

Climate change impacts and adaptation measures in the Carpathian Region

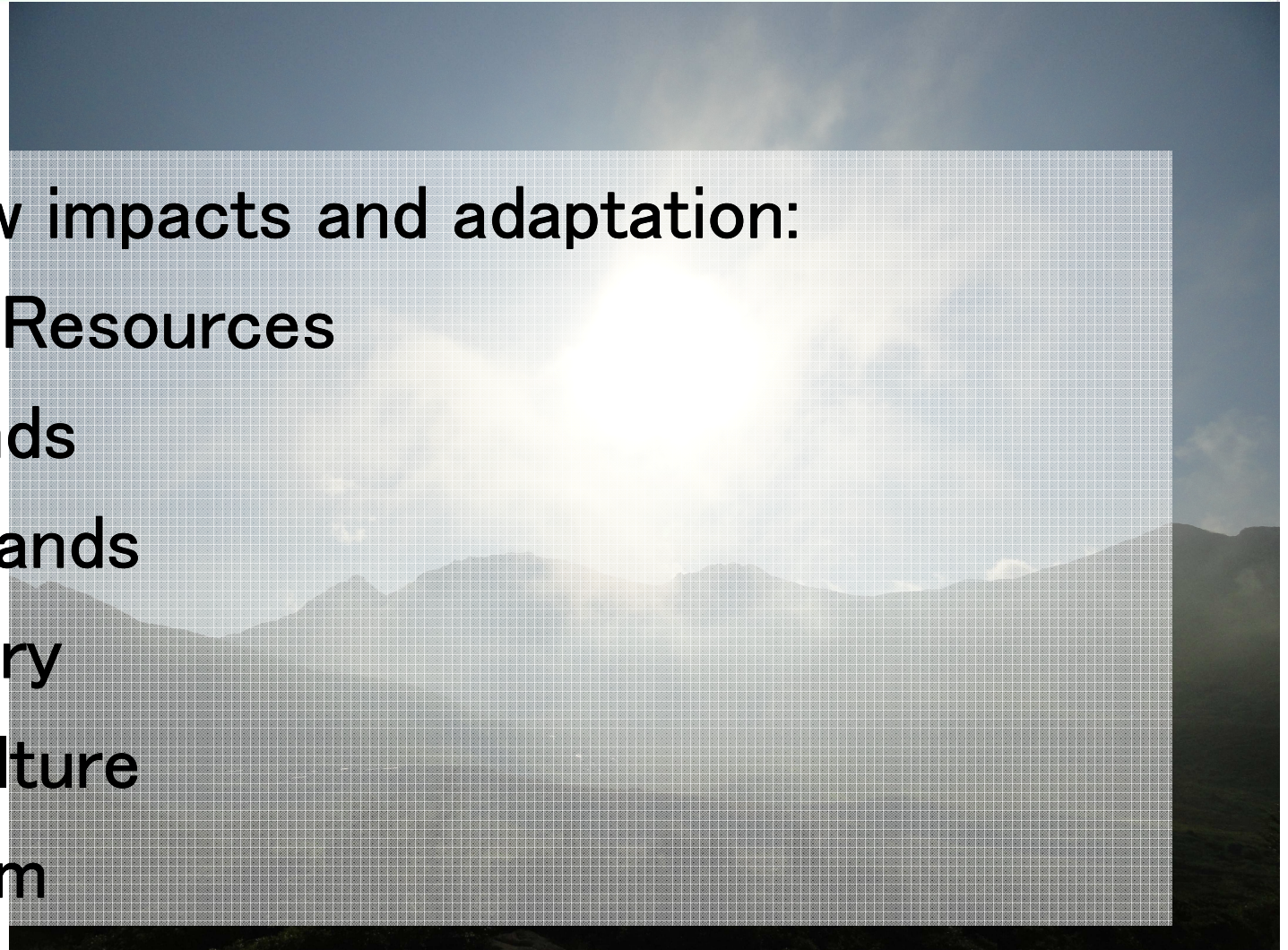
Lawrence Jones-Walters, ECNC–European Centre for Nature
Conservation



Today

Overview impacts and adaptation:

- Water Resources
- Wetlands
- Grasslands
- Forestry
- Agriculture
- Tourism



Key Questions

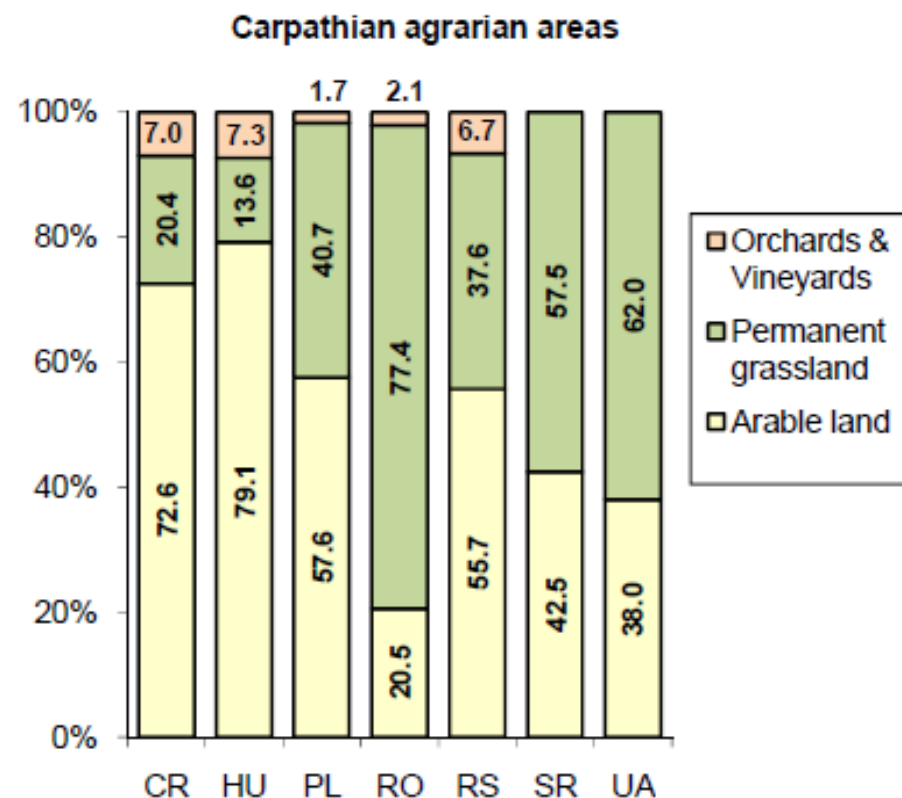
- Which of the impacts and measures are of particular relevance in the Carpathians?
- Barriers and opportunities?



Land-use in the region

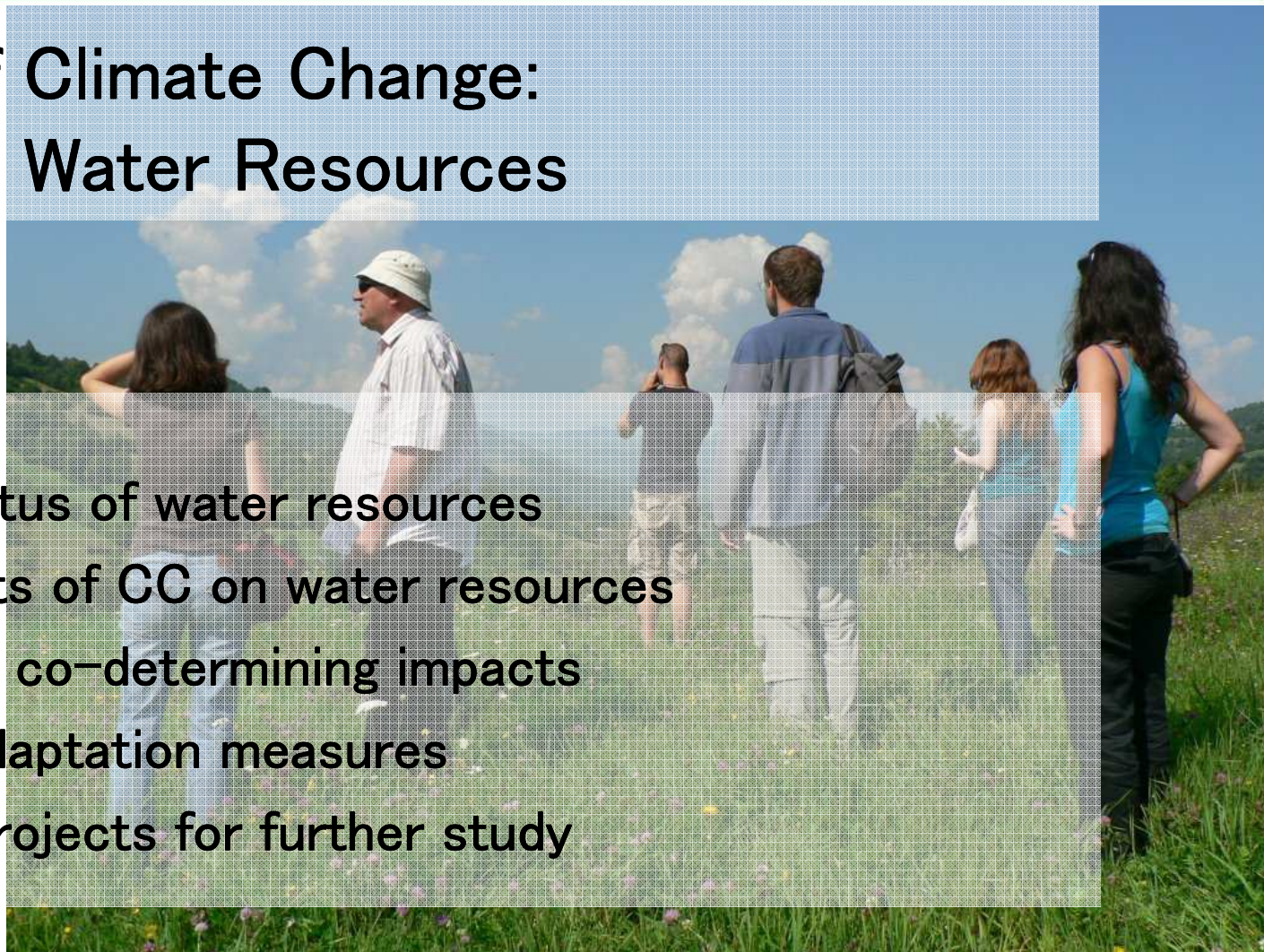
49,2% forests, 39,2% agricultural lands

Country	Virgin forest area in the Carpathian region (ha)
Czech Republic	463
Hungary	n.a.
Poland	55 645
Romania	207 500
Serbia	3 248
Slovakia	15 428
Ukraine	40 300
Total	322 610



Impacts of Climate Change: Threats to Water Resources

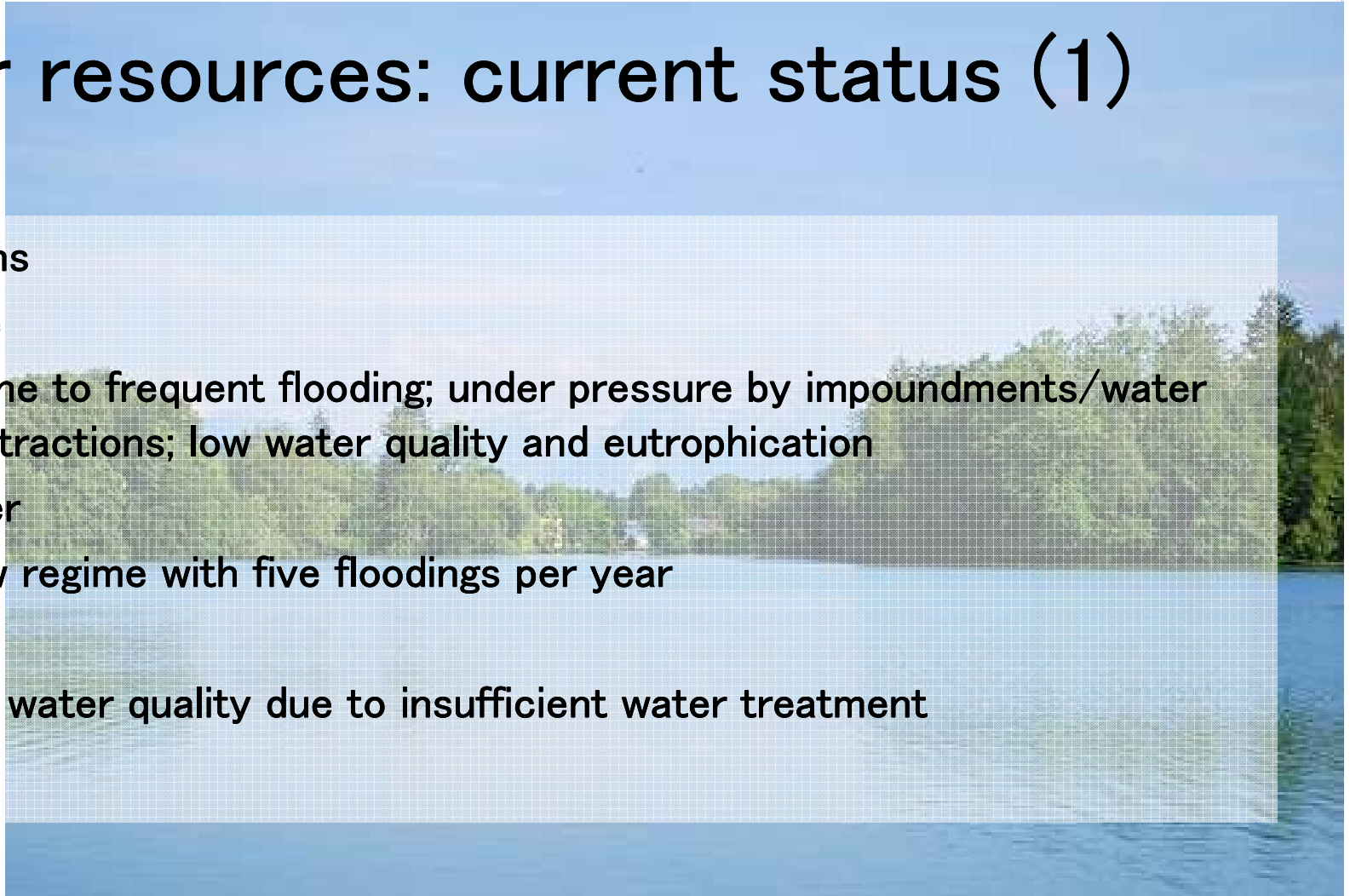
- Current status of water resources
- Main impacts of CC on water resources
- Key factors co-determining impacts
- Potential adaptation measures
- Proposed projects for further study



Water resources: current status (1)

River basins

- Danube
 - prone to frequent flooding; under pressure by impoundments/water abstractions; low water quality and eutrophication
- Dniester
 - flow regime with five floodings per year
- Vistula
 - low water quality due to insufficient water treatment



