Climate change and forest dynamics in the Carpathians

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6^{th} Meeting of the Carpathian Convention Working Group

on Sustainable Forest Management

and

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Land Use Policy

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ELSEVIER

Forest and agricultural land change in the Carpathian region—
A meta-analysis of long-term patterns and drivers of change

Catalina Munteanu[a,*], Tobias Kuemmerle[b,c], Martin Boltiziar[d,e], Van Butsic[b,f], Urs Gimmi[g], Lúboš Halada[d], Dominik Kaim[h], Géza Király[i], Éva Konkoly-Gyuró[j], Jacek Kozak[h], Juraj Lieskovský[d,g], Matej Mojses[d], Daniel Müller[f,b], Krzystof Ostafin[h], Katarzyna Ostapowicz[a,h], Oleksandra Shandra[k], Přemysl Štych[l], Sarah Walker[m], Volker C. Radeloff[a]

Mountain Research and Development Vol 23 No 4 Nov 2003: 369–375

Jacek Kozak

Forest Cover Change in the Western Carpathians in the Past 180 Years

A Case Study in the Orawa Region in Poland

ELSEVIER

Remote Sensing of Environment

Volume 151, August 2014, Pages 72–88

Forest disturbances, forest recovery, and changes in forest types across the Carpathian ecoregion from 1985 to 2010 based on Landsat image composites

Patrick Griffiths[a], Tobias Kuemmerle[a], Matthias Baumann[b], Volker C. Radeloff[b], Ioan V. Abrudan[c], Juraj Lieskovsky[d], Catalina Munteanu[b], Katarzyna Ostapowicz[b, e], Patrick Hostert[a]

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Forest cover change and illegal logging in the Ukrainian Carpathians in the transition period from 1988 to 2007

Tobias Kuemmerle[a,c,*], Oleh Chaskovskyy[b], Jan Knorn[c], Volker C. Radeloff[a], Ivan Kruhlov[d], William S. Keeton[e], Patrick Hostert[c]

- 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 deteriorater 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 strenghtening orientation of close-to-nature management, damage to forests is increasing

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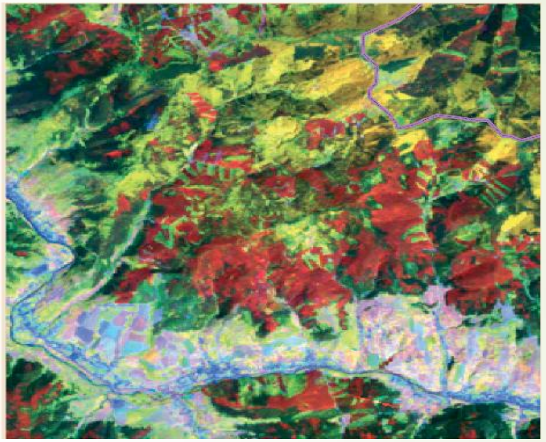
Article

POST-SOCIALIST FOREST DISTURBANCE IN THE CARPATHIAN BORDER REGION OF POLAND, SLOVAKIA, AND UKRAINE

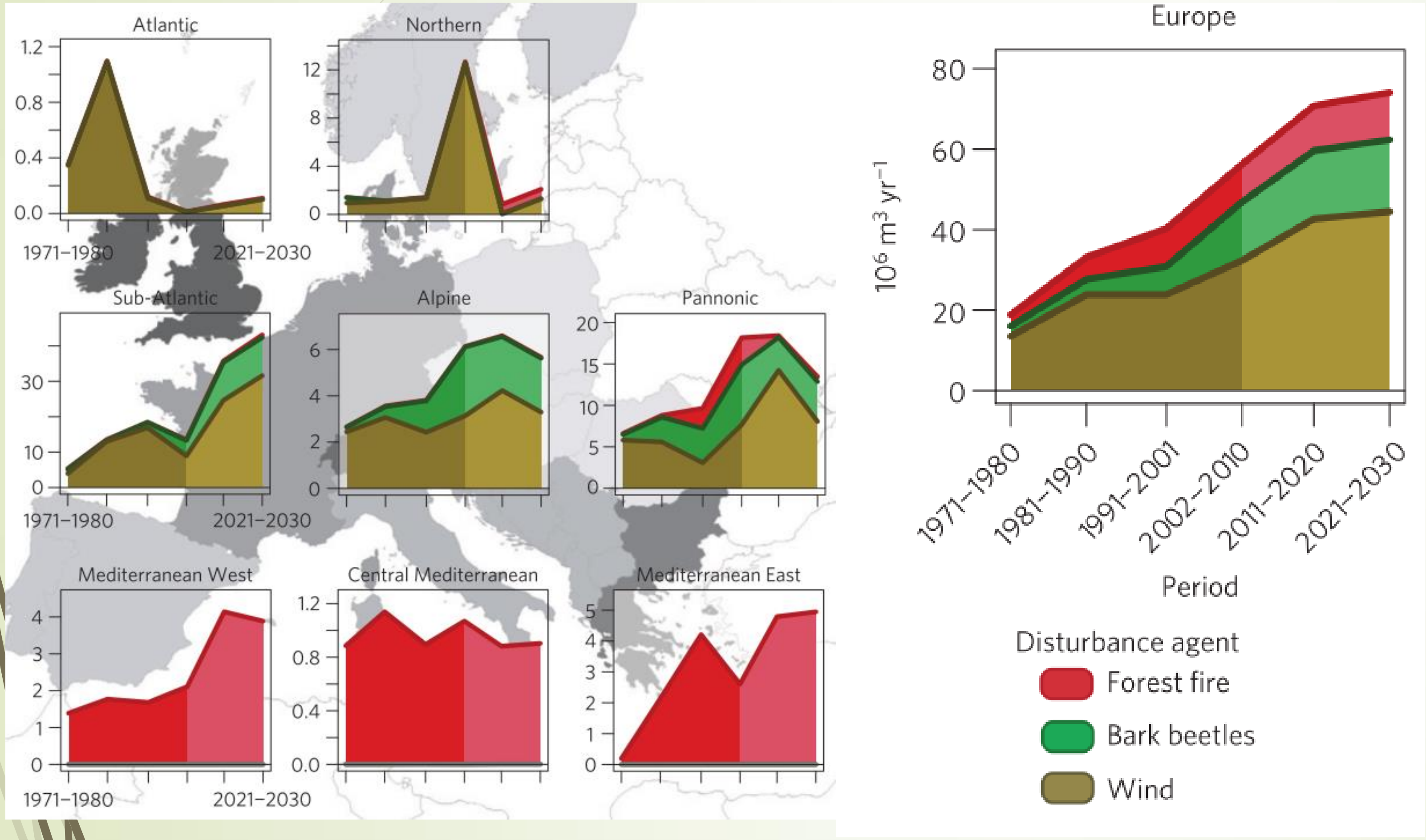
Tobias Kuemmerle, Patrick Hostert, Volker C. Radeloff, Kajetan Perzanowski, Ivan Kruhlov

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.



