GREENING THE SAHARAN DESERT

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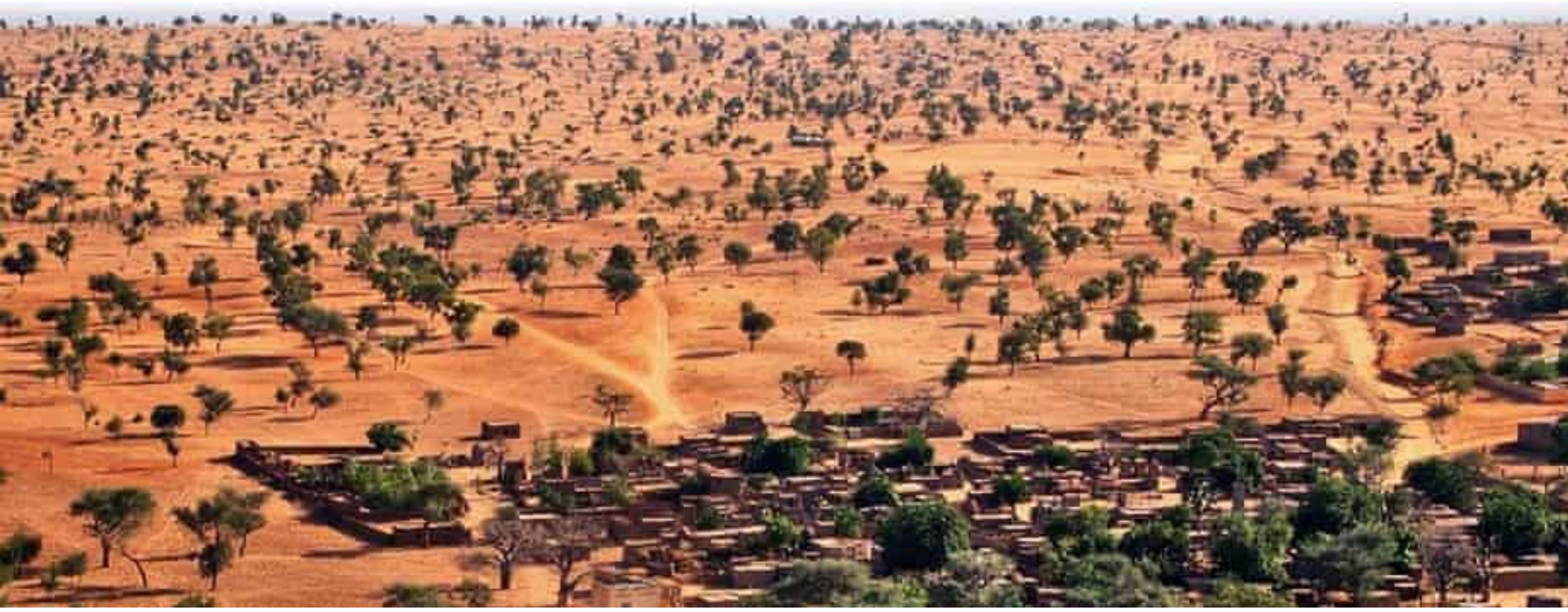

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BACKGROUND

Everybody knows by now that the Saharan Desert has to deal with the phenomenon of desertification, a form of land degradation in which the desert expands, and infertile land is created. It is essential to look at ways to minimize or even combat this problem. Preferably as natural as possible. A great example of a project already (partly) executed and reviewed by professionals is the Great Green Wall.[1] The idea is to plant trees along the edges of the Saharan Desert, which will bring back life to a poor landscape. And it is already succeeding! That means that we can continue with this great idea and expand it to other parts of the desert.

RESEARCH QUESTIONS

The main question this project investigates is: "Which parts of the Sahara Desert region are most promising for regreening projects?".

A sub question is: "Which plant is most suitable to survive in (extreme) desert circumstances?". Once this question is answered, it can be used to find an answer to the main question.

APPROACH & EXPERIMENTS

To find an answer to this question, a GIS spatial analysis was performed. This usually contains 4 steps: data collection, data storage & manipulation, analysis, and visualization. For clarity, these will also be the steps in this report.

