Identification of Suitable Tea Growing Areas in Malawi under Climate Change Scenarios

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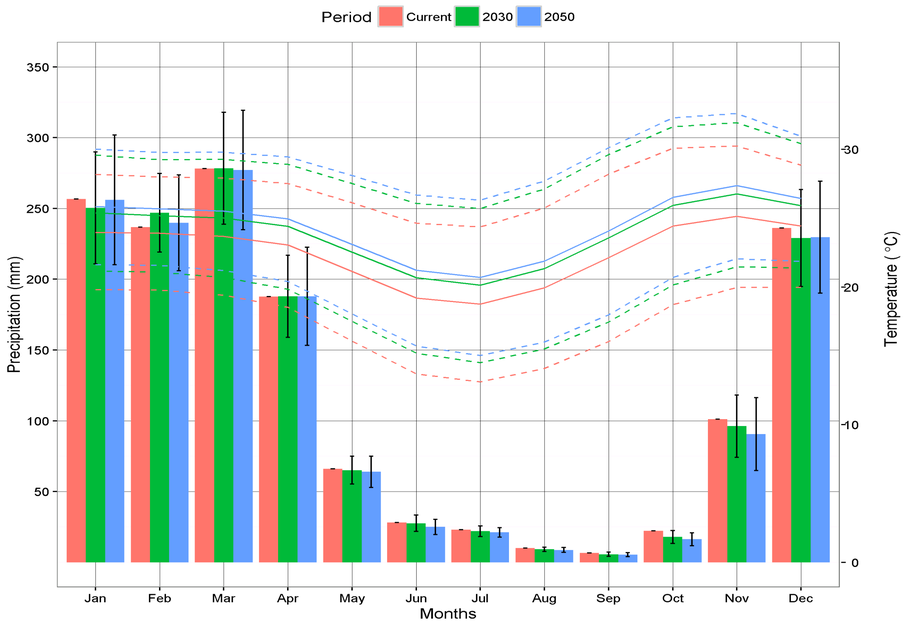
1. Tea in Malawi

- Malawi is one of the most vulnerable countries of the world to climate change since **climate hazards strongly weaken the food security** of the country with a society still facing **extreme poverty** (Asfaw et al., 2014).
- The agricultural sector is of great importance to the economy, and highly vulnerable to these climatic changes, especially due to the precipitation heterogeneity.
- In Malawi (see graph below), the winter period (starting from May) is characterized by low temperatures (lines) and low precipitation rates (bars). The temperature rises in September, while the precipitation rates increment. For the future (2030 and 2050), an increment of two to three degrees is predicted, as well as a slight precipitation decrement.


Photo credit: Neil Palmer, 2010



2. Methodology

Data:

- 33 bioclimatic variables (Wordclim), and projected data based on the Representative Concentration Pathway (RCP) 6.0 of the fifth report of the Intergovernmental Panel on Climate Change (IPCC).
- 123 GPS data points of the tea distribution in the tea growing districts of Malawi.

Random Forest:

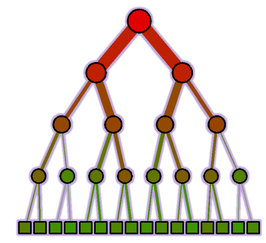
Random Forest is an **ensemble learning method** which is used for image classification. In this technique different **decision trees** (models) are considered for calculating a response (Breiman, 2001).

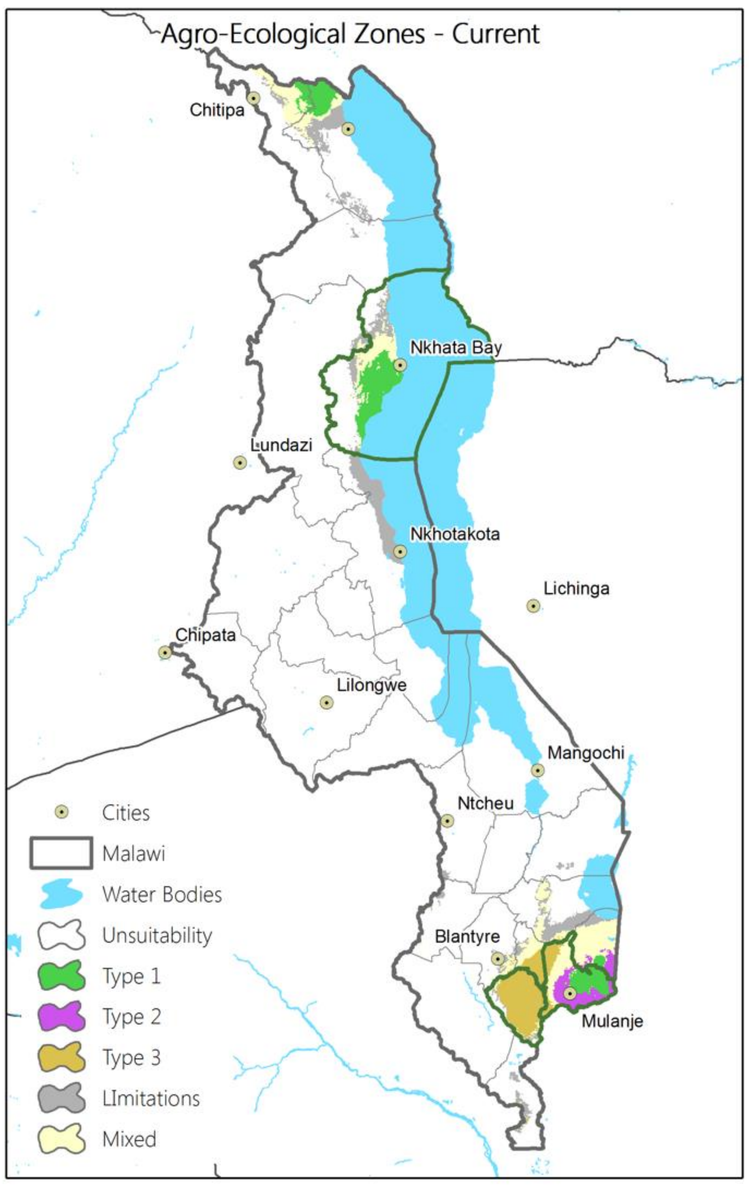
The modelling technique was trained to calculate suitable tea production areas in Malawi for the:

