Change detection in satellite image time series for continuous land cover map updating

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1. Introduction

- Most land cover (LC) maps are produced for a single date
- Change processes over time are often more interesting than static land cover
- These can be derived from yearly-updated land cover maps, but a class may shift in a different year due to a small shift in model parameters, and not real change on the ground
- Dedicated LC change maps are released years after the changes happen, making them suitable for climate but not land management applications

2. Objectives

Time series break detection used to:

- Reduce spurious change between year by masking by detected change
- Provide the classifier with stable time series (before or after change, not change itself)
- Potentially save processing time by not reprocessing unchanged pixels

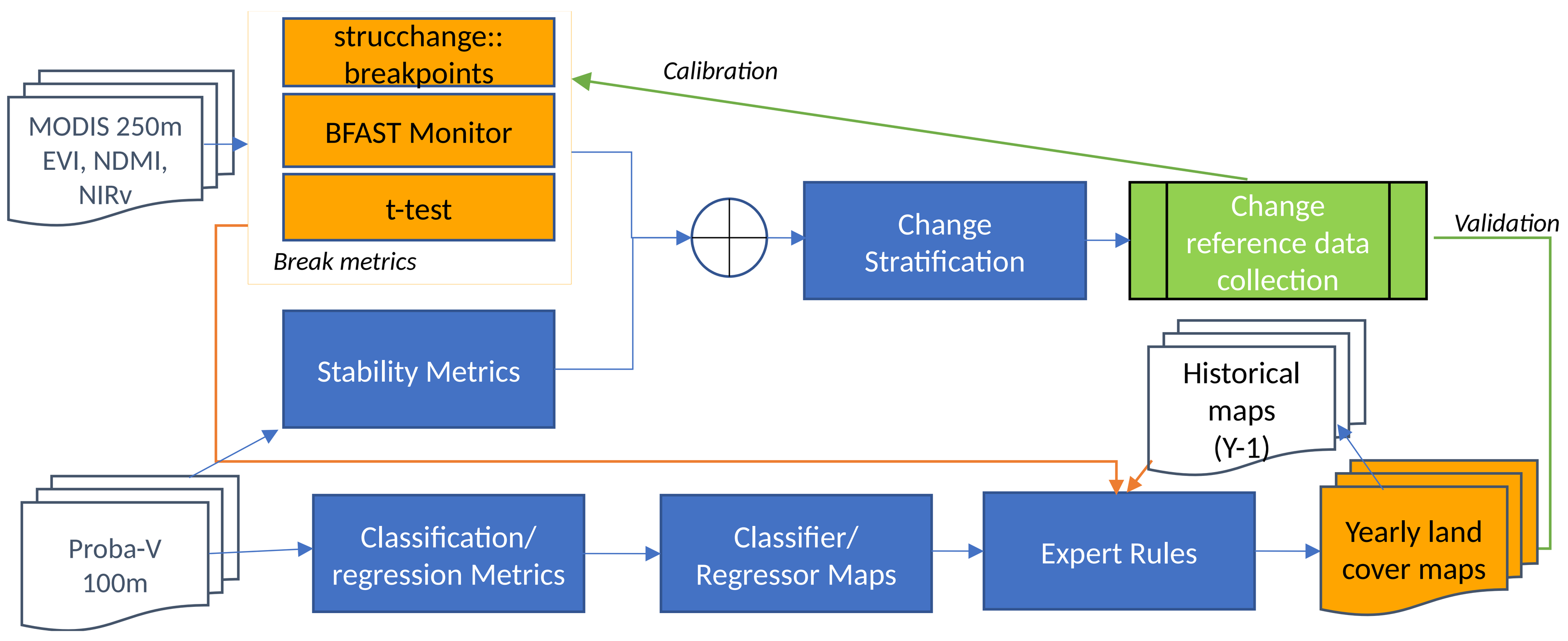

Figure 1. Proposed CGLS-LC100 yearly updated map production chain. Our tested algorithms are combined into a stratification map for reference data collection, and also used in expert rules to filter out spurious change in the classifier/regressor output.

