ReForMit - Understanding and securing the resilience of forest-based climate change mitigation

Stockholm Resilience Centre (SRC), Potsdam Institute for Climate Impact Research (PIK), KTH Royal Institute of Technology (KTH), and Stockholm International Water Institute (SIWI)

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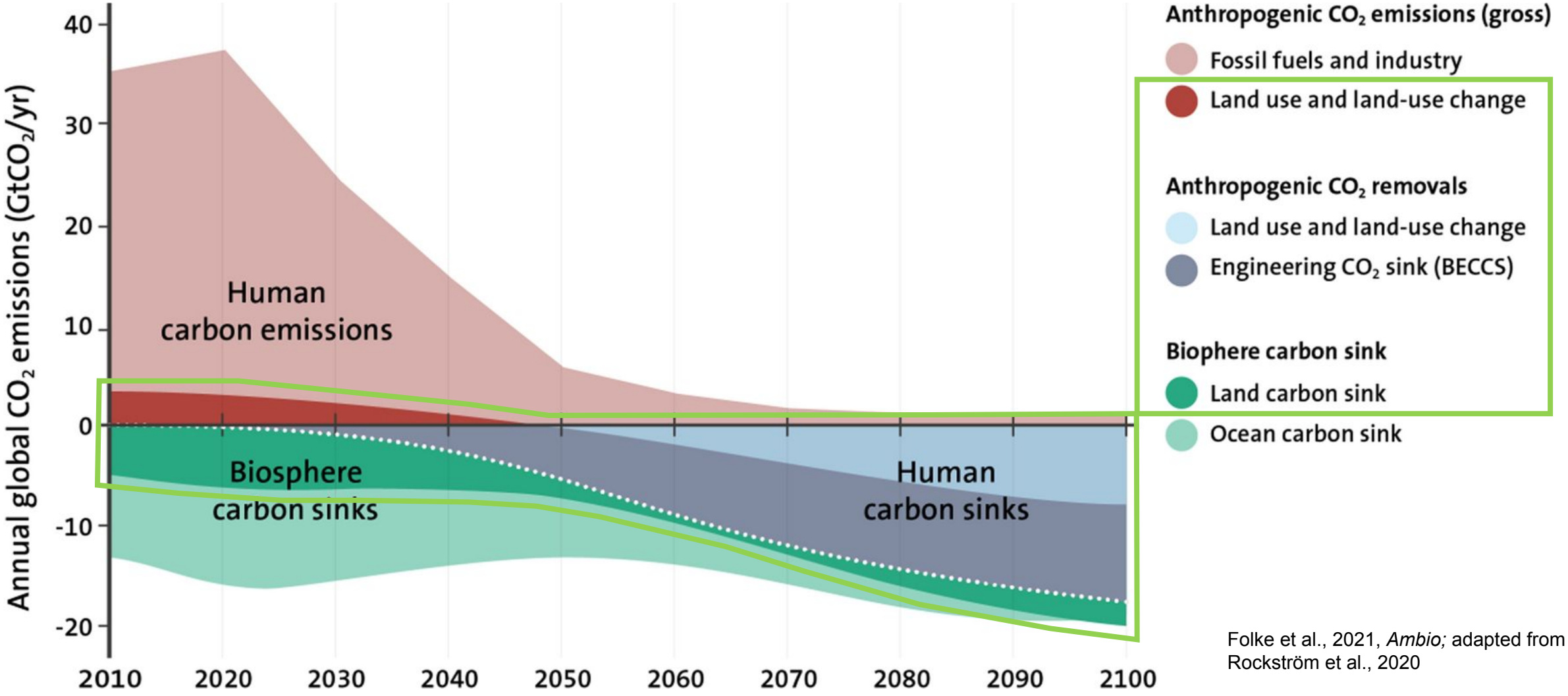
Today's agenda