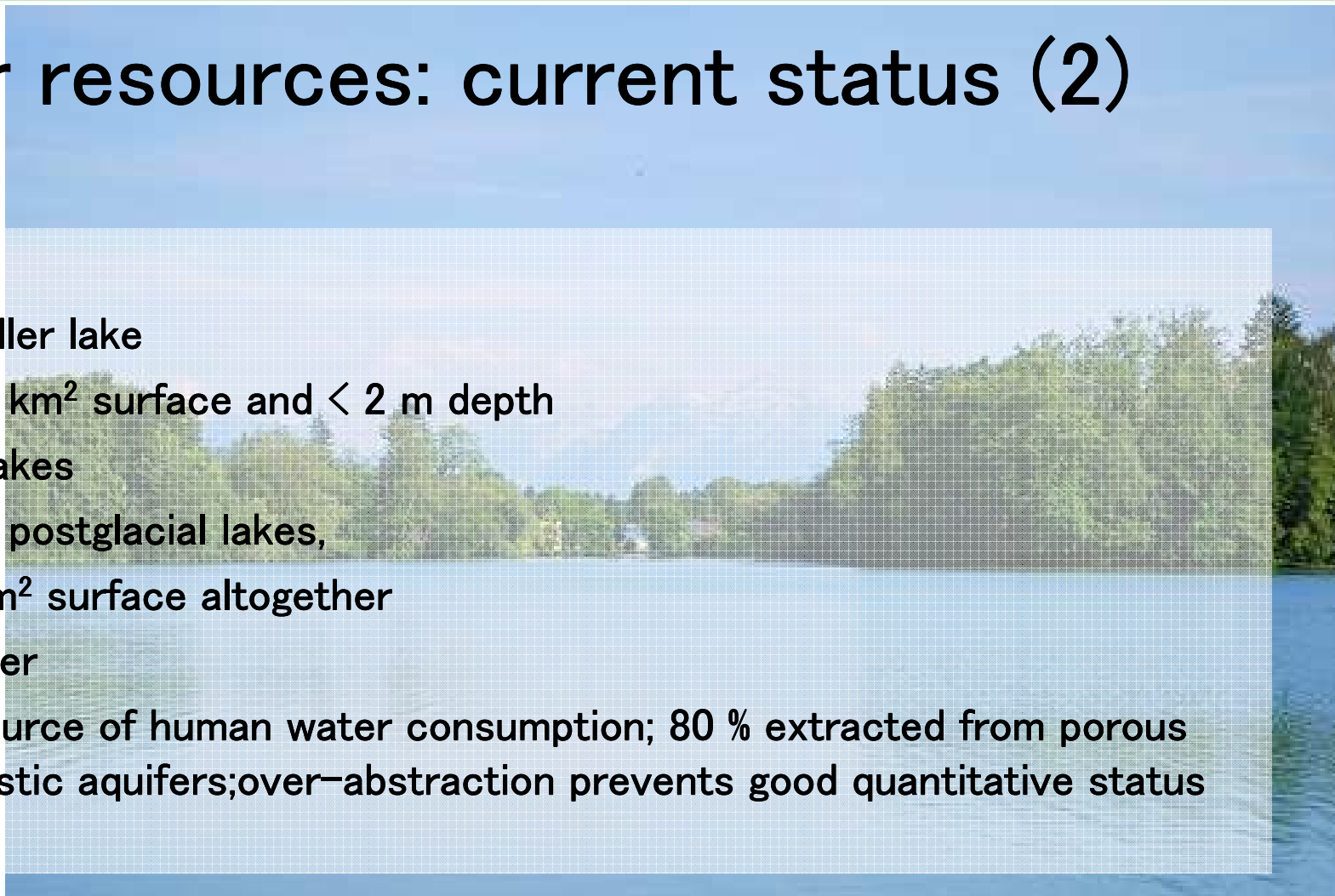
Water resources: current status (2)

Lakes

- Neusiedler lake
 - 315 km² surface and < 2 m depth
- Other lakes
 - 450 postglacial lakes,
 - 4 km² surface altogether

Groundwater

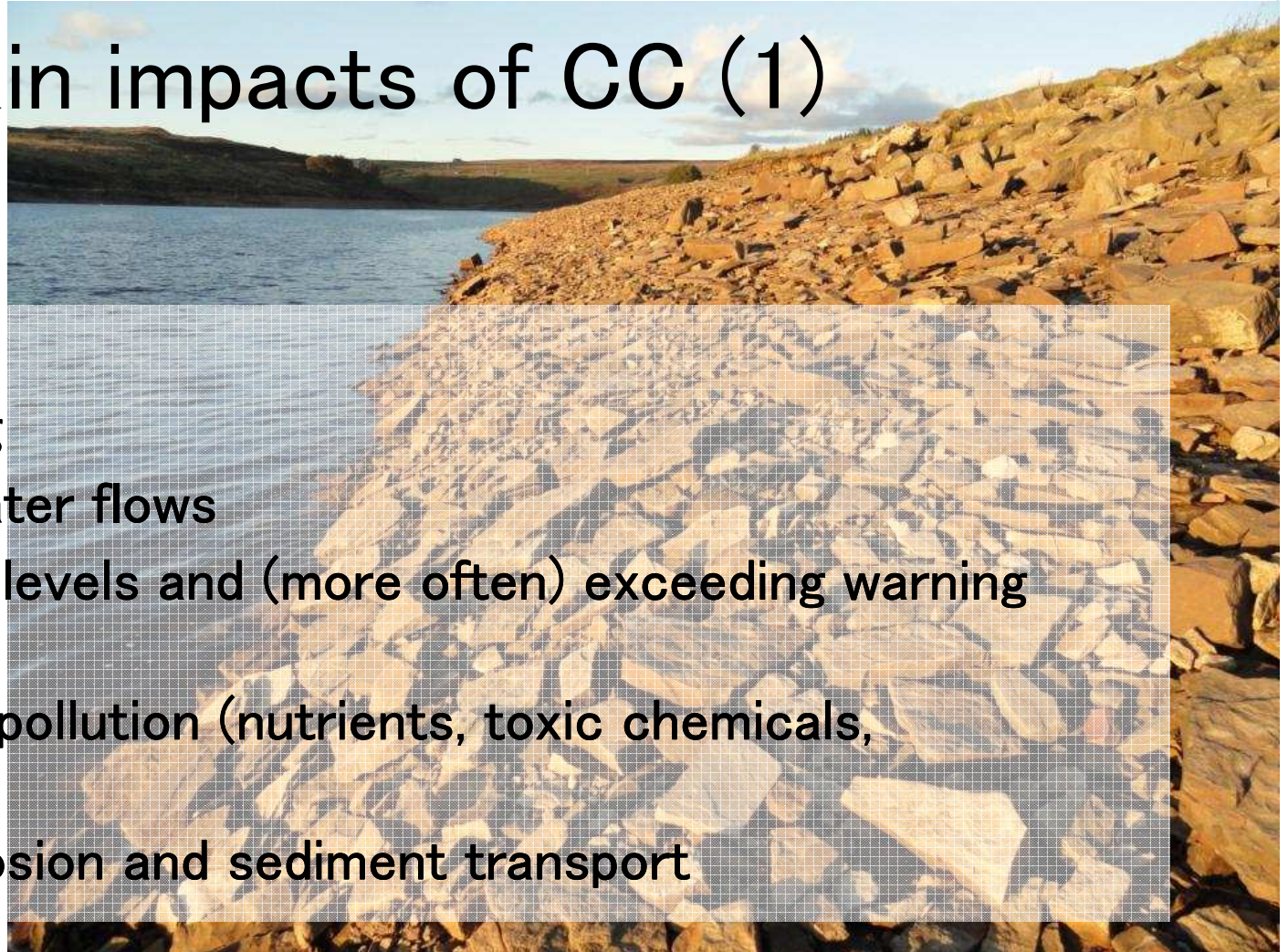
- Main source of human water consumption; 80 % extracted from porous and karstic aquifers; over-abstraction prevents good quantitative status



Rivers: main impacts of CC (1)

Floods

- More flooding
- Increasing water flows
- Higher water levels and (more often) exceeding warning levels
- More diffuse pollution (nutrients, toxic chemicals, pathogens)
- Increased erosion and sediment transport



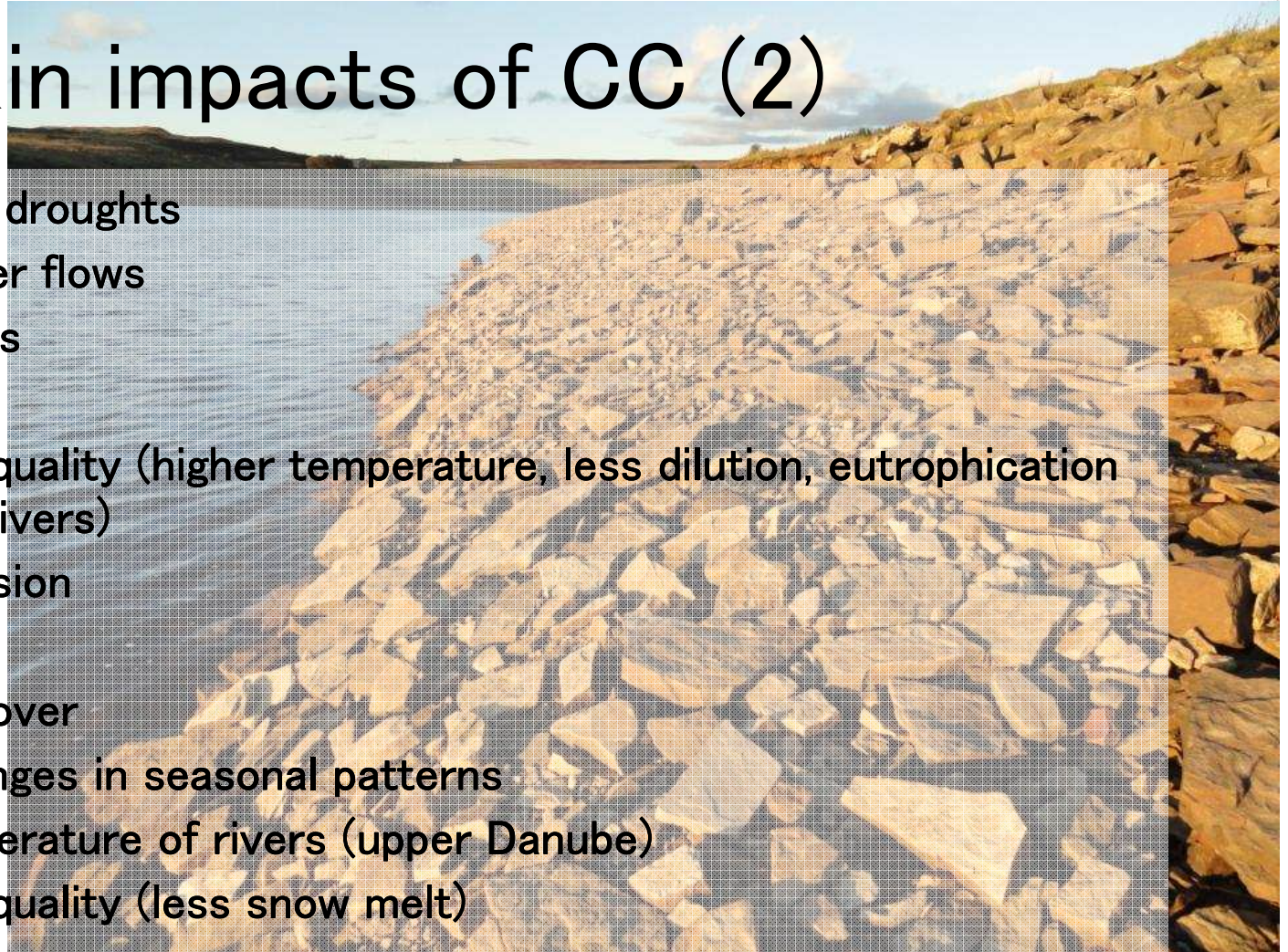
Rivers: main impacts of CC (2)

Water scarcity and droughts

- Decreasing water flows
- Low water tables
- Temperature
- Impaired water quality (higher temperature, less dilution, eutrophication in slow flowing rivers)
- Salt water intrusion

Changes in snow cover

- Water flow; changes in seasonal patterns
- Increasing temperature of rivers (upper Danube)
- Impaired water quality (less snow melt)



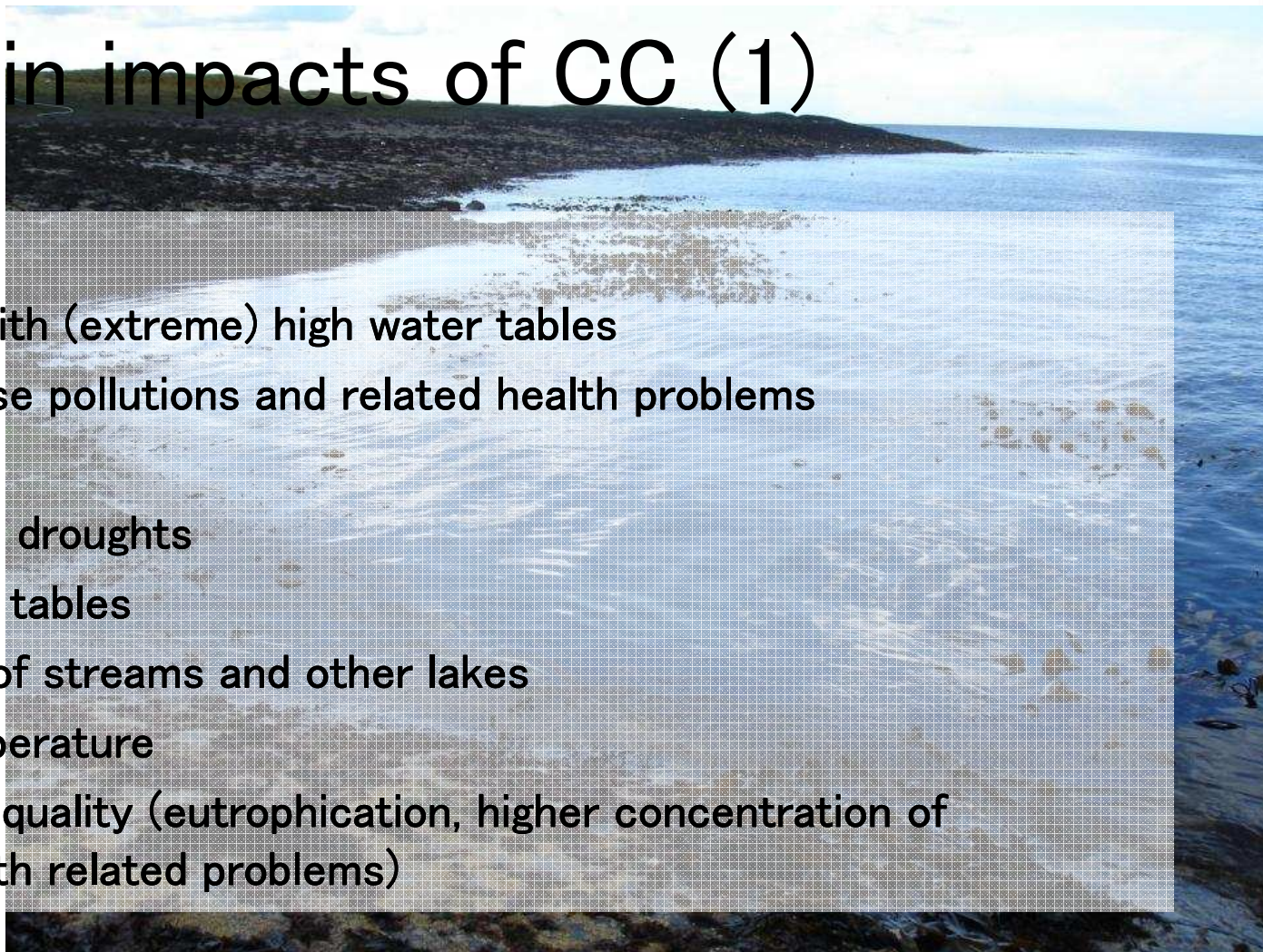
Lakes: main impacts of CC (1)