3. Input data, methods and validation

MODIS 250m vegetation indices and 3 algorithms used to detect changes, the output of which can then be used to update the map (see Figure 1). First two algorithms based on Breaks For Additive Season and Trend (BFAST) code at `https://github.com/GreatEmerald/bfast`.

Run in two modes (see Figure 2):

- Near real-time (NRT) for fast detection of change (BFAST Monitor/*t*-test only)
- Consolidated (CONSO) for confirmed change

Validated against a land cover change dataset being collected over Africa (by IIASA and WUR): so far 1010 points over Sahel, additional 607 over Africa, for year 2016. Processing was run on Proba-V MEP Spark cluster at VITO.

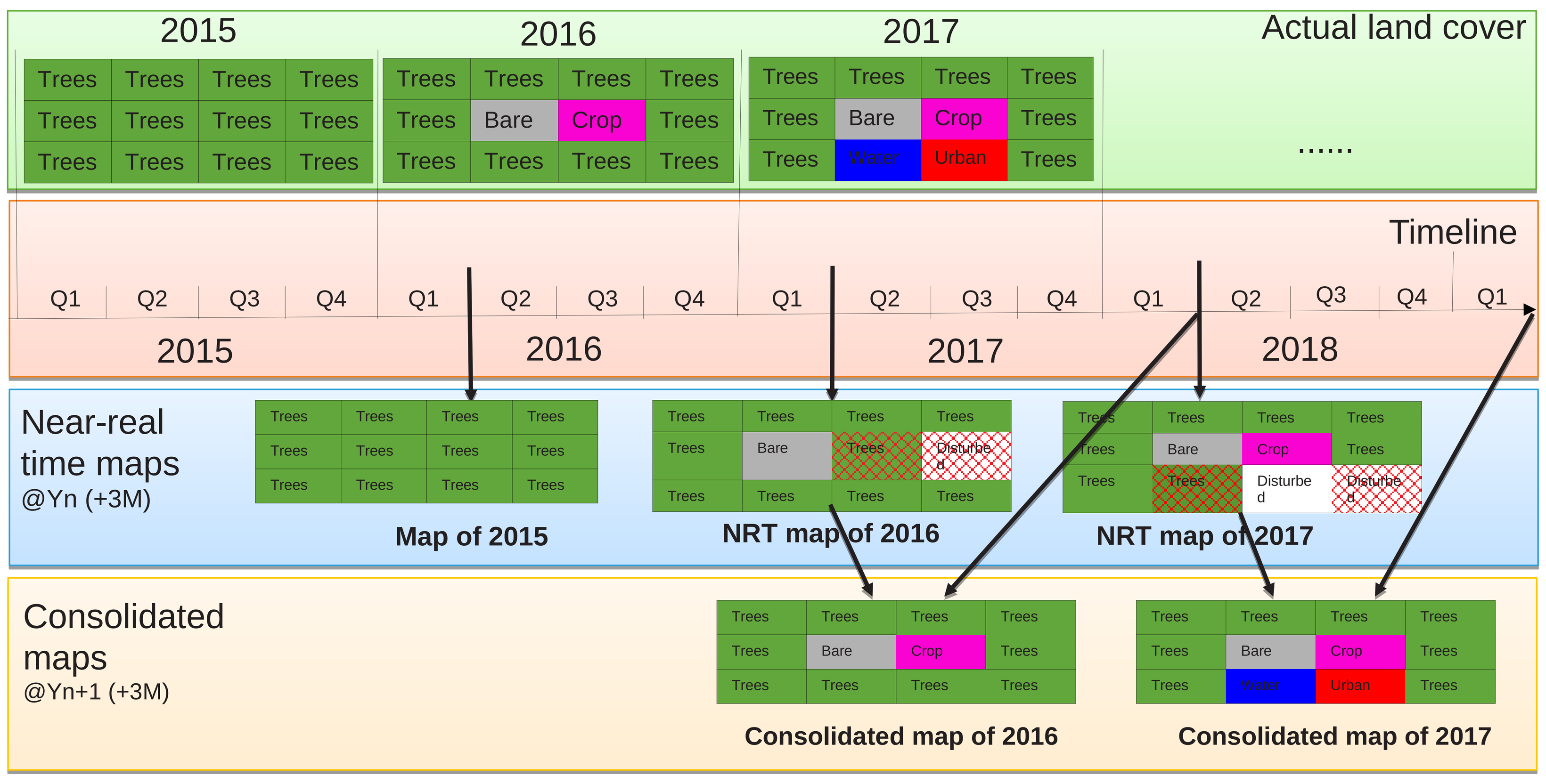

Figure 2. Proposed CGLS-LC100 updating process. An NRT map to be released a quarter after the end of the year to be mapped, together with the consolidated map of the year before.

