Beneficial land-use change in Europe

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Beneficial land-use change

- *Introduction of new biomass production systems that enhance ecosystem services and/or conditions for biodiversity*

Strategic perennialization

- *Strategic establishment of suitable perennial production systems to provide specific environmental benefits*

- Implemented in intensively managed agriculture landscapes, subject to environmental impacts

Beneficial LUC through strategic perennialization in Europe

- Explores options and potentials for strategic perennialization in EU27+UK
- For each of the >81.000 sub-watersheds in Europe, we map and quantify:

1. Degree of current environmental impact
    - Soil loss by water erosion
    - Soil loss by wind erosion
    - Nitrogen emissions to water
    - Recurring floods
    - Accumulated losses of soil organic carbon (SOC)
2. Mitigation effectiveness by strategic perennialization for each impact

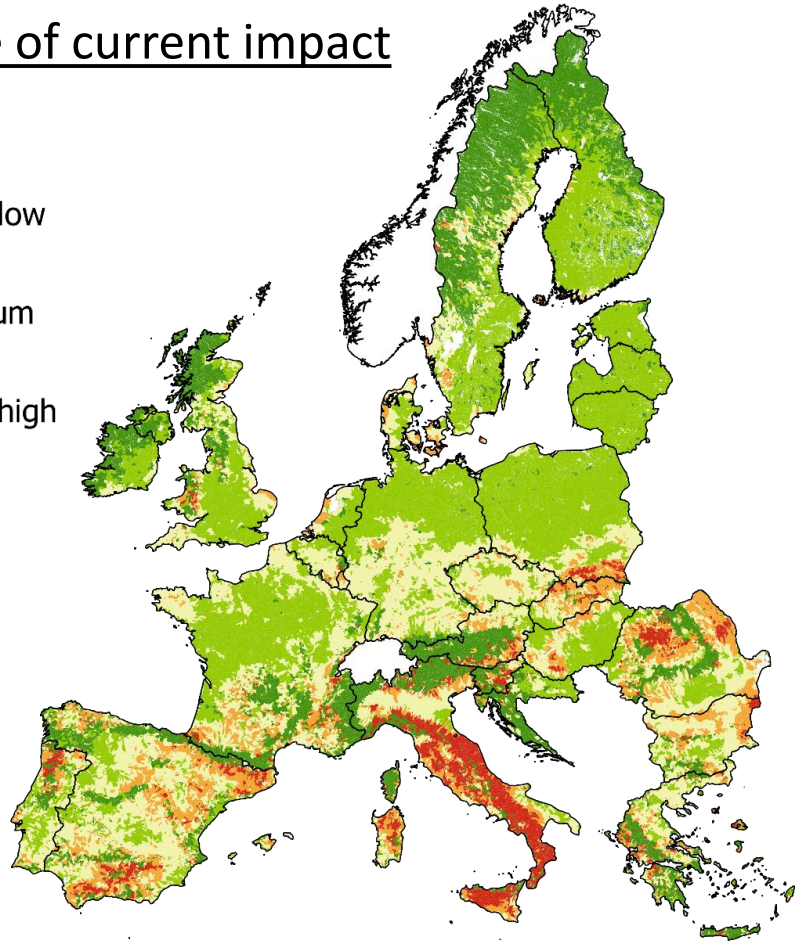
(Englund et al., 2020)

(Englund et al., 2020a)