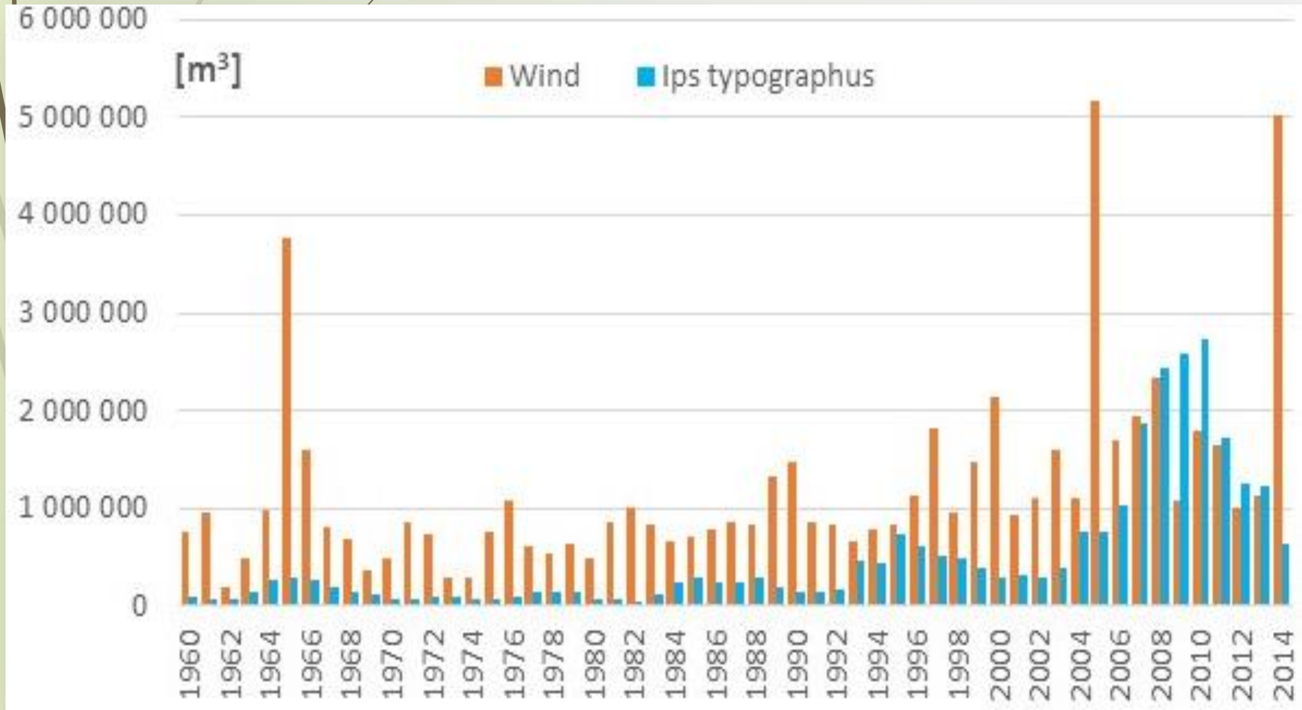
Intensifying disturbances across Europe

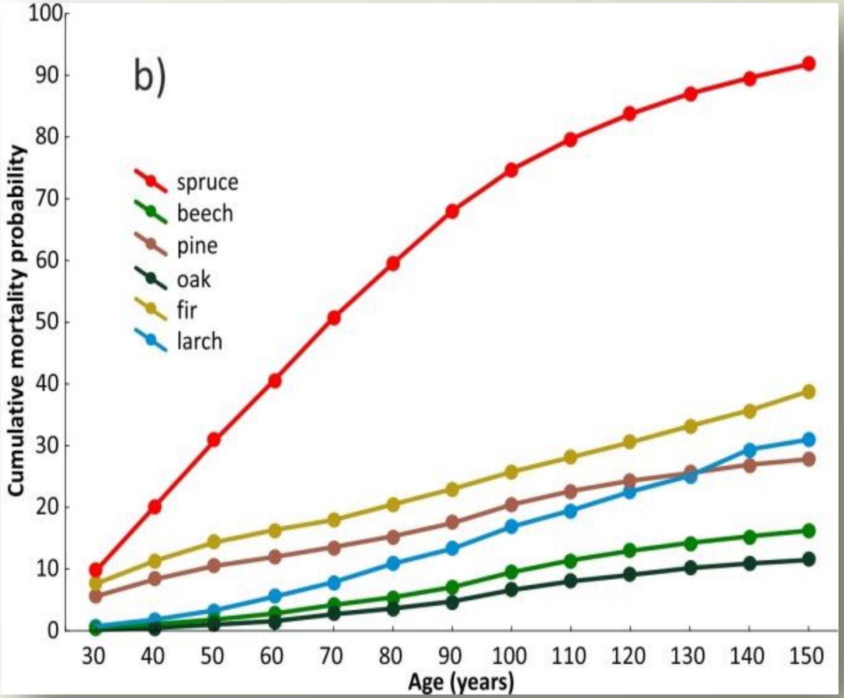


Seidl, R., Schelhaas, M.-J., Rammer, W., & Verkerk, P. J. (2014). Increasing forest disturbances in Europe and their impact on carbon storage. *Nature Climate Change*, *4*: 806–810.

Carpathian perspective

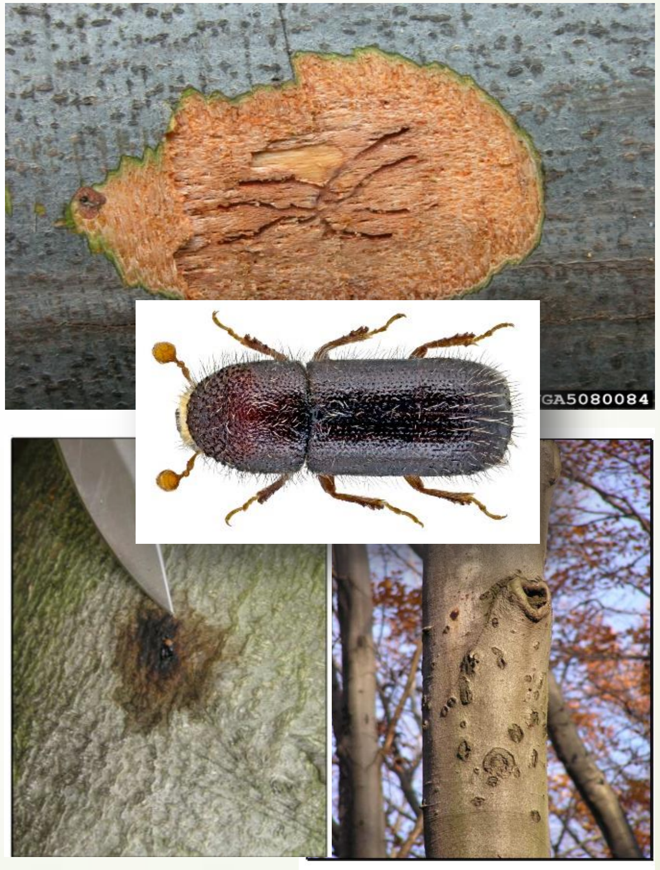
- Ca 20 % of forests disturbed during recent 25 years (Griffiths et al. 2014)
- Impact of large-scale windthrows, e.g. SK 2004, RO 1995
- Indications of drought-induced mortality and decline in vigor appearing (HU, RO)
- Observations of new insect pests (northern bark beetle being the most well-known)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



