Ecological impacts of climate change: the need for resilient landscapes

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Nature is a barometer
The magnitude of the changes ahead
### Physiological impacts

<table>
<thead>
<tr>
<th>CO₂ ↑</th>
<th>Temp ↑</th>
<th>Water ↑</th>
<th>Increasing biological productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂ ↑</td>
<td>Temp ↑</td>
<td>Water ↓</td>
<td>Physiological stress, dieback</td>
</tr>
</tbody>
</table>

- Dying beech forest
- Dieback of perennial grasses in a semiarid grassland
Phenological impacts

Shifts in the flowering period of black locust (Robinia pseudoacacia) between 1890 and 1990 (Walkovszky 1998)
Phenological impacts

Visser & Both 2005
Impacts on species distributions
Distributional impacts

**Winners**

- heat and drought tolerant
- good reproductive and dispersal ability
- unspecialized (generalist), disturbance tolerant

**Losers**

- the majority of the species 😞
Cabomba caroliniana
Distributional impacts

- Migration is crucial

Europe
- North Sea / Arctic icecap
- Alps/Carpathians
- Mediterranean Sea

North-America
- Pacific Ocean
- Rocky Mountains
- Appalache-Mts
- Atlantic Ocean
Pacific Ocean = Rocky Mountains = Appalachian-Mts = Atlantic Ocean

North Sea / Arctic icecap = Alps/Carpathians = Mediterranean Sea
Can species still migrate???
The SEE region is particularly endangered

... due to the magnitude of the transformation:

LPJ model output

UN SEG 2007
The SEE region is particularly endangered

... due to migration barriers:

Araújo et al. 2004
Losing ecological integrity

stability

unreliability
“Quite simply, we will not be able to mitigate climate change or adapt to it if we do not protect our ecosystems and biodiversity. And we will not manage to halt the loss of biodiversity if we do not mitigate climate change.”

Connie Hedegaard
(EU Commissioner of Climate)
What can be done?

• Mitigation (→ ”traditional” climate policy)
• Adaptation (→ enhance the autonomous adaptive capacity of ecosystems)
  – reduce additional stresses
  – increase landscape diversity and connectivity
Reduce additional stresses

- agrochemicals (pesticides, fertilizers)
- disturbances (intermittent ploughing)
- unnecessary drainage
- bad mowing practices
- etc.
How to achieve connectivity?
• core areas
  – (usually given)

• corridors
  – rivers, streams, canals, road margins, tree lanes, hedgerows, ditches,…

• stepping stones
  – interrupted corridors, chains of small habitat patches

• buffer zones
  – extensive land use
Samu et al. 2008

- Weeds, pests: no clear relationship (7:1)
- Natural enemies of pests: strong positive effect (3:0)
What else should be a landscape resilient to?

Resilience:

the capacity of a **system** to preserve **functions** in a broad range of **changing** external conditions

• system = socio-economic-ecological
• function = sustaining humans
• changing conditions = climate change**+ ??**
Consumer expenditure ($)

Goods and services

HOUSEHOLDS

FIRMS

Labour, capital...

Wages, rents, dividends ($)
Global ecological system

Economic system

Solar, fossil and atomic energy

 wastes heat

 Raw materials

 Households

 Firms

 Waste materials, pollution
The "energy base" of natural ecosystems ~2400 EJ/year

The "energy base" of human economy ~900 EJ (2008)
Figure 4. Human consumption of biomass (dark grey bar) from the marine environment in comparison with that of 54 species of marine mammals. The 95% confidence limits among non-human species are indicated by the right and left edges of the pale grey shaded area.

Figure 6. Production of CO$_2$ by humans (dark grey bar) within the biosphere in comparison with that by 63 species of mammals approximating human body size. The 95% confidence limits among non-human species are indicated by the right and left edges of the pale grey shaded area.

Fowler & Hobbs 2003

+ ~30 more…
Global economic crisis

Energy crisis (e.g. peak oil)

Biodiversity loss

Climate change
A resilient landscape
A resilient landscape

Resilience to:

• Climate change (+biodiv loss)
  – increase landscape diversity & connectivity

• Resource/energy scarcity (+global economic crisis)
  – relocalization !!!
Intelligent Design

Maybe it's just a stage.