Soil loss by erosion

Degree of current impact

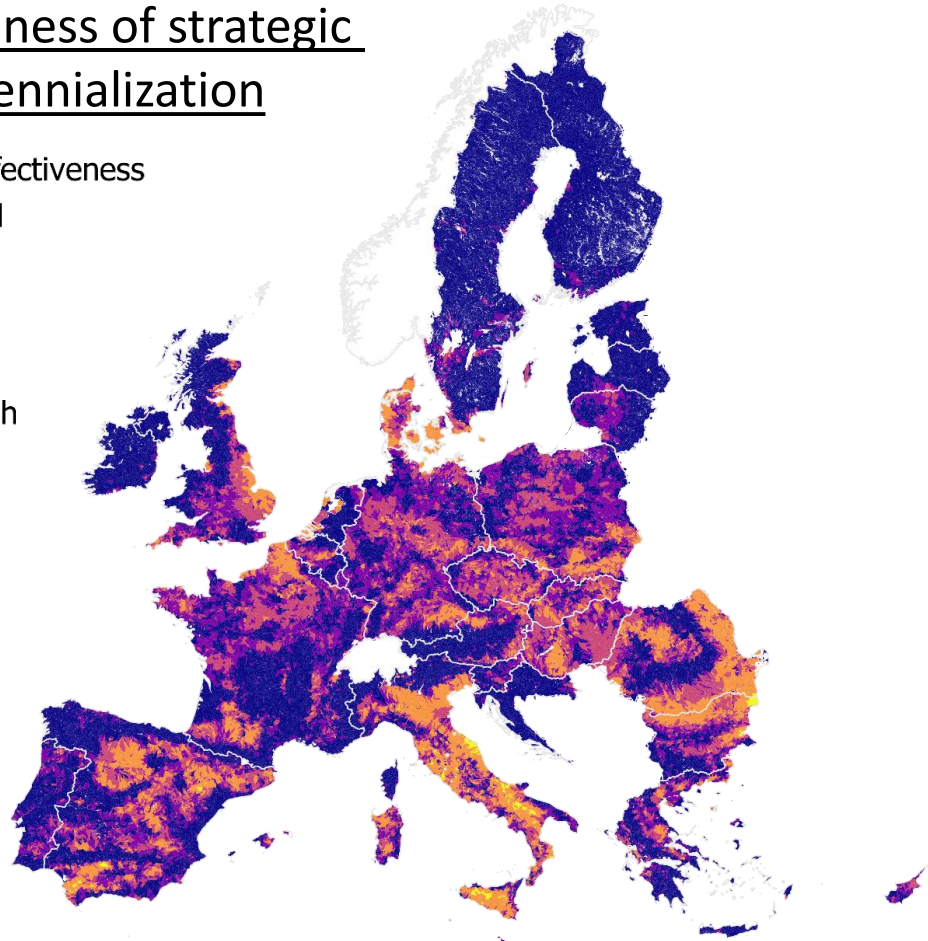
- Very low
- Low
- Medium
- High
- Very high



Effectiveness of strategic perennialization

Mitigation effectiveness

- Marginal
- Low
- Medium
- High
- Very high



(Englund et al., 2020a)

N emissions to water

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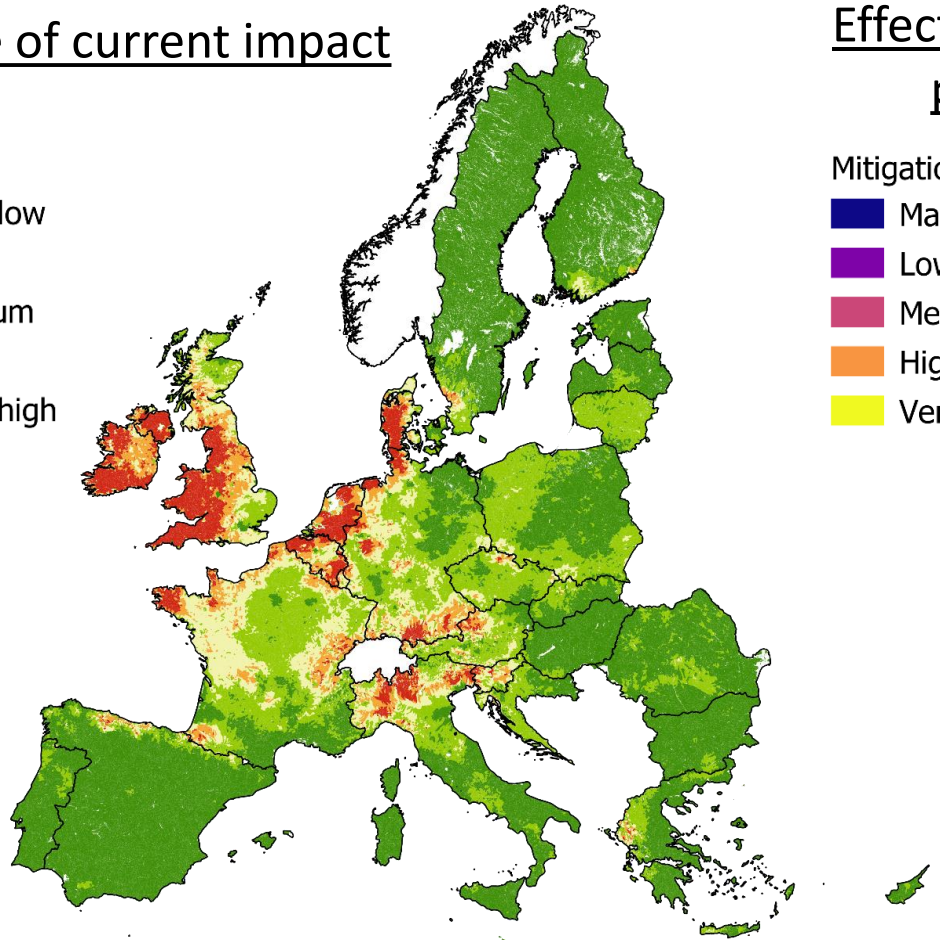