Floods

- More periods with (extreme) high water tables
- Increased diffuse pollutions and related health problems

Water scarcity and droughts

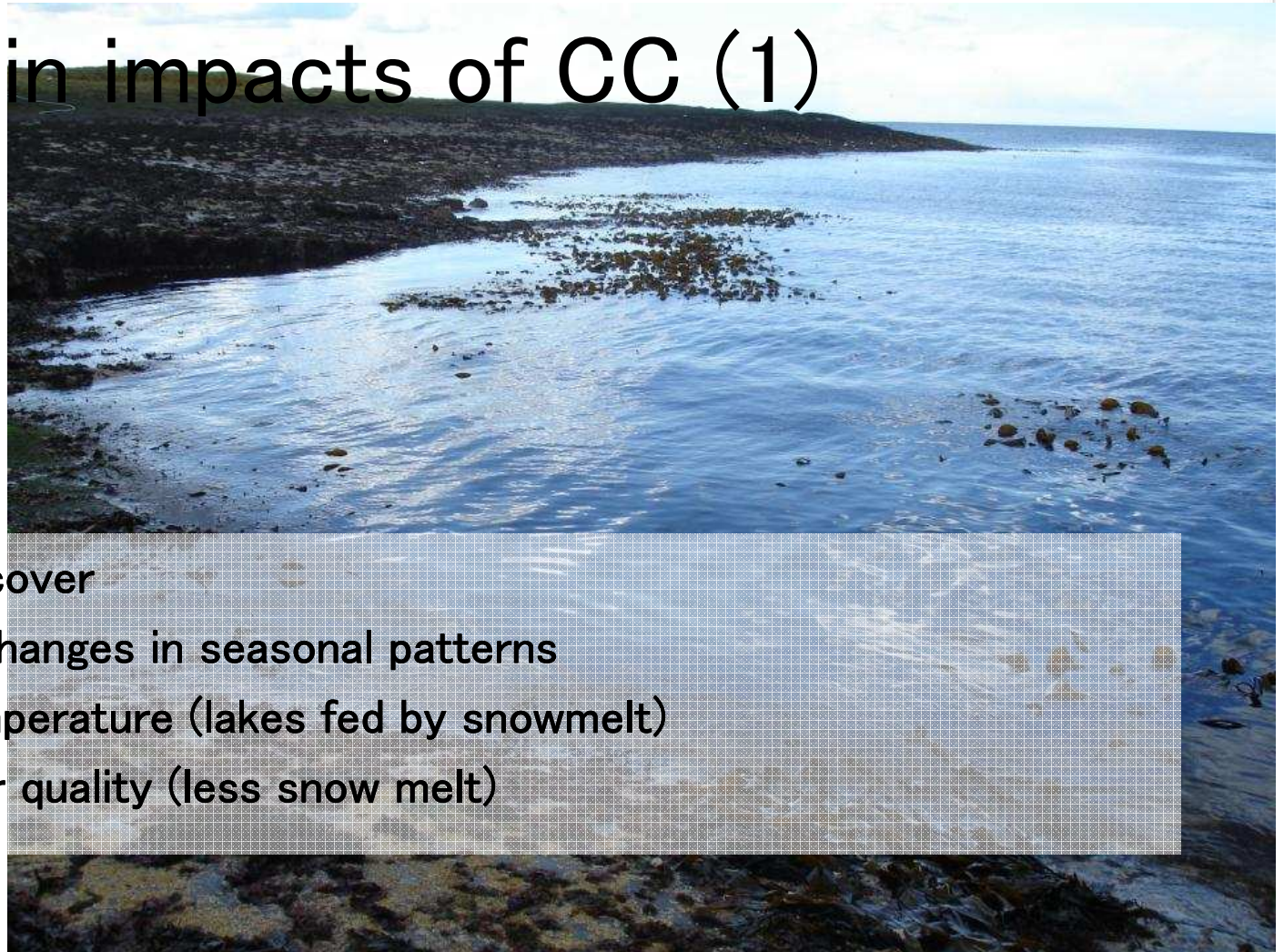
- Lowering water tables
- Disconnection of streams and other lakes
- Increasing temperature
- Impaired water quality (eutrophication, higher concentration of pollutants, health related problems)



Lakes: main impacts of CC (1)

Changes in snow cover

- Water tables; changes in seasonal patterns
- Increasing temperature (lakes fed by snowmelt)
- Impaired water quality (less snow melt)



Main impacts of CC on Groundwater

Floods

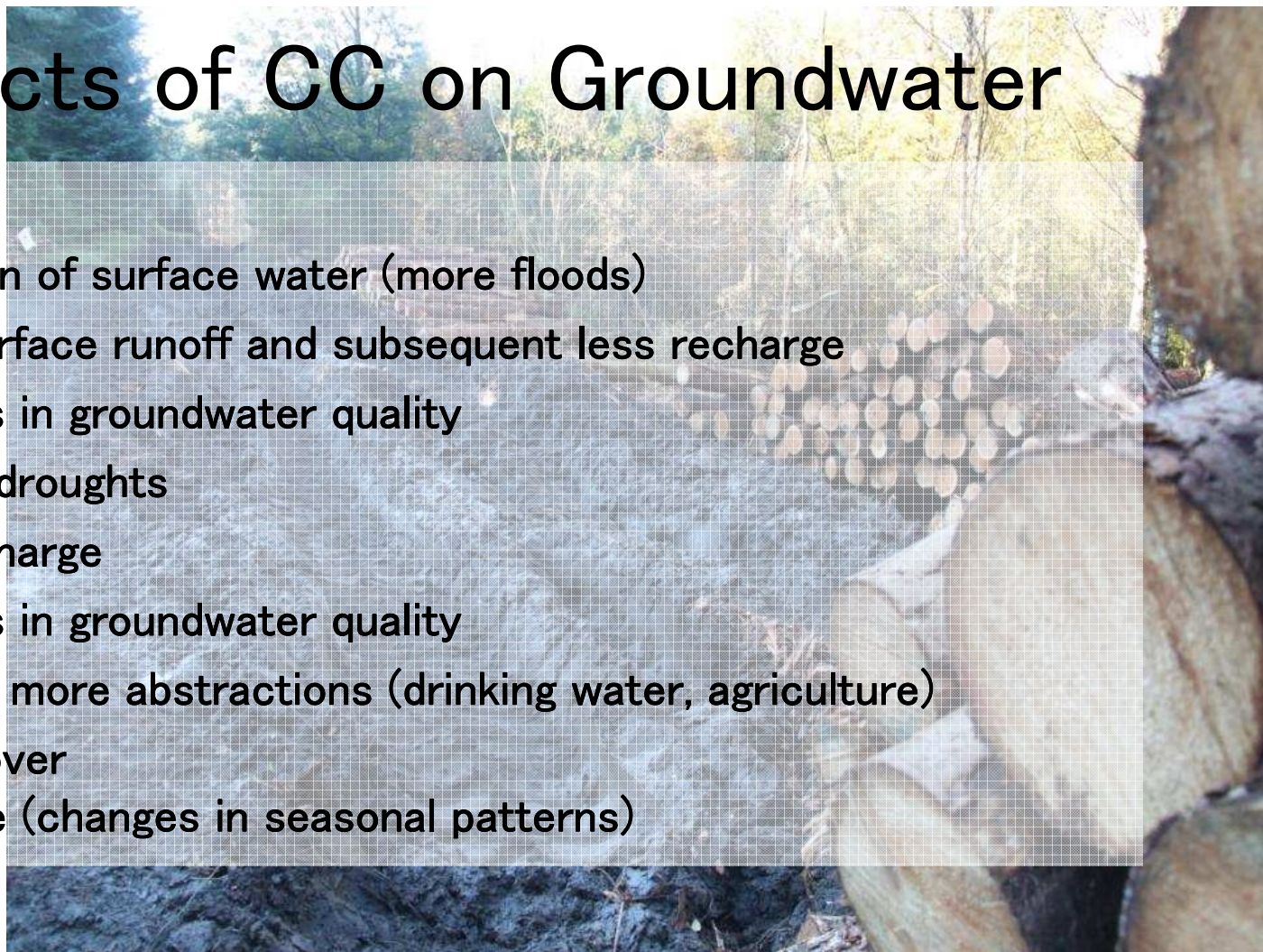
- Infiltration of surface water (more floods)
- More surface runoff and subsequent less recharge
- Changes in groundwater quality

Water scarcity and droughts

- Less recharge
- Changes in groundwater quality
- Indirect: more abstractions (drinking water, agriculture)

Changes in snow cover

- Recharge (changes in seasonal patterns)



Key factors co- determining impacts

- Altitude
- Land-use
- Topography



Floods: potential adaptation measures

Non-technical measures	Technical measures
Afforestation	Reallocation of houses to less vulnerable areas
Warning systems	Ground floor space
Preparation programmes	Retention reservoirs for floods
Acquisition of operational flood prevention And cooperation between authorities	Increasing natural retention and storage capacity of reservoirs in rural and urban areas
Incentives to provide flood storage	Increasing water discharge capacity of rivers and floodplains (deepening of river meadow, obstacle removal)
Rainwater and storm water management in urban areas	Acquisition of temporary flood control structures
Changing land use and strategic zoning	Dike and dam construction and improvement
	River restoration (room for the river)

Water scarcity and droughts: potential adaptation measures

Non-technical measures	Technical measures
Adopt long-term perspective in planning, modelling and management	Irrigation strategy
Develop adaptation programmes	Move power plants to coastal area
Weather derivatives	New water supply options
Restrictions and consumption cuts	Sustainable drainage systems
Drought management plans	Water sensitive urban design
Droughts communication system	Silvicultural management – improve tree water balance
Monitoring to provide information that may indicate inception of drought	
Raise awareness for efficient water use	

Water quality: potential adaptation measures

Non-technical measures	Technical measures
Develop monitoring programmes for surface water quality	Install purification facility
Develop management strategies for fertilizer and waste	Create areas for lagooning, surface impoundment
Adopt quality goals and develop management plans	Different fertilizer (slow release of nutrients, prevent leaching of excess fertilizer)

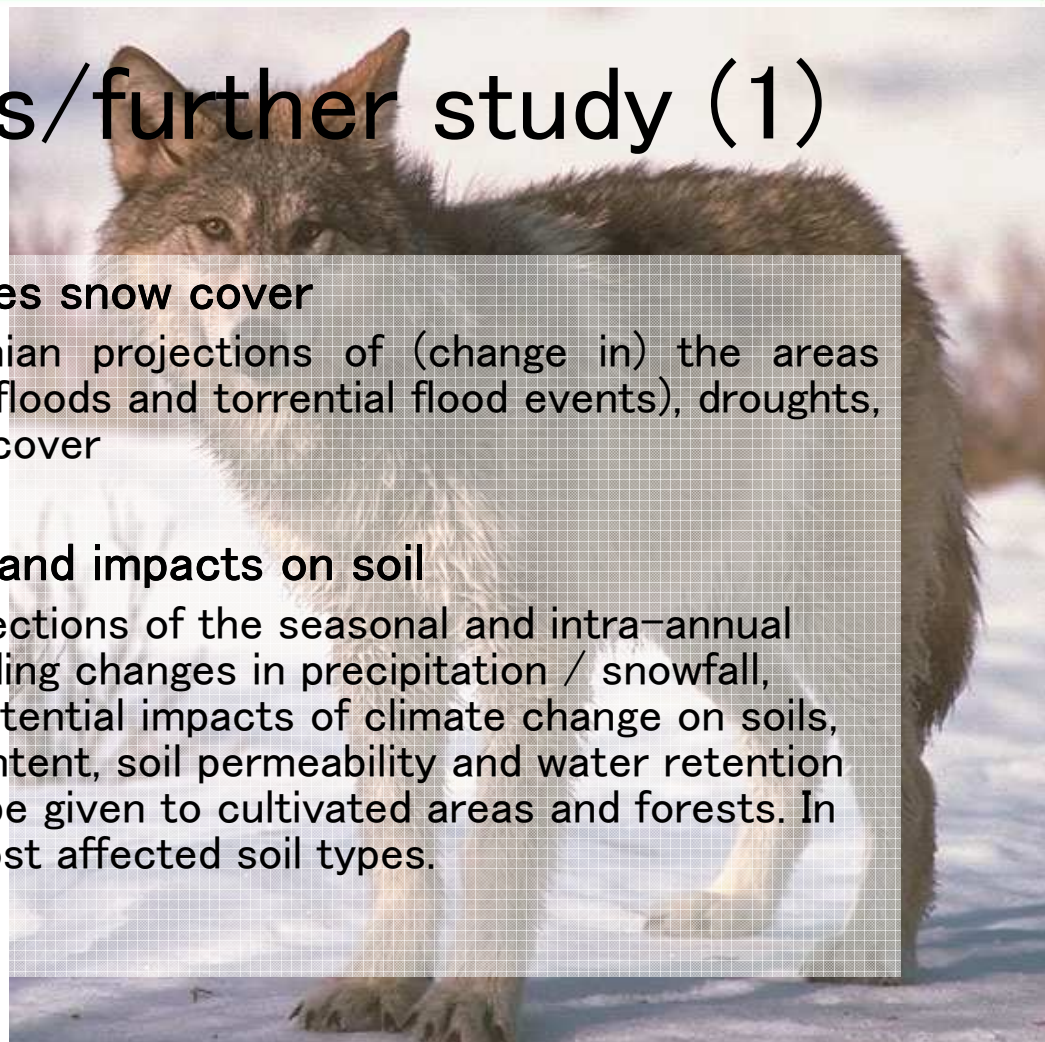
Proposed projects/further study (1)

Map floods, droughts and changes snow cover

- **Objective:** Deliver pan-carpathian projections of (change in) the areas affected by floods (both winter floods and torrential flood events), droughts, heat waves and changing snow cover

Seasonal shift in water balance and impacts on soil

- **Objective:** Carpathian wide projections of the seasonal and intra-annual changes in water balance, including changes in precipitation / snowfall, evaporation. Inventory of the potential impacts of climate change on soils, especially on organic matter content, soil permeability and water retention capacity. Special attention will be given to cultivated areas and forests. In addition, identification of the most affected soil types.



Proposed projects/further study (2)

Assessment of impacts of CC on the implementation of the water framework directive and flood directive

- **Objective:** Determine trends in and criteria to switch to “climate adjusted” values of the reference conditions. Evaluate the implementation of the Water Framework Directive and Flood Directive under climate change and in particular the performance of criteria and markers for ecological status.

