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Carbon accounting for restored peatlands

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and the ECORESP-C team at NINA

ECORESP-C seminar
11.4.2024

Outline

1. Carbon accounting – background
2. IPCC overview 2023 – potential to meet reduction goals
3. Reduction options - Tradeoffs and benefits, conservation and restoration perspective
4. IPCC carbon accounting principles, drained and restored peatlands
5. GHG accounting for drained and restored peatlands of temperate climate zone
6. Legacy of management – increases in C stocks
7. Legacy of management – reductions to GWP
8. Restoration impacts on GWP and C stock - ECORESP-C sites
9. How to interpret the values? - National context
10. Why restore? – Global context
11. Rapid loss of peatland habitats
12. Briefly on ecosystem accounting

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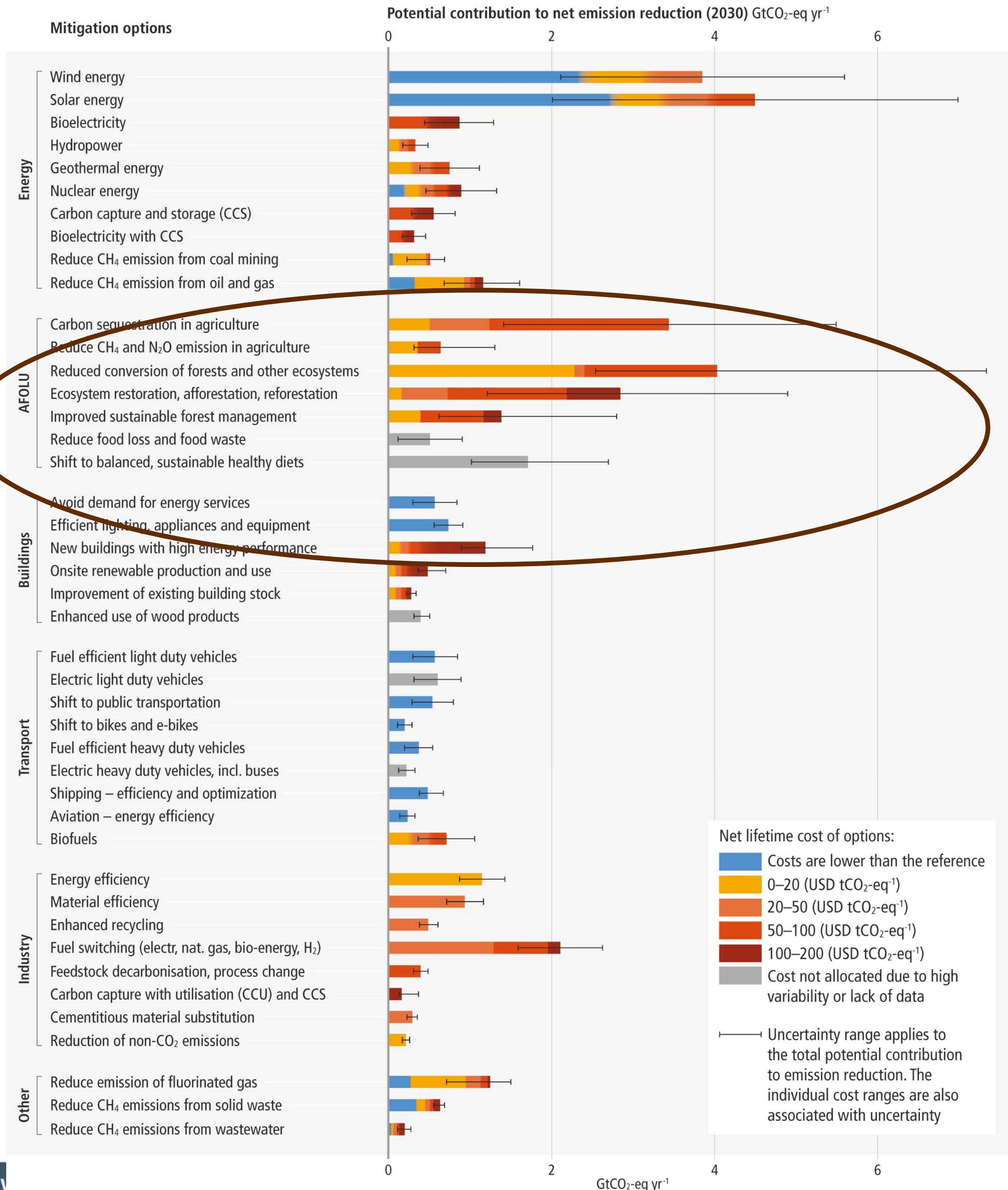
Carbon accounting - background

Carbon accounting = GHG accounting = UNFCCC/IPCC

Global level: Kyoto protocol

- Parties with commitments under the Kyoto have accepted targets for limiting or reducing emissions. These targets are expressed as levels of allowed emissions, or assigned amounts, at over the 2008-2012 commitment period. The allowed emissions are divided into assigned amount units (AAUs)
- Emissions trading, as set out in Article 17 of the Kyoto Protocol, allows countries that have emission units to spare - emissions permitted them but not "used" - to sell this excess capacity to countries that are over their targets.
- Thus, a new commodity was created in the form of emission reductions or removals. Since carbon dioxide is the principal greenhouse gas, people speak simply of trading in carbon. Carbon is now tracked and traded like any other commodity. This is known as the "carbon market."

Many options available now in all sectors are estimated to offer substantial potential to reduce net emissions by 2030. Relative potentials and costs will vary across countries and in the longer term compared to 2030.



IPCC overview 2023 – potential to meet reduction goals

- Large potential for reductions from AFOLU sector
- Net lifetime costs per net emission reduction of restoration comparatively high
- For many Central European countries "reduced conversion" of peatlands is no longer an option

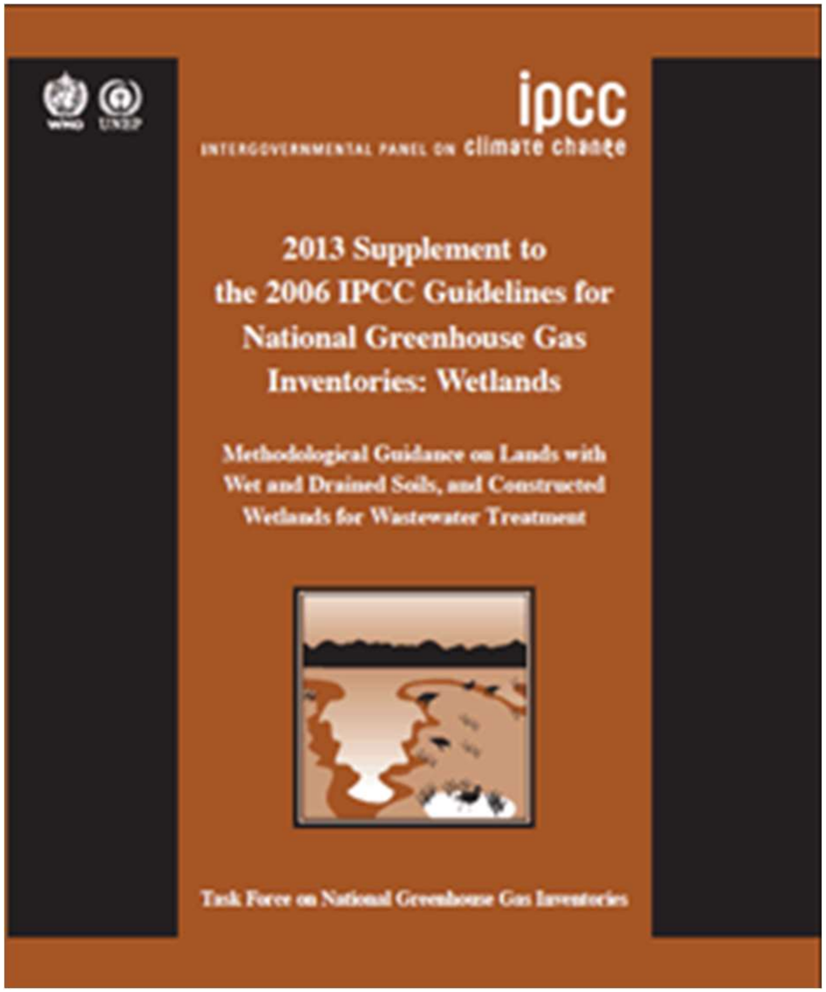
Lee, H., Calvin, K., Dasgupta, D., Krinner, G., Mukherji, A., Thorne, P., Trisos, C., Romero, J., Aldunce, P., Barret, K. and Blanco, G., 2023. IPCC, 2023: Climate Change 2023: Synthesis Report, Summary for Policymakers. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland.