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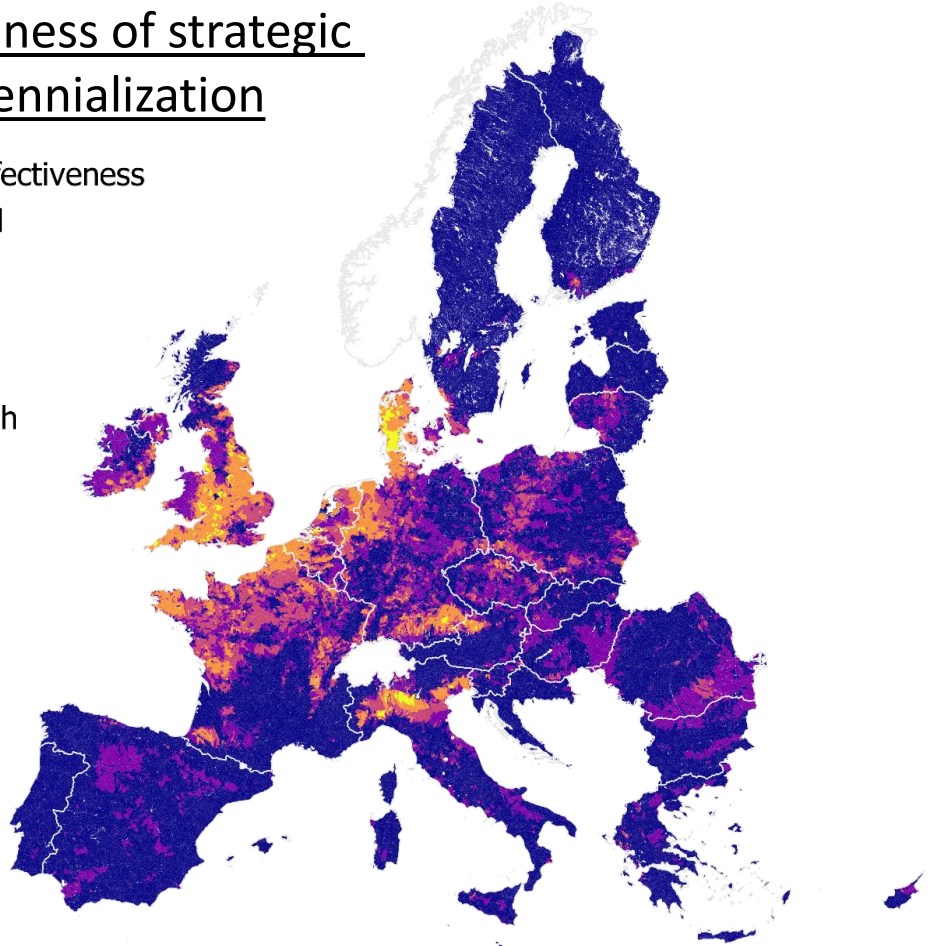

(Englund et al., 2020a)

Recurring floods

Degree of current impact

- Very low
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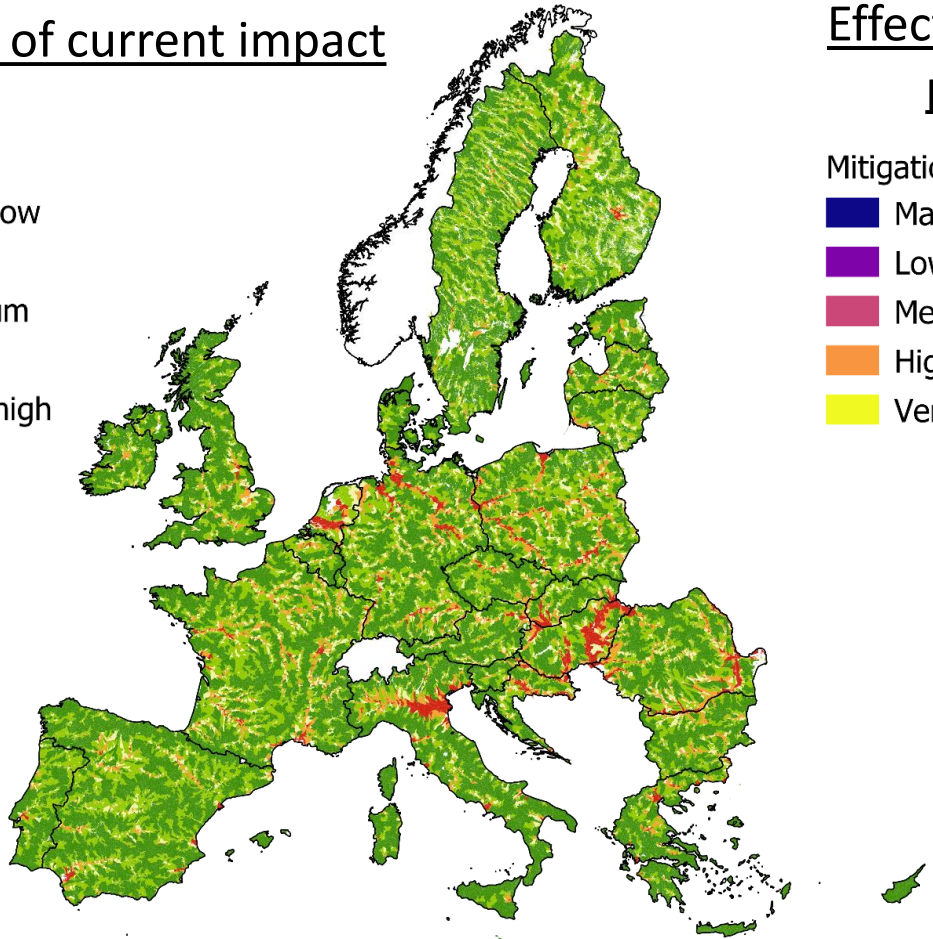
- Very high



