Europe's biodiversity in a changing climate

Part 1: Overview and Adaptation

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Biodiversity

The main story

What is 'biodiversity'?

Biodiversity refers to the diversity of living organisms of any origin. It includes the diversity within species (genetic diversity), between species (species diversity) and the diversity of ecosystems.

Adaptation potential

The processes brought about by anthropogenic climate change will most probably exceed the adaptation potential of many biological systems and will therefore threaten the diversity and stability of species, habitats and ecosystems in general.

Most vulnerable species

The most threatened species include those with poor tolerance to climate change, those with restricted possibilities for geographical expansion (such as species in mountain-tops, islands, and capes or species under other restrictive physical factors) or those with small populations. According to the most recent studies, the threat of becoming extinct by 2050 concerns approximately one third of the species, and many of these species live in the tropical zone.

Threshold vulnerability

Few ecosystems can adjust to a rise of 3°C or more. More than 20% of the ecosystems worldwide will then completely change. It is not just the absolute temperature rise, the rate of this rise is also of particular importance. A rate of 0.1°C per 10 years is considered by many experts to be a threshold value. In such a situation, 50% of the current ecosystems are still capable of coping with the changes. Above this threshold level, ecosystems will become damaged.

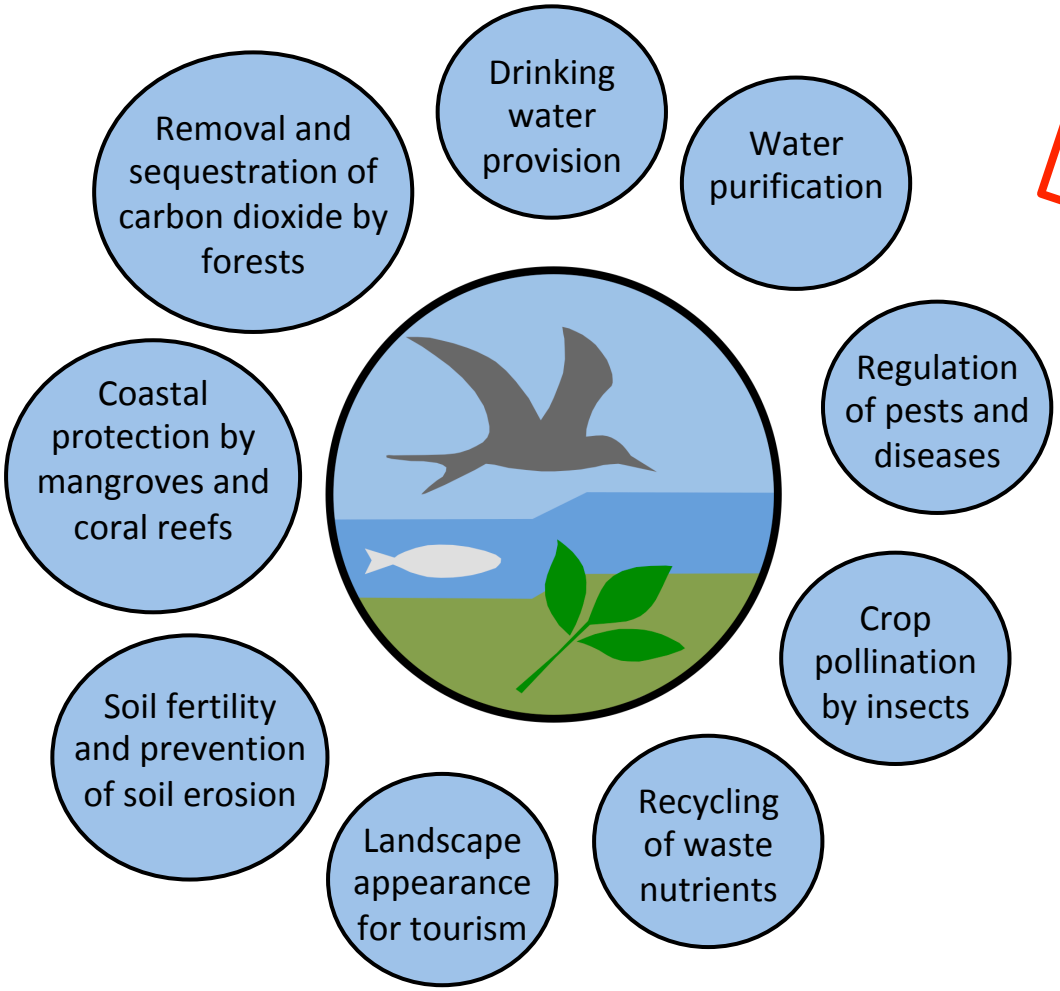
Not just climate change

In addition to climate change, other human impacts affect ecosystems, such as land-use change, urbanization, and soil degradation. Many of these effects are likely to become even stronger in the future because of the expanding human population and economic activity.

