Impacts of Climate Change on Terrestrial Ecosystem Functioning – An Overview

CLiMA!TE - background
The concentration of CO₂ in the atmosphere is increasing, global temperatures are increasing, and local precipitation patterns are changing with increases in the intensity of rain events and drought periods. This is expected to affect the structure and functioning of terrestrial ecosystems (IPCC, 2013) with major impacts on natural environments as well as ecosystems used for agriculture or forestry. Over the past three decades, major efforts have been devoted to understanding and predicting such impacts of climate change on ecosystem processes and functioning in order to understand the urgency of the changes as well as the possibilities for ecosystem adaptation or climate change mitigation. These efforts have included observations of past changes, monitoring of ongoing changes, observations across environmental gradients (space for time substitution), ecosystem manipulation experiments mimicking future climate changes, and dynamic ecosystem modelling (Beier, 2004; Rustad, 2008). Each of these approaches has its forces and drawbacks, but across all a general limitation is that observations and experiments have focused on onesingle climate factor. For example, observations across gradients can hardly combine simultaneous and ideal differences in two or even three climate factors at the same time to provide a multi-factor perspective. Ecosystem experiments, which could do it, often limits themselves to one factor for practical reasons or because of lack of resources, since inclusion of one extra factor doubles the number of experimental units and the demand for resources in a classic experimental design. Therefore, very few multi-factor climate change experiments exist. Instead the underlying assumption has been that if the individual responses are known based on single factor experiments, then dynamic ecosystem or global models can predict the responses of the combined factors. This approach may seem reasonable but is constrained by at least two problems, which CLiMA!TE specifically aimed to overcome: 1. When several factors act together, they may interact, and these interactions among the different climate change factors may not be linear and/or predictable. Computer models may predict some of these interactions relatively well (e.g. resource limitations due to increased growth), while other interactions may be unpredictable. 2. The assumption that the impact of the “climate change cocktail” may be predicted from an understanding of the individual factors may therefore be erroneous.

2. Even when models do predict the interactions, we still need multifactor experiments to train and test the models in order to know if the predictions are correct. Another inherent problem related to climate change and experimentation is the time scale. Climate change acts over decades, meaning that climate change experiments running for 2-4 years only highlight short term and transient effects on the ecosystems, while lacking the ability to inform about long term and more stable effects. The "long term" perspective of climate change was therefore another important rationale for the CLiMA!TE experiment. The "long term" perspective of climate change calls for long term experiments, which for decades has been argued from the scientific community, was therefore another important rationale for the CLiMA!TE experiment. The VILLUM FOUNDATION provided a very rare opportunity to pursue this in reality. In summary, the CLiMA!TE experiment was driven by two major rationales: 1) a need for realistic experiments involving combinations of the main climate change drivers and 2) the long term perspective of climate change.

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