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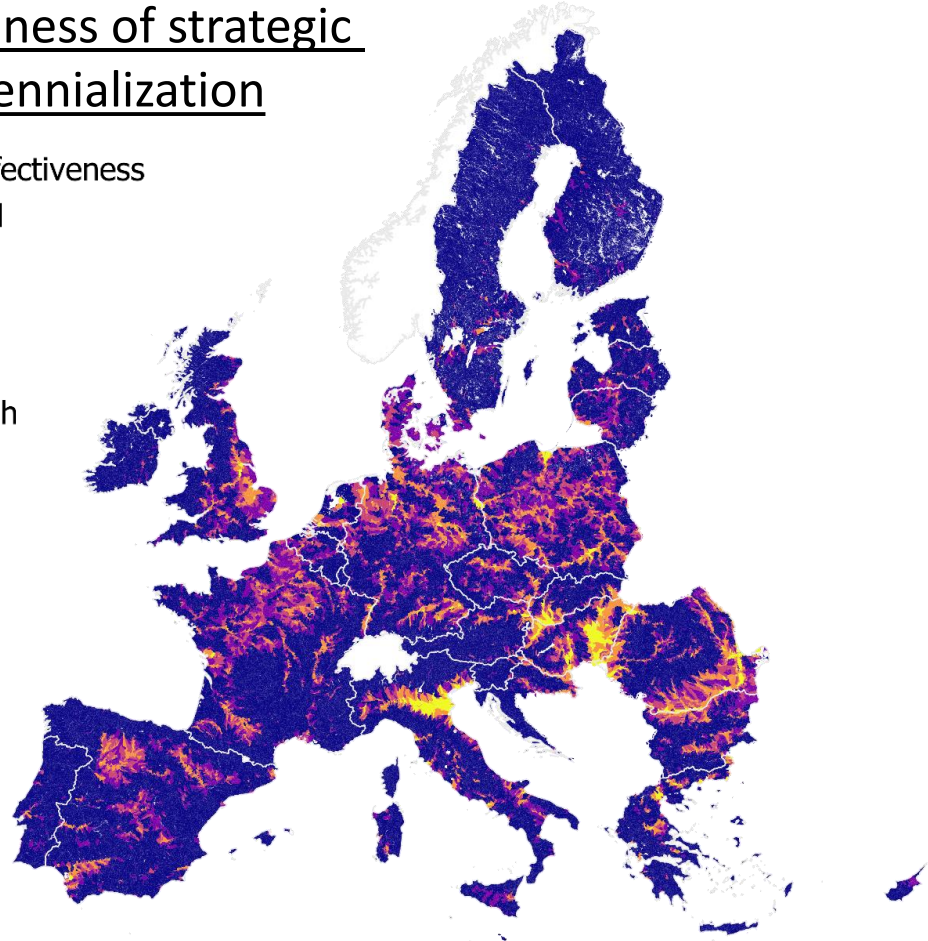

(Englund et al., 2020a)