Biodiversity

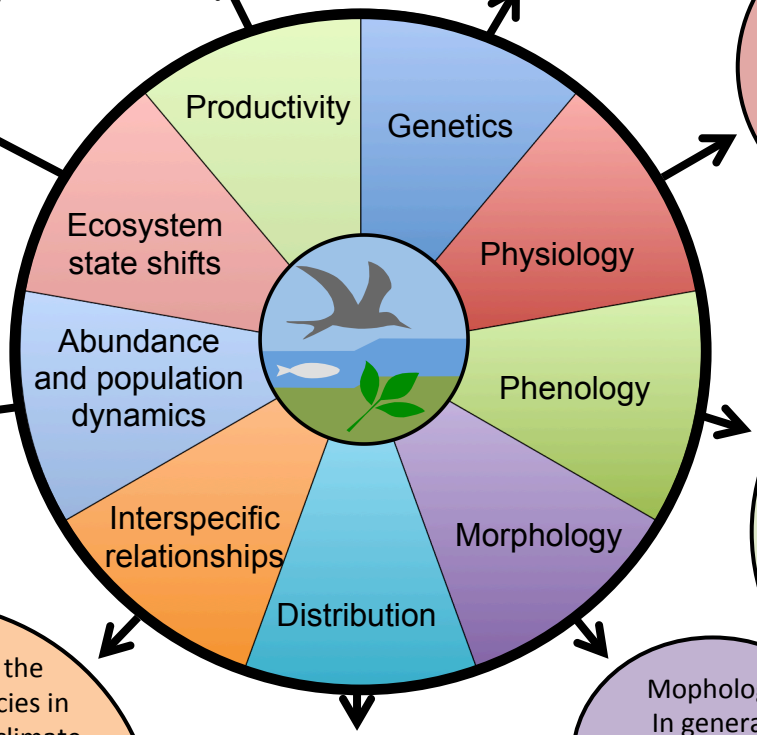
The main story: ecosystem services

Biodiversity and healthy ecosystems help to fight against climate change: ecosystems store a very significant quantity of carbon (forests, wetlands, peat bogs, etc.), but they also help to combat the effects of climate change (floods, droughts, soil leaching, natural water purification, etc.). Protecting and restoring biodiversity and ecosystems is therefore an efficient and cost-effective means of combating and adapting to climate change.



Climate change may lead to large-scale loss of ecosystem services

Climate change impacts on biodiversity – an overview



Productivity
Both increases and decreases of productivity are possible.

There is strong evidence for genetic responses to climate change of small organisms with short generation times.

Physiology (the functioning of organisms) may adapt to higher temperatures and other climate-mediated changes, or fail to do so.

There is overwhelming evidence that migrations and life-history processes (such as budding and flowering in plants, hatching and fledging in birds, and hibernation in mammals) have been affected by climate change. Across marine, freshwater, and terrestrial ecosystems, spring phenologies have advanced by 2.3 to 5.1 days per decade.

Mophology
In general, decreasing body size with warming is expected.

Tropical species are expanding their ranges into environments previously dominated by temperate cold-tolerant species (“tropicalization”). Likewise, boreal fish communities are shifting northward into the Arctic (“borealization”).

As a by-product of the redistribution of species in response to changing climate, existing interactions among species are being disrupted, and new interactions are emerging. This may lead to predator-prey mismatches, for instance due to an earlier bloom or geographical shift of prey compared with the predator.

