Enhancing drought resilience through forest restoration

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Background

Climate change is expected to increase the frequency and severity of droughts across Africa. Agriculture in Africa is highly vulnerable to droughts because it is predominantly rainfed. Forest restoration is increasingly being promoted as a nature-based solution to reduce drought risks.

Objective

In this project, we aim to develop a data-driven model to assess the effectiveness of forest restoration in reducing drought risk. With our model, we seek to provide quantitative insights on where, how much and when forest restoration can offset climate-change induced drought.

Model development

A neural network model paying particular attention to teleconnection effects was developed based on convolutional long-short term memory. The model which we call, ***DeepRainForest***, simulates daily rainfall across Africa as a function of fractional tree cover and non-tree vegetation cover, LAI, surface albedo, wind speed and direction, air pressure, sea surface temperature and solar radiation.

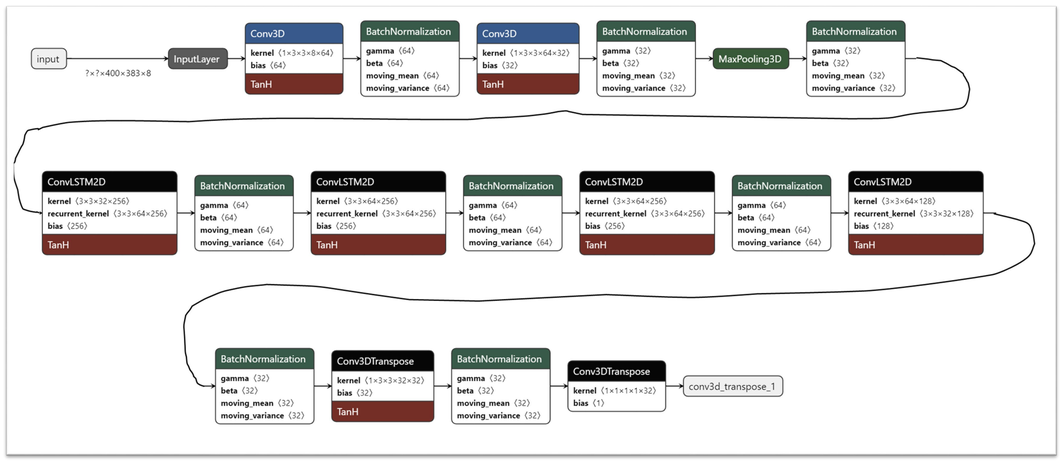

Figure 1. DeepRainForest neural network architecture.

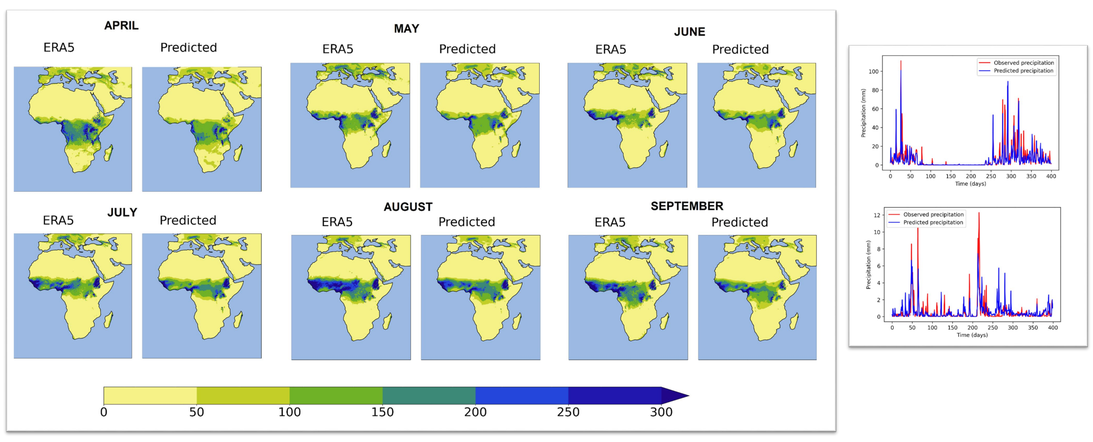

Figure 2. Comparing ERA5 average monthly rainfall for 2015 – 2019 period with DeepRainForest model output over the same period. Data from 2015 – 2019 period was independent test data (left panel). Comparing temporal rainfall pattern for two selected grid cells in 2015 (right panel).