Reduction options - Tradeoffs and benefits, conservation and restoration perspective

- Some options, such as conservation of high-carbon ecosystems (e.g., peatlands, wetlands, rangelands, mangroves and forests), deliver immediate benefits, while others, such as restoration of high-carbon ecosystems, take decades to deliver measurable results.
- Maintaining the resilience of biodiversity and ecosystem services at a global scale depends on effective and equitable conservation of approximately 30% to 50% of Earth's land, freshwater and ocean areas, including currently near-natural ecosystems (high confidence).
- Land restoration contributes to climate change mitigation and adaptation with synergies via enhanced ecosystem services and with economically positive returns and co-benefits for poverty reduction and improved livelihoods (high confidence).

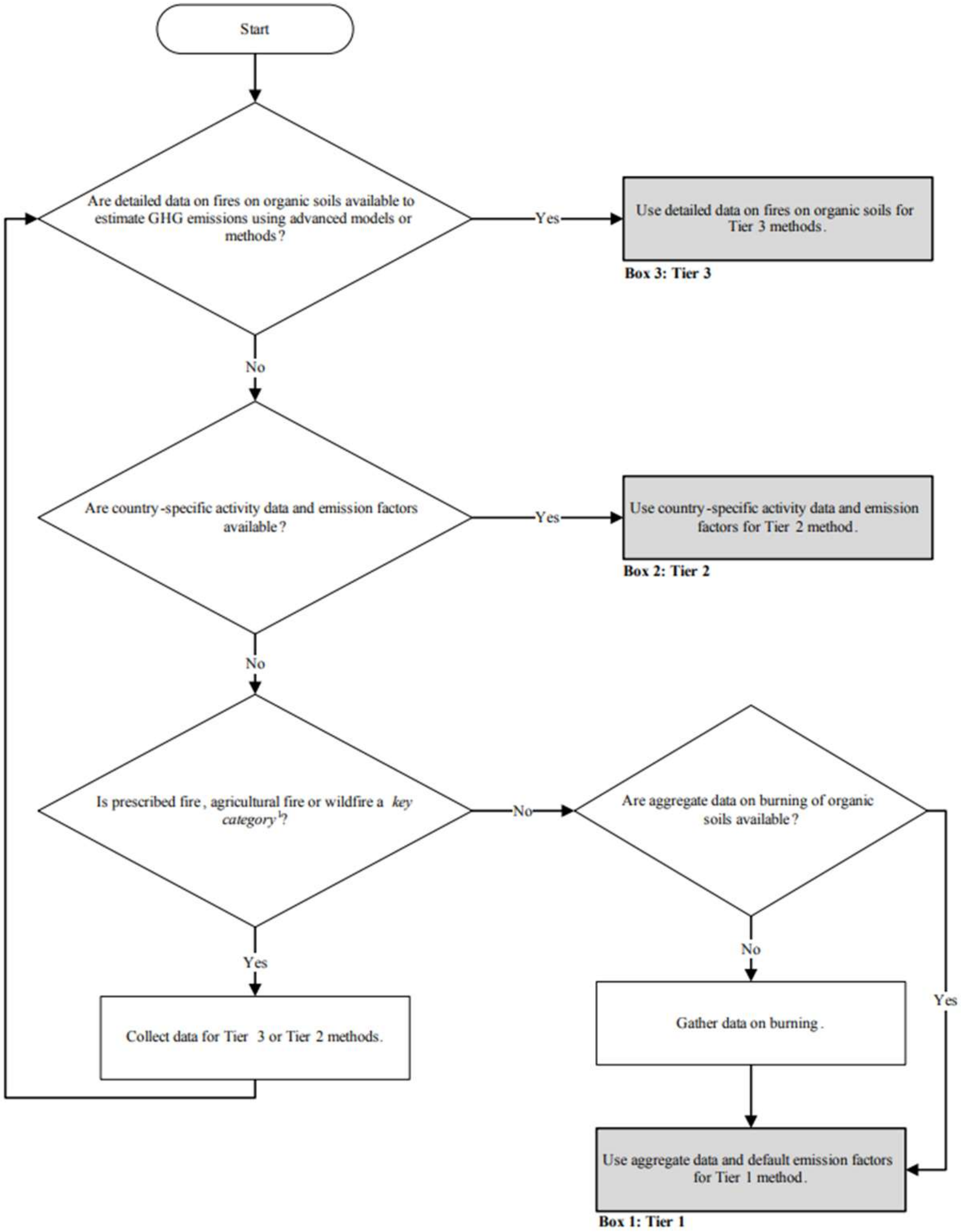
Lee, H., Calvin, K., Dasgupta, D., Krinner, G., Mukherji, A., Thorne, P., ... & Park, Y. (2023). IPCC, 2023: Climate Change 2023: Synthesis Report, Summary for Policymakers. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland.

IPCC carbon accounting principles, drained and restored peatlands (1)



- Outcomes: CO_2-C, CH4-C and N2O-N as tons/ecosystem (or nation)
- Conversion units for non-CO2 gases = 25 CH_4, 298 for N_2O (radiative forcing in 100 yr –time horizont), nations report removals from restored peatland still as ton C or ton N.
- Simplified equation:

  ton C and/or N/yr = Area x EF
- EF = emission factor, as ton C or N/ha/yr
- Emission factors include activity data (landuse, fertilization, nutrient status). For restored peatlands a simplified model with only poor/rich is currently used



IPCC GHG accounting principles, drained and restored peatlands (2)

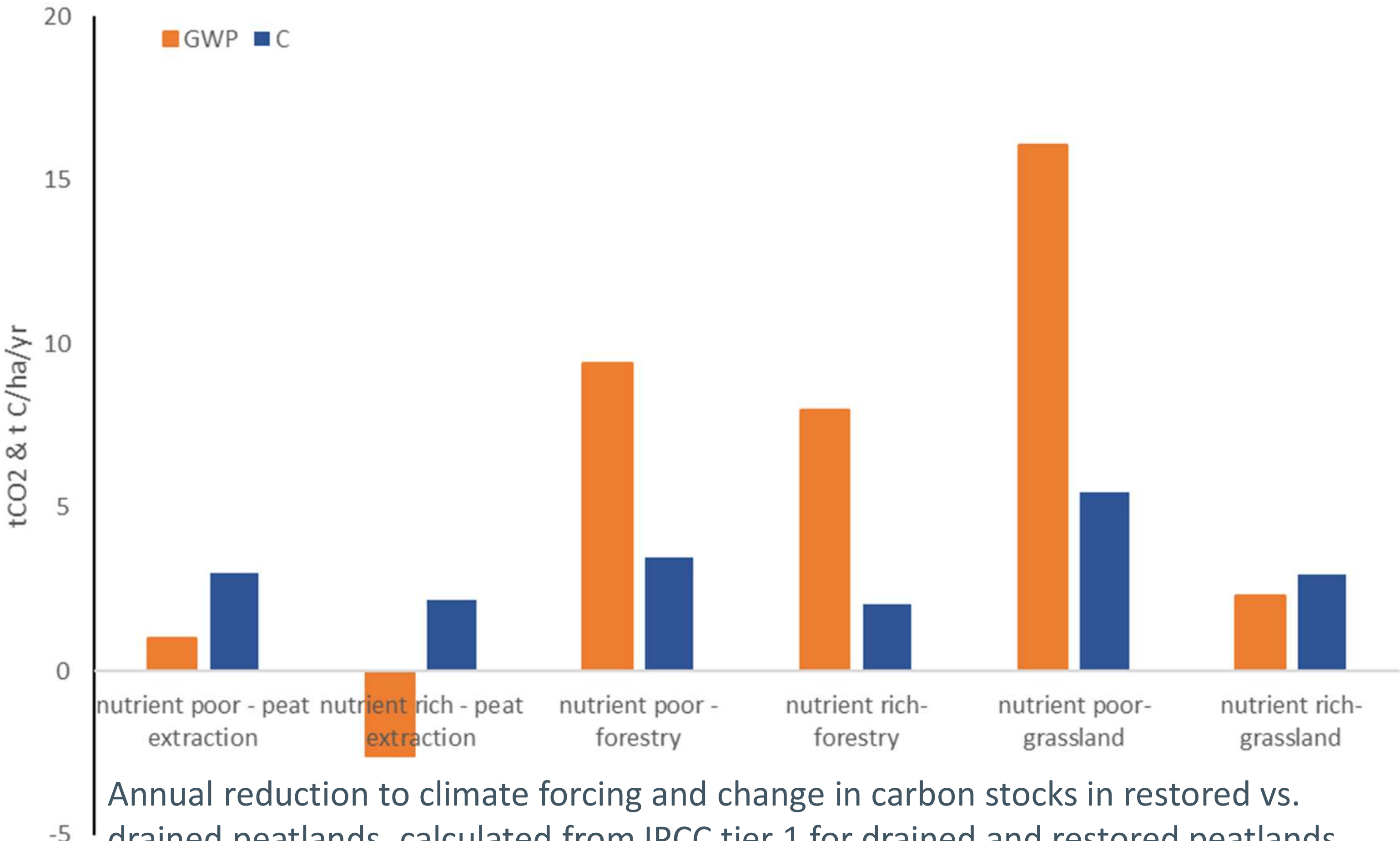
Tier 1: Using IPCC default EF values (collected from international data for boreal, temperate and tropical ecosystems) and default calculation models from IPCC

