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 deteriorating 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)

Taphroychus 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 and the most active pest in Europe. Though, *I. typographus* is the most damaging of all European *Ips* spp. and the one which is sometimes regarded to be, as a primary pest, it is nevertheless most often a secondary pest attacking and killing trees which are already stressed for other reasons (Schrecks 1979) or damaged by windstorm (Foster 1933).

The beetle has an effective aggregation phenotype and also carries a load of spores of several brownrot fungi which contaminate the phloem and cambium and play an active role in killing the trees (Christiansen and Brennan 1940).

Today, one annual generation is produced at high altitude and latitude, the species has generally two generations in the lowlands of Central Europe and even three generations per year at warmer sites. Norway spruce is the main host of *Ips 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. 2006). Climate change is also expected to influence the resuscitation activity, diapause and winter mortality. The temperature range during autumn could have a decisive impact on the size of the overwintering population in the next spring (Simonsen et al. 2009).

**Data and methods**

The analysis was based on the model PHENIPS - A Complex Phenological Model of *I. typographus* (Baier et al. 2001). The in situ stage-specific developmental thresholds were proposed by Wormsener and Soller (1989).

Used climate data were taken from the FORESER database (Dobere et al. 2012), which contains the modified results of regional climate simulations performed within the frame of the EU FRAME project (van der Linden et al. 2009).

Average of Three Regional Climate Models (RCM) were used for the description of future climate - RCM1, - RCM2, - RCM3. Norway spruce distribution data were taken from standard mapping of two species over Europe (Borm et al. 2013). Original data were corrected using the Corine Landcover data.

**Estimated number of generations completed per year under the reference climate**

**Change in mean annual temperature (2071-2100) - (1961-1990) (average of 3 RCMs)**

**Proportion of Norway spruce forests in Carpathian countries in categories allowing for development of certain number of bark beetle generations**
Shifting climate and vegetation

Retraction & Expansion

Foto: Cs. Mátyás; Gy. Csóka; T. Szép
Peñuelas et al. 2007; Moiseev & Shiyatov 2003; Solár 2013
Kricsfalusy, V. et al. 2008 Historical changes of the upper tree line in the Carpathian Mountains, Ukraine
Climatic exposure as driver of forest dynamics

Future climate of the Carpathians: climate change hot-spots and implications for ecosystems

Tomáš Hlásky1,2, Jiří Tromšík2, Laura Dobor3, Zoltán Barcaza1, Ivan Bárka1,2

www.hydrol-earth-syst-sci.net/19/177/2015/
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Estimating the water needed to end the drought or reduce the drought severity in the Carpathian region

T. Antóf, G. Naumann, J. Spinaoi, and J. Vogt

Advances in Meteorology
Volume 2014, Article ID 943487, 14 pages
http://dx.doi.org/10.1155/2014/943487

On underestimation of global vulnerability to tree mortality and forest die-off from hotter drought in the Anthropocene

Craig D. Allen, David D. Breshears, Nate G. McDowell

Forecasts needed for retreating forests

Csaba Mátyás

Nature 464, 1271 (29 April 2010) | doi:10.1038/4641271a
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 interaction with science are needed more than ever before.

Thank you for your attention.

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