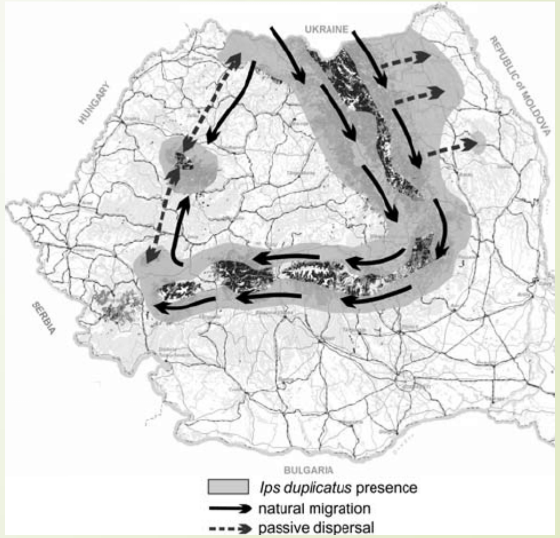


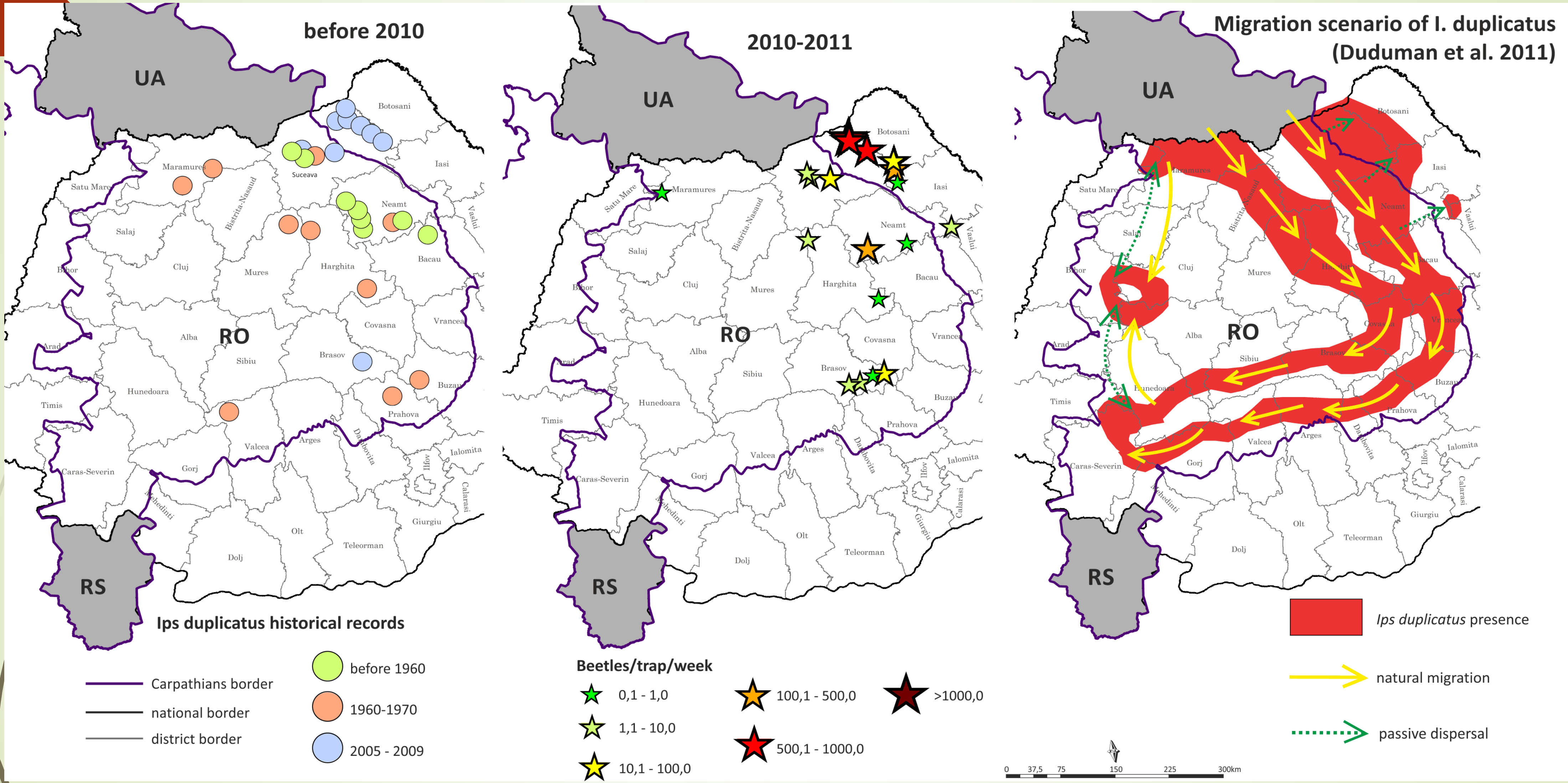
Xylosandrus germanus
e.g. beech and oak forests in SK
(SK Forest Protection Service)

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)*




before 2010
UA
RO
RS
Ips duplicatus historical records
Carpathians border
national border
district border
before 1960
1960-1970
2005 - 2009
2010-2011
UA
RO
RS
Beetles/trap/week
0,1 - 1,0
1,1 - 10,0
10,1 - 100,0
100,1 - 500,0
500,1 - 1000,0
>1000,0
Migration scenario of I. duplicatus
(Duduman et al. 2011)
UA
RO
RS
Ips duplicatus presence
natural migration
passive dispersal
0 37,5 75 150 225 300km

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 genus *Ips* and the most serious pest on spruce in Europe. Though *I. typographus* is the most damaging of all European *Ips* spp. and the one which is sometimes reported to behave as a primary pest, it is nevertheless most often a secondary pest attacking and killing trees which are already stressed for other reasons (Schwenke 1996) or damaged by windstorms (Forster 1993).

The beetle has an effective aggregation pheromone and also carries a load of spores of several blue-stain fungi which contaminate the phloem and cambium and play an active role in killing the tree (Christiansen and Horntvedt 1983).