Tier 2: Using national EF's, but default modelling from IPCC. EF's for CO_2 should include change is above and belowground biomass overtime, for DOC, CH_4 and N_2O *in situ* flux measurements are required

Tier 3: Using national EF's and/or nationally developed specified models

GHG accounting for drained and restored peatlands of temperate climate zone

Note! Change in soil carbon stock and GHG emissions (i.e. climate forcing, reported to IPCC) are not the same thing. **They are also separate ecosystem services!**



Annual reduction to climate forcing and change in carbon stocks in restored vs. drained peatlands, calculated from IPCC tier 1 for drained and restored peatlands

Emission factors and calculation guidelines from: Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M., & Troxler, T. G. (2014). 2013 supplement to the 2006 IPCC guidelines for national greenhouse gas inventories: Wetlands. *IPCC, Switzerland*

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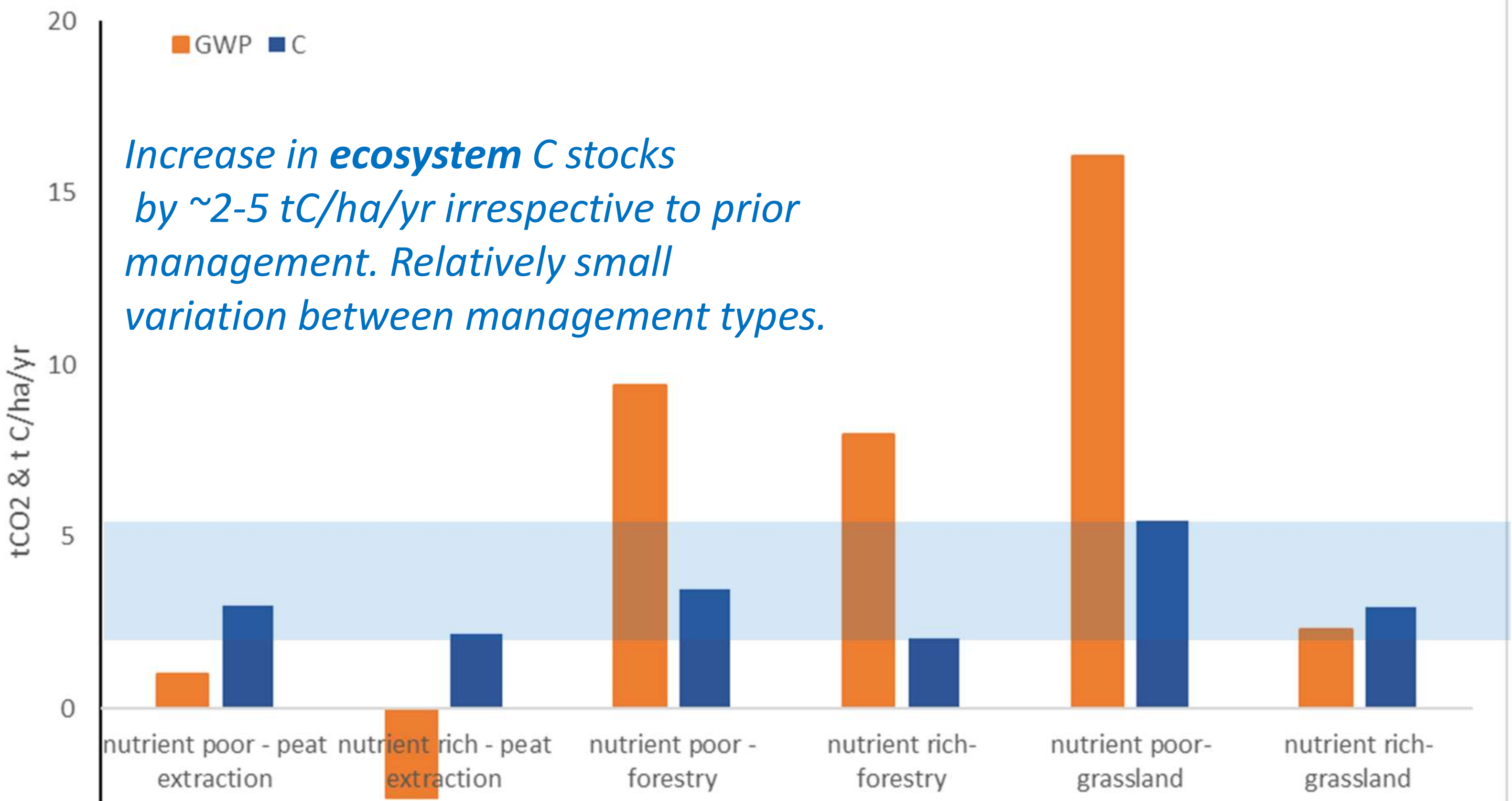
Legacy of management – increases in C stocks (1)

Note! Change in soil carbon stock and GHG emissions (i.e. climate forcing, reported to IPCC) are not the same thing. **<u>They are also separate ecosystem services!</u>**

Change in ecosystem C stock here account for loss/gain of CO_2 from above and below ground biomass, DOC, and CH_4-C. Calculation is a difference between drained and restored ecoystems. Croplands are not considered, as area cropland to be restored is assumed to be negligible in Slovakia