Risk of landslides in relation to changing precipitation patterns and flash floods

- **Objective / Product:** Development of future Landslide and Mudflow Maps for the Carpathian region. The current satellite technology also allows for better monitoring of slope movement and early warning. The analysis can serve as foundations for measures, including land use planning and stabilization works.

Key Questions

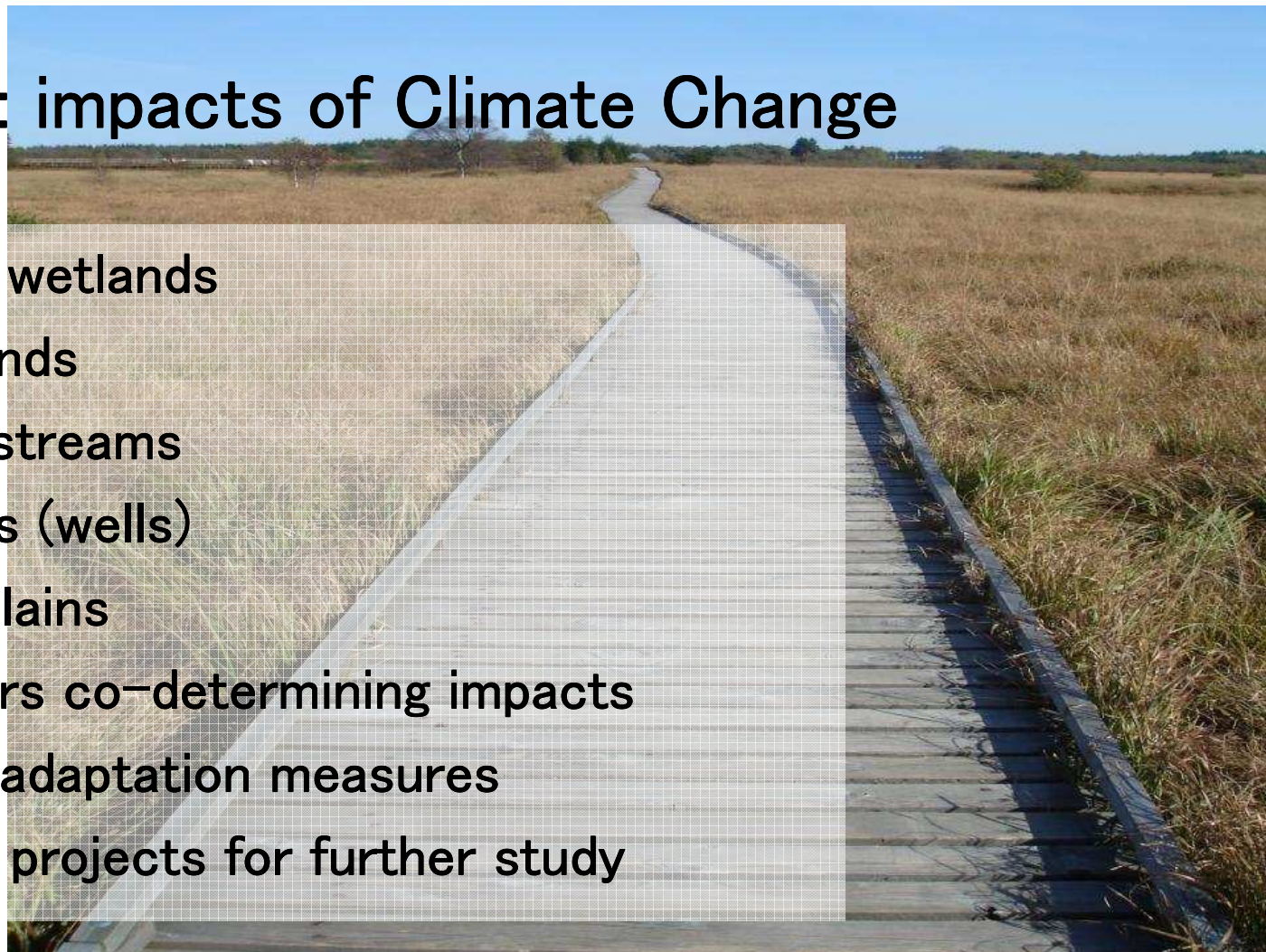
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Wetlands: impacts of Climate Change

Overview of wetlands

- ✓ Peatlands
- ✓ Small streams
- ✓ Springs (wells)
- ✓ Floodplains
- Key factors co-determining impacts
- Potential adaptation measures
- Proposed projects for further study

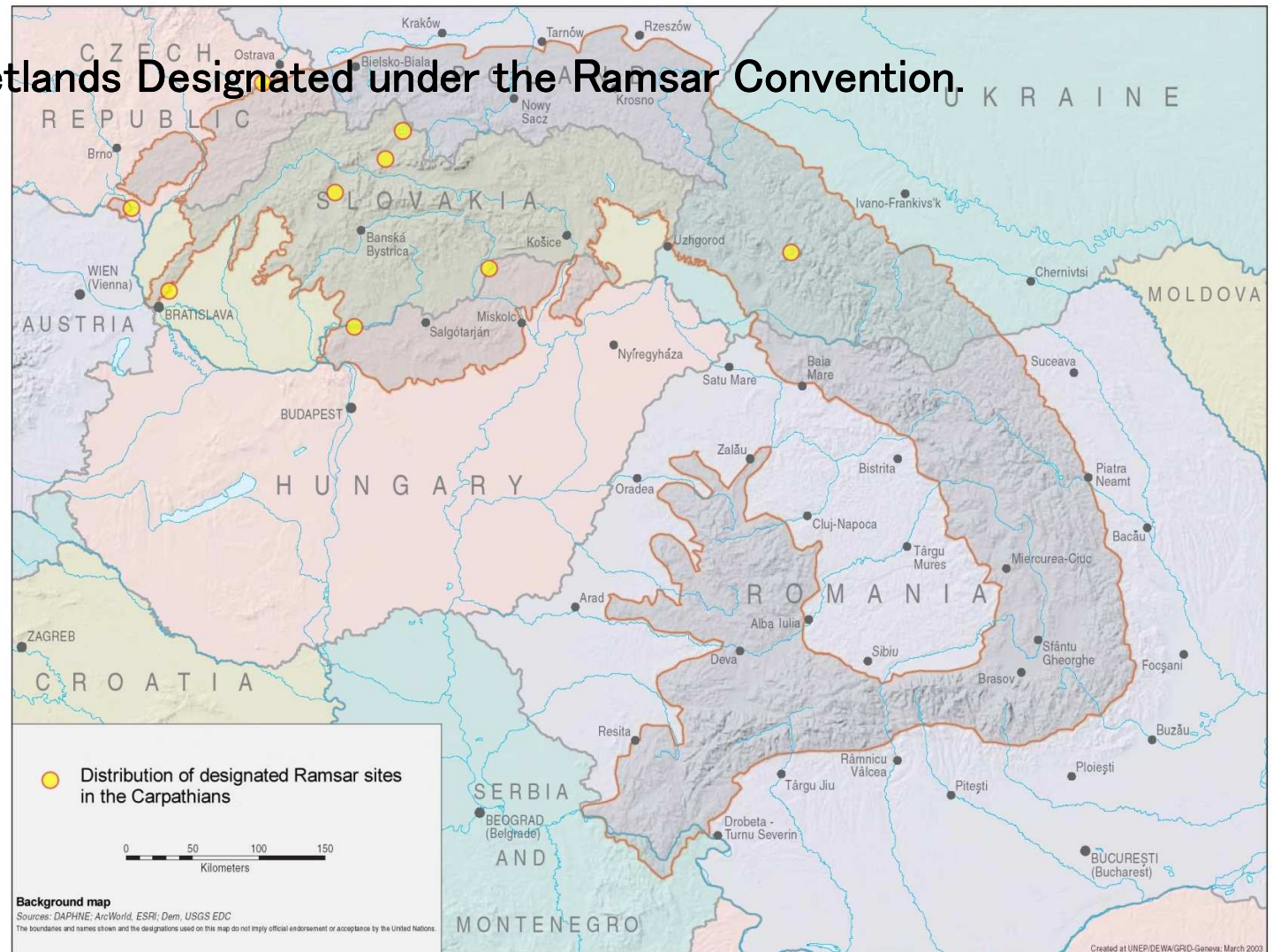


Current status of wetland ecosystems

- No coherent overview available
- Wetlands in the Carpathians are usually small
- The diversity is high. (51 wetland habitats in the Western Carpathians)
- Peatlands (fens, bogs) are especially vulnerable to climate change



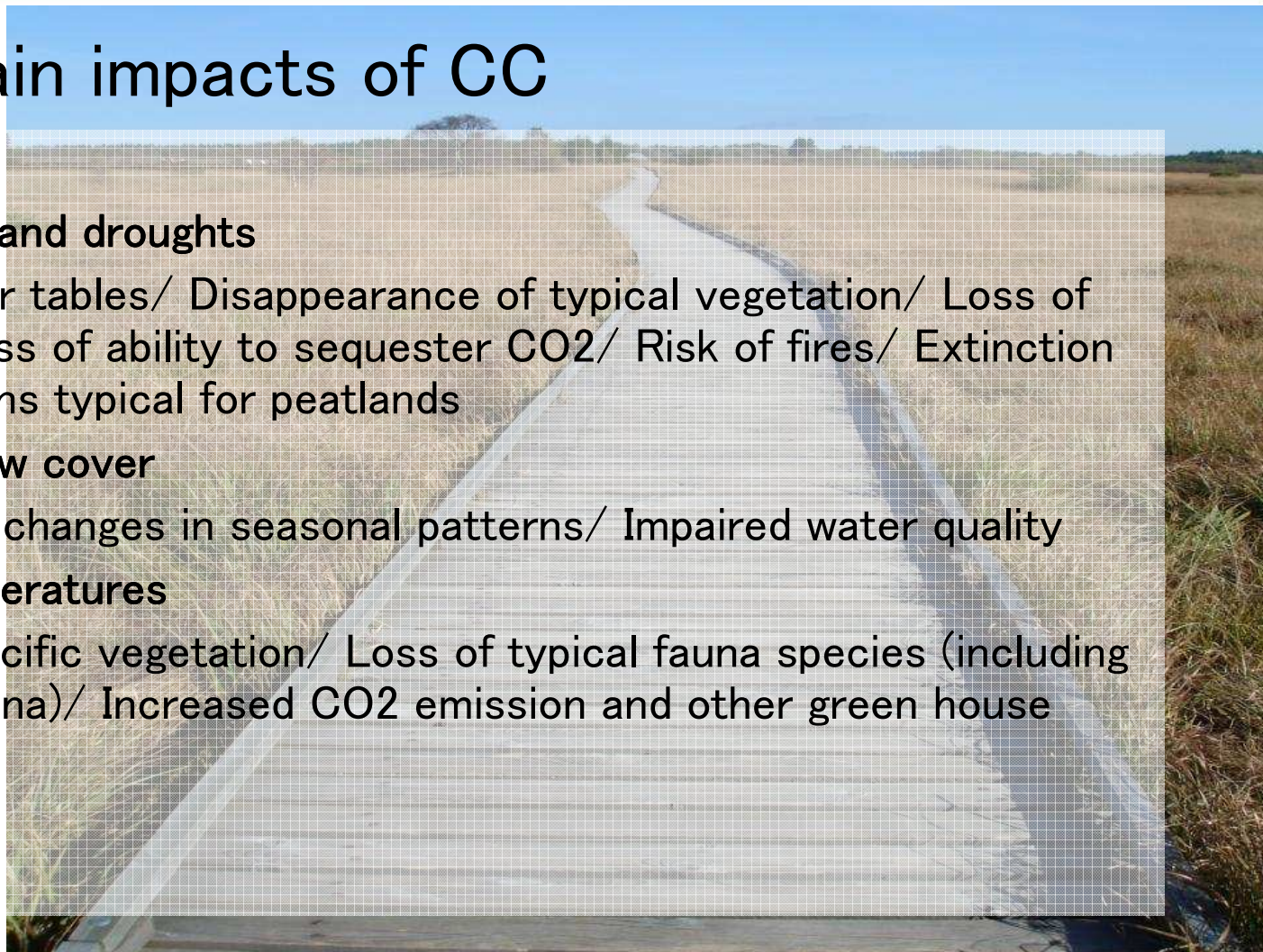
Distribution of Wetlands Designated under the Ramsar Convention.



Wetlands: main impacts of CC

Peatlands

- **Water scarcity and droughts**
 - Lower water tables/ Disappearance of typical vegetation/ Loss of habitat/ Loss of ability to sequester CO₂/ Risk of fires/ Extinction of amphibians typical for peatlands
- **Changes in snow cover**
 - Water flow; changes in seasonal patterns/ Impaired water quality
- **Increased temperatures**
 - Loss of specific vegetation/ Loss of typical fauna species (including entomo-fauna)/ Increased CO₂ emission and other green house gasses
- **Floods**
 - Unknown



Wetlands: main impacts of CC

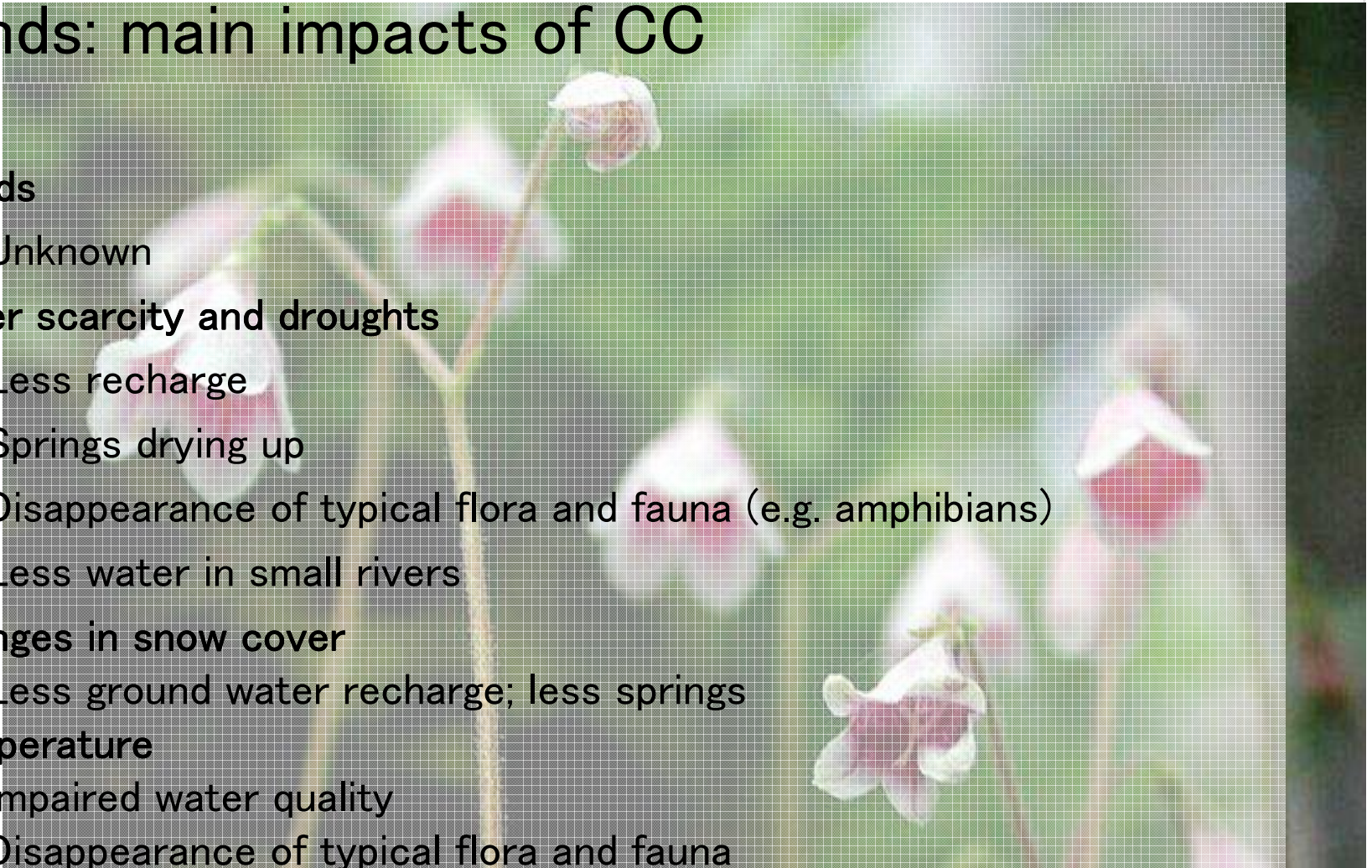
Small streams

- **Floods**
 - More periods with (extreme) high water tables resulting in flash floods/ Changes in the morphology (caused by flash floods)/ Changes in the flora and fauna
- **Water scarcity and droughts**
 - Periods without discharge/ Habitat loss/ Changes in fauna and flora/ Impaired water quality (eutrophication, higher concentration of pollutants,)
- **Increased temperature**
 - Shorter periods with discharge/ Impaired water quality
- **Changes in snow cover**
 - Unknown