~80% of communities across terrestrial, freshwater, and marine ecosystems exhibited a response in abundance that was in accordance with climate change predictions. 52% of warm-adapted marine species, for instance, increased in abundance, whereas 52% of marine cold-adapted species decreased.

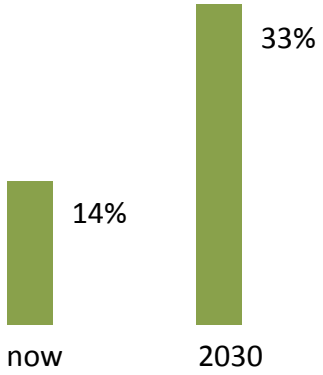
Diminished resilience may lead to ecological regime shifts, in which one ecosystem state shifts to an alternative and potentially undesirable stable state. In lakes, for instance, climate change has increased the risk of regime shifts from clear water to turbid states and increased the occurrence of cyanobacteria blooms.

(source: Scheffers et al., 2016)

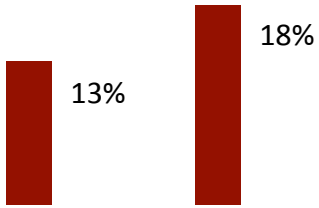
Biodiversity

The main story: extinction risk from climate change

habitats under pressure climate change
(source: EEA, 2017)

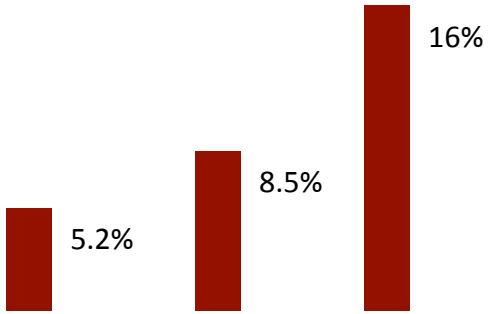


species under pressure climate change
(source: EEA, 2017)



European national reports suggest that 14% of habitats and 13% of species of European interest are already under pressure because of climate change over their natural European range. In the near future, 33% of habitats and 18% of species may be threatened by climate change. However, consistent, global estimates of species extinctions attributable to future climate change are still lacking.

species under pressure climate change
(source: Urban, 2015)



Climate change threatens one in six species (16%) globally if we follow our current, business-as-usual trajectory (resulting in a global warming of 4.3°C). Lower percentages of species at risk due to global warming have been calculated for lower global warming.

These results must be interpreted cautiously, however. In studies, important biological mechanisms that may increase or decrease predicted risks, such as species interactions, evolution, landscape dispersal barriers, habitat degradation, and intraspecific trait variation, are generally omitted.

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The main story: extinction risk from climate change - examples

In **Belgium**, biodiversity losses can be explained by air, water and soil pollution, fragmentation and destruction of habitats, intensive agricultural and forestry practices, exotic invasive species etc. Climate is becoming an increasingly important factor, however, and may be the main source of perturbation in the future.
During the 21st century climate change will probably result in the disappearance of a part of the species that occur in Belgium. Besides, climate change can also lead to the decoupling of food webs and the break-up of symbiotic relations between species.
The arrival of new species adapted to the warmer climate may have adverse effects. Some species will disrupt the structure of existing ecosystems or modify relations between species, in particular due to competition for food or habitat.

Changes in species composition, linked to climate change, have already been observed in **Germany** and Central Europe. In Germany, among monitored plants, 28.7% are threatened and 3.7% have already gone extinct. Among animals, e.g. 71% of amphibian and reptile species, 37% of bird species, and 38% of mammal species are threatened. 6% of bird species and 13% of mammals have already gone extinct. In the medium to long term, changes in species composition and communities in Germany cannot be avoided.

The “worst case” scenario shows a possible loss of present species in Germany by the year 2080 ranging from 25% (north-western Germany) to over 50% (southern and eastern Germany). Especially strong declines of up to 36% are found in the Alpine region and in south-western Germany.

Today **Albania** has one of the highest rates of biodiversity loss in Europe. Deforestation, soil erosion, uncontrolled land use, and pollution are rapidly destroying precious resources. Unsustainable levels of hunting, fishing and grazing are also threatening diversity. The main endangered types of ecosystems and habitats in Albania are littoral and coastal ecosystems, such as sand dunes, river deltas, alluvial forests, lagoons and coastal lakes.

