Climate change and forest dynamics in the Carpathians

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Management and disturbances are the main drivers, with climate change amplifying the disturbances.

Almost 20% of the forests experienced stand-replacing disturbances over the past 25 years (Griffiths et al. 2014).

Regions with largely deteriorated forest health occur (e.g. Western Beskids, SK-PL-CZ).

Forest cover slightly increased, mainly due to the land-abandonment.

Recent increase in broadleaved forests by as much as 9% (Gutman and Radeloff 2017).

Despite the strengthening orientation of close-to-nature management, damage to forests is increasing.
Main drivers of forest dynamics

- Management patterns varying in time and space
  - From overharvesting and excessive salvage operations to protection, conversion and adaptation

- Intensifying disturbances
  - Abiotic (wind, fire, snow)
  - Biotic (insects, diseases)
  - Anthropogenic (air pollution, illegal logging)

- Changing climate:
  - Range retraction and expansion
  - Dieback
  - Invasion
  - Change in species competition
  - etc.
Intensifying disturbances across Europe

Carpathian perspective

- Ca 20% of forests disturbed during recent 25 years (Griffiths et al. 2014)
- Impact of large-scale windthrows, e.g. SK 2004, RO 1995
- Indications of drought-induced mortality and decline in vigor appearing (HU, RO)
- Observations of new insect pests (northern bark beetle being the most well-known)
- Indigenous pests changing population dynamics and distribution (e.g. spruce bark beetle)
**Xylosandrus germanus**
e.g. beech and oak forests in SK
(SK Forest Protection Service)

**Taphrorychus bicolor**
e.g. beech forests in HU
(Mátyás et al. 2010)

**Ips duplicatus**
Spruce forests in UA, RO, CZ, SK, PL (Duduman et al. 2011)
Spruce bark beetle (*Ips typographus*) in the Carpathians: Estimated number of generations completed per year under the future climate 2071-2100

European spruce bark beetle

European spruce bark beetle (*Ips typographus*) is the most destructive species of the group in the most northern part of Europe. Although *I. typographus* is the most damaging of all European *Ips* spp. and the one which is sometimes regarded as a pest, it is nevertheless more often a secondary pest attacking and killing trees which are already stressed for other reasons (Nachtigall 1969) or damaged by windstorms (Foster 1993). The beetle has an effective aggregation phenomenon and also carries a load of spores of several brown rot fungi which contaminate the phloem and cambium and play an active role in killing the trees (Christiansen and Henriksen 1963). Today, annual generations are produced at high altitudes and latitude, the species has generally two generations in the lowlands of Central Europe and evergreen three generations per year at warmer sites. Norway spruce is the main host of *I. typographus* in Europe.

Spruce bark beetle is expected to benefit mainly from an accelerated developmental rate, thus allowing for the earlier completion of life cycles and establishment of additional generations within a season (Lange et al. 2008). Climate change is also expected to influence the host-feeding activity, diapause, overwintering mortality, and temperature regime during autumn could have a decisive impact on the size of overwintering population in the next spring (Blasius et al. 2009).

Data and methods

The analysis was based on the model PHENOPS - A Complex Phenological Model of *Ips typographus* (Baier et al. 2007). The used stage-specific developmental times were provided by Wohlgemuth and Seifert (1989).

Used climate data were taken from the FORESER database (Dobler et al. 2012), which contains the modelled results of regional climate simulations performed within the frame of the ESF-HERA project (von der Linden et al. 2009). Average of Three Regional Climate Models (RCMs) were used for the description of future climate - RegCM, HIRHAM, RACMO. Norway spruce distribution data were taken from updated mapping of tree species over Europe (From et al. 2013). Original data were corrected using the Corine Landcover data.
Shifting climate and vegetation

Kricsfalusy, V. et al. 2008 Historical changes of the upper tree line in the Carpathian Mountains, Ukraine
Climatic exposure as driver of forest dynamics
What to expect?

- Intensifying disturbances, which include new pests and diseases

- Shifting disturbance regimes towards the prominence of heat, drought and forest fires

- Disturbances reduce the share of vulnerable species and age classes, and may catalyze forest conversion and adaptation (should be used wisely in management)

- Increased forest dynamics in water limited environments

- Drought-tolerant species will be favoured and management might consider assisted migration and similar concepts
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Future is really challenging management and conservation, and interactions with science are needed more than ever before.

Thank you for your attention

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