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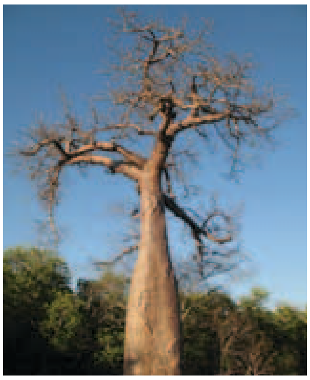

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BIODIVERSITY AND CLIMATE CHANGE: ACHIEVING THE 2020 TARGETS

Abstracts of Posters Presented at the 14th Meeting of the Subsidiary Body on Scientific, Technical and Technological Advice of the Convention on Biological Diversity, 10-21 May 2010, Nairobi, Kenya

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Cover Photos
(Top to bottom) Baobab, *Adansonia madagascariensis*, endemic to Madagascar (photo: Joachim Gratsfeld, Botanic Gardens Conservation International); Students investigating the intertidal area, Chumbe Island Coral Park, Zanzibar, Tanzania (photo: Chumbe Island Coral Park); Seed diversity, India (photo: Paul Bordoni, Platform for Agrobiodiversity Research, Bioversity International); Coral reef walls, Apo Island, Philippines (photo: © Greenpeace/Daniel M Ocampo)

18. CLIMATE CHANGE THREATS TO BIODIVERSITY IN GERMANY AND AUSTRIA

The Potential Distribution of Alien Plants

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INTRODUCTION

Biological invasions are recognized as an important element of global change and as a major threat to the conservation of biodiversity (Ruiz & Carlton 2003). Invasive alien plants can transform ecosystems by establishing viable populations with growth rates high enough to displace native species and thereby damage ecosystem structures and functions. Likewise it is expected that climate change will have essential impact on the development and growth of plants by which biodiversity will be directly or indirectly affected (Woodward 1987). The question of how climate change will interact in this global process of introduction and expansion of alien species is becoming highly relevant for nature conservation management.

The German Federal Agency for Nature Conservation picked up this question and commissioned a project to the Austrian Federal Environment Agency. The project prepared the application of the precautionary principle of the CBD which is transferred into national law by the German Federal Nature Conservation Act (BNatSchG 2010) by modelling the potential habitats for invasive and potentially invasive plant species in Germany and Austria under different climate change scenarios. Both countries, located in Central Europe, have undergone "typical" European land use histories, are similar in regard to their biogeographic setting and to invasion-relevant socio-economic drivers (e.g. gross domestic product per capita, trade intensity). On the other hand, they differ in regard to some other factors (e.g. size, population density, access to coasts). Shifts in species distribution induced by climate change are likely to be transnational. With regard to the two countries, species are expected to expand their distribution range rather from Austria to Germany than otherwise.

The project focused on 30 alien plant species which include some of the worst invasive alien species (IAS) in Europe and for which good quality data on their ecology and distribution are available (Table 1).

ASSESSING THE MAGNITUDE OF POTENTIAL DISTRIBUTION CHANGES OF ALIEN PLANT SPECIES BY CLIMATE CHANGE

We quantified changes in the potential distribution of the examined species under four climate change scenarios from the climate normal period (1961–1990) to a scenario period in 2050–2060. Species were selected to represent different stages of invasion, pathways, and life histories. Species listed on the German and Austrian interim black and grey lists of alien species were preferred (BfN in prep.). A methodical limitation was given by the minimum number of different records which is necessary to use statistical methods: species less than 30 records were excluded from the analysis. Modelling of the future potential distribution was based on the species' current distribution in Germany and Austria (fine-scaled grid-based distribution maps, cell size appr. 35 km2) and environmental predictors (baseline 1961–1990). The distribution data of the 30 species were extracted from the databases of the floristic mappings of Germany (BfN) and Austria (University of Vienna). Floristic data was completed by additional data from literature and herbaria specimen. The set of environmental variables included topography (elevation), infrastructure (highways, railways, streets), settlements, preferred land cover types (extracted from CORINE land cover units) and river density as well as various climate variables (temperature, precipitation), which are expected to determine current distribution of alien plant species. We used recently favored ensemble forecast techniques to predict current distribution of potential habitats. We employed generalized linear models (GLMs) and generalized additive models (GAMs) in combination with gradient boosting machines (GBMs). Predictions to the decade 2051–2060 were performed using the Global Circulation Model HadAM3 with four different European climate change scenarios (PIK 2004) resulting from four emission scenarios (A1f, A2, B1 and B2), each of which emphasizes a different set of social, environmental and economic ideals (IPCC 2001). All in all these climate change scenarios are relatively similar to each other, however, they show regional differences, e.g. in the increase in the annual mean temperature (Figure 1).

CLIMATE CHANGE WILL INCREASE INVASION RISKS

Our results clearly show differences in current patterns among species which reflect different habitat requirements. With the exception of alpine regions, almost all grid cells provide suitable habitats for at least one of the selected species. Under current climate, “invasion hot spots” are primarily large cities and their surrounding areas, warm regions like valleys as well as margins along important water ways and motor high ways. In Germany the Ruhr district and cities like Berlin, Dresden, Frankfurt/Main, Hamburg, Karlsruhe, Munich and Stuttgart as well as large water ways like the Danube and the Rhine provide suitable habitats for a wide range of alien plant species (> 20). In Austria cities like Vienna, Linz and Klagenfurt as well as the warmer eastern and southeastern regions are hot spots for alien plant species (Figure 1).