In **Spain** up to 97% of animal species may be affected by climate change. Most vulnerable ecosystems are the islands and isolated ecosystems in the mountains.

Europe's biodiversity adaptation strategies in a changing climate

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Biodiversity

Adaptation strategies

Promote the resilience and adaptive capacity of ecosystems

The main story

- **Reduce**
  - the rate and magnitude of climate change
  - the other stresses operating on ecosystems
  - habitat fragmentation
- **Maintain**
  - a large pool of genetic diversity and functional evolutionary processes
- **Increase**
  - connectivity, and thus preserve migratory corridors
- **Intervene**
  - manage habitats intensively to restore critical habitat types, with whole communities recreated from populations surviving elsewhere
  - assist translocation of slow moving organisms or those whose migration is impeded, along with the species on which they depend
  - manipulate disturbance regimes to keep them within the ranges necessary for species persistence and sustained ecosystem functioning

Current knowledge of future climate change impacts is limited. Management needs to be flexible to respond to the real evolution of problems.

- Practice adaptive management
- Monitor and evaluate changes in ecosystems and biodiversity

Current results indicate that natural and artificial ecosystems with high species diversity and healthy ecosystems will most probably be capable of adapting to on-going and anticipated climate change

Biodiversity

Adaptation strategies

The main story

Reduce

- the rate and magnitude of climate change
- the other stresses operating on ecosystems (invasive species, fragmentation, pollution)
- habitat fragmentation

Many ecosystems in the world, including Europe, suffer already from land-use changes, air pollution, landscape fragmentation and habitat destruction. These pressures have led to the degraded functioning and species extinction that is at a rate 100-1,000 times greater than is considered normal over history.

Barriers to dispersal, such as habitat fragmentation, prior occupation of habitat by competing species and human-made impediments such dams on rivers and urbanized areas on land, reduce the ability of species to migrate to more suitable climates. Species that cannot move fast enough to keep pace with the rate of climate change will lose favourable climate space and experience large range contractions.

Example Low Countries
Plants and animals continually face man-made barriers and therefore cannot always shift their habitat. Species need to shift by 4 km per year (10 m per day) to keep pace with the current temperature rise.

Example mountains
A major problem in many parts of the European Alps is that ecosystems have been so fragmented and the population density is so high, that many options for ecosystem conservation may be impossible to implement.

Biodiversity

Adaptation strategies

The main story

Increase → connectivity, and thus preserve migratory corridors

Preserve migratory corridors between protection areas and, where necessary, other valuable nature areas:

- Increase connectivity
- Increase number of reserves
- Protect large areas, increase reserve size
- Create/manage buffer zones around reserves
- Create ecological reserve networks, large reserves, connected by small reserves and stepping stones
- Institute flexible zoning around reserves
- Secure boundaries of existing reserves
- Protect many small reserves rather than single large
- Create linear reserves oriented longitudinally

To cope with climatic changes, species are expected to shift from southwest to northeast Europe, as has already been observed for several plant, animal and lichen species, with high reproducing and/or dispersal capabilities. However species with much lower adaptation capabilities are at risk.

Biodiversity

Adaptation strategies

The main story

Maintain → a large pool of genetic diversity and functional evolutionary processes

Establish additional conservation areas to better account for climate change impacts (in-situ conservation):

- Protect full range of bioclimatic variation
- Protect current and predicted future refugia
- Locate reserves in areas of high heterogeneity, endemism
- Locate reserves at northern boundary of species' ranges
- Protect mountains
- Protect primary forests
- Protect urban green space
- Increase wetland protection
- Focus protection on sensitive biomes
- Locate reserves so that major vegetation transitions are in core
- Locate reserves at core of ranges
- Reconstruction and restore mires and peat lands, and valuable forest habitats (where appropriate)

Biodiversity

Adaptation strategies

The main story

- Protect endangered species ex situ (ex-situ methods), involving captive breeding and genetic manipulation in zoological and botanical gardens and recently developed cryogenic seed banks
- Establish neo-native forests plant species where they were in the past, but are not found currently; broaden genetic and species diversity in restoration and forestry

manage habitats intensively to restore critical habitat types, with whole communities recreated from populations surviving elsewhere