Accumulated SOC losses

Degree of current impact

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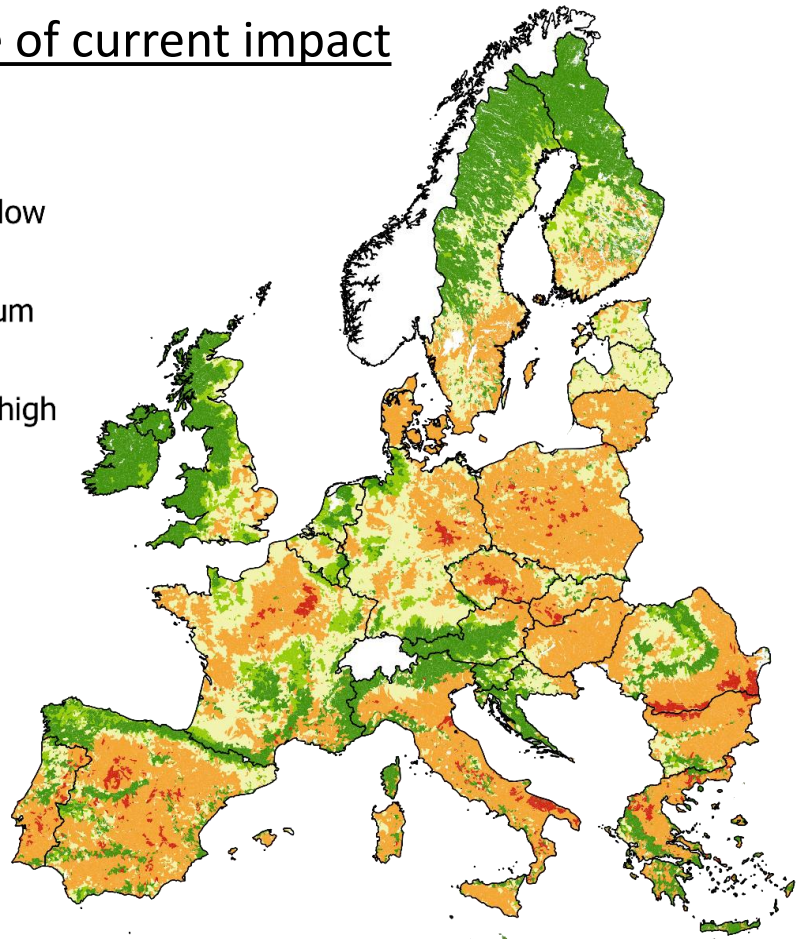