Wetlands: main impacts of CC

Springs

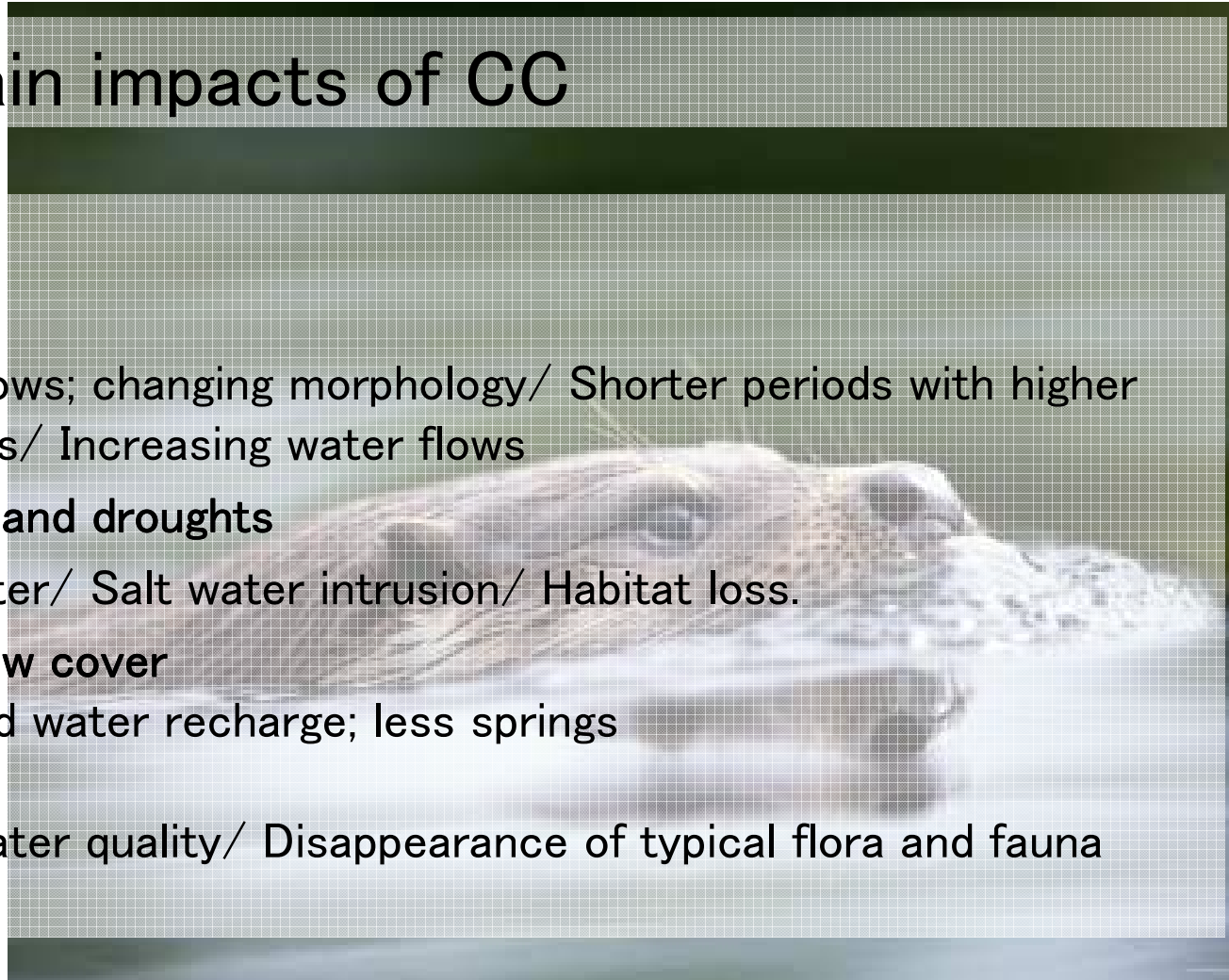
- **Floods**
 - Unknown
- **Water scarcity and droughts**
 - Less recharge
 - Springs drying up
 - Disappearance of typical flora and fauna (e.g. amphibians)
 - Less water in small rivers
- **Changes in snow cover**
 - Less ground water recharge; less springs
- **Temperature**
 - Impaired water quality
 - Disappearance of typical flora and fauna



Wetlands: main impacts of CC

Floodplains

- **Floods**
 - Stronger flows; changing morphology/ Shorter periods with higher water tables/ Increasing water flows
- **Water scarcity and droughts**
 - Lack of water/ Salt water intrusion/ Habitat loss.
- **Changes in snow cover**
 - Less ground water recharge; less springs
- **Temperature**
 - Impaired water quality/ Disappearance of typical flora and fauna



Floods: potential adaptation measures

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Proposed projects further study

Map wetlands across the Carpathians

Objective: Deliver pan-Carpathian overview of the location, size and value of wetlands across the Carpathians to be able to make predictions on the impact of climate change, design targeted adaptation schemes and implement protection and restoration plans.

Detailed study of the impact of climate change on water availability and water quality on the various types of wetlands

Objective: To be able to design adaptation and management measures information is needed about the impact of climate change on the availability and quality of water for the various types of wetlands.

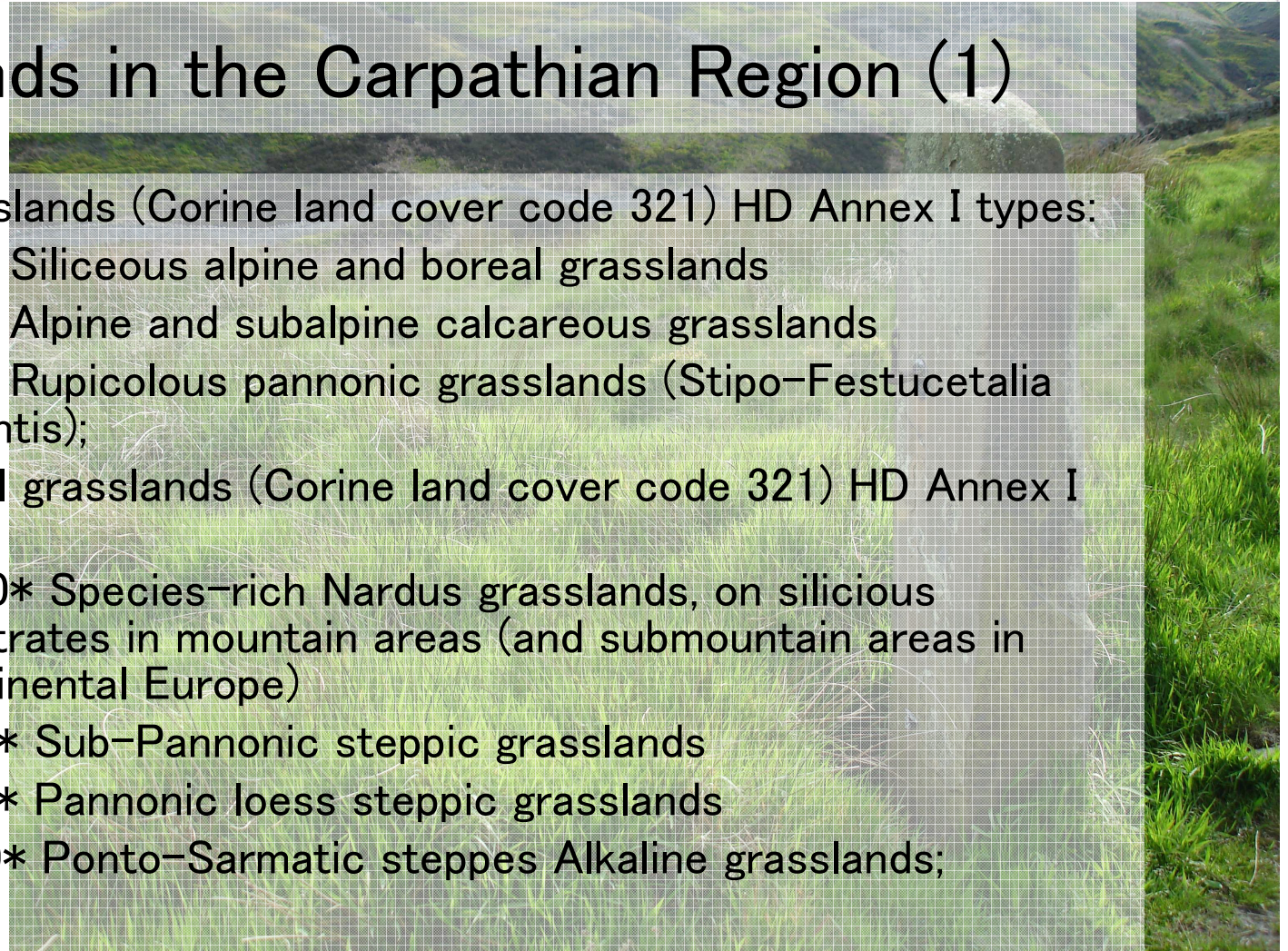
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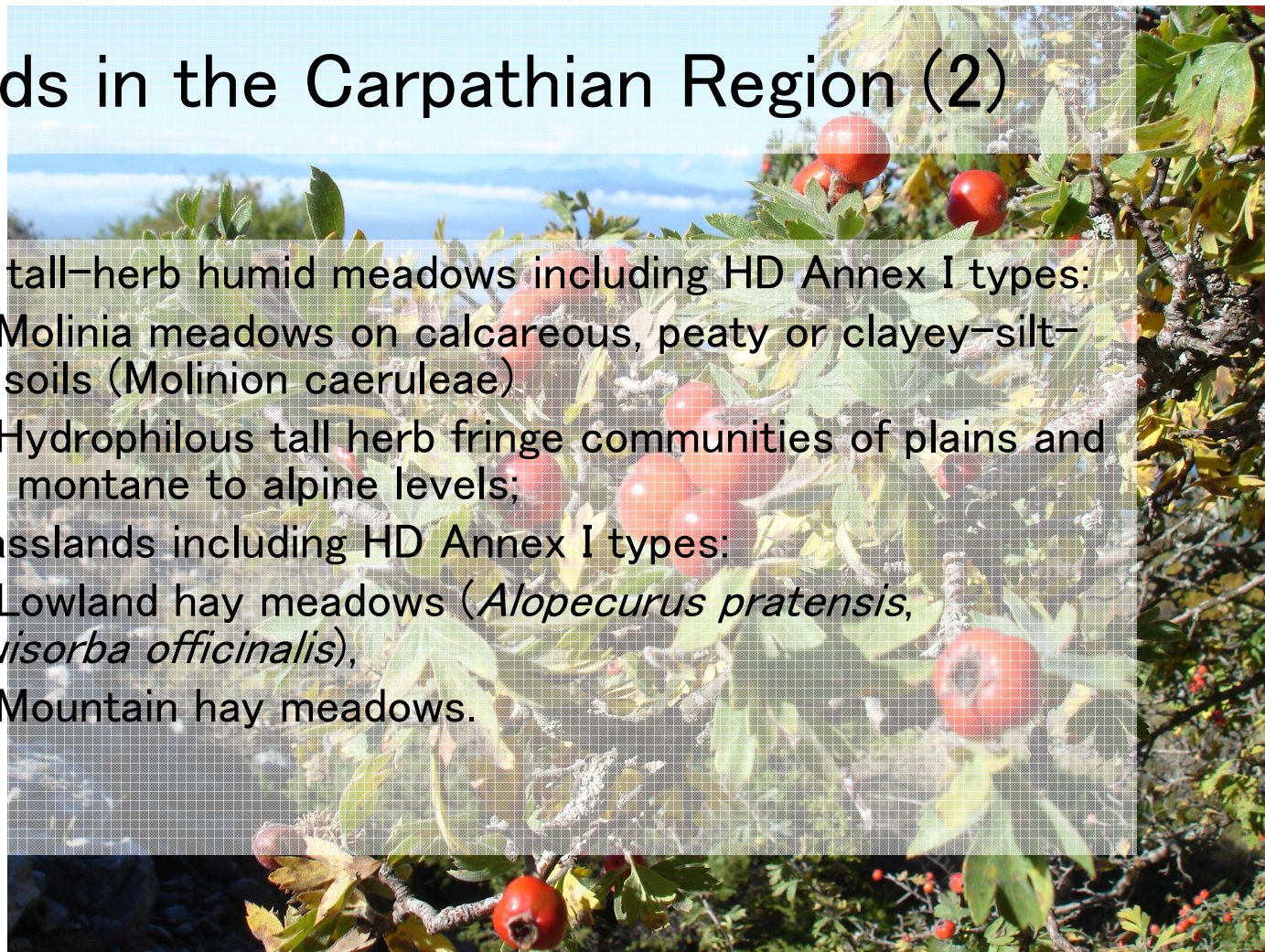
Grasslands in the Carpathian Region (1)

- Natural grasslands (Corine land cover code 321) HD Annex I types:
 - 6150 Siliceous alpine and boreal grasslands
 - 6170 Alpine and subalpine calcareous grasslands
 - 6190 Rupicolous pannonic grasslands (*Stipo-Festucetalia pallentis*);
- Semi-natural grasslands (Corine land cover code 321) HD Annex I types:
 - 6230* Species-rich *Nardus* grasslands, on silicious substrates in mountain areas (and submountain areas in Continental Europe)
 - 6240* Sub-Pannonic steppic grasslands
 - 6250* Pannonic loess steppic grasslands
 - 62C0* Ponto-Sarmatic steppes Alkaline grasslands;