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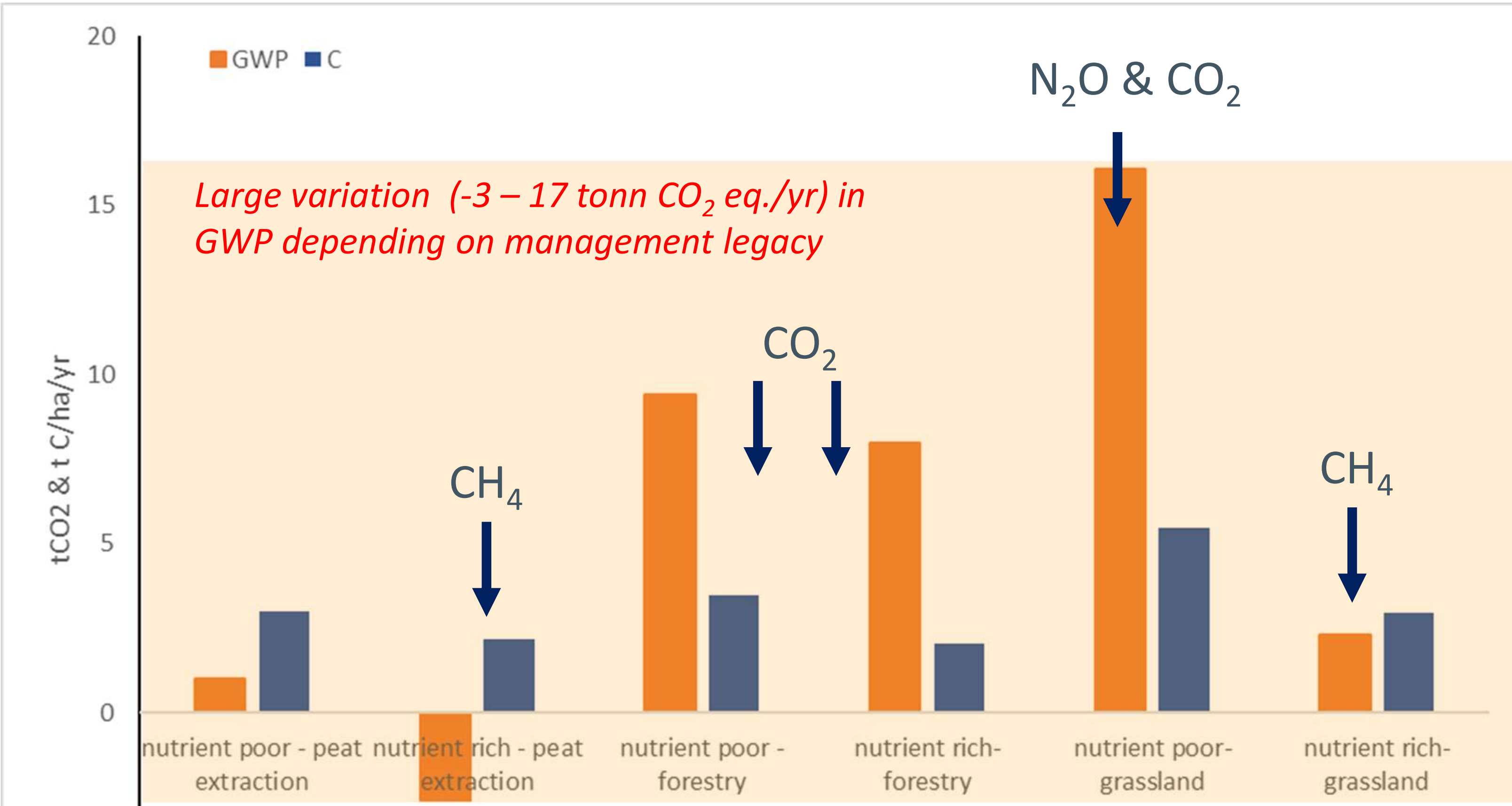
Legacy of management – Reductions to GWP (1)

GWP accounts for loss/gain of CO_2 from above and below ground biomass, DOC, CH_4 and N_2O. Non-CO_2 GHG's were converted to CO_2eq. according to IPCC guidelines.



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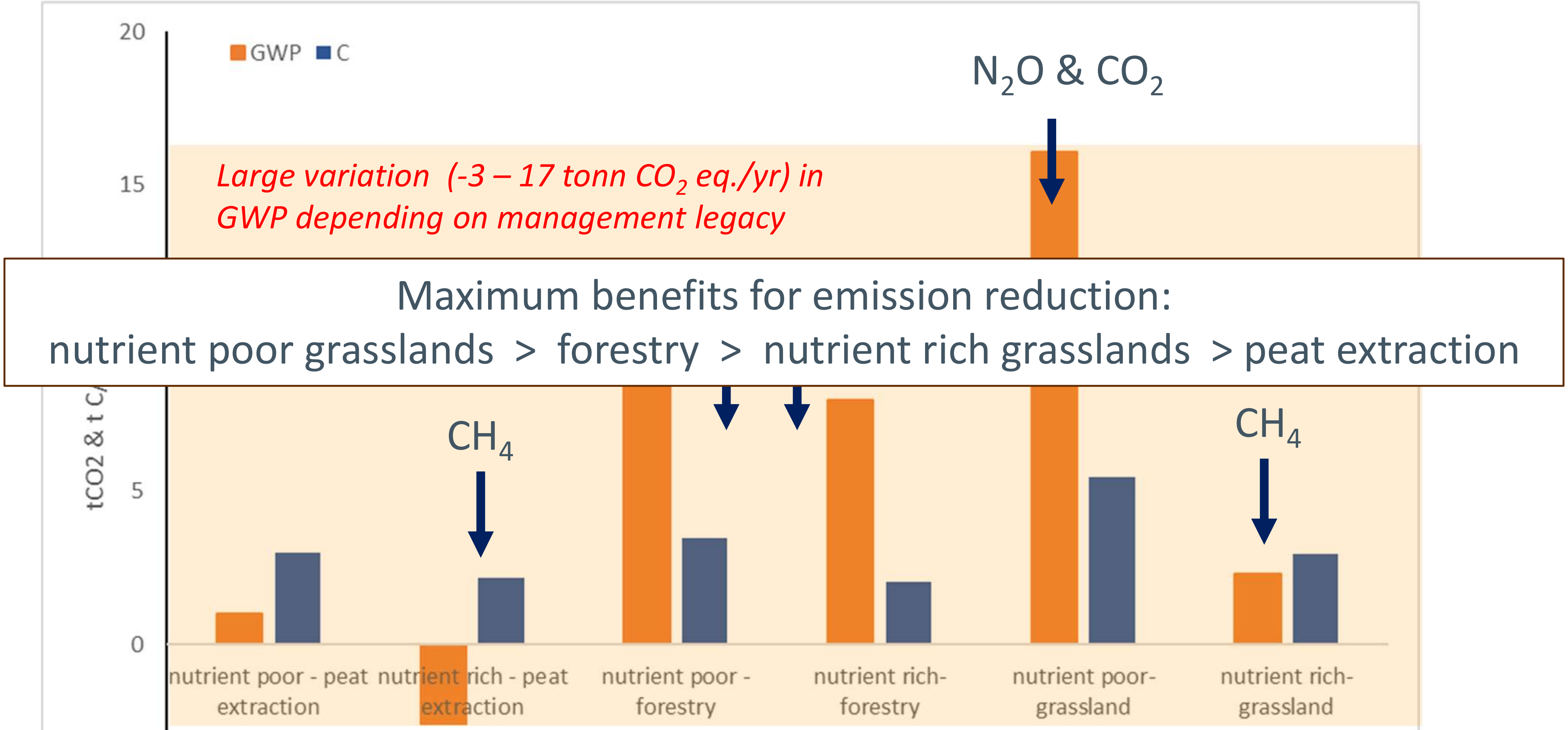
Legacy of management – Reductions to GWP (2)

GWP accounts for loss/gain of CO_2 from above and below ground biomass, DOC, CH_4 and N_2O. Non-CO_2 GHG's were converted to CO_2eq. according to IPCC guidelines.