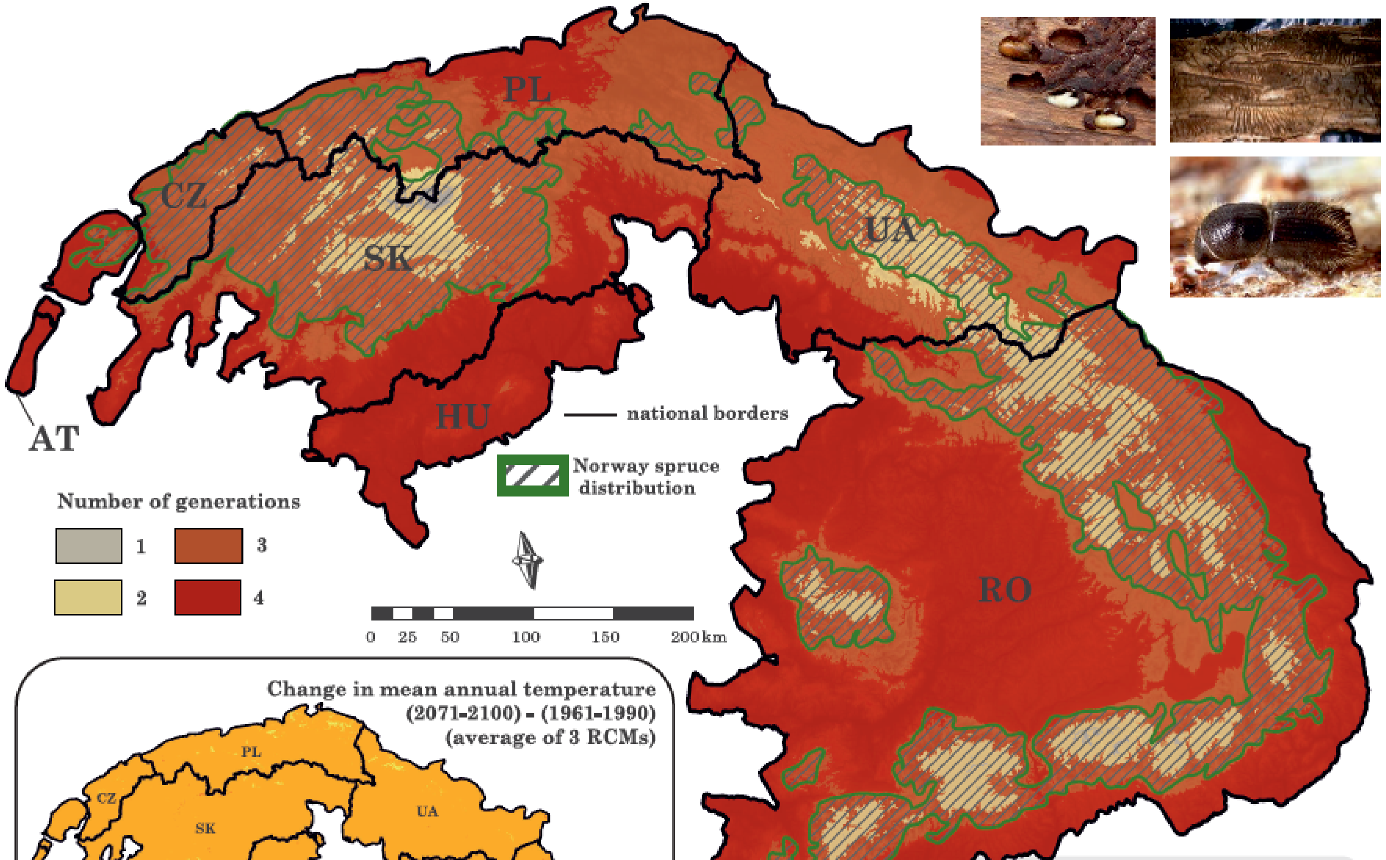
Today one annual generation is produced at high altitude and latitude, the species has generally two generations in the lowlands of Central Europe and even three generations per year at warmer sites. Norway spruce is the main host of *I. typographus* in Europe.

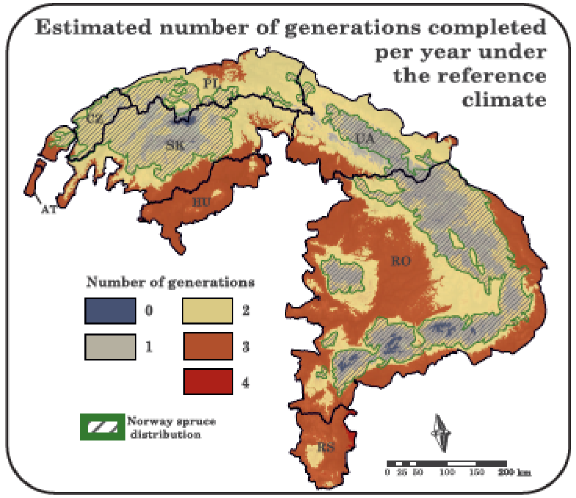
Spruce bark beetle is anticipated to benefit mainly from an accelerated developmental rate, thus allowing for the earlier completion of life cycles and establishment of additional generations within a season (Lange et al. 2006). Climate change is also expected to influence the pest swarming activity, diapause and winter mortality. The temperature regime during autumn could have a decisive impact on the size of the swarming population in the next spring (Jönsson et al. 2009).

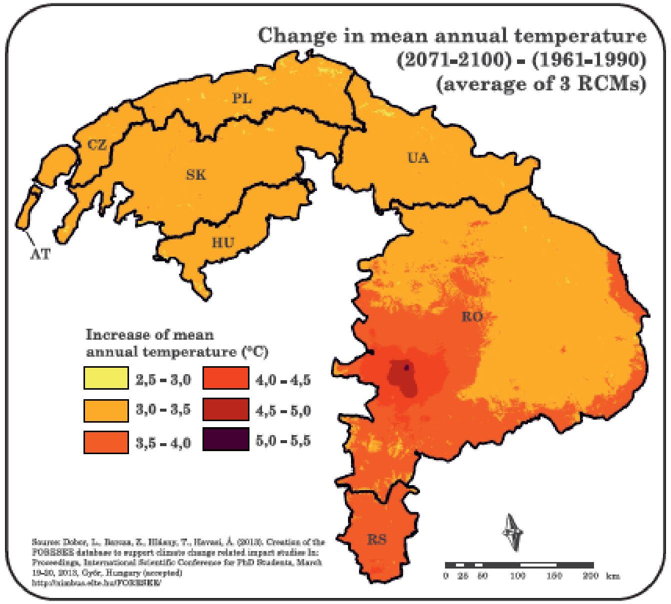
Data and methods

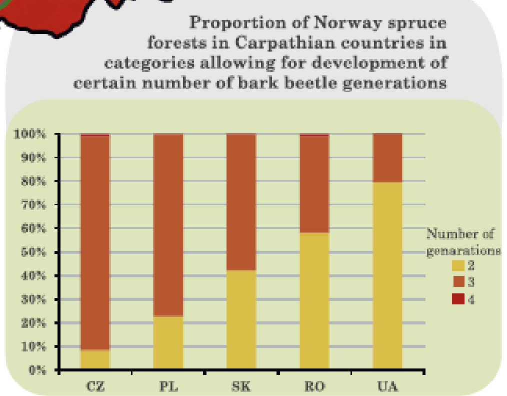
The analysis was based on the model PHENIPS – A Complex Phenological Model of *I. typographus* (Baier et al. 2007). The used stage-specific developmental thresholds were proposed by Wermelinger and Seifert (1998).