1. Data collection

The first step is to find the correct spatial data. Preferably specifically about the area of interest, but if this is not available global data in the correct resolution will suffice. In the scope of this project, the following data was collected:

- Elevation data at a global scale and with a spatial resolution of 2.5 arcminutes, from WorldClim.[2]
- Data about bioclimatic variables at a global scale and with a spatial resolution of 2.5 arcminutes, from WorlClim.[3]
    - Not all variables will be used, as not everything is relevant. Used are: BIO5 (maximum temperature of warmest month) & BIO6 (minimum temperature of coldest month), BIO12 (annual precipitation).
- Landcover data at a global scale with a spatial resolution of 100m, from Copernicus.[4]
- Other climatic variables at a global scale and with a spatial resolution of 2.5 arcminutes, from Envirem.[5]

Not all datasets have been used as the landcover data was not useful due to lacking metadata and the other climatic variables were a bit out of scope for this research. However, some other data is still needed for the analysis. There should also be information on the plant species for the analysis to make sense, for example the type of plant species and the environmental characteristics most preferable to the survival of this species.

Figure 1: Desert Ironwood

The tree species used for this project is: *Olneya tesota*, also known as Desert Ironwood.[7] The characteristics of this plant species important to this project[8 & 9] are:

- Elevation: Desert Ironwood only occurs on heights up to **900m**.
- Temperature: the tree can resist temperatures between **-6°C** and **45°C**.
- Precipitation: annual rainfall should be between **75mm** and **400mm**.
- Sunlight: the tree loves semi shade or no shade. Therefore, slope directions of **East till West** are best.

It should, however, be kept in mind that this is not the only possible plant species that could qualify for this analysis. Moreover, this plant species could even not at all be suitable since it is not a native species to this area but only occurs in a desert like area in the USA. More research should be performed in order to make this analysis realistic.

2. Data storage & manipulation

The next step is to check and change the data if needed. In this case, the coordinate system had to be changed to *GCS_WGS_1984* for a few datasets. No georeferencing was needed. In the case of metadata, it was hard to find good landcover data containing a nice description of the classes as well, which makes it difficult to use this dataset. Other datasets appear to be very clear.

3. Analysis

In this step the key goal is to convert the collected (& corrected) data into usable output data to show the results of the project. To do so, a lot of ArcGIS tools had to be used. Here's an overview of the steps in the analysis:

GENERAL: First a Study Area should be defined. A new shapefile was created using ArcCatalog, in which a rectangular shape around the area of interest was drawn using ArcMap. Since all relevant data covers the entire globe, the CLIP tool was used to specify the layer to the Study Area. This is also to prevent the ArcMap file from getting too big and to make it easier to apply tools.

PRECIPITATION: the data from the BIO12-layer has been clipped to the scope of the study area, so now the Reclassify tool is used to define 3 classes: too little (0-75mm), good (75-400mm) and too much (400mm+) precipitation.

ELEVATION: the data from the Elevation layer has been clipped to the scope of the study area, so now the Reclassify tool is used to define 2 classes: good (0-900m) and too high (900m+). Besides, the Hillshade tool is used to make a base layer for all maps showing the elevation.

TEMPERATURE: the data from the BIO5 and BIO6 layers has been clipped to the scope of the study area, so now the Reclassify tool is used for both layers separately. The maximum temperature (BIO5) is divided into 2 classes: good (0-45°C) and too hot (45°C+). The minimum temperature (BIO6) is divided into 2 classes as well: too cold (-6°C and lower) and good (-6°C+).

SUNLIGHT: the data from the clipped elevation layer is used to create an overview of the slope directions in the area using the Aspect tool. Then, the Reclassify tool is used to define 3 classes: too much north (0-67,5 degrees & 292,5-360 degrees) and good (East to West).

Now that every environmental aspect has been reclassified into useful categories, the layers can be combined. To do so, a model is built in Model Builder using Weighted Overlay, Con and Majority Filter. A map containing the most suitable areas to plant Desert Ironwood trees is the result.