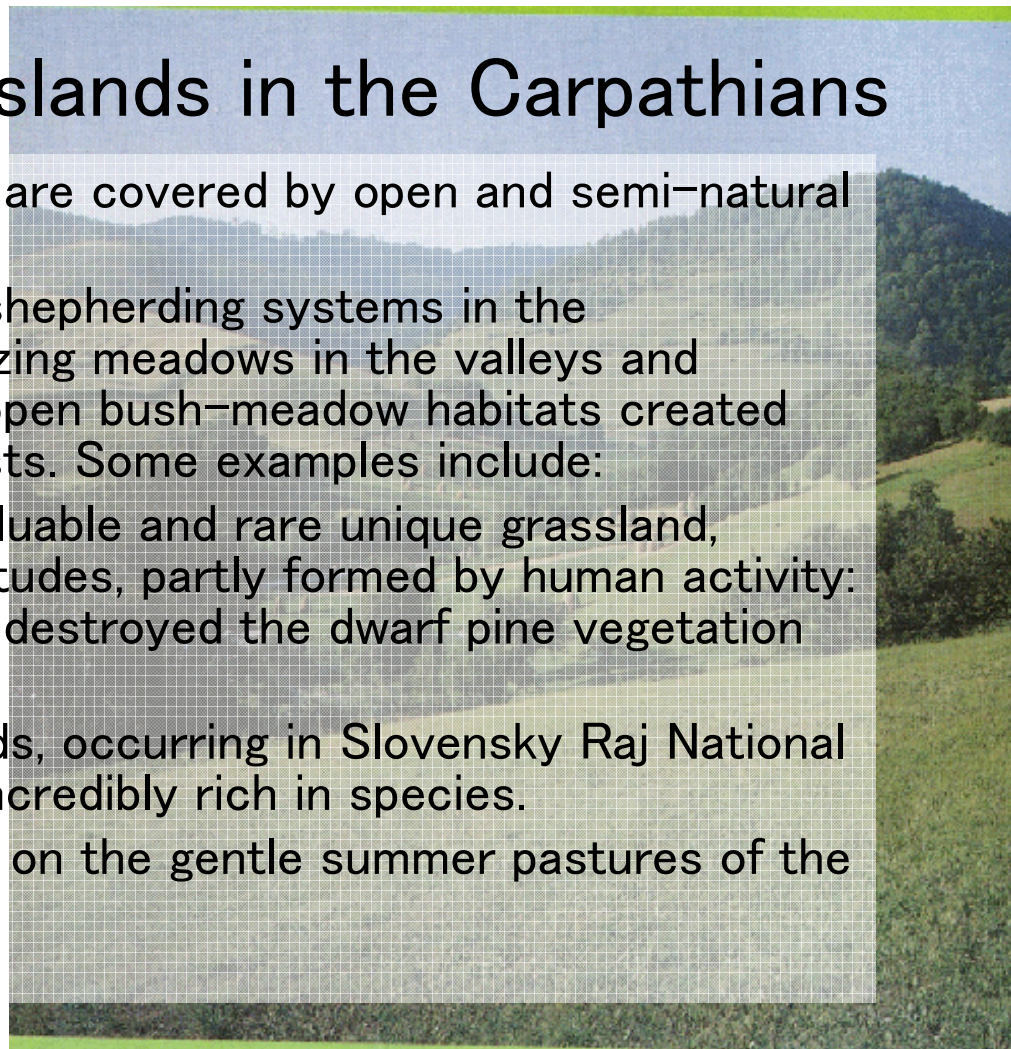
Grasslands in the Carpathian Region (2)

- Semi-natural tall-herb humid meadows including HD Annex I types:
 - 6410 *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)
 - 6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels;
- Mesophile grasslands including HD Annex I types:
 - 6510 Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*),
 - 6520 Mountain hay meadows.



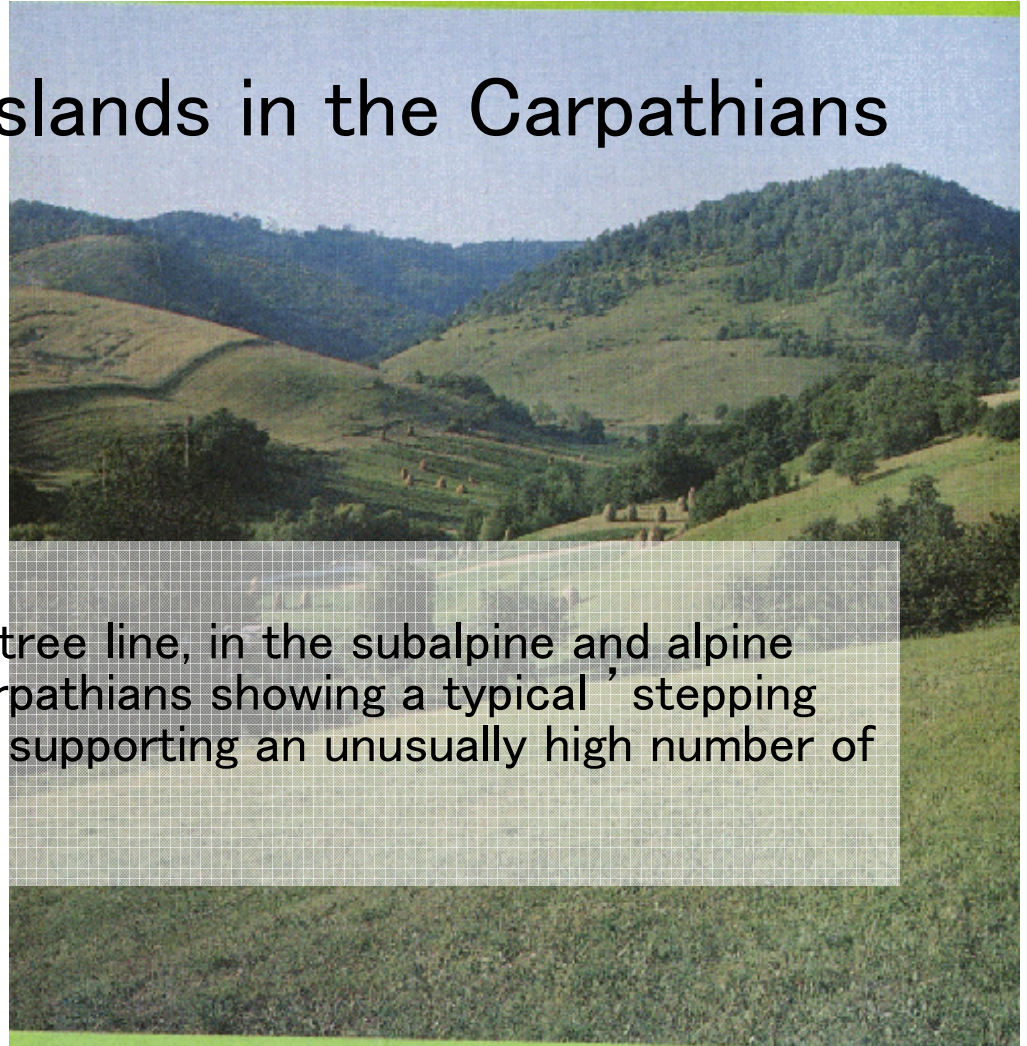
Current status of grasslands in the Carpathians

- Almost a third of the Carpathians are covered by open and semi-natural habitats, predominantly grassland,
- Over the generations, traditional shepherding systems in the Carpathians have created the grazing meadows in the valleys and mountain foothills; and the semi-open bush-meadow habitats created from grazing livestock in the forests. Some examples include:
 - The 'poloniny' meadows – valuable and rare unique grassland, occurring naturally at high altitudes, partly formed by human activity: where the grazing cattle have destroyed the dwarf pine vegetation and forests.
 - calcareous mountain grasslands, occurring in Slovensky Raj National Park in the Slovak Republic, incredibly rich in species.
 - open plant communities found on the gentle summer pastures of the Beskidy region;



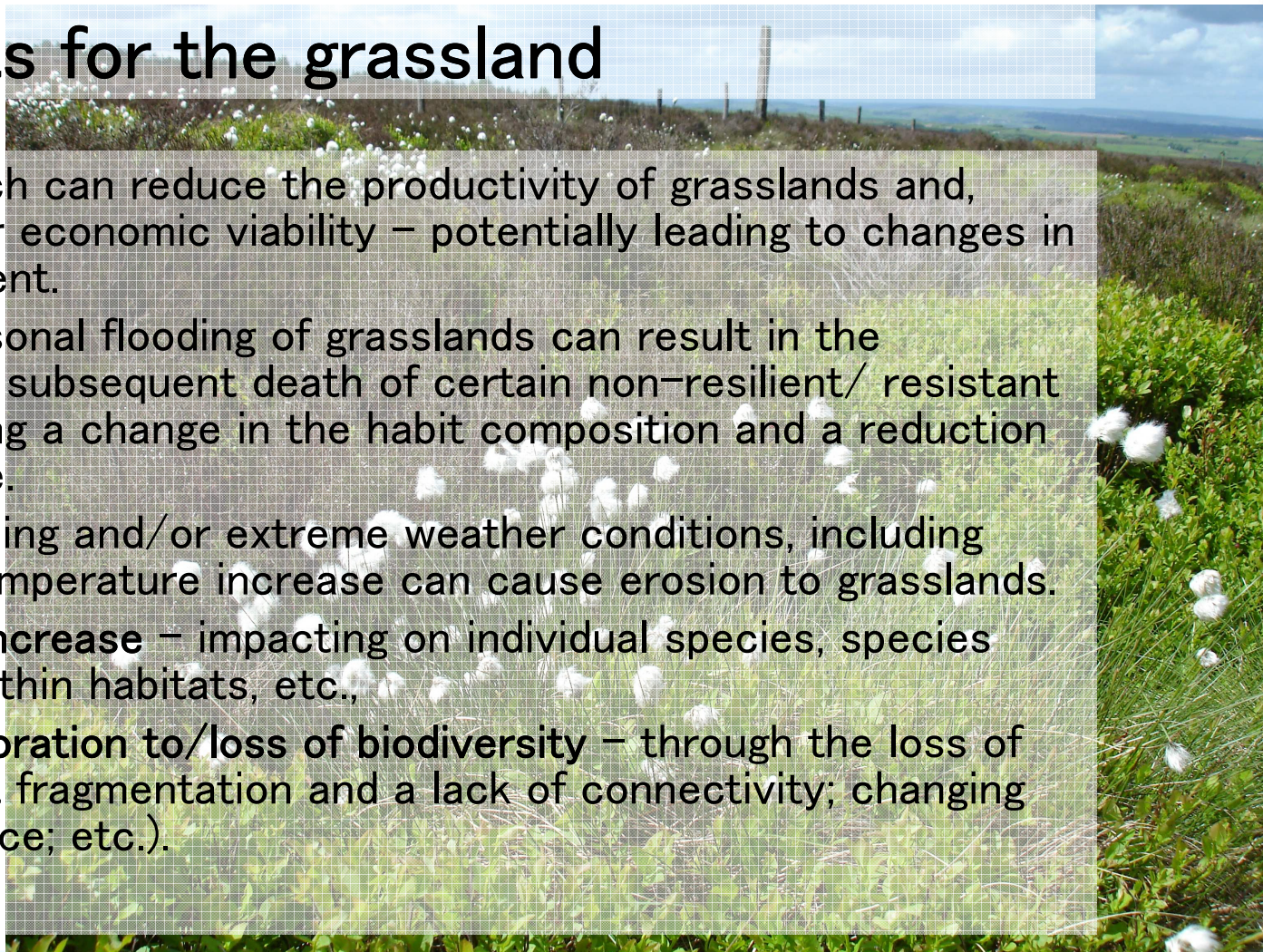
Current status of grasslands in the Carpathians

- Natural open habitats above the tree line, in the subalpine and alpine zones, are very limited in the Carpathians showing a typical 'stepping stone' pattern – very important, supporting an unusually high number of endemic species.



Main threats for the grassland

- **Drought** – which can reduce the productivity of grasslands and, therefore, their economic viability – potentially leading to changes in land management.
- **Flood** – unseasonal flooding of grasslands can result in the inundation and subsequent death of certain non-resilient/ resistant species, causing a change in the habit composition and a reduction in its resilience.
- **Erosion** – flooding and/or extreme weather conditions, including drought and temperature increase can cause erosion to grasslands.
- **Temperature increase** – impacting on individual species, species composition within habitats, etc.,
- **General deterioration to/loss of biodiversity** – through the loss of habitat; habitat fragmentation and a lack of connectivity; changing land use practice; etc.).