Scenario analysis

The scenario analysis will comprise the following steps

- Analysis of changes in rainfall under SSP5-8.5 for the period 2081 – 2100 relative to rainfall climatology in 2001 -2020
- Analysis of changes in rainfall due to forest restoration relative to the modelled rainfall climatology in 2001 – 2020. For this, the target is to restore, where possible, to tree cover levels of 1982 (earliest possible date for which tree cover data is available). Constraints in terms of current agricultural land and urban land are taken into consideration.

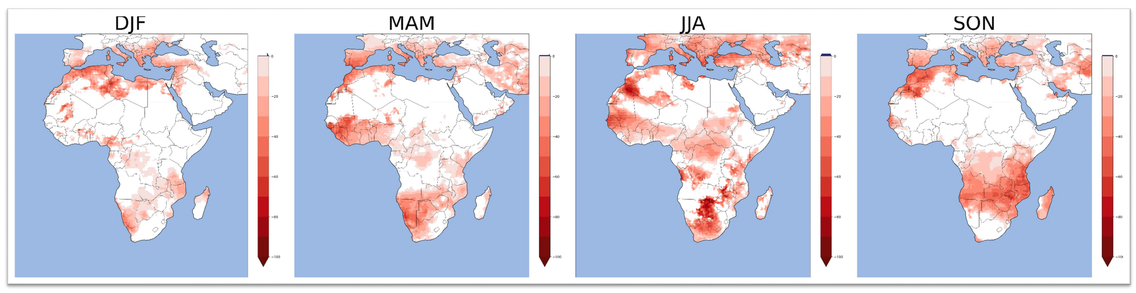

Figure 3. Relative rainfall reductions (%) as a result of climate change. The map has been masked to show only areas expected to experience rainfall reductions under SSP5-8.5 scenario (2081 – 2100) relative to the period 2001 – 2020.

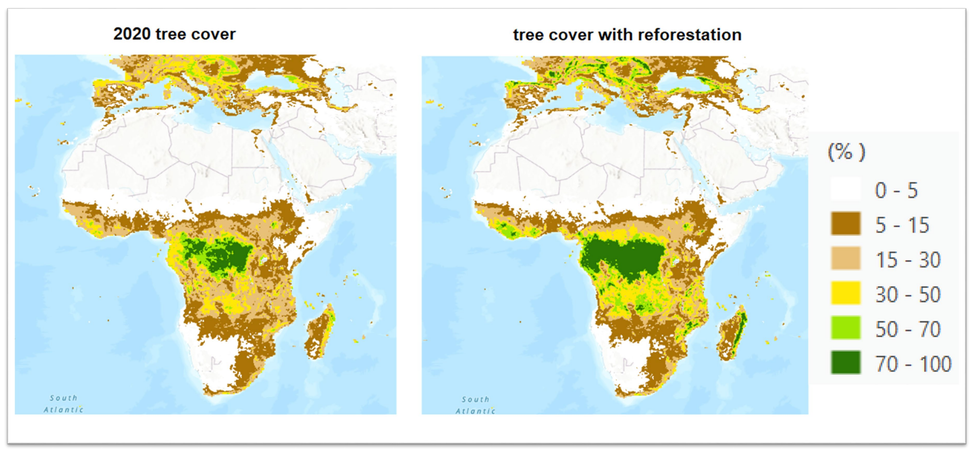

Figure 4. Comparing tree cover levels in 2020 with tree cover under restoration. Restoration takes into consideration constraints for agriculture and urban areas and the target is to restore, where possible, to 1982 tree cover level.

Next step

Simulate rainfall response of forest restoration as specified in Figure 4 using the validated DeepRainForest model.

Acknowledgements

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