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Potential and actual distribution of tree species – influences of varying data sets on climate envelopes derived

Steffen Taeger (1), Holm Seifert (1), Philipp Gloning (1), Ulrich Schäffler (2), Christian Kölling (3), Matthäus Schilcher (2), and Annette Menzel (1)

(1) Germany (gloning@wzw.tum.de)Fachgebiet für Ökoklimatologie, Technische Universität München, Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising, Germany, (2) Fachgebiet Geoinformationssysteme, Technische Universität München, Institut für Geodäsie, GIS und Landmanagement, Arcisstraße 21, 80290 München , (3) Landesanstalt für Wald und Forstwirtschaft, Hans-Carl-von-Carlowitz-Platz 1, 85354 Freising, Germany

In the context of climate change spatial patterns of species distribution are discussed and modeled in countless publications within the last years. Actual species distributions as well as potential ranges are the basis to demonstrate possible impacts of climate change. Climate envelopes are derived from distribution maps to predict climate change effects.
We present a comparison of actual and potential distribution information for major tree species across Europe, spruce (Picea abies (L.) H.Karst.), fir (Abies alba Mill.), pine (Pinus sylvestris L.), larch (Larix decidua Mill.), beech (Fagus sylvatica L.), and oak (Quercus robur L.). In total, we used two maps of actual distribution and three maps of potential distribution. The maps of Atlas Florae Europaea ("AFE-dataset") as well as the maps developed by R. Kölbe and G. Seufert ("ISPRA-dataset") show actual distributions of tree species, whereas the maps of Meusel, Bohn, and Euforgen exhibit potential natural vegetation. For comparison, the five European maps have been "resampled" to a 2 km grid and transformed to a uniform UTM coordinate system. As climate data we derived mean temperatures and precipitation from WorldClim (1950-2000).
In the first analysis step we compared the two maps of actual distribution areas and the three maps of potential areas among themselves as well as potential and actual distributions against each other.
The second step was to build climate envelopes from the climate data. The climate envelope for Europe, for example, gives a two-dimensional coordinate system of all combinations of mean annual temperature against mean annual precipitation across the respective area. By means of a link-up between the tree species distribution maps and the information about the climatic conditions that are prevailing there, climate envelopes for the areas of the tree species were gathered and compared for the different input data.
Finally, if we presume that a combination of temperature and precipitation once realized by tree species is suitable for them, our findings allow a spatial extrapolation of the distribution maps to all grids in Europe that fulfill these climatic parameters.
A special emphasis was given to indentify interesting areas, i.e. areas that are only realized by one initial distribution map or areas that present areas of presence of tree species that are thought to have extreme climate conditions like the peripheries of the climate envelope. Those patterns can be especially well investigated when the absolute occurrences in the climate envelopes are normalized to 100%.