- **Welcome and introduction**, *Lan Wang-Erlandsson, SRC*
- **Modeling framework**, *Fabian Stenzel, PIK*
- **Social-ecological resilience assessment**, *Sara Anamaghi, KTH*
- **Results from stakeholder survey**, *Anna Tengberg, SIWI*
- **Panel discussion**, moderated by *Zahra Kalantari, KTH*
  - *Amani Alfarra*, Food and Agriculture Organization of the United Nations (FAO)
  - Sara Casallas Ramirez, Food and Agriculture Organization of the United Nations (FAO)
  - *Lis Mullin Bernhardt*, United Nations Environment Programme (UNEP)
  - *Vivek Shah*, United Nations Environment Programme (UNEP)
  - *Fredrik Silfwerbrand*, Swedish Forest Agency
- **Group discussions**, moderated by *Massoud Behboudian, KTH*
- **Closing**, *Lan Wang-Erlandsson, SRC*

Forests regulate climate, biodiversity, & water

- **Climate regulation**: Carbon sequestration, Local cooling/warming, Clean air
- **Biodiversity**: Habitat, Future uses (e.g. medicine)
- **Water:**
  - Water provision
  - Water regulation
  - Water use
- **Economic goods**: Timber, Wood for energy, Food
- **Recreational value**: Hunting, Outdoor sports

Trees can make or break climate mitigation



Folke et al., 2021, *Ambio;* adapted from Rockström et al., 2020

Forest-based mitigation measures involve:

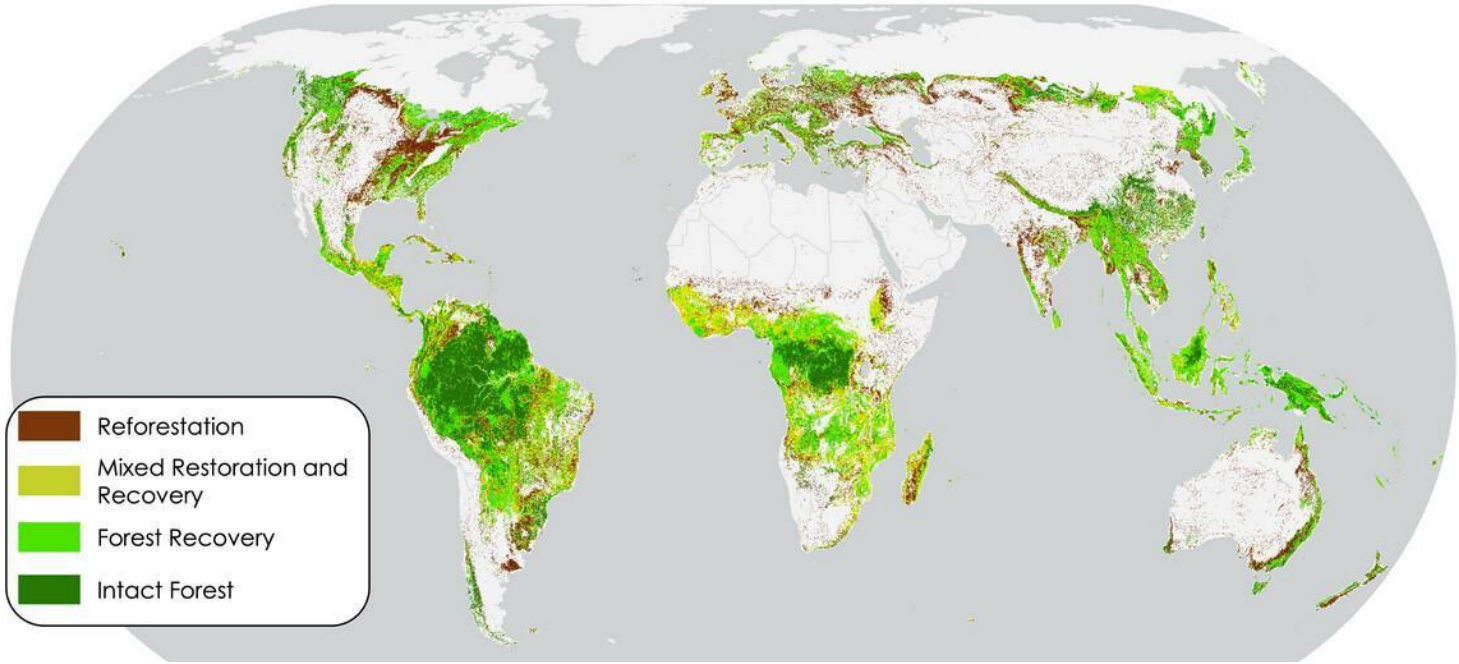


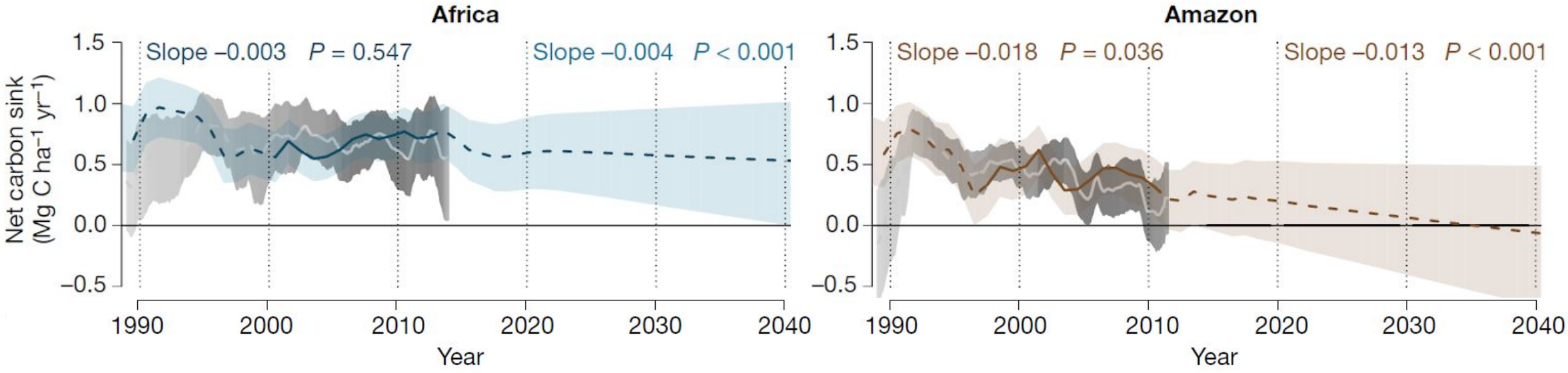
Fig. from Rayden *et al.*, 2023, *Conservation Biology*

- **Reduced conversion of forests and other ecosystems**
- **Ecosystem restoration, afforestation, reforestation**
- **Improved sustainable forest management**
- **Bioenergy with carbon capture and storage (BECCS)**

Ordered by mitigation potential until 2030 (from high to low), IPCC WG III, Fig SPM7.

However, forest functions already threatened among others by droughts and deforestation

For example, recent loss in tropical forest carbon sink strength:

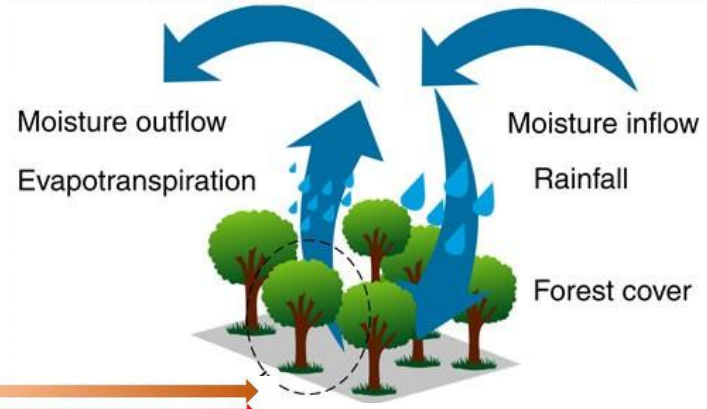


Drivers: deforestation, fire, droughts.