Used climate data was taken from the FORESEE database (Dobor et al. 2012), which contains the modified results of regional climate simulations performed within the frame of the ENSEMBLES project (Van der Linden et al. 2009). Average of Three Regional Climate Models (RCMs) were used for the decription of future climate – RegCM , HIRHAM5, RACMO. Norway spruce distribution data were taken from statistical mapping of tree species over Europe (Brus et al. 2011). Original data were corrected using the Corine Landcover data.

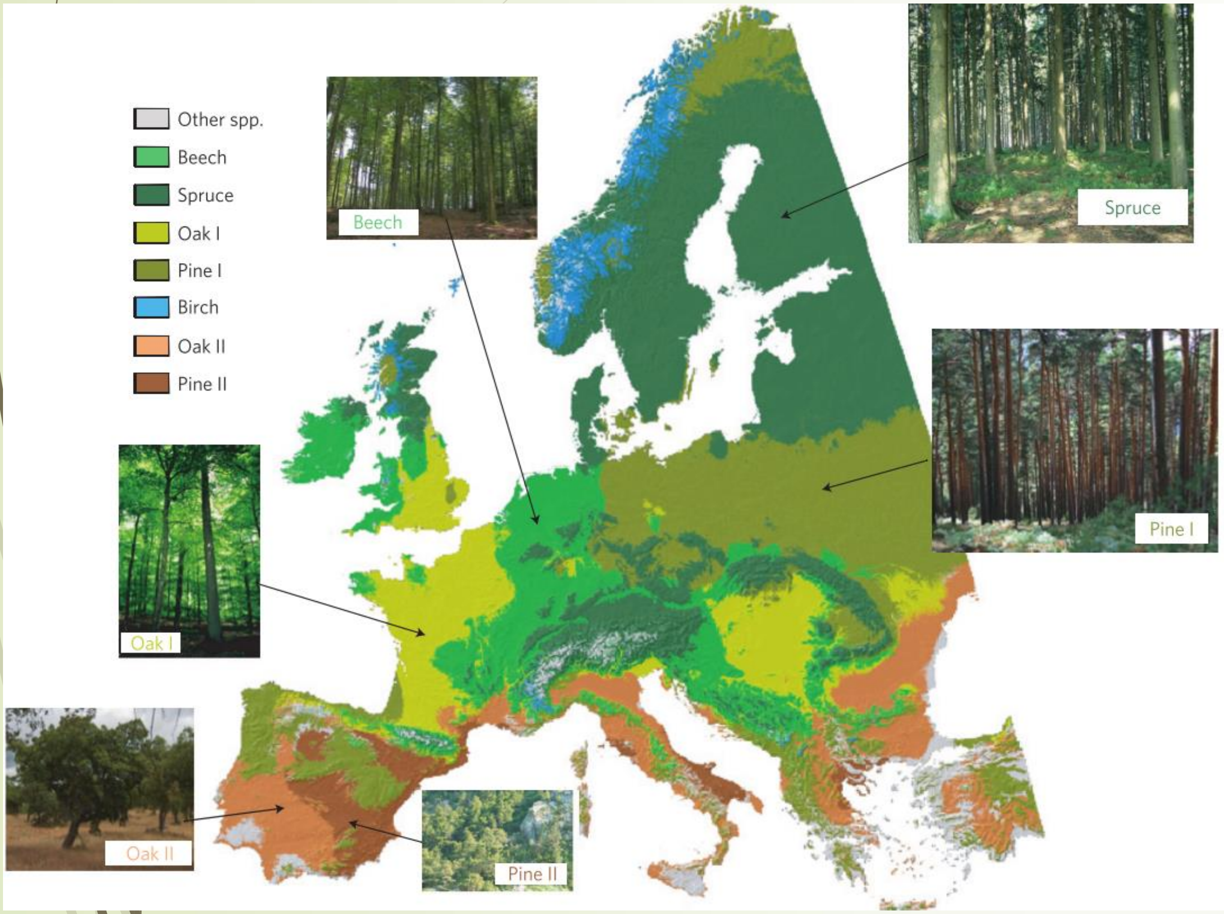


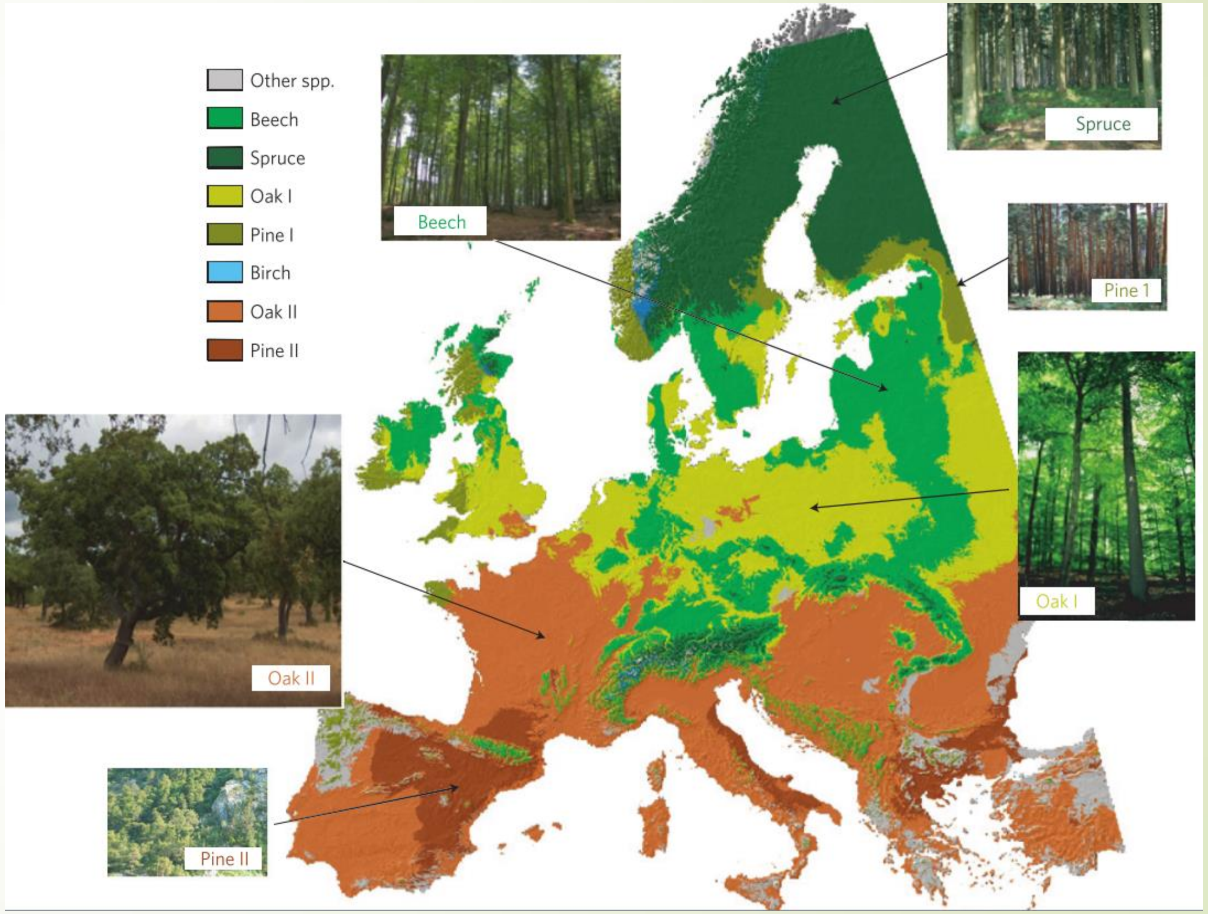






Shifting climate and vegetation





Hanewinkel, M., Cullmann, D. A., Schelhaas, M.-J., Nabuurs, G.-J., & Zimmermann, N. E. (2012). Climate change may cause severe loss in the economic value of European forest land. *Nature Climate Change*, doi:10.1038/nclimate1687