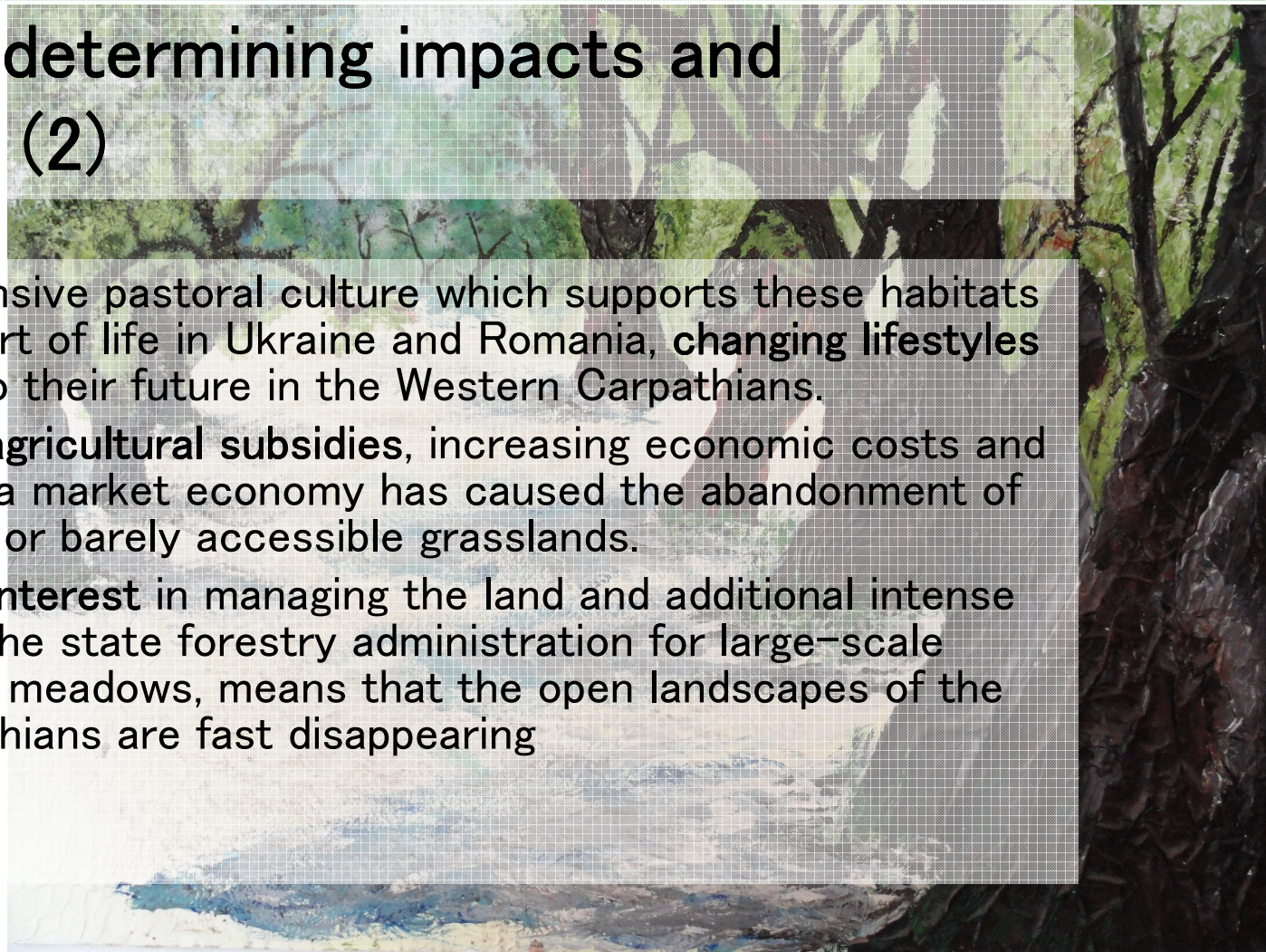


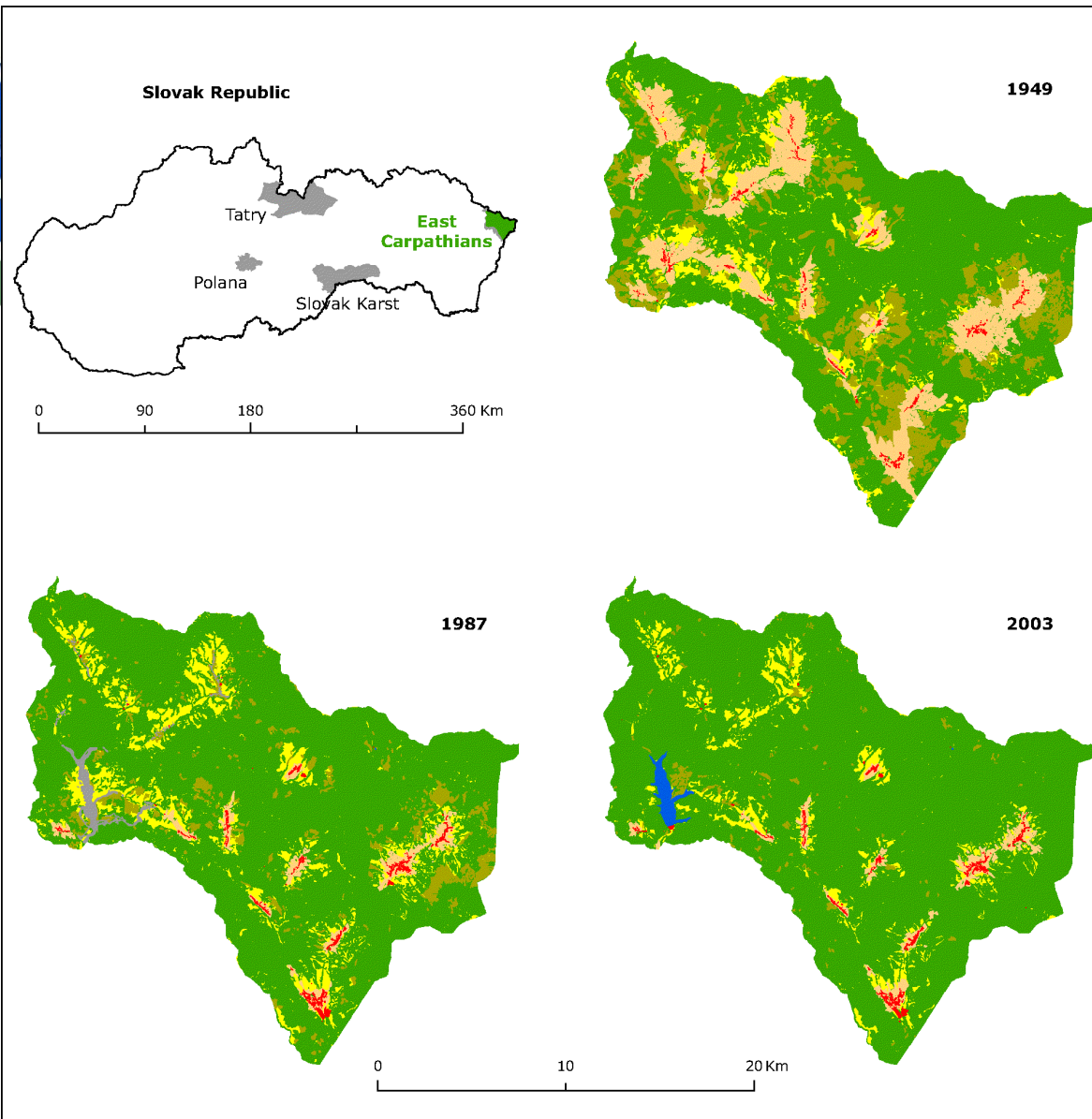
Factors co-determining impacts and vulnerability (1)

- Unemployment and poverty have accelerated rural decline leading to land abandonment; traditional forestry and agriculture are replaced by more intensive methods.
- **Highly fragmented land-ownership structure** is encouraging short-term forms of exploitation, such as heavy grazing at high altitudes and cropping on unstable slopes.
- **Increasing outside investments** coming into the region, political decentralisation and planning systems unable to cope with the new demands raise the chances of inappropriate development and threaten habitats with fragmentation

Factors co-determining impacts and vulnerability (2)

- Whilst the extensive pastoral culture which supports these habitats is still a vital part of life in Ukraine and Romania, **changing lifestyles** pose a threat to their future in the Western Carpathians.
- **A reduction in agricultural subsidies**, increasing economic costs and the transfer to a market economy has caused the abandonment of less productive or barely accessible grasslands.
- **A lack of local interest** in managing the land and additional intense pressure from the state forestry administration for large-scale afforestation of meadows, means that the open landscapes of the Western Carpathians are fast disappearing





Land use

■ Urbanised area	■ Agricultural mosaic	■ Shrub
■ Construction area	■ Grassland	■ Forest
		■ Water

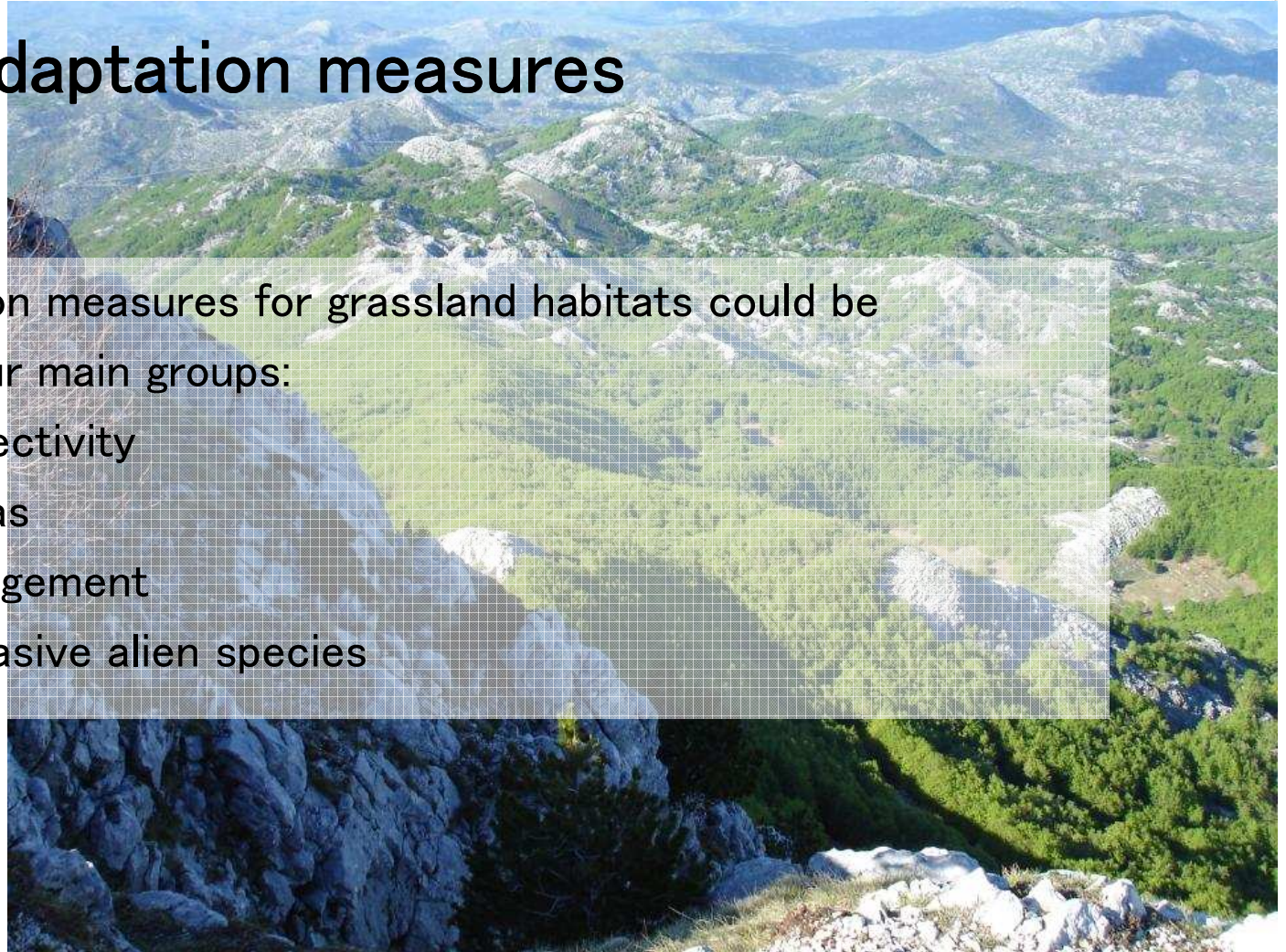
NT OF VULNERABILITY TO
ED ADAPTATION MEASURES

- Land use development of the East Carpathians Biosphere Reserve in 3 time series (1949, 1987, 2003) identified from aerial photographs (EEA, 2011)

Potential adaptation measures

Possible adaptation measures for grassland habitats could be summarised in four main groups:

- Increase connectivity
- Protected areas
- Adaptive management
- Combating invasive alien species



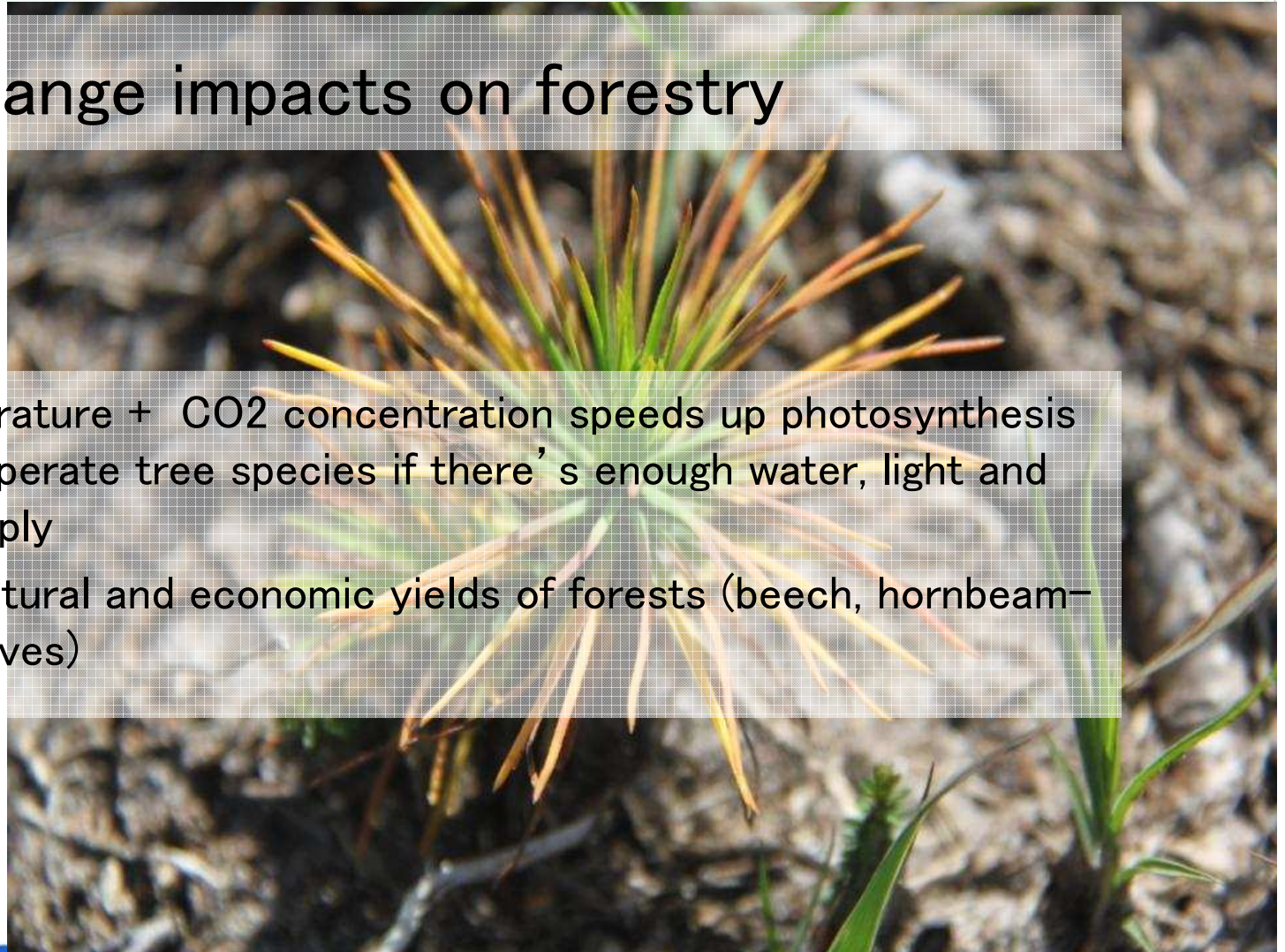
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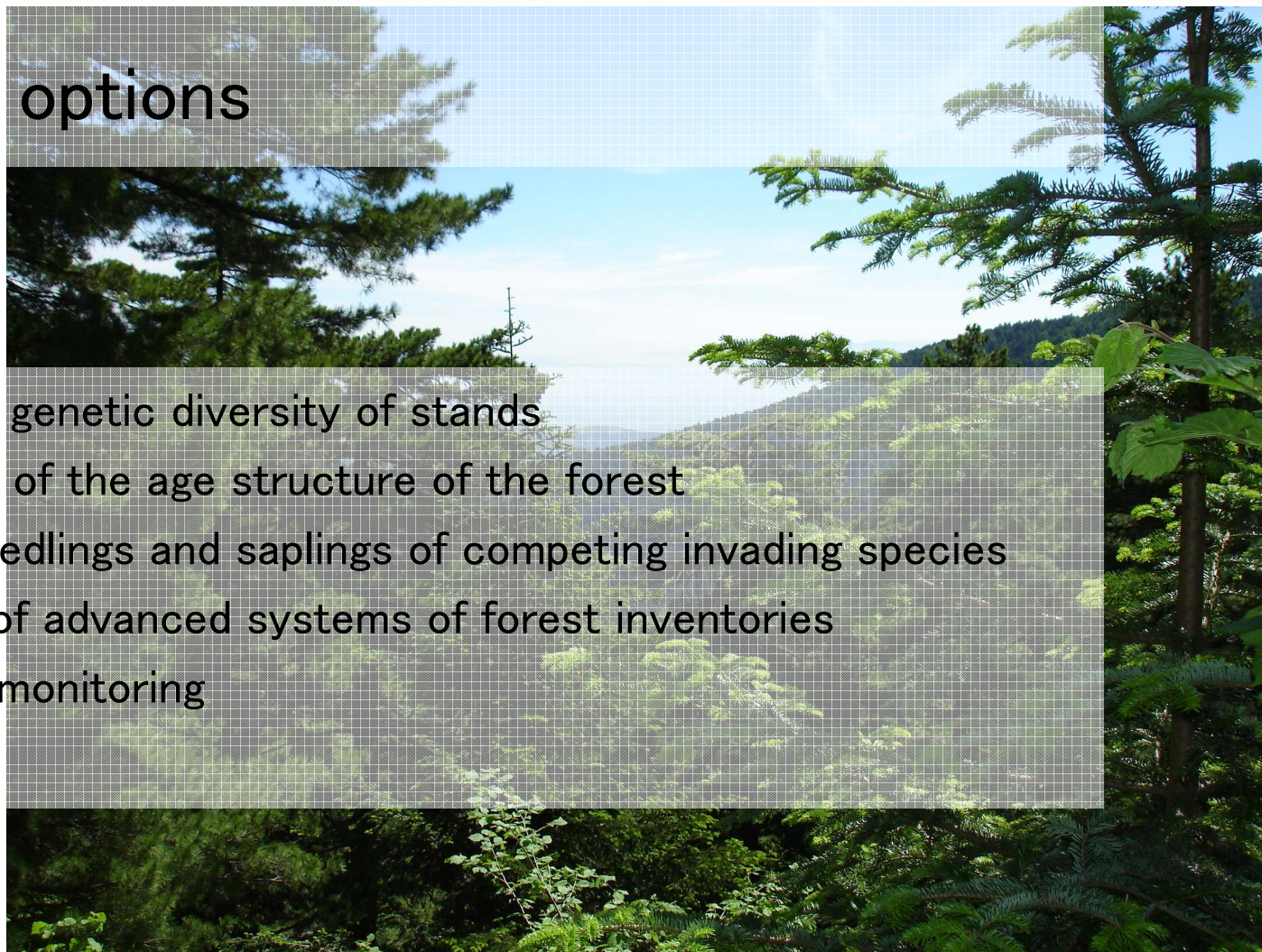
Climate change impacts on forestry