Hubau et al., 2020, *Nature*

Resilience can be strengthened in both ecosystems and managed land – but 'how' in practice?

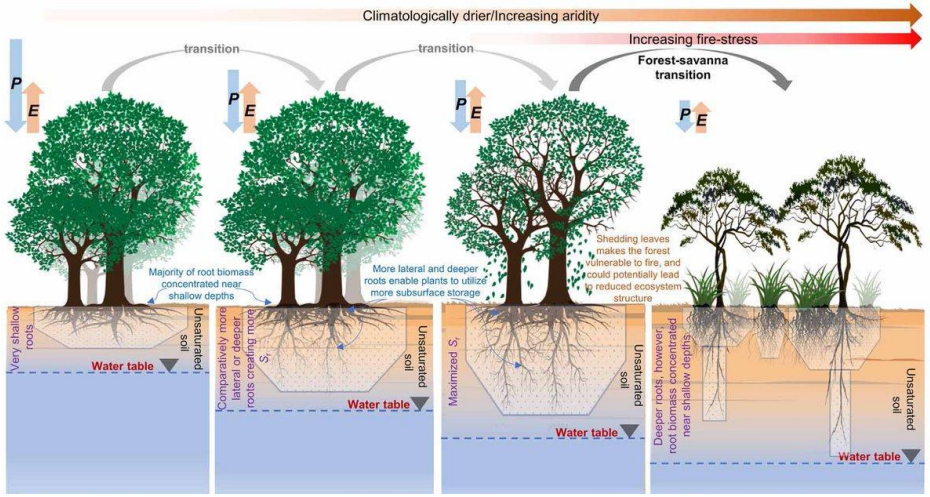
For example:



Rainfall generation & drought buffering

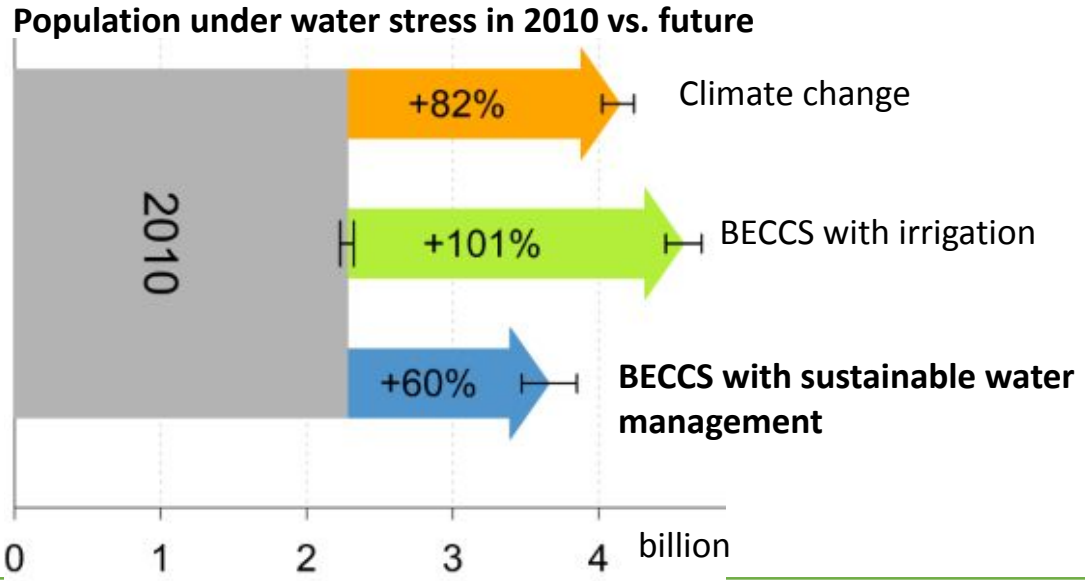
Zemp *et al*., 2017, Nat Comm

Ecosystem adaptation



Singh *et al*., 2020, ERL

Sustainable water management



Stenzel *et al*., 2022, Nat Comm

Key questions of ReForMit:

How to safeguard the resilience of forest-based climate mitigation globally under shifting hydroclimate?