Retraction & Expansion

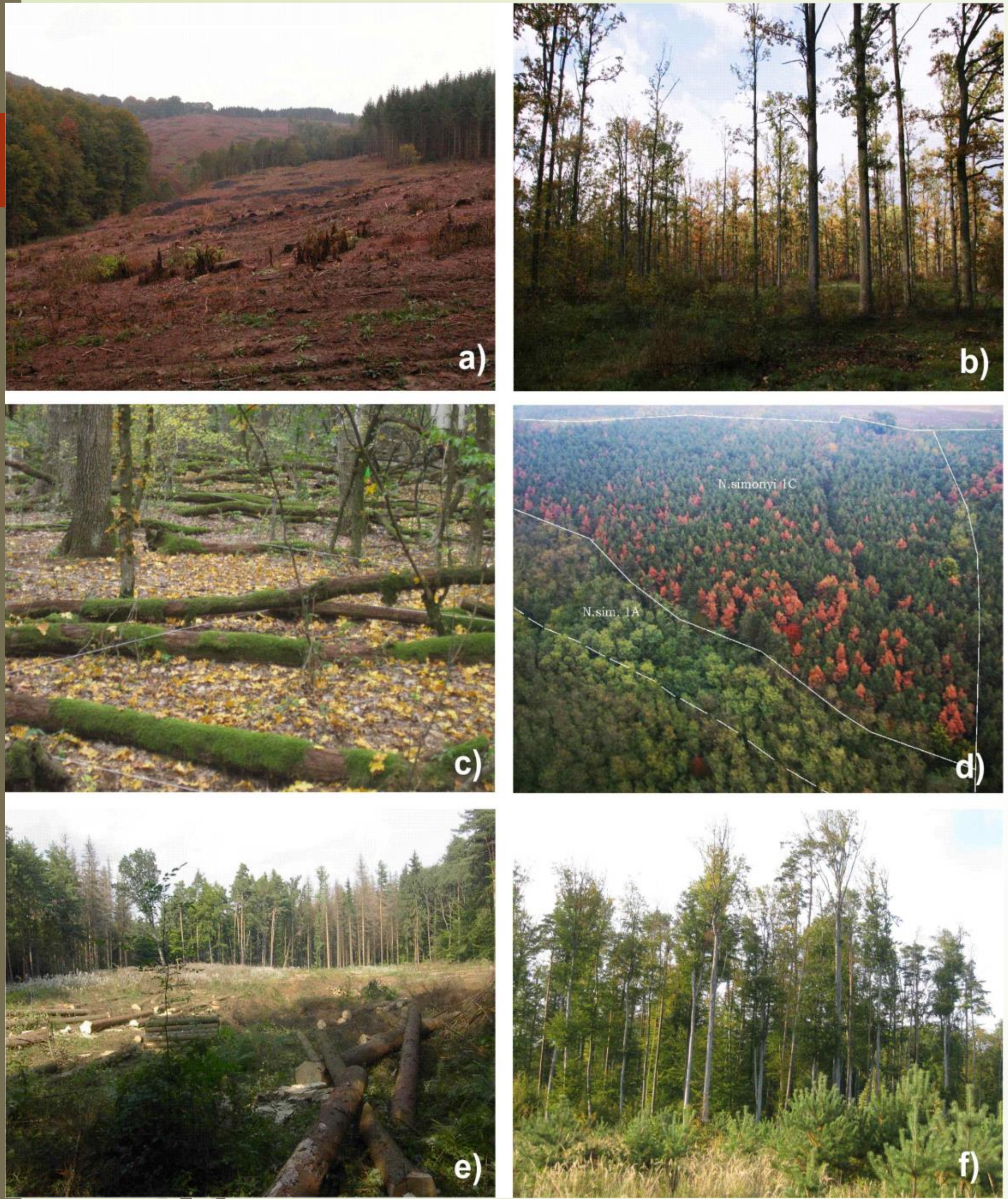
