Adapting the landscape to climate change: linking ecosystem networks.

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Introduction

Adaptation strategies to improve resilience of ecosystems to the effects of climate change should be focussed on a landscape scale and not on single reserves. The processes of range shifts and increased population fluctuations, caused by climate change, will interact with habitat fragmentation and human-induced land use changes. Landscape ecology can contribute to the knowledge of these dynamics and the development of effective adaptation strategies.

Adaptation strategies

Whether species will be able to follow their suitable climate space depends both on species and landscape characteristics. Such a response might be prevented or inhibited by habitat fragmentation (Opdam and Wascher, 2004). In human dominated landscapes, natural or semi-natural ecosystems have become fragmented and are embedded in unsuitable landscape, with low permeability. Populations of species that are restricted to these remnants of suitable habitat often show characteristics of a metapopulation structure. The persistence and dynamics of these metapopulations are determined by the spatial cohesion of the habitat networks in such landscapes. At a larger scale, the species range can be conceptualized as a spatial configuration of habitat networks varying in size, density, quality and in the type of landscape in which they are embedded.

When climate change results in a potential pole ward expansion of the suitable climate space, species can only respond by colonizing unoccupied parts of existing networks, or would be able to 'jump' to neighbouring networks. A prerequisite is that distances between patches can be crossed with enough probability. That requires that source habitat patches are producing sufficient dispersing individuals, whereas distances must be within the dispersal capacity of species and not impassable because of physical barriers. Hence, adaptation of terrestrial ecosystems to climate change requires a sufficient degree of spatial cohesion within and between ecological networks over large spatial scales.

We designed landscape adaptation strategies and indicated search areas where adaptation measures are needed to improve the climate change robustness of ecosystems.

Linking ecological networks

When the suitable climate envelop shifts because of climate change, some habitat will no longer be suitable at the contracting side of a species range, while habitat patches become suitable at the expanding range side. Habitat networks and single patches that are within a suitable climate zone but that have no overlap with the previous suitable climate zone are not climate proof. The distance is too large for the species to be colonized from the already suitable and occupied habitat networks. However adaptation measures that connect this

network to the nearest already climate proof network, would turn it into a climate proof network. There are several measures that contribute to the linking of ecological networks, e.g. enlarging existing habitat patches, creating new habitat patches, creating robust corridors, improving matrix permeability or mitigate barrier effects (Opdam *et al*., 2003; Vos *et al*., 2007).

Increase expanding potential

Also the size of populations in the overlap zone, the part of the network that is suitable in successive climatic time frames, is an important prerequisite for climate robustness. The larger the overlap between consecutive climate zones, the larger the growing potential from which habitat patches that have become suitable can be colonized. A second adaptation strategy is therefore to increase suitable habitat in the overlap zone. Indeed, populations in the overlap zone are the sources from which new suitable habitat are to be colonized. In this respect the speed of the colonizing process in relation to the speed of shifting climate envelope space, determines whether species will able to keep up with climate change. Thus mitigation measures which slow the process of climate change are also a very important adaptation measure.

Protect climate refugia

Finally an important strategy is to put extra conservation effort in the protection of species in parts of their range that are not influenced by climate change. These regions form stable 'climate refugia', and might function as important source areas from which species can expand when climatic conditions become again more favourable.

The role of the Natura 2000 network

Under European conservation policy the Natura 2000 network has been launched to protect biodiversity. It is a physical network through which key habitats, key species and prime conditions for their long term preservation are legally protected. At the same time, it is a coordinating mechanism through which the partners can develop and implement cooperative actions. However, the planning of the Natura 2000 network is based on a static view on the distributions of habitats and populations, and does not imply the impact of climate change. An urgent question to be answered is to what extent and where the spatial cohesion of the Natura 2000 network will make it climate change proof, and where bottlenecks in the network prevent adaptation of species ranges to shifting climate space.

References

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