- ↑ · Mean temperature + CO₂ concentration speeds up photosynthesis in most temperate tree species if there's enough water, light and nutrient supply
- ↓ · Drought: natural and economic yields of forests (beech, hornbeam-oak, oak groves)



Adaptation options

- Increasing the genetic diversity of stands
- Diversification of the age structure of the forest
- Removal of seedlings and saplings of competing invading species
- Development of advanced systems of forest inventories
- Forest health monitoring



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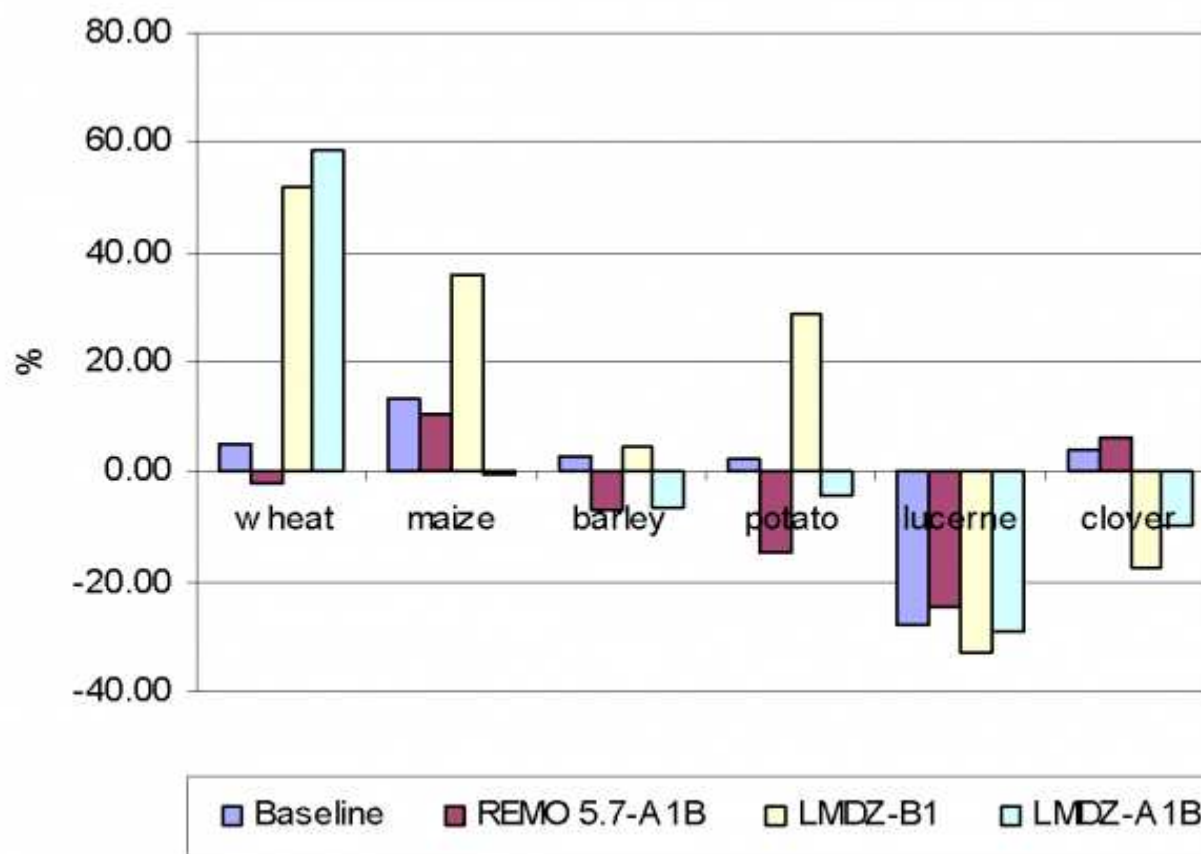


Climate change impacts on agriculture

- Longer growing season
- Increase in the northern range for soy and sunflower
- Potato yields should increase, winter wheat – especially in the highlands
- In the Panonian plain further water deficits will limit rain-fed agriculture
- Decrease of maize yields in the lowlands
- Widening of the pests' areas

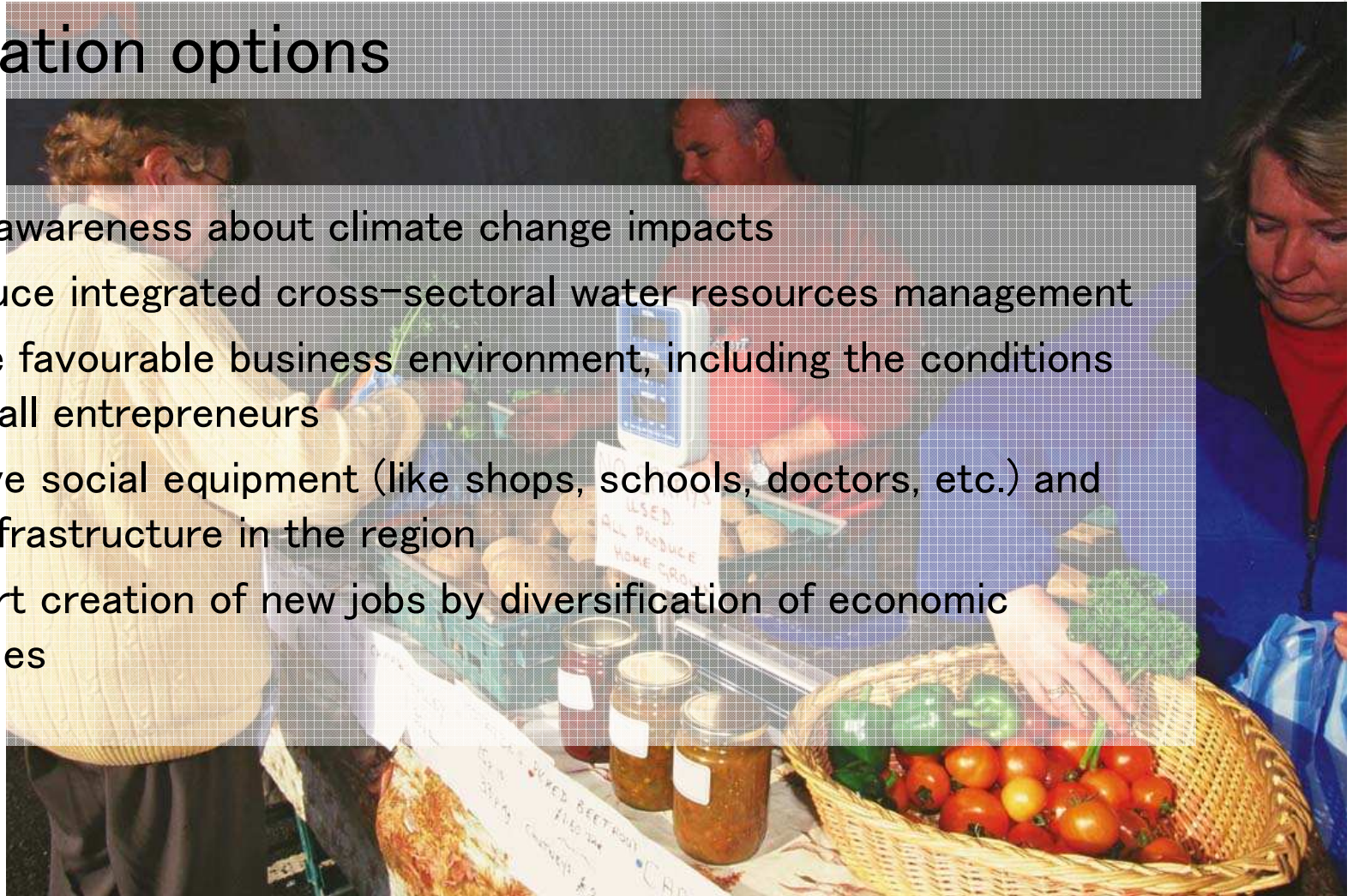


Climate change impacts on agriculture



Adaptation options

- Raise awareness about climate change impacts
- Introduce integrated cross-sectoral water resources management
- Create favourable business environment, including the conditions for small entrepreneurs
- Improve social equipment (like shops, schools, doctors, etc.) and civil infrastructure in the region
- Support creation of new jobs by diversification of economic activities



Key Questions

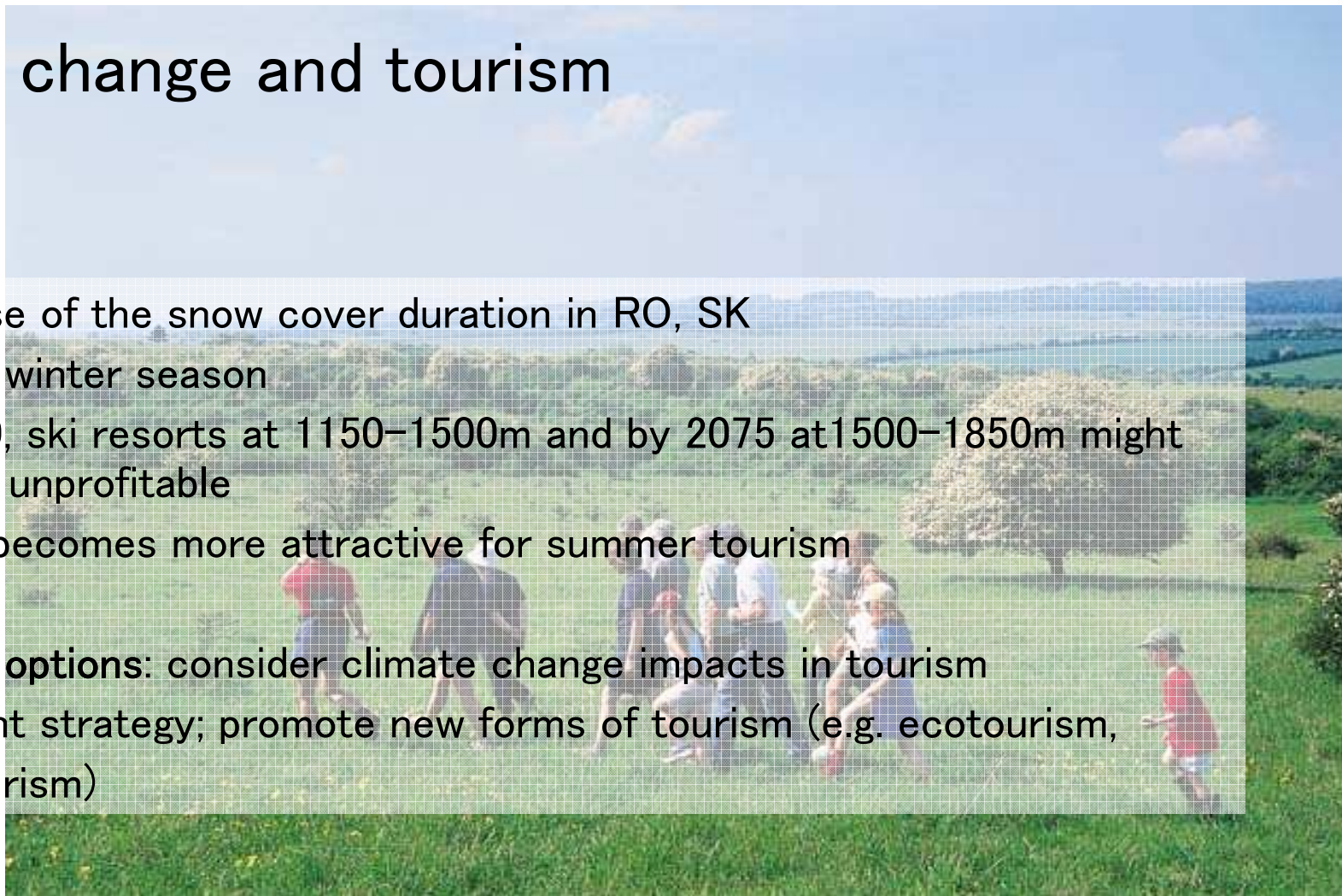
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Climate change and tourism

- Decrease of the snow cover duration in RO, SK
- Shorter winter season
- By 2030, ski resorts at 1150–1500m and by 2075 at 1500–1850m might become unprofitable
- Region becomes more attractive for summer tourism

Adaptation options: consider climate change impacts in tourism development strategy; promote new forms of tourism (e.g. ecotourism, cultural tourism)



Key Questions

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Thank you