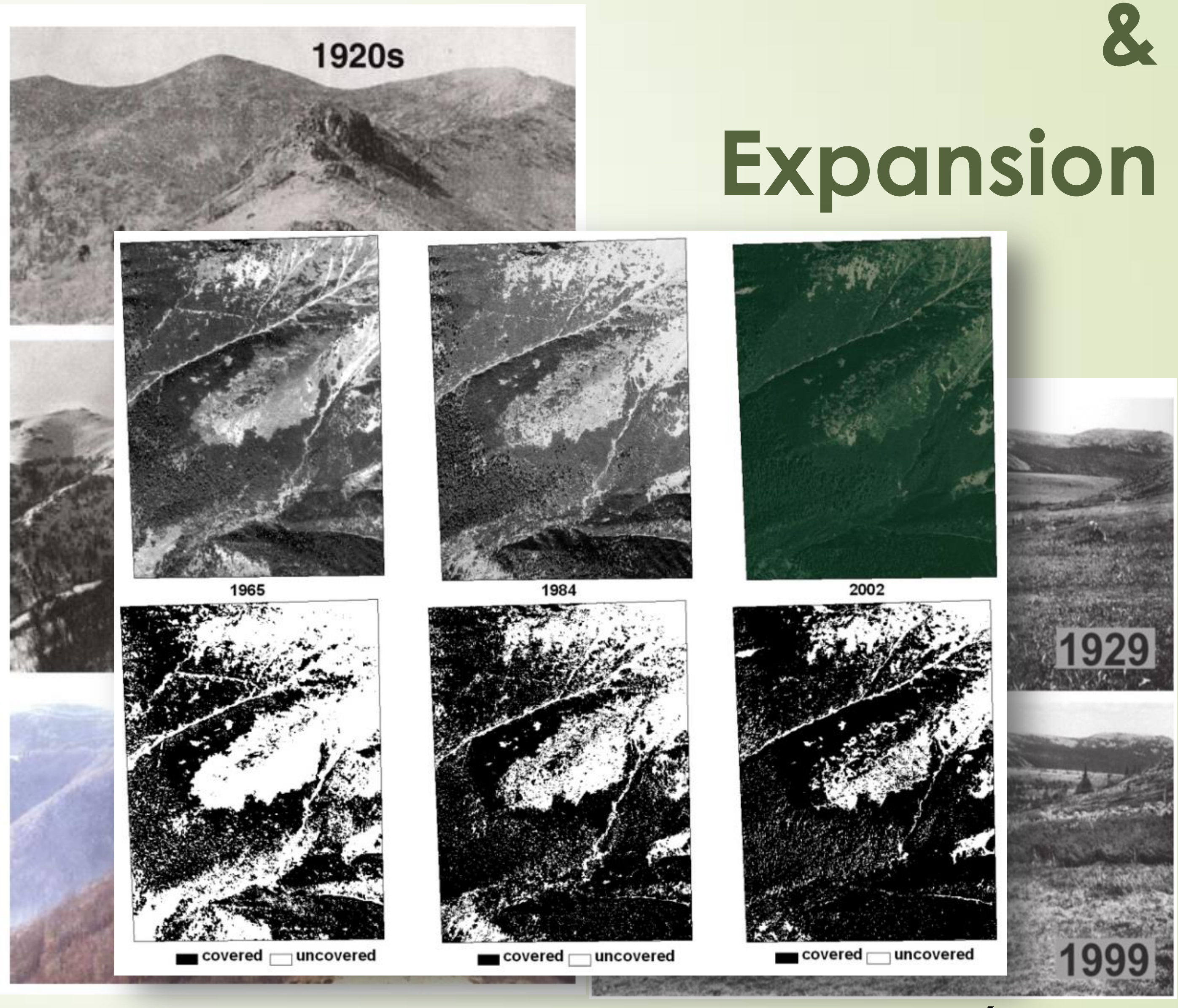
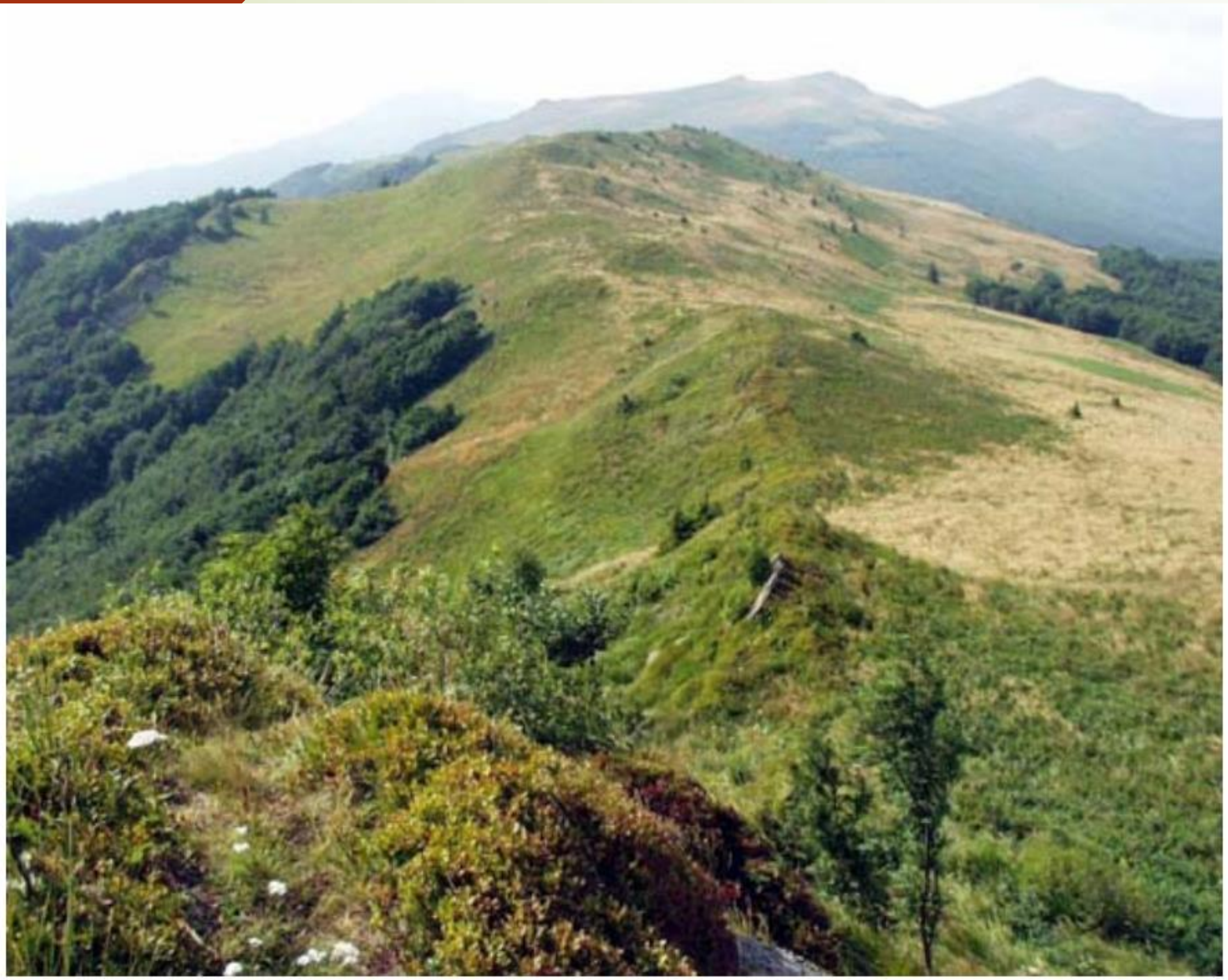


