Current research project related to cloud forest vegetation

Taxonomic and functional diversity and geographical distribution of the Subtropical Montane Cloud Forest in Taiwan: A multiscale approach

Ministry of Science and Technology, 109-2621-B-002-002-MY3; duration: 2020/08/01-2023/07/31

Mountain cloud forests worldwide belong to one of the most peculiar and at the same time one of the most endangered forest ecosystems. Frequent fog causes high air humidity and horizontal precipitations, which in turn also decrease air temperature, solar radiation and decomposition rate, resulting in a combination of the humid, dark and nutrient-limited environmental conditions. In Taiwan, around 48,000 ha of Subtropical Montane Cloud Forest (SMCF) still occurs in elevations between 1500–2500 m a.s.l. The main threat to cloud forests worldwide and also in Taiwan are land-use changes, mainly converting the forest into agricultural land or into forestry plantations, and anthropogenic climate change, which is likely to result in vertical uplift of the cloud base, directly affecting the habitats of cloud forests in lower elevations by drought. Since cloud forests provide important ecosystem services (e.g. availability of drinkable water for downstream regions), detailed understanding of the relationship between vegetation and environment is necessary for designing effective conservation and management strategies to protect their habitats.

In this project, we aim to study the SMCF in Taiwan, using a multiscale approach. We will focus on three distinct scale levels (in the sense of extent): fine-scale, regional scale and broad-scale of the

whole Taiwan. Fine-scale studies will include establishing and resurveying a small (1-ha) forest dynamics plots, with a focus on exploring the spatial, compositional and age structure of selected cloud forest stands. The study at the regional scale will focus on the effect of cloud on the taxonomic and functional composition of forest vegetation while minimizing the effect of other confounding environmental factors. For this, we will sample vegetation plots along “horizontal transect”, located along the east-west gradient of decreasing cloud frequency and intensity, with individual localities at similar elevations. The study at the broad, whole-Taiwan scale, will focus on explaining vertical distribution pattern of lower and upper cloud forest in the context of Massenerhebung effect, and also describing the diversity pattern of forest vegetation along elevation. Massenerhebung effect combines together the effect of landmass heating (increasing the elevation of vegetation types against expectation in the central parts of the mountain ranges) with the effect of cloud and wind (decreasing the elevation in the marginal parts of mountain ranges and at isolated mountains); understanding relative importance of these effects will be useful for forecasting the upslope shift of the cloud forest under future climate scenarios.

Our goal is to understand in more detail the fine-scale dynamics of cloud forest vegetation and compare the importance of individual fine-scale and broad-scale environmental factors on the diversity, composition and distribution of cloud forest in Taiwan. Since cloud forest ecosystems are under threat from ongoing climate change and land-use changes, this information is necessary for predicting its response to climate change and changes in its diversity, species composition and spatial distribution in the future.

Past research projects

Changes in species- and community-level properties of forest vegetation along cloud and chronic-wind gradients in Taiwan

Ministry of Science and Technology, 106-2621-B-002-003-MY3; duration: 2017/08/01-2020/07/31

Taiwan as a subtropical island exposed to East-Asian monsoon system offers a unique opportunity to study vegetation along two peculiar stress gradients, cloud frequency and chronic-wind intensity. Frequent cloud or persistent strong winds have remarkable ecological effects on vegetation and require specific species adaptations. Cloud and monsoon forests thus represent unique vegetation types, hosting a number of endemic and relict species. In the near future, ongoing climate change is expected to modify both cloud frequency and chronic-wind intensity. To understand the impact of these changes on future diversity and species composition of cloud and monsoon forests and the ecological mechanisms behind has therefore not only high theoretical values, but also practical importance in conservation.

In this project, we will use patterns of forest vegetation along the gradient of cloud frequency and chronic-wind intensity in Taiwan as a model system to study mechanisms how species from species pool assemble to a local community. Apart from taxonomical approach (species census), we will also focus on plant functional traits, since these allow more mechanical and general explanation of environmental filtering. Four aims will be conducted on our model system:

1. to analyse species- and community-level changes in leaf and wood functional trait properties along cloud and wind gradients,
2. to analyse the pattern of taxonomic and functional diversity,
3. to compile Ellenberg-like species indicator values along gradients of cloud frequency and chronic-wind intensity, and
4. to identify cloud and wind specialists and their functional trait properties.

Additionally, we will invest considerable energy to sample the environment factors together with long-term microclimate monitoring, since detail knowledge of actual soil and microclimatic conditions are the keys to understanding how vegetation response to them.

Studies focused on cloud and wind gradients are rather rare, especially from subtropical regions, and many ecological questions remain unresolved. We believe that our project, applying modern methods from the toolbox of vegetation ecologists, can answer at least some of them. Such findings, apart from the general importance for theoretical ecology, have also a good potential for application in conservation, management and restoration of these habitats, which are threatened by land-use and climate changes.

Community assembly along stress gradients: effect of cloud frequency and chronic-wind intensity on forest vegetation in Taiwan

Ministry of Science and Technology, 105-2621-B-002-004; duration: 2016/09/01-2017/07/31

This project focuses on changes in species and functional composition of forest vegetation along two strong environmental stress gradients, namely gradient of cloud frequency and chronic-wind intensity, to better understand underlying processes of community assembly. Peculiar stress effects of elevated cloud and chronic-wind intensity on vegetation are far less studied and understood compared to other factors like productivity, temperature, precipitation or soil properties, offering potential for new and interesting findings. Taiwan, as a subtropical island exposed to frequent cloud formations from the sea and nearly constant winds related to East-Asian monsoon system, offers a unique opportunity to study forest vegetation along both stress gradients.

To study different aspects of changes in species composition along the cloud frequency and the chronic-wind intensity gradients, we will employ a wide range of methods which are part of the modern toolbox of vegetation ecologists, at both the whole-community and individual-species level. At the whole-community level, we will focus on describing patterns of taxonomic and functional alpha, beta and gamma diversity. We will also deconstruct the species composition into the level of individual species and examine the degree of their habitat specialisation and ecological preferences, which will allow us to link ecological behaviour of individual species with their functional trait properties.

An important part of the project is extensive field campaign focused on collecting vegetation and trait data along the studied gradients. Vegetation sampling will focus on all vegetation layers accessible from ground together with a thorough record of local environmental conditions, including detailed soil sample analysis. Part of the sampling strategy is also the establishment of a set of small-scale permanent plots equipped with sensors for microclimatic measurements. These plots will serve as a long-term reference localities for future re-sampling with potential for further and more detail investigations and monitoring. Additionally, we will use data from other sources, including data which

we have collected within previous projects in Taiwan, vegetation plots from National Vegetation Database of Taiwan, publicly available floristic data (e.g. www.gbif.org), and datasets (vegetation and trait) from Japan which we will gain from our co-operation with Japanese colleagues (namely Prof. Yasuhiro Kubota and his team).