Further climate change will influence the geographical distribution of many species and will lead to significant changes in native biocoenoses. Higher temperatures will also favor the survival capability of alien species from subtropical regions. Several alien species already introduced into southern European areas will also expand their distribution range northwards as temperatures rise. Furthermore our results suggest that climate change will reduce the currently tight association of alien plants to German and Austrian metropolitan areas and transport infrastructures and will be responsible for an increasing occurrence of alien plant species in wide areas of the rural regions of Germany and Austria (Figure 1). Climate change induced expansion will lead to increasing problems in nature conservation, especially if invasive species are involved. Today invasive plant species already impose a significant threat on native species in Germany and Austria by inter-specific competition (e.g. *Fallopia japonica,* which finds suitable habitats in about 50% of the quadrants under current climate, Table 1), by hybridisation (e.g. *Populus x canadensis*) and by altering the invaded habitat (e.g. *Robinia pseudacacia*, with actually suitable habitats in about 60% of the quadrants, Table 1).

Despite uncertainties in bioclimatic modelling linked to biases in data sampling, modelling technique, spatial autocorrelation, biotic interaction or species evolution, the results of our transnational study may serve as a general model for predictions of climate induced shifts of species distribution. Finally, our results will provide an important basis in discussions about the development of more extensive prevention measures to stop the introduction of alien species, the arrangement of an early warning system on IAS in both countries and in the EU as well and a forward-looking nature conservation policy and planning to protect native biodiversity in a changing world.

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TABLE 1: List of modelled alien plant species and percentage of suitable quadrants of Germany and Austria under current climate conditions.

SPECIES	SUITABLE QUADRANTS	SPECIES	SUITABLE QUADRANTS
Acer negundo	33.08 %	*Impatiens parviflora*	60.21 %
Ailanthus altissima	18.05 %	*Lupinus polyphyllus*	54.00 %
Amarantus retroflexus	46.49 %	*Mahonia aquifolium*	38.29 %
Ambrosia artemisiifolia	27.21 %	*Parthenocissus inserta*	28.90 %
Amorpha fruticosa	26.56 %	*Paulownia tomentosa*	6.05 %
Artemisia verlotiorum	22.30 %	*Pinus strobus*	33.24 %
Asclepias syriaca	29.42 %	*Prunus laurocerasus*	16.89 %
Buddleia davidii	22.50 %	*Prunus serotina*	39.92 %
Bunias orientalis	40.70 %	*Pseudotsugo menziensii*	34.83 %
Duchesnea indica	16.93 %	*Quercus rubra*	48.67 %
Fallopia japonica	49.57 %	*Robina pseudacacia*	59.59 %
Fallopia sachalinensis	45.65 %	*Rudbeckia laciniata*	34.68 %
Helianthus tuberosus	47.04 %	*Solidago canadensis*	59.90 %
Heracleum mantegazzianum	44.96 %	*Solidago gigantea*	52.83 %
Impatiens glandulifera	55.53 %	*Sorghum halpense*	25.69 %

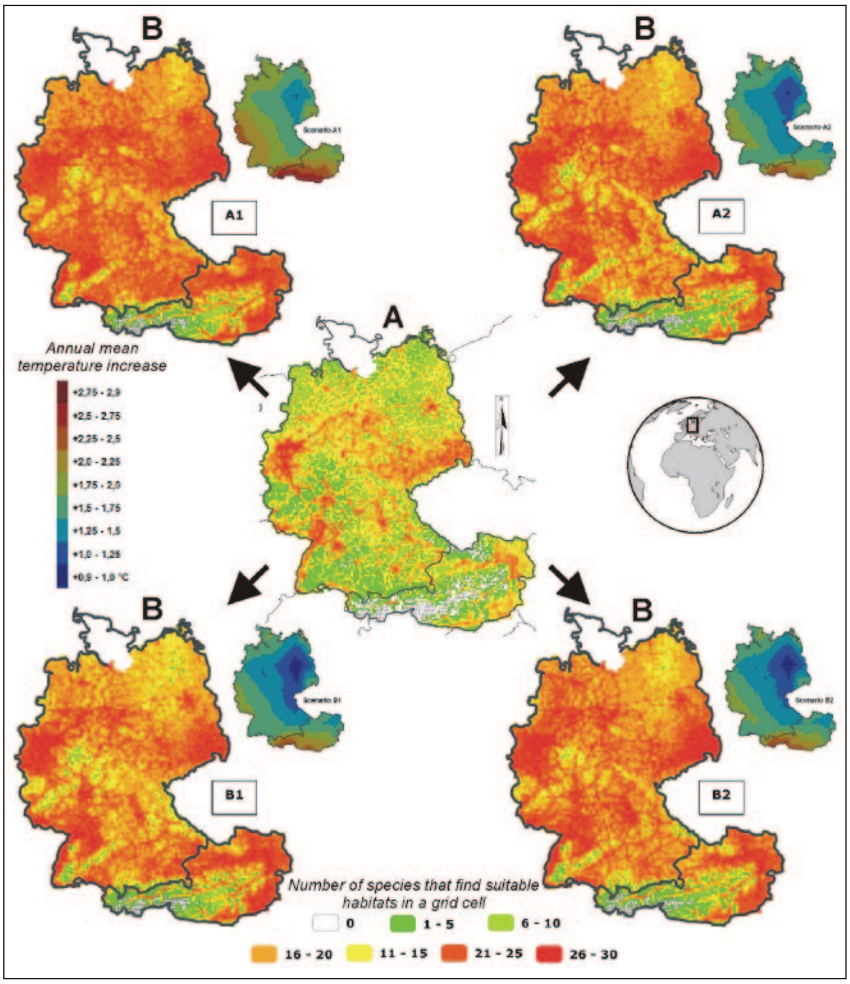

FIGURE 1: Invasion hot spots of alien plants in Germany and Austria. Cumulative map of potential habitat suitability A) under current climate and B) under four different climate change scenarios by 2051–2060.