Effectiveness of strategic perennialization

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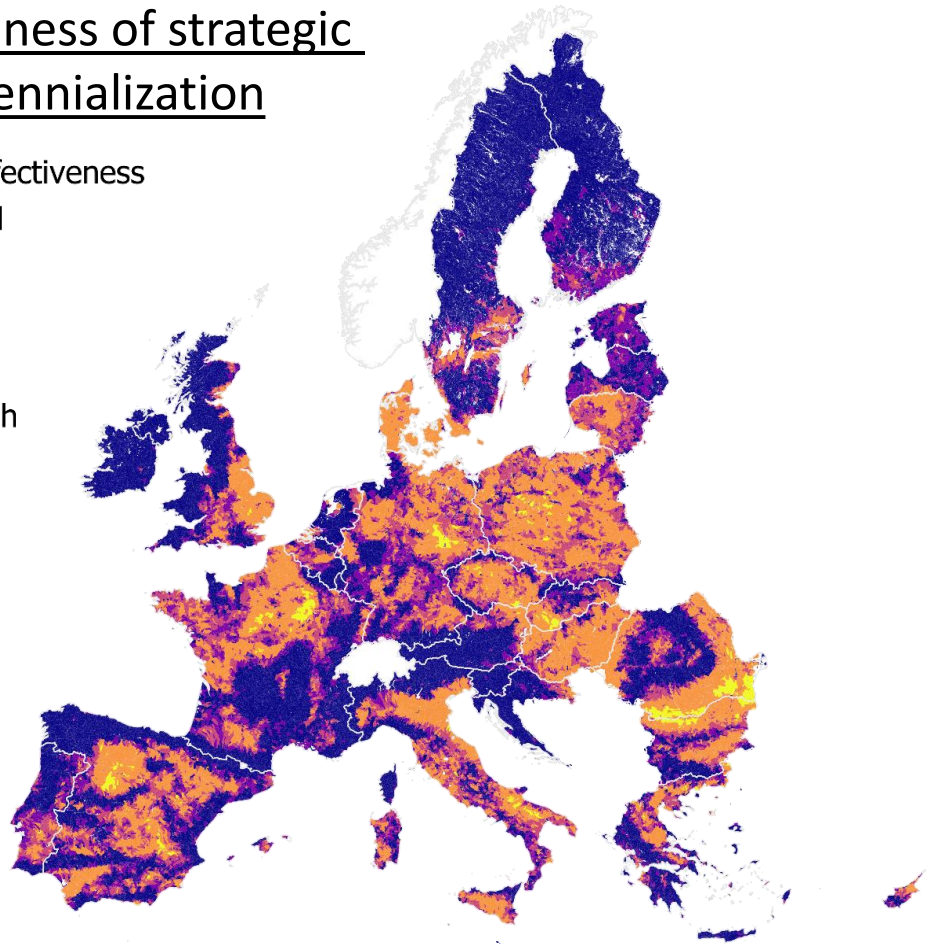
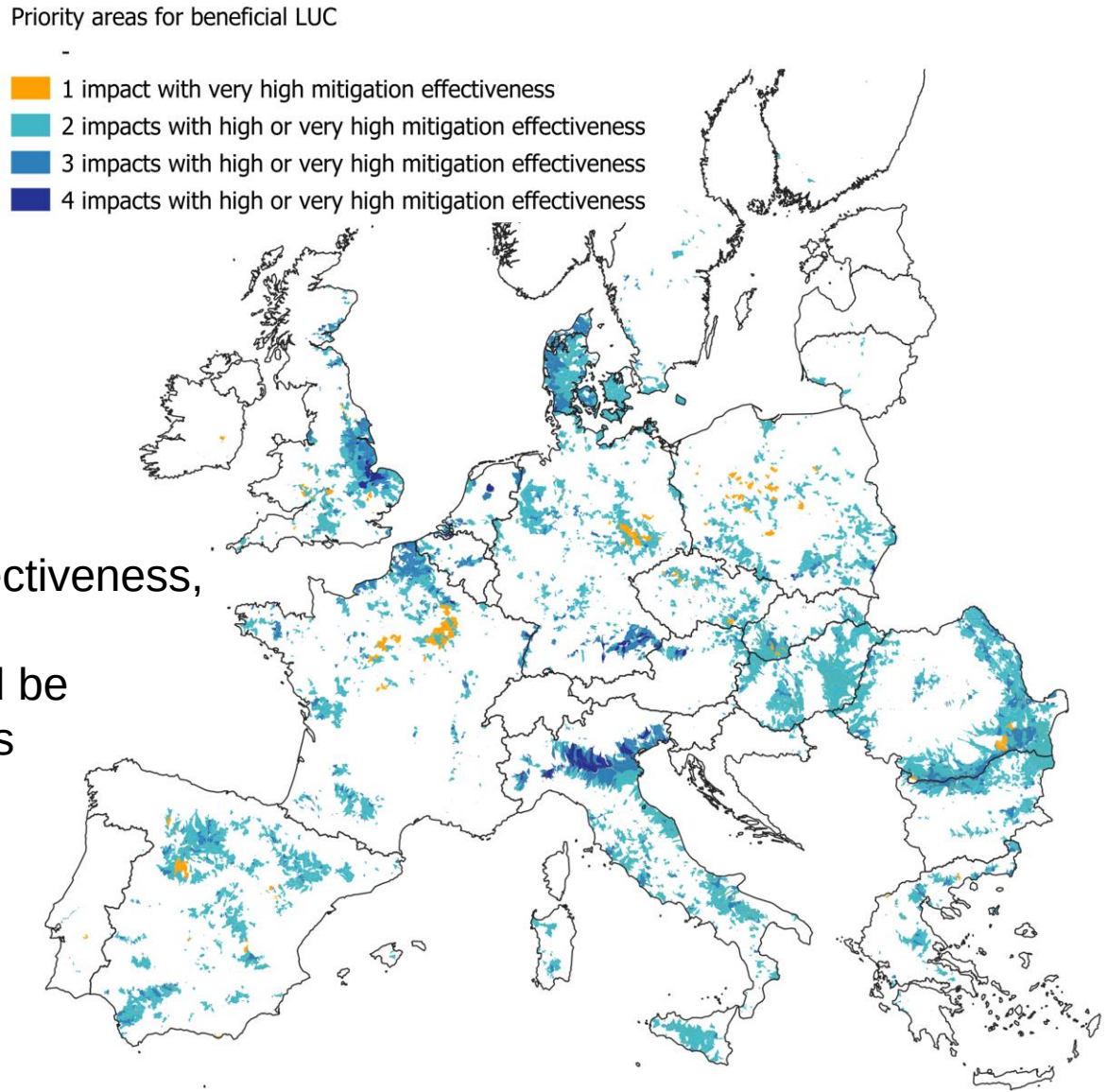


Priority areas



- Areas where
  - Multiple impacts could be mitigated simultaneously with at least *high* effectiveness, or
  - Areas where one single impact could be mitigated with *very high* effectiveness

- 10-46% of total area under annual crops
- 15-60 Mha

(Englund et al., 2020a)

So what to do in practice then?

