Project No: 329935
Project Acronym: CLIMADYST-RainFor
Project Full Name: INFLUENCE OF CLIMATE VARIABILITY ON THE DYNAMICS AND STRUCTURE OF OLD-GROWTH TEMPERATE RAINFORESTS
Final report

1. PUBLISHABLE SUMMARY (2 pages max)

A summary description of the project objectives

The CLIMADYST-RainFor project aims at the identification of the a broader range of climatic drivers that influence temperate rainforest development. Although, temperate rainforests would seem more resilient to climate changes because of their wet and cool climates, drought and other climatic factors have been a historical driver of forest structure in these areas. In a context of abrupt climate changes, we proposed research towards understanding how these rainforests will respond to future global changes. For this we focused on the Colchic forest in the Lesser Caucasus of northeastern Turkey and the Republic of Georgia. These forests receive up to 4000 $mm \cdot y^{-1}$ of precipitation due to the effect of the Black sea and the surrounding orography. Even in these wet forests, trees may still be sensitive to drought. Long periods of drought might be stronger drivers for compositional and structural changes than shorter and more intense ones. Our knowledge on how wet forest ecosystems respond to climate is limited to the range of climate conditions observed during the last 100-150 years, conditions which might be unique compared to those experienced in the past. Using dendrochronology, we will identify the relationship between disturbance and climate over centuries by investigating differential climate response of trees and long lasting effects of past climate events in forest structure and composition. These empirical results will complement a forest succession modelling approach to examine possible ecological effects under global change. Understanding the past will contribute useful lessons on the response of these communities to a changing environment.

A description of the work performed since the beginning of the project.

During the period of the project we have carried out three field campaigns of different duration. Part of this fieldwork was used to identify locations with high abundance of old trees (>350 years) that could be sensitive to climate and collect dendrochronological samples with which to reconstruct precipitation and temperature variability. In addition, we locate patches of old-growth forest in the Lesser Caucasus and set up a network of research 30m-radius plots. In these plots, we inventoried all standing and dead trees and collected dendrochronological samples to reconstruct centuries of stand dynamics and disturbances. With the samples collected, we have developed the most extensive dendrochronological and ecological network to date in these forests. We have developed over 15 new tree-ring width chronologies from 7 different species and at different elevations (50m-2400m asl).

Our main research strategy was comparing tree-ring reconstructed dynamics with model simulations to calibrate and constrain a dynamic forest development model. Before approaching this aim in the Colchic forest where more data is necessary for calibrating the model parameters, we used it in the temperate broadleaf dominated forests of Eastern North America where more data is available for model parametrization and where a similar network of ecological and dendrochronological plots was started some years before.

A description of the main results achieved so far

Using these new chronologies we have investigated the climatic responses of different tree species and at several locations within the landscape. In general, species showed different responses to precipitation and temperature that allowed to identify specific climatic requirements. In some cases, however, trees of the same species displayed different responses to climate depending on site characteristics such as slope, elevation, or

aspect. These responses to climate also highlighted the strong influence of the Black Sea as a source of moisture for the region. Our improved understanding of what climatic factors is being used in combination with projections of future climate change to explore possible future trajectories of these forests. This diversity of responses have also allowed us to reconstruct precipitation and temperature for the last several centuries.

Our first objective was to reconstruct climate back in time to scales more relevant for forest development and conservation, in the order of centuries, than the climate data currently available which mostly for the last 60-70 years. With part of our tree-ring width chronologies we have developed the first precipitation reconstruction for the Caucasus region back to the 1750s (**Figure 1**). In this study, drought showed enhanced variability prior to the instrumental period (20th century). We also identified several of the atmospheric circulation patterns that affect the region (i.e. North Atlantic Circulation, East Atlantic-Western Russia Pattern).

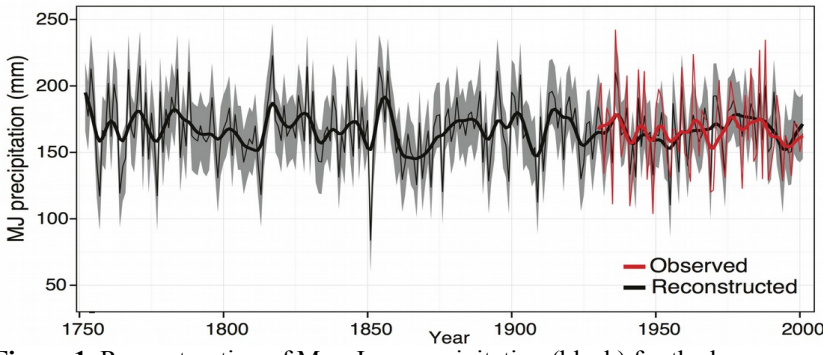

Figure 1. Reconstruction of May-June precipitation (black) for the lesser Caucasus region shows larger variability before instrumental observations (red) (Martin-Benito et al 2016).

Expected final results and their potential impact and use (including the socio-economic impact and the wider societal implications of the project so far).

- The first multi-century reconstructions of precipitation (published) and temperature (in preparation) for the Caucus region. These results will contribute to a better understanding of past climatic variability. In a region in great part depending on rain-fed agriculture and rapidly developing hydropower, understanding the broader climatic variability can be crucial to improve water resource management. In addition, these data is being used to estimate the influence of past and future climates on forest development.
- Identification and location of old growth forests: during this project we have located several areas of old-growth forest, dominated by trees over 350 years of age, and in good state of conservation. In collaboration with local and regional authorities and research collaborators these activities will continue and we expect that this will contribute towards the valorization and conservation of these forests.
- Disturbance and biomass reconstructions from our plot network will establish and benchmark for what natural dynamics are in these forests. This will aid in the sustainable management of forest resources towards multiple ecosystems services. In addition, our network of plots allows investigating whether forest dynamics are coherent at the regional scale and elucidate the timing of canopy disturbance at multiple-scales
- The parameterization of an existing dynamic vegetation model will contribute towards developing tools to analyze the impacts of global change on forest biomass and composition. These tools will improve our understanding of how ecosystem services and biodiversity might change across the region.