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## Satellite-based detection of potential land grabs

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## INTRODUCTION

Large scale land acquisitions (LSLAs), often referred as “land grabbing”, are highly dynamic and complex land use systems that are rapidly transforming ecosystems and societies in many low-income countries of the world, bringing on one hand sustainability challenges and, on the other hand, undermining the right of peoples to self-determination over natural resources. Because information on those acquisitions is often opaque and scarce, systems allowing near real-time LSLAs detection, characterization and monitoring are needed<sup>1</sup>.

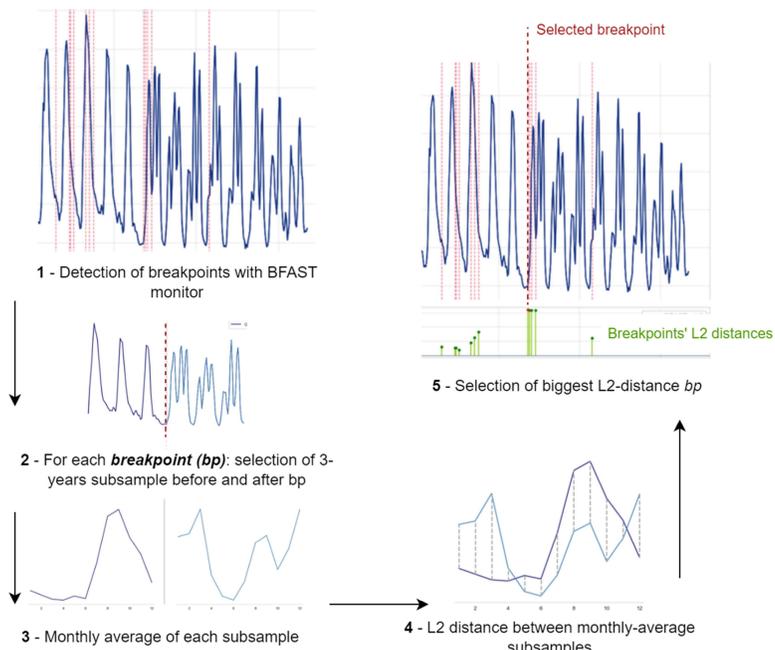
In this context, the increasing availability of free-of-cost global satellite data products has shown great potential for providing insights into land dynamics, particularly of large and remote areas. While LSLAs are not directly observable from remote sensing images (no one-to-one relation between land cover and functionality), they may be inferred from observable land cover and spatio-temporal characteristics at different scales, and structural elements in the landscape. At a pixel level, land use and land cover (LULC) changes are often detected using change detection algorithms applied on temporally-dense satellite image time series (SITS) of vegetation indices<sup>2</sup>. So far, most of the LULC change studies have focused on forested land covers where significant deviations (anomalies) from the mean are relatively easy to detect<sup>3</sup>. However, LULC changes, and in particular human-driven ones such as those induced by LSLAs, often imply a change in (seasonal) interannual patterns (not always with significant shifts from the mean), that are less well detected by change detection algorithms<sup>4</sup>. Accurate, automatic and fast detection of those type of changes would thus pave the way for the development of generic and unsupervised approaches to LULC change detection.

## MATERIALS AND METHODS

This study proposes a simple method to automatically select at large scale, in dense MODIS NDVI time series with multiple breakpoints, the optimal breakpoint linked to the most important land use change (i.e. linked to the most important seasonal change). The detection method proposed here (BFASm-L2) is based on a two-step approach:

- 1- the detection of (if any) breakpoints in dense MODIS NDVI time series using the very fast BFAST monitor algorithm<sup>5</sup>;
- 2- the selection, for each pixel, of the breakpoint associated to the biggest seasonal change based on a L2 similarity-distance

The approach was tested on a set of 151 200 simulated time series with different unique change types and multiple noise/change intensity levels<sup>4</sup>. It was then tested over an area of 200x200 pixels in Senegal, for which we have ground-truth data on LSLAs. Comparisons were performed with the recently launched BFAST Lite<sup>6</sup>.