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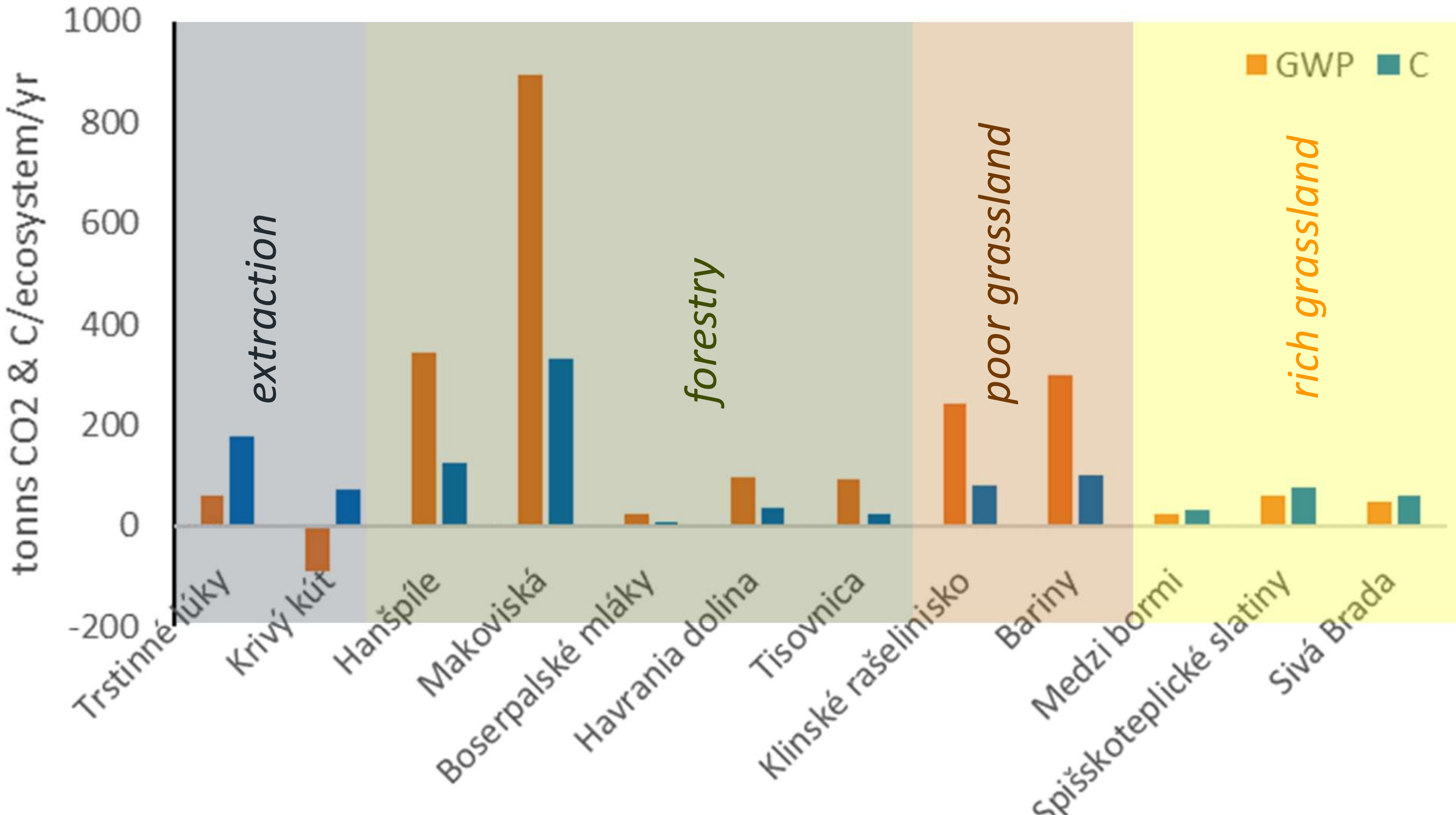
Restoration impacts on GWP and C stock - ECORESP-C sites (1)

Note! Values are *not absolute emissions from the sites,* but calculated theoretical differences for drained and restored state. Positive value indicates higher reduction in GWP/ increase in C after restoration



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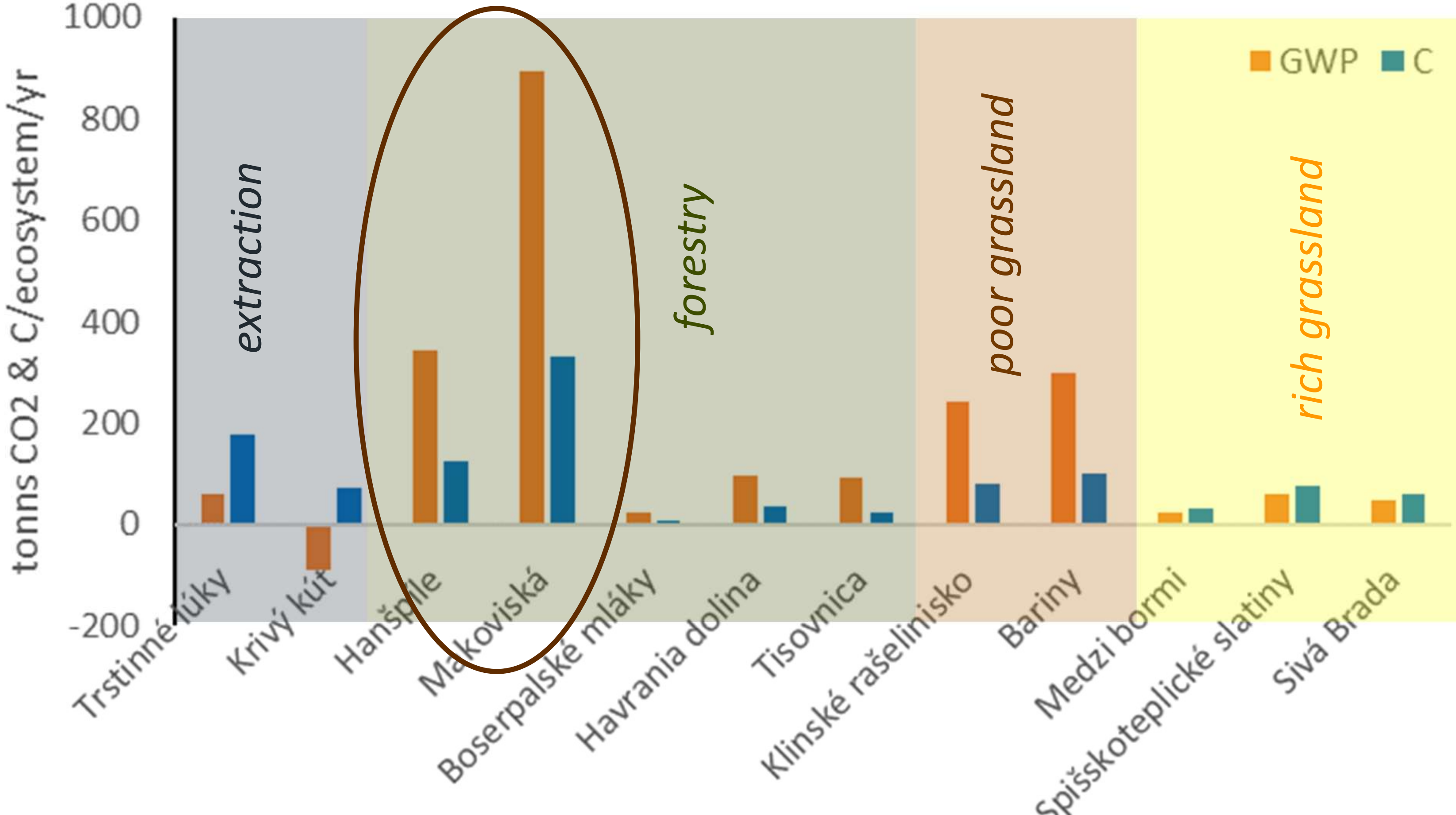
Restoration impacts on GWP and C stock - ECORESP-C sites (2)– Impact of area