Intervene

assist migration and translocation of slow moving organisms or those whose migration is impeded outside their native range, along with the species on which they depend

- Manage wild populations outside of protected areas (inter-situ management)

manipulate disturbance regimes to keep them within the ranges necessary for species persistence and sustained ecosystem functioning

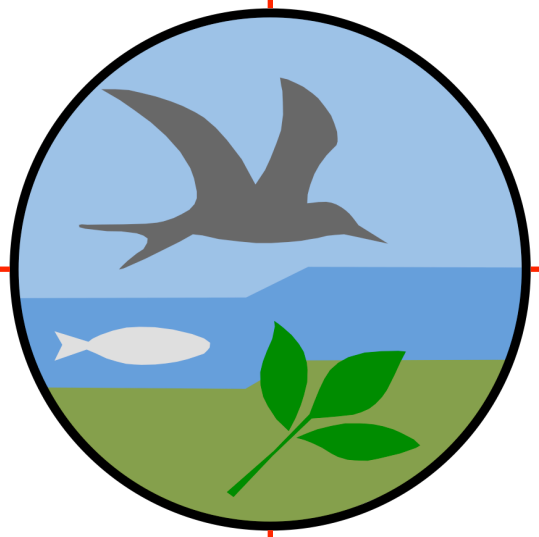
- Practice intensive management to secure population
- Focus management on decreasing the expectable danger of the invasive species, and enhancing the acceptable (least worse) colonisation processes

Biodiversity

Adaptation strategies

Specific ecosystems

Birds
Any attempt to understand and ameliorate migratory bird losses must consider threats far away from their breeding sites. These threats could include killing and taking, human disturbance at staging sites, pesticide exposure, or collisions with human obstacles such as wind turbines and traffic. Conservation actions needed to halt the decline of these migratory species include the protection of wetlands and woody vegetation, and stopping of illegal taking and killing.



Freshwater ecosystems
Anthropogenic activities that affect the quality of the river systems habitats, such as water extractions during low flow periods, and thermal pollution, should be minimized.

Marine ecosystems
Actions that reduce the flow of nutrients and sediments from coastal catchments, as well as those that reduce activities such as the deforestation of mangroves and the overfishing of key ecological species, will become increasingly important as the impacts of climate change mount.

Terrestrial ecosystems
Climate-related changes in soil systems have direct impacts on natural production systems, on water cycles (both qualitatively and quantitatively) and on biological diversity. At the same time, proper precautionary measures help reduce and prevent soil erosion, and adverse soil compression, and they help protect organic substances in the soil, thereby protecting the soil's ecological vitality. Such measures are thus suitable measures for adaptation to climate change.

Biodiversity

Adaptation strategies

Interaction other sectors

Preservation biodiversity depends on adaptation water management, forestry, agriculture and traffic as well

Forestry

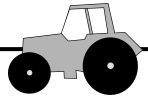
- Apply forest management based on natural processes, including the careful and sparing use of all available water resources of forest sites, with the main objective of the storage of water for watering of plants and animals and for water-game habitat preservation purposes
- Maintain continuous forest cover and use natural forest renewal methods
- Maintain non-closed canopy in the forest steppe zone
- Preserve diversity of forests (in terms of the landscape, habitat type, succession, species and gene)
- Assure buffer zones around the sensitive habitats
- Apply afforestation of large areas by using suitable native species

Traffic and transportation

- Consider nature conservation aspects in planning the routes of transportation corridors
- Create ecological passages (wild game passages) across main roads and motorways, and use native species for planting the hedges and forest strips along these passages

Water management

- Consider ecological aspects in reservoir operation
- Restore water storage capacities of the habitats and develop options for potential water supplementation
- Establish near natural water regime and water supply conditions
- Manage flood prone areas such as to let floods inundate wetlands and other depressions



Agriculture

- Establish buffer zones in the vicinity of sensitive areas
- Promote less intensive land management techniques in sensitive areas, in order to reduce environmental pressure
- Increase the heterogeneity and mosaic character of agricultural landscape (ridges, hedges, alleys, smaller cultivated lots)
- Apply soil- and water saving technologies, promote extensive and ecological farming methods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