Foto: Cs. Mátyás; Gy. Csóka; T. Szép

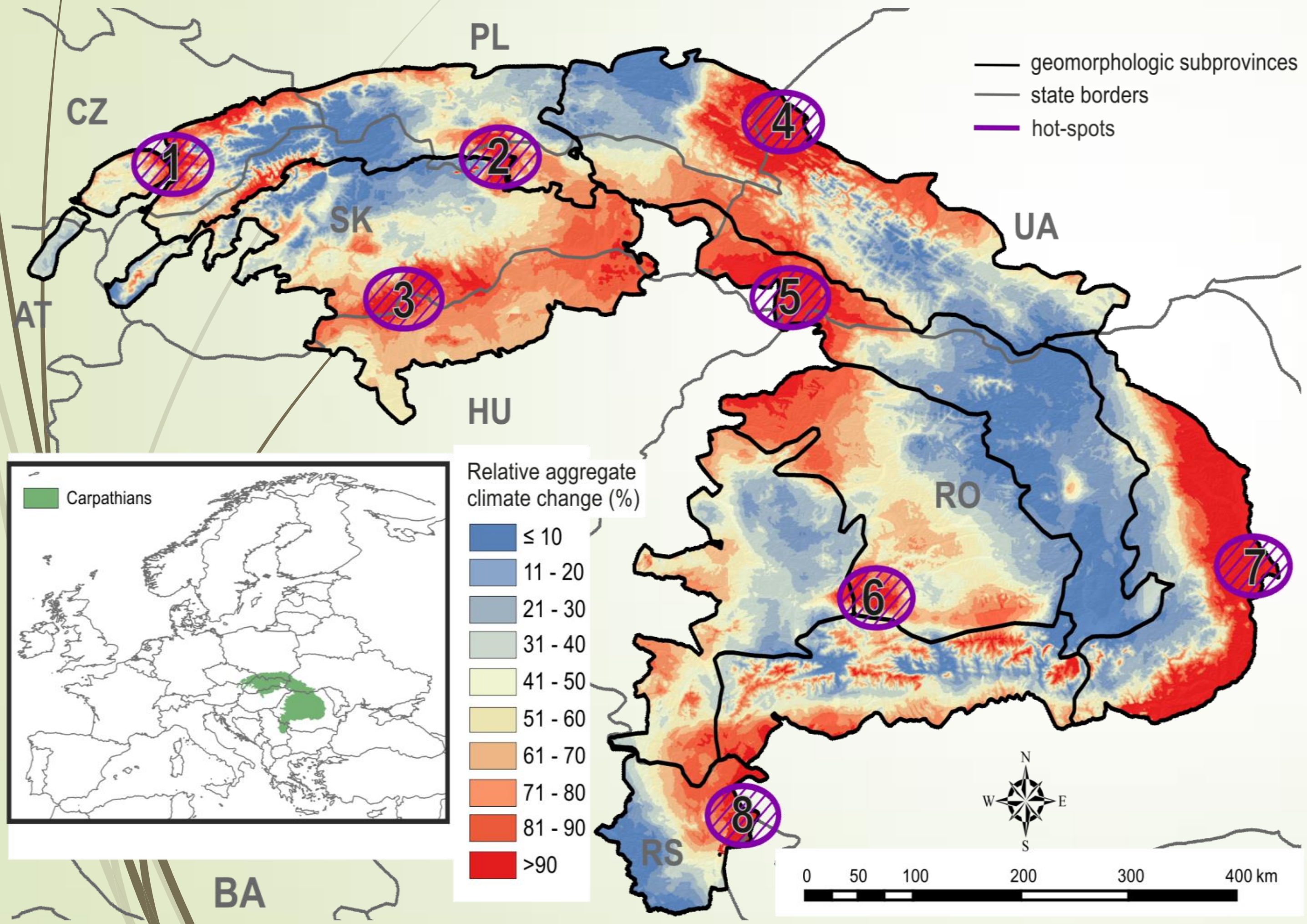


Peñuelas et al. 2007; Moiseev a Shiyatov 2003; Solár 2013



Kricsfalusy, V. et al. 2008 Historical changes of the upper tree line in the Carpathian Mountains, Ukraine

Climatic exposure as driver of forest dynamics



Reg Environ Change
DOI 10.1007/s10113-015-0890-2
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Tomáš Hlásny[1,2] · Jiří Trombik[2] · Laura Dobor[3] · Zoltán Barcza[3] · Ivan Barka[1,2]

Hydrol. Earth Syst. Sci., 19, 177–193, 2015
www.hydrol-earth-syst-sci.net/19/177/2015/
doi:10.5194/hess-19-177-2015
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T. Antofie, G. Naumann, J. Spinoni, and J. Vogt

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

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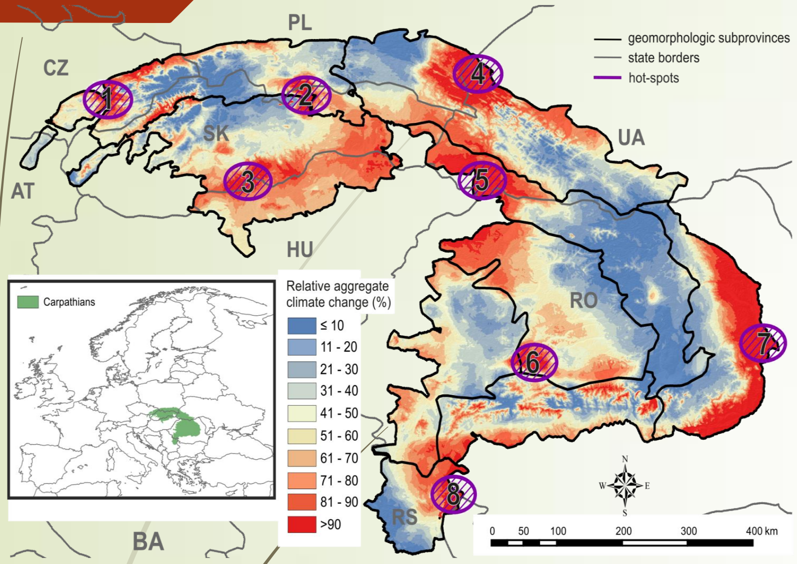
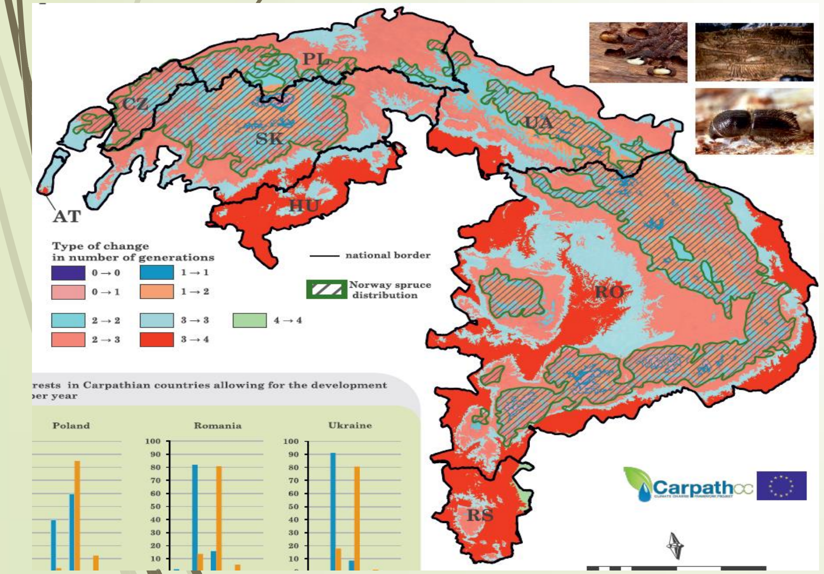
Csaba Mátyás

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

Climate change and forest dynamics in the Carpathians

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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