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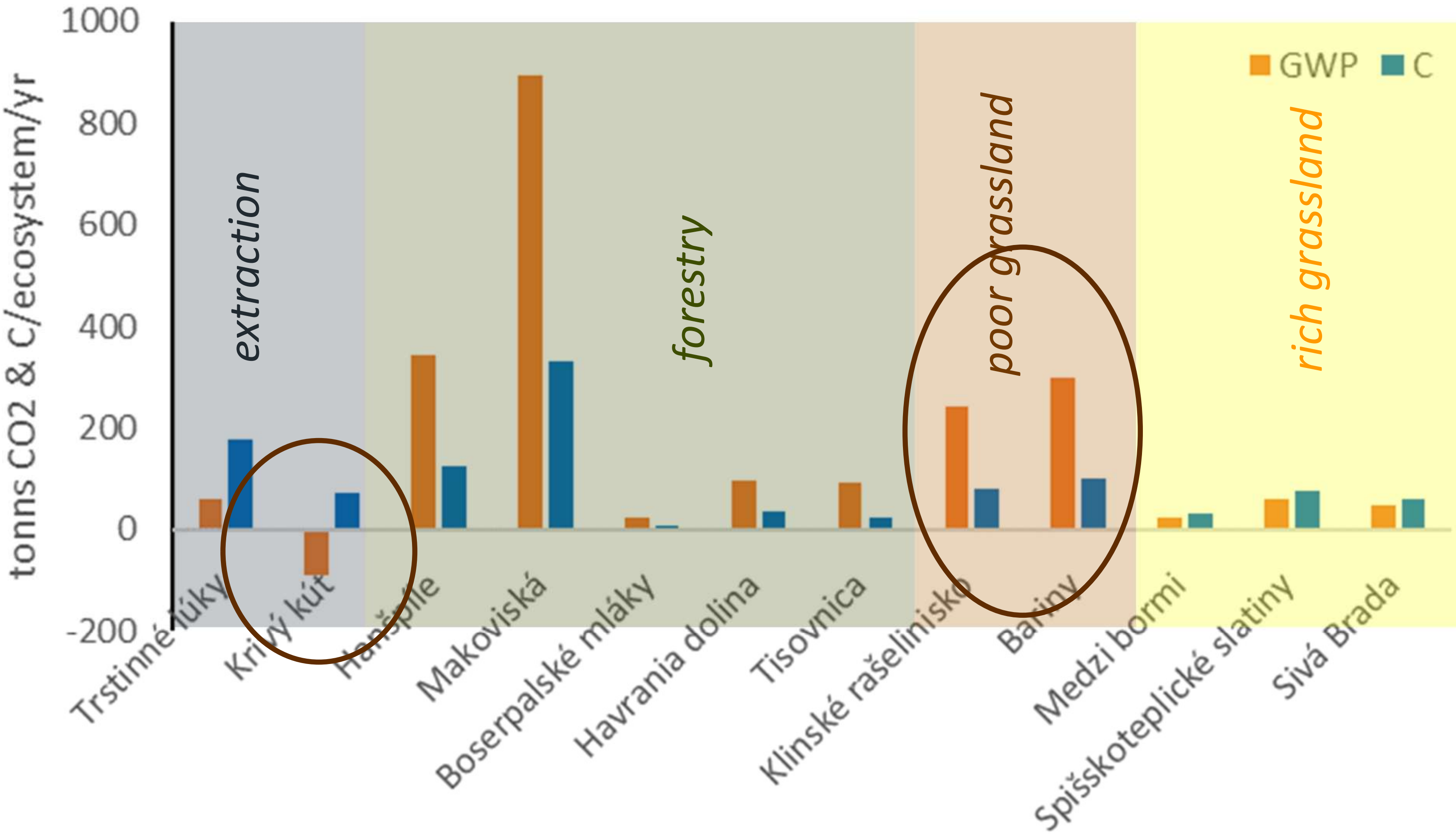
Restoration impacts on GWP and C stock - ECORESP-C sites (3)– Importance of CH_4 and N_2O



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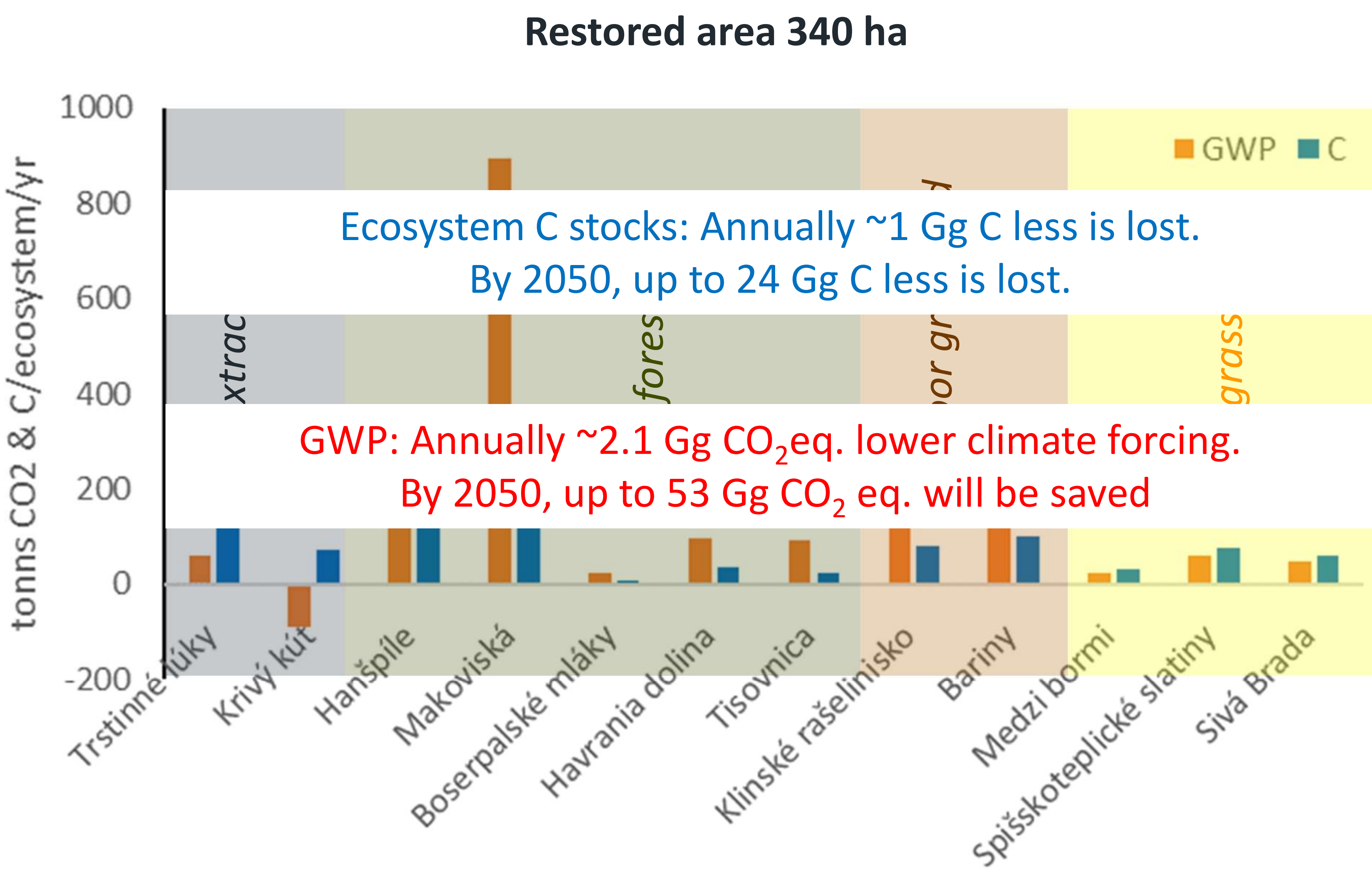
Restoration impacts on GWP and C stock - ECORESP-C sites (4) – Overall impact by 2050



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How to interpret the values? - National context

- Area of histosols (organic soil, potentially old peatland and potentially restorable area) is comparatively small in Slovakia: 450 ha (note 340 ha included in ECORESP-C project)
- Slovakia has reviewed the area estimates for organic soils under cultivation, as high as 26kha and 35 kha have been suggested, but the estimate of 450 ha stands in the current inventory
- Due to the negligible area of organic soil in Slovakia, **emissions are deemed «under the threshold of significant», in NIR, Slovak republic**

Table 6.14: *Activity data, emission factors, threshold, and impact on GHG emissions in particular years*

