EGU22-9840
https://doi.org/10.5194/egusphere-egu22-9840
EGU General Assembly 2022

Detecting regreening effects of land restoration in semi-arid Africa using a spatial-context approach in Google Earth Engine

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Drylands in Africa, consisting of arid, semi-arid and dry sub-humid areas, are particularly vulnerable to land degradation, due to large climate variability and water scarcity, and land degradation is still largely present in these areas. On top of that, the number of people living in the drylands is expected to increase rapidly, especially in Sub-Saharan Africa, which further increases the number of people subject to land degradation in the future. On the bright side, land degradation in dryland Africa as well as in other parts of the world has not gone unnoticed and several restoration initivatives have emerged to reduce, reverse and prevent further degradation through practices such as reforestation, natural regeneration or agroforestry. Through these practices they aim to improve soil quality, contribute to carbon sequestration, improve the local climate and therefore the overall livelihood of the local people.

In line with this development, the number of land restoration projects has increased rapidly over the past years. However, only a small part of the organisations monitor the trees after planting. On top of that, the organisations that do monitor the projects, often report small survival rates of the plants. In combination with the fact that a complete and open database of land restoration projects does, to our knowledge, not exist, there is a large lack of information on the amount, and effectiveness, of regreening after the implementation of these projects. This negatively affects much needed reflection on the effectiveness of land restoration projects.

Remote sensing can be a practical alternative to detect greening due to land restoration, as vegetation indices like the NDVI are able to detect changes in vegetation greenness over large areas and long time series. Vegetation greenness does, however, not only change through land management, but also through processes such as CO_2 fertilisation, nitrogen deposition, climate change and feedbacks between those, which makes it challenging to directly measure the greening effects of land restoration projects. The aim of this study is to detect regreening trends in semi-arid environments in Africa using remote sensing while correcting for natural climate variability.

To this end, an analysis is performed in Google Earth engine, where MODIS NDVI 16-day time series are pixel-wise compared to a time series created by averaging the neighbourhood of the respective pixel. Because climate induced changes in NDVI are expected to act on a larger scale than changes in land management, subtracting the neighbourhood NDVI from the pixel NDVI corrects the time series for climate induced changes. Next, a BFAST algorithm is applied to the corrected time series to detect breakpoints and trends in NDVI. This method then allows for the detection of small scale greening hotspots across semi-arid Africa. In addition, the method is applied to several case study restoration projects in semi-arid Africa to illustrate the method on smaller scales.

Preliminary results show that small scale regreening hotspots, i.e. increases in NDVI compared to the surrounding area, are more prominent in semi-arid environments than in humid and hyper-arid environments in Africa.