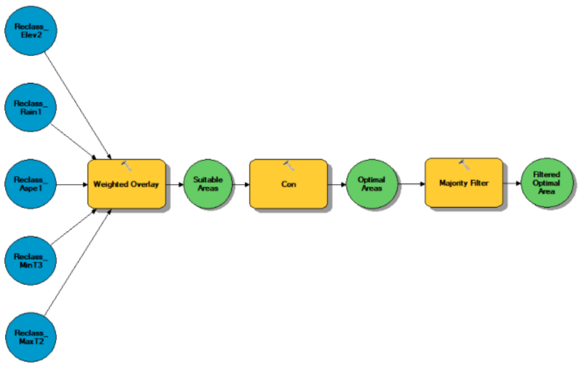
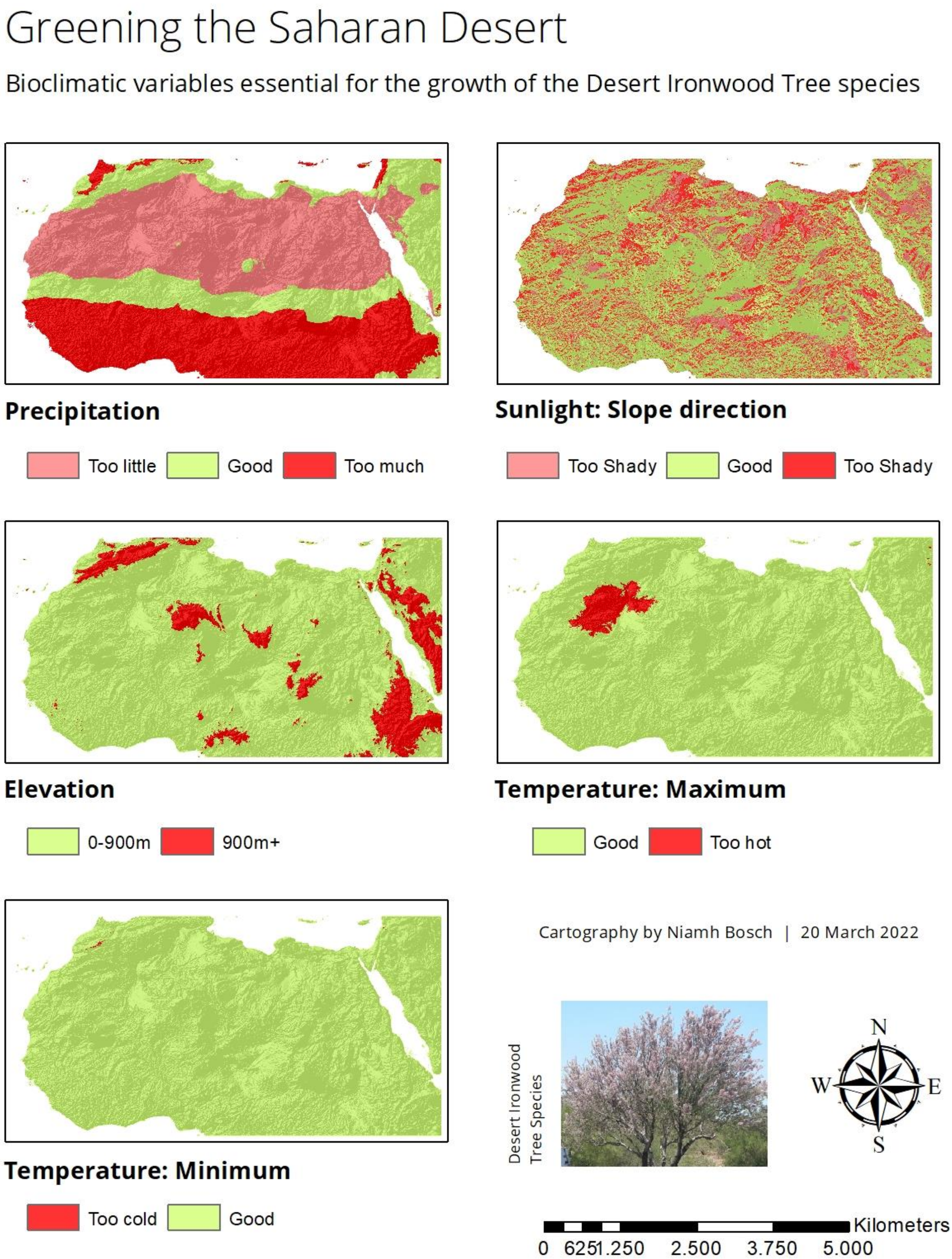


