Project Database of ICP Forests
PROJECT DESCRIPTION

PROJECT INFORMATION

Project title: ICP Forests-EuMIXFOR Interaction: Evaluation of soil and foliar nutrient status of mixed vs. pure stands in Europe as categorized by European Forest Types

Project ID: 75

Contact person: Andres Bravo Oviedo (bravo@inia.es)

PROJECT DESCRIPTION

The expected higher levels of resilience and resistance of mixed forests have raised the interest of researchers on mixed forests as a reflection of more complex demands from society (Bravo-Oviedo et al. 2014). There is a strong need to understand the underlying mechanisms that control the interactions between species. Species effect and their interaction on foliar nutrient concentrations (Rothe et al. 2003) as well as on soil properties (Augusto et al. 2002; Vesterdal et al. 2013) are examples of such interest.

Nutrient cycling in forests can be studied following two approaches: i) the competitive reduction vs. facilitation principles, reviewed by Rothe and Binkley (2001) and the production ecology equation, PEE, reviewed by Richards et al. (2010) which is defined as the product of resource supply, the proportion of resource supplied captured by trees and the resource-use efficiency.

Rothe and Binkley (2001) described how nutrient status is improved in mixtures if species exploits nutrients at different times/depths or if one species improved the growing conditions of another. The first mechanism is known as the competitive production principle whereas the second is known as the facilitative production principle (Vandermeer 1989). Mixture can enhance tree nutrition if species are limited by different nutrients or if increasing rates of nutrient recycling occurs.

The second approach analyzes the effect of mixtures if any part of the PEE is enhanced, e.g. higher N2 fixation in mixtures, differential fine root architecture or higher nitrogen use efficiency among others (Richards et al. 2010).

Those reviews show that the effects of mixing species still need to be documented because there is a lack of consistency about the improvement of foliar nutrient content across sites in mixtures. The higher nutrient supply in mixtures compared to monocultures is difficult to extrapolate and the so-called nitrogen compensation, where lower N concentrations in the forest floor are balanced by higher N concentrations in upper mineral horizons, does not always occur. Although N-fixing species play a key role on mixing effects there is no linear

relationship between N and N-fixing species proportion. In addition the irregular distribution of litter in mixed stands is another confounding factor when analyzing the mixture effect as well as antagonistic and additive effects on decomposition rates.

Recently, Jonard et al. (2014) evaluated the foliar nutrient content across Europe using data from ICP Forests Level II intensive plots. They found that species identity is an important factor explaining the declining nutrient content from 1992 to 2009. However the effect of species composition that may affect nutrient use and thus, foliar nutrient content is still unexplored.

The increasing interest in mixed forests has led to the creation of EuMIXFOR, an international network supported by COST Association (COST Action FP1206, www.mixedforests.eu) where scientists from 30 European countries and 7 non-European institutions are analyzing the effects of species mixture considering ecological, managerial and socio-economic aspects as compared to pure stands. Within this network, working group 1 aims to analyze the impacts of the different components of global change on mixed forests like stability, biodiversity and environmental services. Nutrient and soil condition could serve as indicators of the magnitude and direction of such changes. Working group 2 focuses on adaptive forest management of species mixtures.

Objectives and research questions

Under the previous premises the main objective of this proposal is to provide a reliable statistic of the relative proportion of single species vs. mixed tree stands in Europe, framed by European Forest Types categories (Barbati et al., 2014), and to analyze the impacts of mixtures on foliar nutrition and soil properties, taking advantage of the large ecological gradient covered by the ICP level I and BioSoil+ plots. More precisely, we would like to answer the following research questions:

1. What are the most widespread mixed forest stands in Europe?
2. What is the proportion of mixed forest stands across ecologically distinct group of forest communities, as categorized by the European Forest Types?
3. Is there any difference in foliar nutrient content in mixed vs. pure stands?
4. What is the impact of species mixture in current soil condition along an environmental gradient?
5. Is species mixture a significant factor affecting the temporal change in soil condition?

Material and Methods

The first step is to screen data to identify relevant mixtures sampled in Level I and BioSoil+ plots, and to select an appropriate subsample so as to avoid any confounding effects. Mixtures can be defined by species identity in two-species mixtures or by functional groups, for example Norway spruce – Beech; Scots pine – Beech; Mediterranean pines – oak; broadleaved – conifers, etc. This important step will need access to the general data base, and more specifically to the following parameters for ICP level I plot: plot coordinates (Latitude, Longitude), plot elevation, ecoregion, detailed tree inventory (individual tree-level information, allowing to calculate/derive all plot-level parameters), soil type and parent

material. In addition, to answer Q1-Q2, we request data on general plot characteristics (location, altitude, management, forest type and stand age) and selected structural tree level parameters (tree species, dbh) measured in the subset of BioSoil+ plots.

To accomplish for the other objectives we request data on soil solid phase, including forest floor, and foliar nutrient content on Level I and BioSoil+ databases to assess the status and changes of the following variables in mixed vs. pure stands

Foliar nutrients: N, P, S, K, Ca, Mg, dry mass of 100 leaves or 1000 needles

Forest floor: pH, C, N, C/N, P, K, Ca, Mg, dry matter

Solid soil phase: pH ($CaCl_2$), pH (H_2O), C, N, C/N, bulk density

The response variables for question 3 are concentrations and contents (concentrations multiplied by the corresponding dry mass of 100 leaves or 1000 needles) of macronutrients whereas for question 4 and 5 the response will be both concentrations and stocks of selected variables.

The statistical analysis selected is a linear mixed model where the forest type (mixed/pure) or species proportion, climate and soil type|parent material will act as fixed factors. Plot, inventory (for the temporal analysis) and country will be considered as random). An important asset to the methodological issue is the inclusion of the vertical spatial autocorrelation in the soil data analysis by defining a spatial covariance structure. The external evaluation will meet ICP requirements on data policy.

Expected outputs

1. Classification of mixed species forest types in Europe (Question 1 and 2)
2. Foliar nutrient status of mixed vs. pure stands in Europe (Question 3)
3. Current status and temporal change of soil properties in mixed vs. pure stands in Europe (Question 4 and 5)

References

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