Detecting change in Landsat time series with BFAST in the eastern Hindu Kush region

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Environmental change is a trigger of land use change and possibly for migration in the eastern Hindu Kush mountains. Vegetation along the river valleys has undergone alterations by the impact of geomorphological processes and flood dynamics, but little research has been carried out to detect and map these changes. This study aims to close research gaps by detecting change within Landsat time series for the eastern Hindu Kush region.

The study area is approximately 25000 km² large and located in the highlands of northern Pakistan and eastern Afghanistan. It is part of upper Indus basin and is prone to natural hazards such as floods, glacial lake outbursts and landslides.

The opening of the United States Geological Survey (USGS) Landsat data archive in 2008 led to the development of several satellite image-based time series methods for change detection. Among them, Breaks For Additive Seasonal and Trend (BFAST) was developed in 2010 to detect changes in both trend and seasonal components of the time series. The BFAST tool iteratively decomposes the time series into trend, seasonal and remainder components. The changes in the trend component denote abrupt and gradual changes while changes in seasonal component represent phenological changes.

In this study we use Landsat data in time series analysis to detect change by using BFAST. All available Surface reflectance derived data is accessed from the Landsat data archive of USGS (World Reference System-2, Path 151 and Row 35) for the years 1988 to 2019. Data is acquired from the corresponding scenes of Landsat 4-5 Thematic Mapper (TM), Landsat 7 Enhanced Thematic Mapper Plus (ETM+) and Landsat 8 Operational Land Imager (OLI). It is processed to Landsat Level-2 Surface Reflectance Product by USGS and therefore has already undergone geo-referencing, atmospheric correction and detection of clouds and shadow. Data have spatial and temporal resolutions of 30 m and 16 days respectively.

The BFAST approach was first tested on locations with a known history of change (e.g. floods) and then scaled up to the whole study area. The magnitude and timing of the change was detected and mapped for the study area. We expect that the findings of the research will benefit future local and regional risk studies.