- Two new modeling studies:
  - Large-scale deployment scenarios for
    - Riparian buffers and windbreaks, and
    - In-rotation grass production
  - Covering over 81,000 landscapes in Europe (EU27+UK)
  - Areas, biomass output, and multiple environmental benefits quantified for each production system, in each landscape and deployment scenario

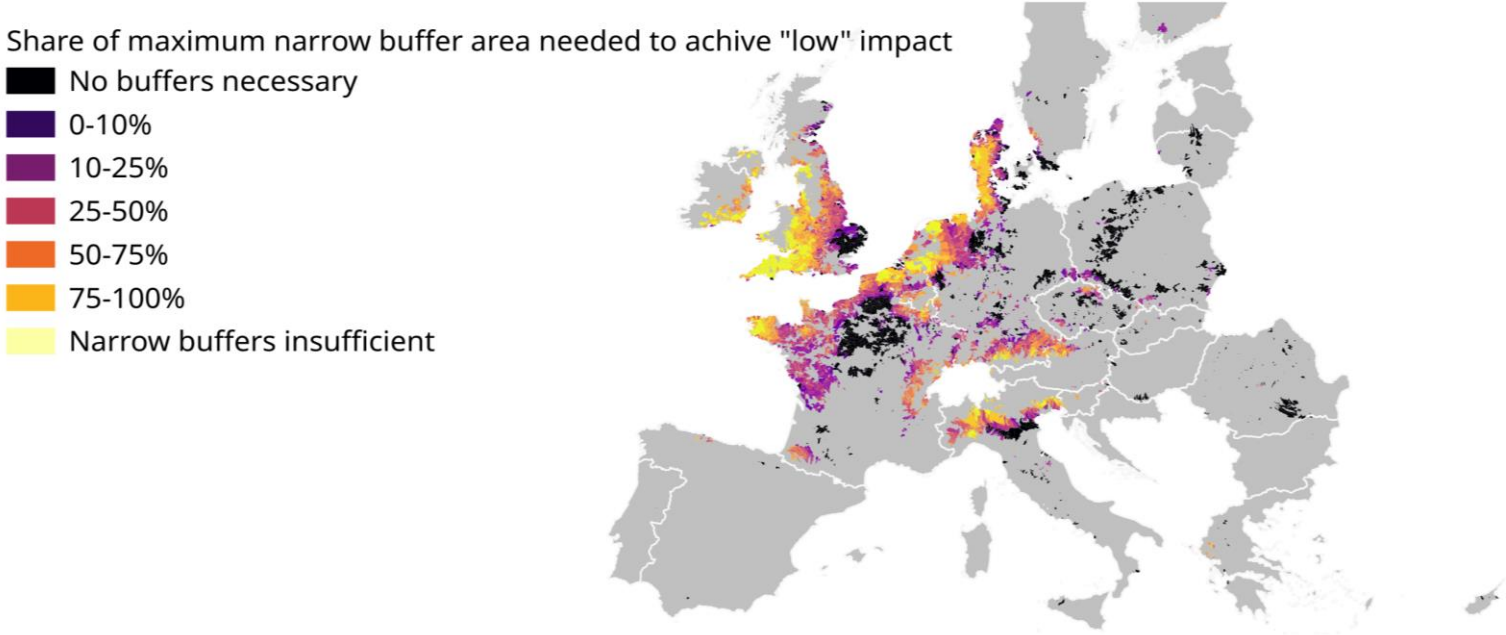
  - <u>Brief example results only due to time constraints</u>

Riparian buffers and windbreaks

- **Primary benefit:** Reduced N emissions to water (RB), reduced wind erosion (WB)
- **Quantified co-benefits:** Reduced water erosion (RB,WB), sediment retention (RB), increased soil organic carbon (RB, WB), reduced N emissions to water (WB)
- **Indicated co-benefits (RB):** Mitigated flooding events (RB, WB), reduced wind erosion (RB)

Riparian buffers

- Large parts of Europe not subject to implementation due to “lack” of primary impact
- Large variations in implementation necessary to achieve predefined mitigation levels