Figure 2: The Suitable Area Finder Model

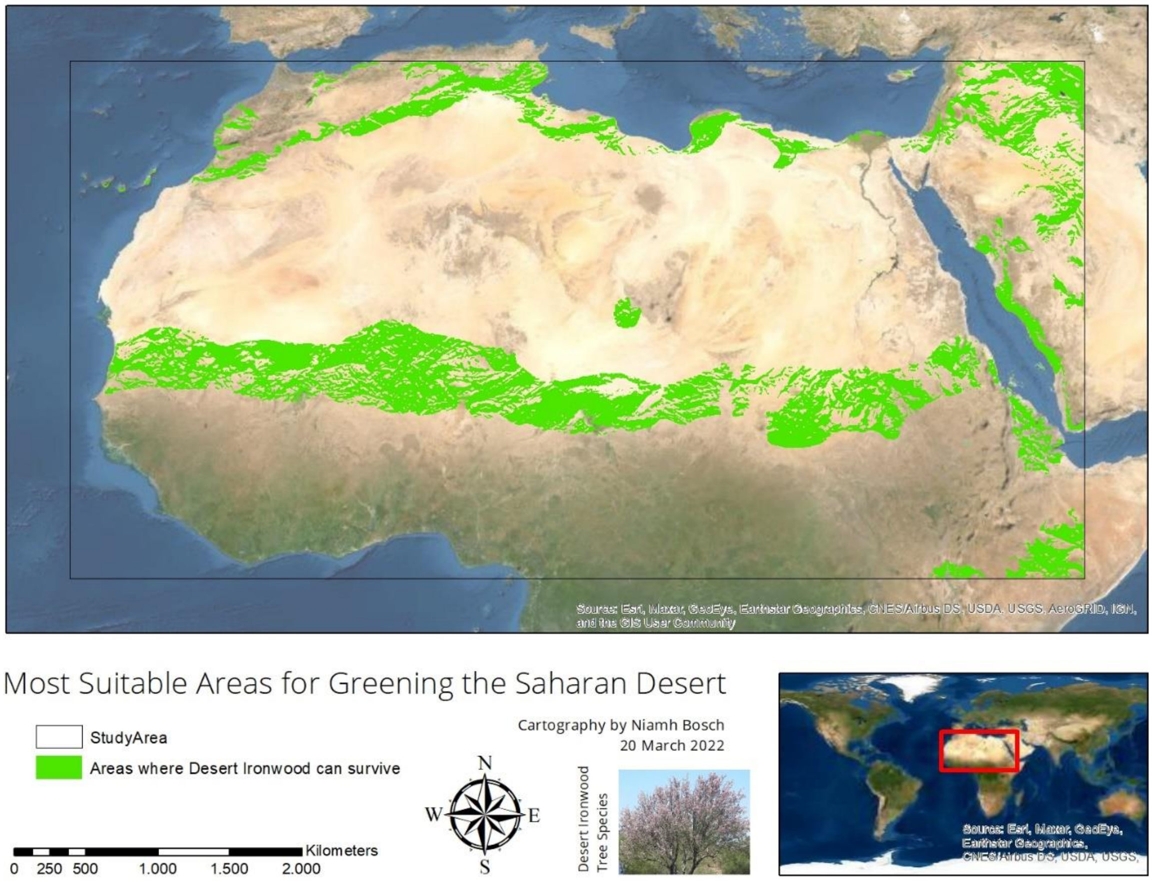
4. Visualization

The model is based on the reclassified environmental properties listed above. These produced the following maps:



RESULTS & CONCLUSION

The result of the analysis is a map showing the most suitable areas where one can start to plant Desert Ironwood trees based on 4 characteristics: temperature, sunlight, elevation and precipitation.



It can thus be concluded that there are still possibilities for greening the Saharan Desert. Planting the Desert Ironwood tree species in the green areas in the map above could provide a starting position for this.

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