YEAR	AREA OF HISTOSOLS	EFs	CO_2 EMISSIONS	GHG TOTAL WITHOUT LULUCF	THRESHOLD	IMPACT ON GHG INVENTORY IN INDIVIDUAL YEARS
	ha	*t CO_2/ha^{-1}*	*Gg*	*Gg CO_2 eq.*		*%*
1990	450	5.0	8.25	73 463	36.731	0.00011
1995	450	5.0	8.25	52 922	26.461	0.00016
2000	450	5.0	8.25	48 770	24.385	0.00017
2005	450	5.0	8.25	50 562	25.281	0.00016
2010	450	5.0	8.25	45 673	22.837	0.00018
2011	450	5.0	8.25	44 700	22.350	0.00018
2012	450	5.0	8.25	42 284	21.142	0.00020
2013	450	5.0	8.25	41 962	20.981	0.00020
2014	450	5.0	8.25	40 009	20.005	0.00021
2015	450	5.0	8.25	40 714	20.357	0.00020
2016	450	5.0	8.25	41 179	20.590	0.00020
2017	450	5.0	8.25	42 263	21.131	0.00020
2018	450	5.0	8.25	42 135	21.067	0.00020

National Inventory report 2022, Slovak Republic

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Why restore? – Global context

- Relative insignificance for GHG emissions in national scale allows to prioritize restoring ecosystems with low emission reducion potential (e.g nutrient rich grasslands) which may increase biodiversity value most
- Central European peatlands are degraded and lost, preserving carbon stocks of those areas is detrimental → paneuropean rather than national goal
- **Importance of holistic ecosystem accounting that includes ecosystem services other than climate mitigation**
- [Nature restoration: Parliament adopts law to restore 20% of EU's land and sea | News | European Parliament (europa.eu)]

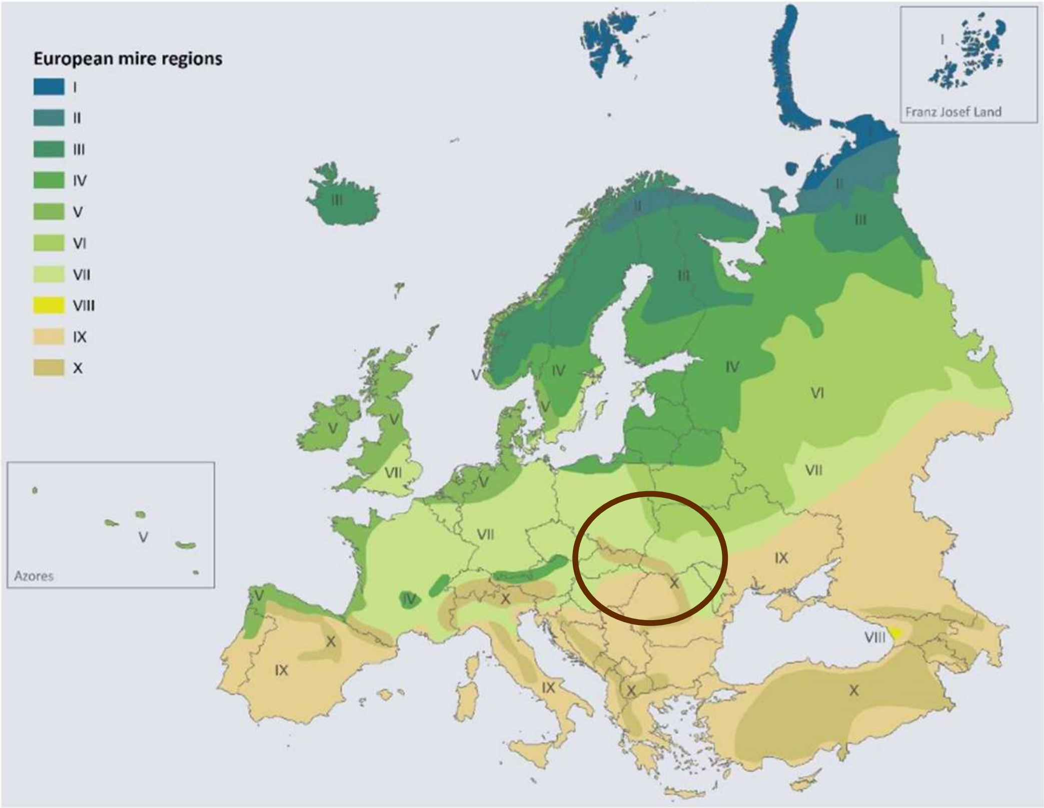

Figure 1. The ten European mire regions (simplified from [27]). (I) Arctic seepage and polygon mire region, (II) palsa mire region, (III) northern fen region, (IV) typical raised bog region, (V) Atlantic bog region, (VI) continental fen and bog region, (VII) nemoral-sub-meridional fen region, (VIII) Colchis mire region, (IX) southern European marsh region, (X) central and southern European mountain compound region.

Tanneberger, F., Moen, A., Barthelmes, A., Lewis, E., Miles, L., Sirin, A., Tegetmeyer, C. and Joosten, H., 2021. Mires in Europe—Regional diversity, condition and protection. *Diversity*, *13*(8), p.381.

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Global context: Total area of degraded peatland in Finland 47 000 km^{2}., total area of Slovak republic 49 036 km^{2} *However, certain peatland habitats are only present in Slovakia.*

Figure 1. The ten European mire regions (simplified from [27]). (I) Arctic seepage and polygon mire region, (II) palsa mire region, (III) northern fen region, (IV) typical raised bog region, (V) Atlantic bog region, (VI) continental fen and bog region, (VII) nemoral-sub-meridional fen region, (VIII) Colchis mire region, (IX) southern European marsh region, (X) central and southern European mountain compound region.

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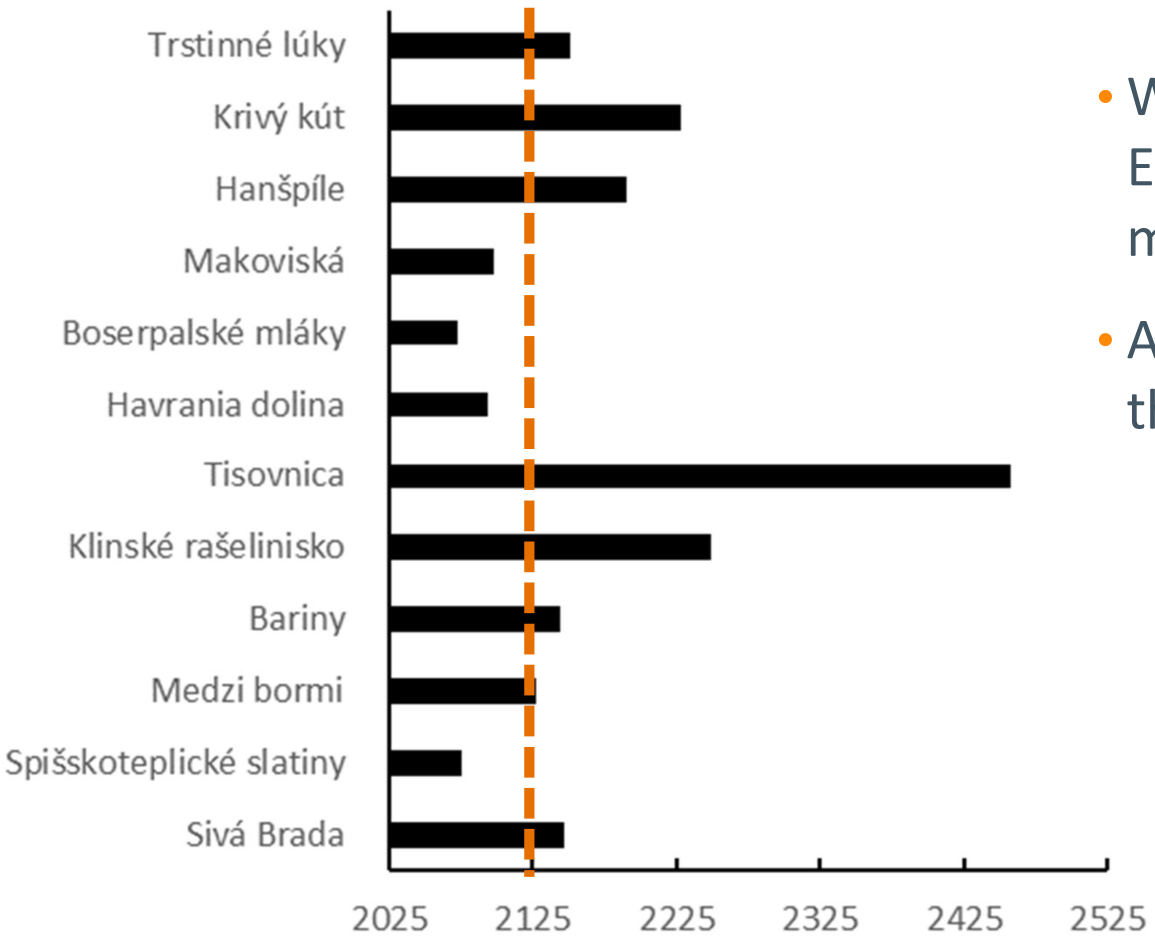
Rapid loss of peatland habitats (1) – Estimated lifetime of ECORESP sites



Theoretical time for complete loss of C stock calculated with C densities measured *in situ* in ECORESP project and IPCC tier 1 emission factors for drained and restored peatlands of temperate climate zone.