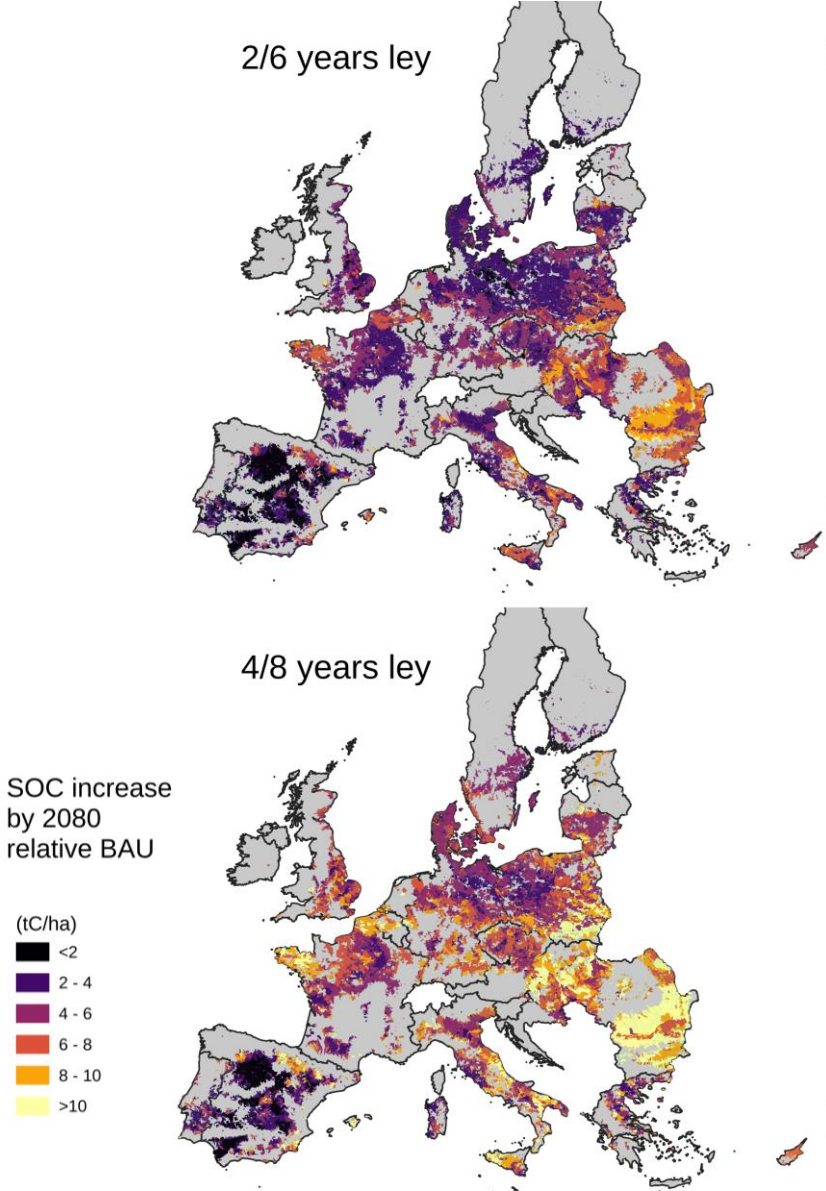
(Englund et al., 2021)

In-rotation grass production

- **Primary benefit:** Increased soil organic carbon
- **Quantified co-benefits:** Reduced water and wind erosion, reduced N emissions to water
- **Indicated co-benefits:** Mitigated flooding events

In-rotation grass production

- Substantial potential for increasing soil organic carbon on European cropland, although with large variations



(Englund et al., in preparation)

Conclusions

- Beneficial LUC can mitigate environmental impacts while producing biomass for the bioeconomy
- Riparian buffers and windbreaks can effectively reduce nitrogen emissions to water and soil loss by wind erosion while providing substantial environmental co-benefits
- Substantial SOC increases, and multiple environmental co-benefits, can be expected from introducing grass into crop rotations.
- To provide more useful information for spatial planning and regional implementation, high-resolution modeling at the landscape scale is necessary.

Articles

- Englund O, Börjesson P, Berndes G, Scarlat N, Dallemand J-F, Grizzetti B, Dimitriou I, Mola-Yudego B, Fahl F, (2020a). Beneficial land use change: strategic expansion of new biomass plantations can reduce environmental impacts from EU agriculture. Global Environmental Change, 60, 101990. https://doi.org/10.1016/j.gloenvcha.2019.101990

- *Englund, O., Börjesson, P., Mola-Yudego, B., Berndes, G., Dimitriou, I., Cederberg, C., Scarlat, N., 2021. Beneficial land-use change in Europe: deployment scenarios for multifunctional riparian buffers and windbreaks. Research Square. https://doi.org/10.21203/rs.3.rs-128604/v1*

  - Under review (accepted pending minor revisions) in *Communications: Earth & Environment*

- *Englund, O., Börjesson, P., Mola-Yudego, B., Berndes, G., Dimitriou, I., Cederberg, C., Scarlat, N., (in preparation).* Large-scale deployment of in-rotation grass cultivation can significantly increase soil carbon while providing biomass and multiple environmental co-benefits

- Englund, O., Dale, V.H., Kline, K.L., Dimitriou, I., Mola-Yudego, B., Murphy, F., English, B., McGrath, J., Busch, G., Negri, M.C., Brown, M., Goss, K., Jackson, S., Parish, E.S., Cacho, J., Zumpf, C., Quinn, J., Mishra, S.K., (2020b). Multifunctional perennial production systems for bioenergy: performance and progress. WIREs Energy & Environment, 9(5), e375. https://doi.org/10.1002/wene.375

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