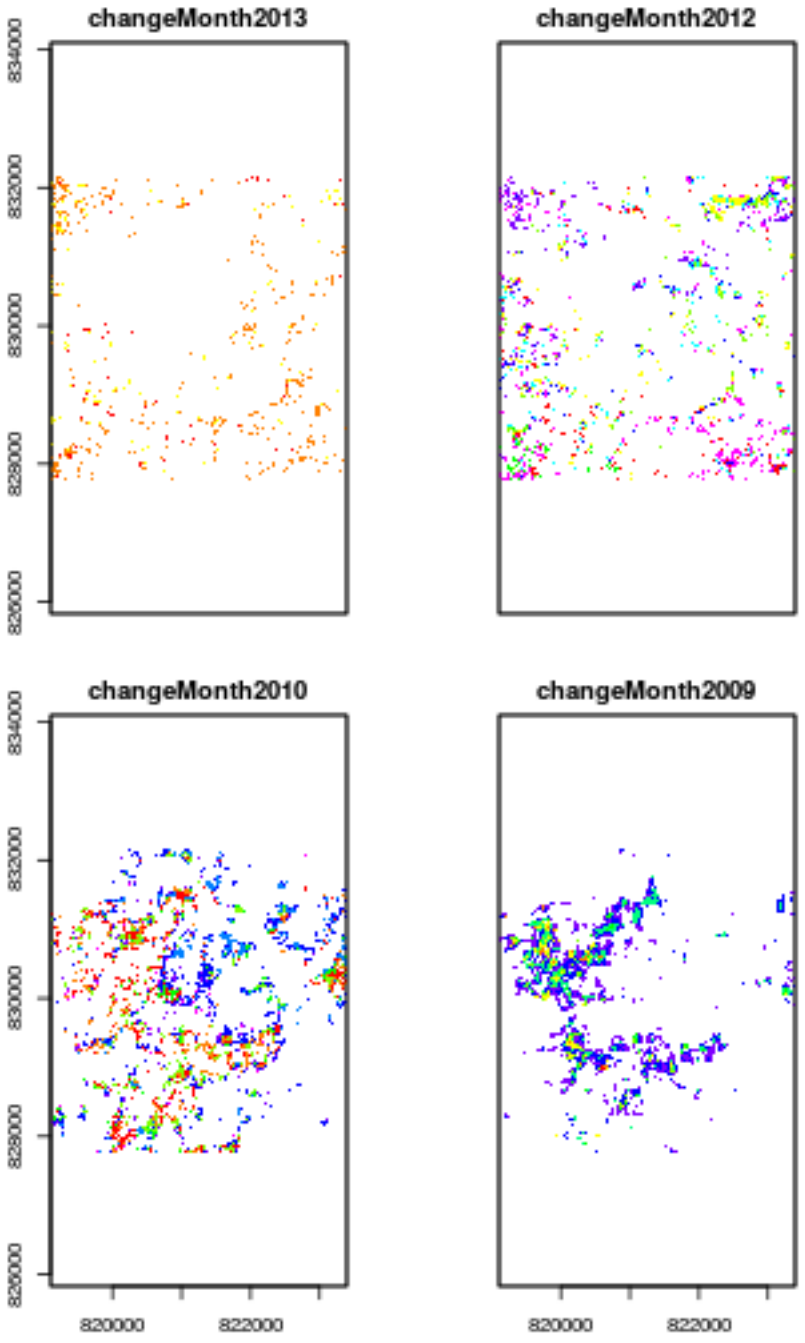

Monthly change per year

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BFAST Spatial

Concluding remarks

- BFASTSpatial is a significant step toward operational semi-automated land cover-change detection methods
- Still at the R&D stage, first operational implementations ongoing already
- Depending on area of interest, proper time-series not easy to obtain (archive size, cloud cover)
- Advent of Sentinel data will be beneficial to time-series change detection algorithms (S1: SAR, S2: optical)
- Computer intensive when applied over large areas

References

- DeVries, Ben, Jan Verbesselt, Lammert Kooistra, and Martin Herold. 2015. "Robust Monitoring of Small-Scale Forest Disturbances in a Tropical Montane Forest Using Landsat Time Series." *Remote Sensing of Environment* 161: 107–121. doi:10.1016/j.rse.2015.02.012.
- Dutrieux, Loïc Paul, Jan Verbesselt, Lammert Kooistra, and Martin Herold. 2015. "Monitoring Forest Cover Loss Using Multiple Data Streams, a Case Study of a Tropical Dry Forest in Bolivia." *ISPRS Journal of Photogrammetry and Remote Sensing* In press. doi:10.1016/j.isprsjprs.2015.03.015.
- Verbesselt, J., R. Hyndman, G. Newnham, and D. Culvenor. 2010. "Detecting Trend and Seasonal Changes in Satellite Image Time Series." *Remote Sensing of Environment* 114 (1): 106–115. doi:10.1016/j.rse.2009.08.014.
- Verbesselt, J., A. Zeileis, and M. Herold. 2012. "Near Real-Time Disturbance Detection Using Satellite Image Time Series." *Remote Sensing of Environment* 123: 98–108. doi:10.1016/j.rse.2012.02.022.

BFAST Spatial: exercise

Based on the tutorial of BFASTspatial

Study area: Kafa region, Ethiopia

Area covered: 143*148 Landsat pixels = 4.3km by 4.4km = 1905 ha

Vegetation type: broadleaf evergreen forest

Let’s go to the Guidelines document of this training session…

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