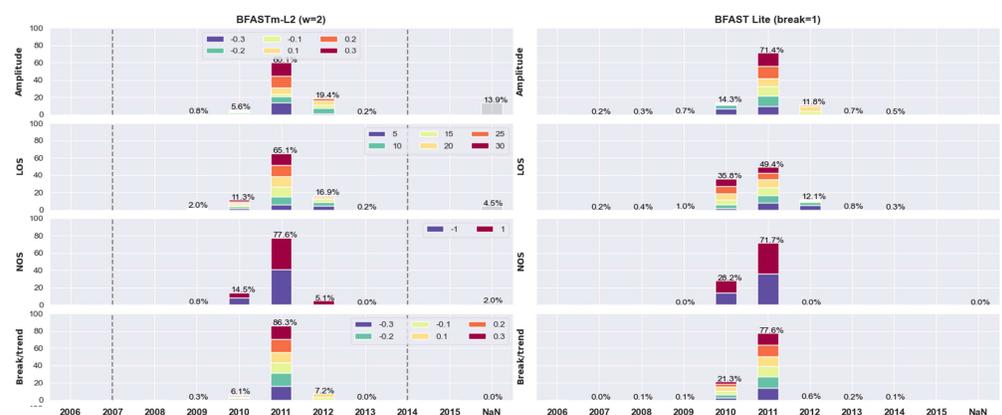


## ACKNOWLEDGEMENTS

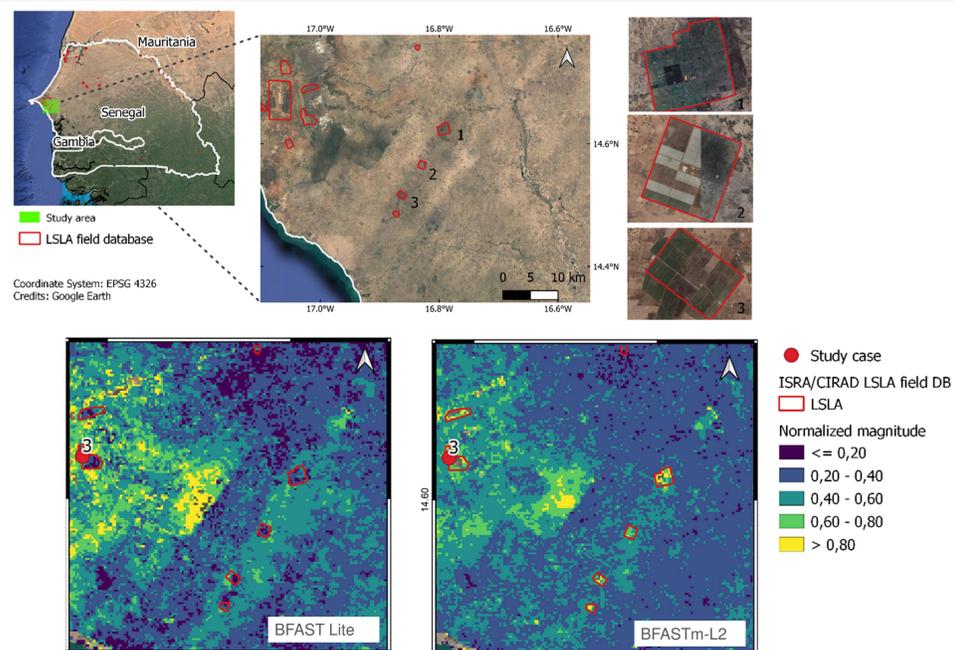
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## RESULTS

**1 - Temporal accuracy assessment** of the BFASm-L2 change detection approach on a set of simulated data with four types of change (in amplitude, length of season (LOS), number of season (NOS) and abrupt change (Break/trend)), and different intensities (represented by the colors), with true changes located in 2011. Comparison is performed with BFAST lite. BFASm-L2 is more effective in detecting seasonal changes (LOS and NOS) and abrupt changes than BFAST lite.

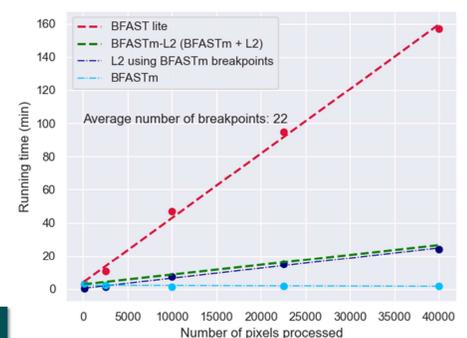


**2 - Spatial assessment** of the BFASm-L2 change detection approach over a 200x200 MODIS pixels area in Senegal, with ground-truth data on the location of LSLAs (represented by red polygons) installed after 2000. Comparison is performed with BFAST lite. Maps represent the normalized magnitude of change of the breakpoint selected on the 2003-2018 MODIS NDVI time series. The BFASm-L2 approach (right figure) is able to spatially highlight LSLAs induced changes, as opposed to BFAST lite (left figure).



## 3 - Running times

Running times of BFASm (BFAST monitor), BFASm-L2 and BFAST Lite to process 2000-2021 MODIS NDVI rasters of different sizes (50x50 to 200x200 pixels) were registered. The average number of breakpoints found by BFASm in the 200x200 area was 22. BFASm-L2 shows to be almost 7 times faster than BFAST Lite, enabling its application at large scales.



## DISCUSSION

The change detection approach developed in this study, BFASm-L2, proved to be:

1. Able to effectively detect seasonal changes (in length of season (LOS) and in number of seasons (NOS) and abrupt changes. Its performance on a simulated data set was better than BFAST Lite one.
  2. BFASm-L2 magnitudes are useful in spatially highlighting land use changes as those induced by LSLAs implementation.
  3. BFASm-L2 is very fast, allowing its application at large scales.
- Studies to reduce the detection of gradual (monotonic) trends are on-going, as well as image analysis to discriminate LSLAs induced changes from other land surface dynamics.

## REFERENCES

1. Batterbury, S., & Ndi, F. (2018). Land-grabbing in Africa. In J. A. Binns, K. Lynch, & E. Nel (Eds.), *The Routledge Handbook of African Development*. Routledge.
2. Verburg, P. H., van de Steeg, J., Veldkamp, A. y Willems, L. (2009). From land cover change to land function dynamics: A major challenge to improve land characterization. *Journal of Environmental Management*, 90(3), 1327–1335.
3. Ochtyra, A., Marcinkowska-Ochtyra, A. y Raczek, E. (2020). Threshold- and trend-based vegetation change monitoring algorithm based on the inter-annual multi-temporal normalized difference moisture index series: A case study of the Tatra Mountains. *Remote Sensing of Environment*, 249, 112026
4. Awty-Carroll, K., Bunting, P., Hardy, A. y Bell, G. (2019). An Evaluation and Comparison of Four Dense Time Series Change Detection Methods Using Simulated Data. *Remote Sensing*, 11(23), 2779.
5. Verbesselt, J., Zeileis, A. y Herold, M. (2012). Near real-time disturbance detection using satellite image time series. *Remote Sensing of Environment*, 123, 98–108
6. Masiiliunas, D., Tsendbazar, N.-E., Herold, M. y Verbesselt, J. (2021). BFAST Lite: A Lightweight Break Detection Method for Time Series Analysis. *Remote Sensing*, 13(16), 3308.