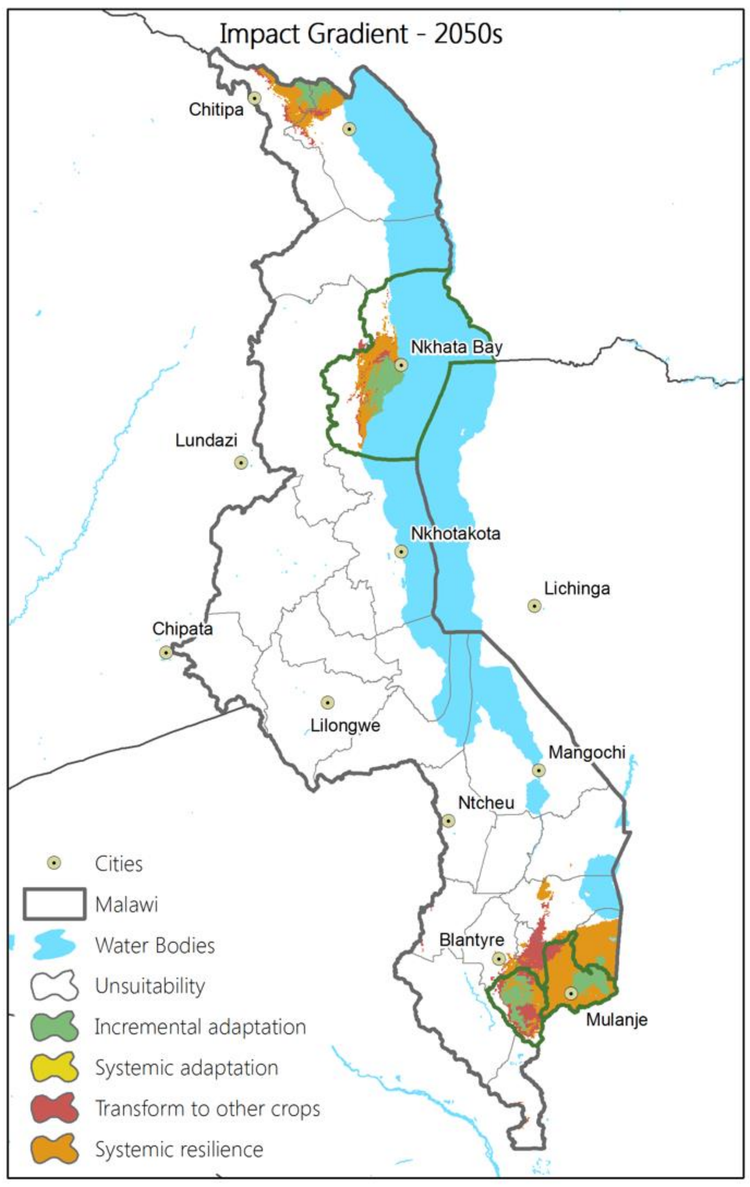
- Present situation;
- Future scenarios of the periods 2020 to 2049 (referred to as 2030) and 2040 to 2069 (referred to as 2050).

Validation:

- The climate change impact model derived from machine learning was validated together with local experts
- Additionally the current distribution was validated using the multiclass area under receiver operating characteristic curve







3. Results

- Occurrences locations of tea in Malawi were clustered into three ecological zones of production
  - Type 1 (green) covered both highlands and lowland lake shores
  - Type 2 (violet) covered the Mulanje district
  - Type 3(sand) covered the Thyolo region
  - Mixed are areas of uncertainty
  - „Limitations“ areas are likely not suitable
- Differences between current and most likely future distribution resulted in a gradient of impacts:
  - **Cope** refers to suitable tea production areas which are not affected by any climatic differences.
  - **Adjustment** sites are suitable tea areas but switch from one climatic zone to another in the future.
  - At **transformation** sites the climate at present condition is classified as suitable but in the future the climate shifts and effects the area to not being suitable for the tea production anymore.
  - **Opportunity** sites are not classified as suitable in the present situation, but due to climatic changes it is predicted that in future scenarios these areas will be suitable.
- A great share of the area falls into the category Cope which means that a fair quantity of area remains suitable and 2050. In the districts in the South (Mulanje and Thyolo) an increase of the category Transform is projected by 2050 which means a loss of suitable area for the tea production.
- Precipitation projections for the regions are highly uncertain so that negative impact of climate change appear inevitable.

4. Conclusions

- Climate change is predicted to have a strong impact on Malawi
- Only the district **Mulanje seems to cope** with the climate change in a rather stable way. The districts Thyolo and Nkhata Bay are estimated to reduce its suitability regarding the tea production, while Mulanje isn’t as much effected.
- The **Random Forest model may be a useful technique** in order to measure the climate change impacts
- **Climate smart practices** such as the use of different tea varieties which adapt to the local climate changes should be implemented

Acknowledgements

This research was supported by UTZ as a donor together with its Sector Partnership for strengthening the capacity of farmers. In particular, we thank Henderson Maposa (UTZ) and Lisa Ryser (UTZ) who provided expertise that greatly assisted the research.

Literature

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