- With no interventions 8/12 ECORESP sites may have lost all or most of their C stock by 2125.
- All ecosystem services provided by the peatland would also be lost.

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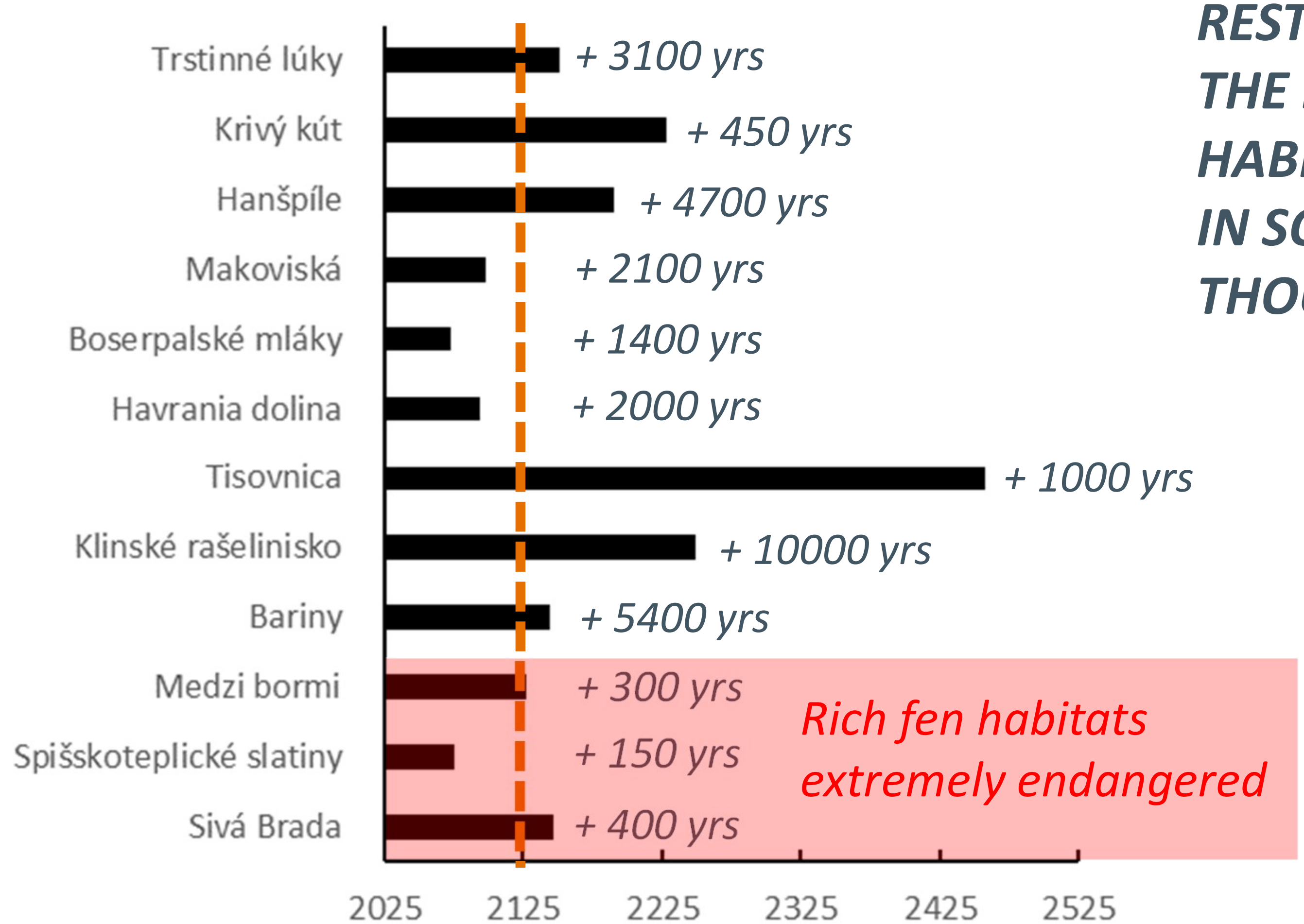
Rapid loss of peatland habitats (2) – Extended lifetime by restoration



RESTORATION MAY EXTEND THE LIFETIME OF PEATLAND HABITATS BY HUNDREDS, IN SOME CASES EVEN THOUSANDS OF YEARS

Theoretical time for complete loss of C stock calculated with C densities measured *in situ* in ECORESP project and IPCC tier 1 emission factors for drained and restored peatlands of temperate climate zone.

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Briefly on ecosystem accounting (1)

- **Aims to identify, make explicit, quantify, and track trends of the *multiple contributions* of ecosystems to society.**

- Consists of:
  - Delineation of areas of specific *ecosystem types* (e.g. an area of peatland).
  - Assessment of the area's *ecological condition* (e.g. water table depth, related to ecological restoration).
  - *Models of ecosystem services* (i.e. a quantitative assessment of the contribution of the ecosystem to society and the level of use).
  - Attach value (in monetary and non-monetary terms).

Rusch, G.M., Engen, S., Friedrich, L., Hindar, K., Krøgli, S.O., Immerzeel, B., Solberg, E., Köhler, B., Dramstad, W., Venter, Z., Spielhofer, R., Stange, E. & Barton, D.N. 2024. Ecosystem services in SEEA EA accounts in Norway. Assessment of available models and data sets (in Norwegian). NINA Rapport 2343. Norsk institutt for naturforskning. https://brage.nina.no/nina-xmlui/handle/11250/3103351

Briefly on ecosystem accounting (2) - Ecosystem services (ES)

Outcome is the result of an ES model, that represents quantitatively (with an associated metrics) the contribution of the ecosystem (patch) to society.

THREE TYPES OF OUTCOMES:

PROVISIONING SERVICES

Food

Feed, fodder

Fiber products, timber

Genetic resources

REGULATING SERVICES

Global climate regulation

Water flow regulation.

Soil and sediment retention.

Habitat maintenance services
(for native biodiversity).

CULTURAL SERVICES

Recreation related services.

Visual ammenity services.

Education, scientific and research services.

Spiritual, artistic and symbolic services.

Rusch, G.M., Engen, S., Friedrich, L., Hindar, K., Krøgli, S.O., Immerzeel, B., Solberg, E., Köhler, B., Dramstad, W., Venter, Z., Spielhofer, R., Stange, E. & Barton, D.N. 2024. Ecosystem services in SEEA EA accounts in Norway. Assessment of available models and data sets (in Norwegian). NINA Rapport 2343. Norsk institutt for naturforskning. https://brage.nina.no/nina-xmlui/handle/11250/3103351

Conclusion

Restoring Slovakia's peatlands will reduce climate forcing, but the impact of the reductions is insignificant both in national and global scales.

- C stock is a key feature of peatland ecosystem, that allows provision of all other ecosystem services of those ecosystem. With no intervention many of the ECORESP study sites will dissapear.
- Restoration efforts should be targeted to maximize impacts on other ecosystem services, despite potential tradeoffs of minor consequence with climate mitigation goals
- Peatland restoration likely plays an important role to comply with Europe's new restoration law
- Next steps in planning peatland restoration strategy and assessing its outcomes should include ecosystem accounting approaches

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