4. Preliminary results

Tested break detection algorithms tend to detect too much change in West African drylands (3.4% of the points collected there are real change). When several algorithms are used as confluence of evidence for actual change, much more true change is detected (71.2%, out of which 61% was burnt areas and 8% the change in water extent). Different algorithms perform better or worse depending on the area (see Figure 3).

Break detection by itself does not give an indication of the class after the change, hence a regularly-updated process from NRT to Consolidated maps is proposed (see Figure 2).

Since the difference between yearly classification/regression algorithm outputs by themselves also shows an overestimation of changes, it is useful to combine the two methods to reduce spurious change.

5. Discussion

Integrating time-series break detection algorithms help to detect real and immediate land cover changes. Our findings are independent of sensor and thus are applicable for any land cover map updating task, as long as more than 5 years of satellite imagery time series is available. Once finished, it should help improve the production of regularly-updated land cover maps.

One limitation of the updating approach is that the original map is considered accurate (any errors in it will propagate to updated maps). Also, further research on combining the algorithms and vegetation indices is needed to find the optimal map updating strategy, as well as on a methodology to capture changes in land cover fractions, especially gradual (non-break) change.

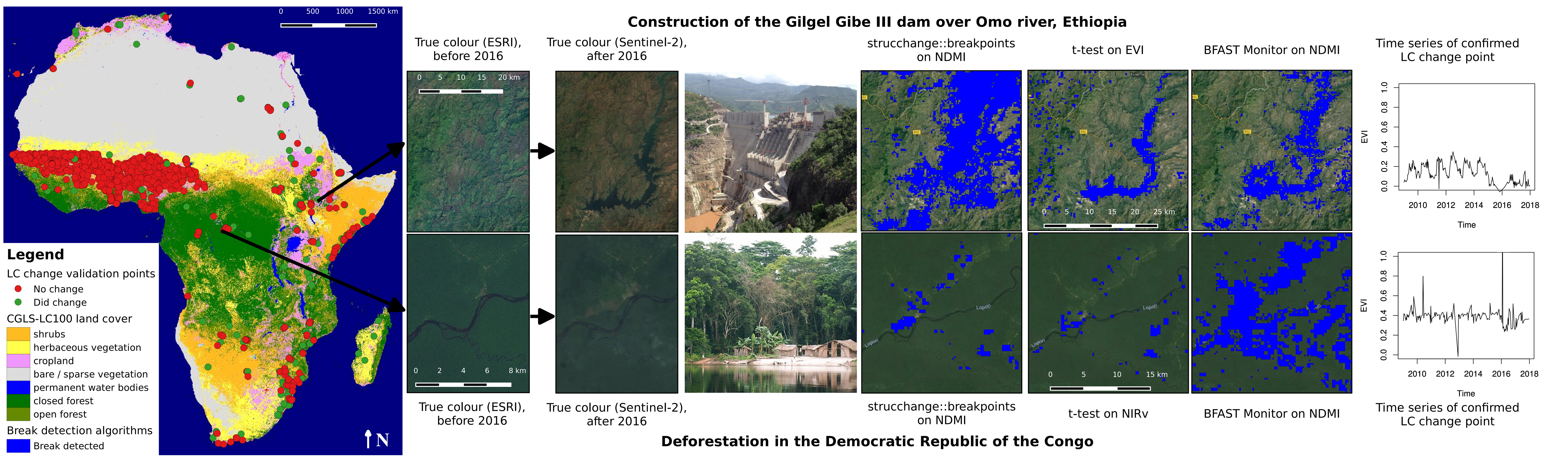

Figure 3. Two examples of confirmed land cover change that happened in 2016, and how the changes are detected with the tested algorithms.

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