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Enhancing approaches for large area tropical forest change monitoring using time-series satellite data

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Background

In the context of global sustainable development, estimating and mapping forest change at large scale is more important than ever before. In the last decade, due to freely available satellite imagery, time-series analysis of satellite data has been established as a tool for detecting and monitoring forest change at small land scale. My research aims to develop methods that advance time series forest change detection techniques from local, to regional and national scale usage, to the point where they can be used as tools for international reporting such as that required by the United Nations Framework Convention on Climate Change (UNFCCC).

In this sense, we emphasize the need to make time-series data and approaches open and more accessible to users, in particular in developing countries, and, to undertake this challenge, we collaborate with the Food and Agriculture Organization (FAO) of the United Nations to develop and integrate our methods with their System for Earth Observation Data Access, Processing and Analysis for Land Monitoring (SEPAL).

Objective

Our focus is to identify and manage the problems associated with larger scale forest loss detection using time series analysis, and to evaluate possible options to improve forest change detection at large scale.

Speeding up time-series analysis: GPU implementation for break detection

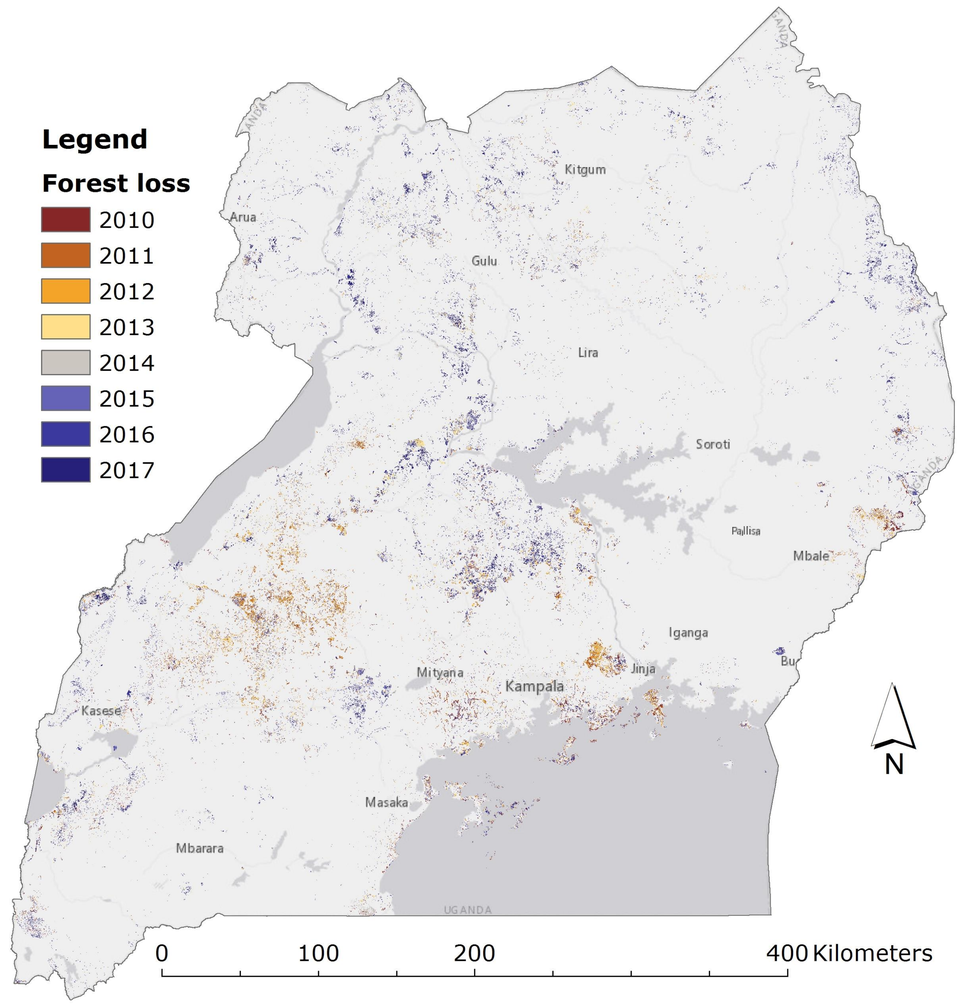
We addresses the data processing issue of exploiting the tremendously big open global satellite archive. With terabytes to petabytes of data needed in order to cover a large area both spatially and temporally, taking advantage of this data-rich situation has become challenging. Open source existing approaches are too slow for processing and analysing all the available data for very large areas.

We propose to adapt the state-of-the-art BFAST Monitor time-series algorithm [1] to new technological developments in massively-parallel compute devices such as the new concept of general purpose computing on graphics processing units (GPUs).

Our initial developments [2] show great potential for the analysis of large datasets, our many-core implementation of the BFAST Monitor algorithm being up to four orders of magnitudes faster than the commonly used R implementation, given both artificial and real input datasets. Nevertheless, this initial implementation could only work with datasets with no missing values (e.g. from masking clouds).

To overcome this limitation we are currently developing a more general implementation that can effectively handle real-world scenarios with time series potentially containing many missing values.

Here we present a proof of concept, of our method applied on 18 years of Landsat data over the forest of Uganda, processed in under 5 hours on a consumer grade computer with 1 GPU.



Breaks detected in Landsat time-series using GPU adapted BFAST Monitor algorithm

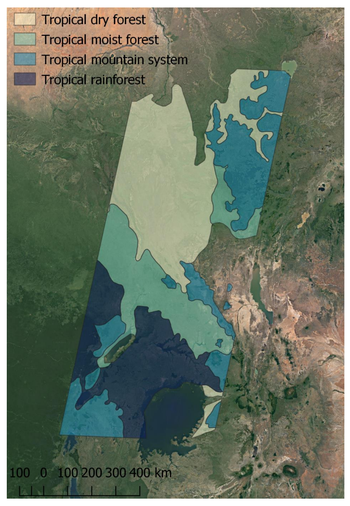
Algorithm parametrization using artificial intelligence decision making to account for large-scale variation

Most studies on forest loss detection focus on specific study areas, concentrating on developing the methodology of the algorithms and less on their applicability at large scale. It is anticipated that the spatial heterogeneity of large-scale time-series analysis will yield issues when predicting forest loss. Our aim is to replace the selection of algorithm parametrization based on expert knowledge with artificial intelligence decision making to account for inherent large-scale variation of forest type, data availability, and deforestation drivers.

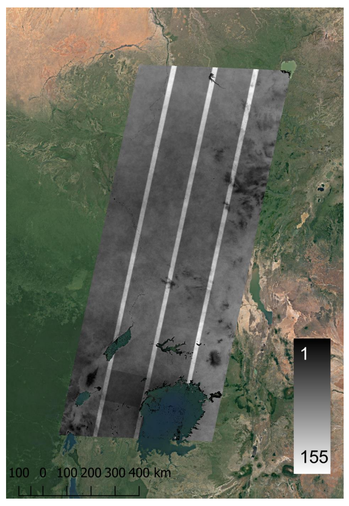
Research Question

How can artificial intelligence improve time-series analysis algorithm parametrization to account for large-scale inherit variation?

Area of interest (East Africa)



Forest types



Cloud free observations (2000-2017)

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