In ReForMit, we will investigate:

1. What **combinations of forest measures** could support **water, climate, and biodiversity functions** under climate change?

2. What is the role of **hydroclimatic adaptation** in forest measures for enhancing the resilience locally **and remotely**?

3. How can the **social-ecological resilience** of forest measures be considered and **integrated in decision-making**?

A long-term goal is to develop a **decision support tool** for evidence-based resilience building in forest-based mitigation.

Methods: Scenario modelling with global dynamic vegetation model, moisture tracking, data analyses, data collection, case studies, and stakeholder dialogue.

ReForMit: Modeling framework

Presenter: Fabian Stenzel (Potsdam Institute for Climate Impact Research)

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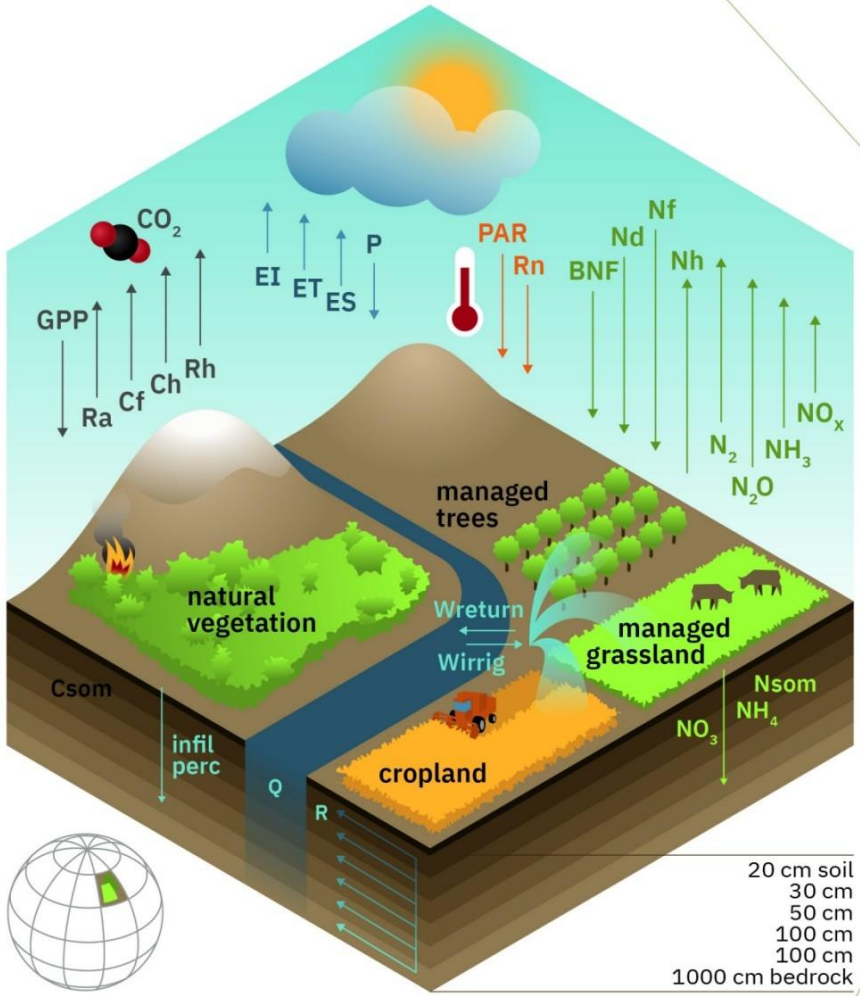
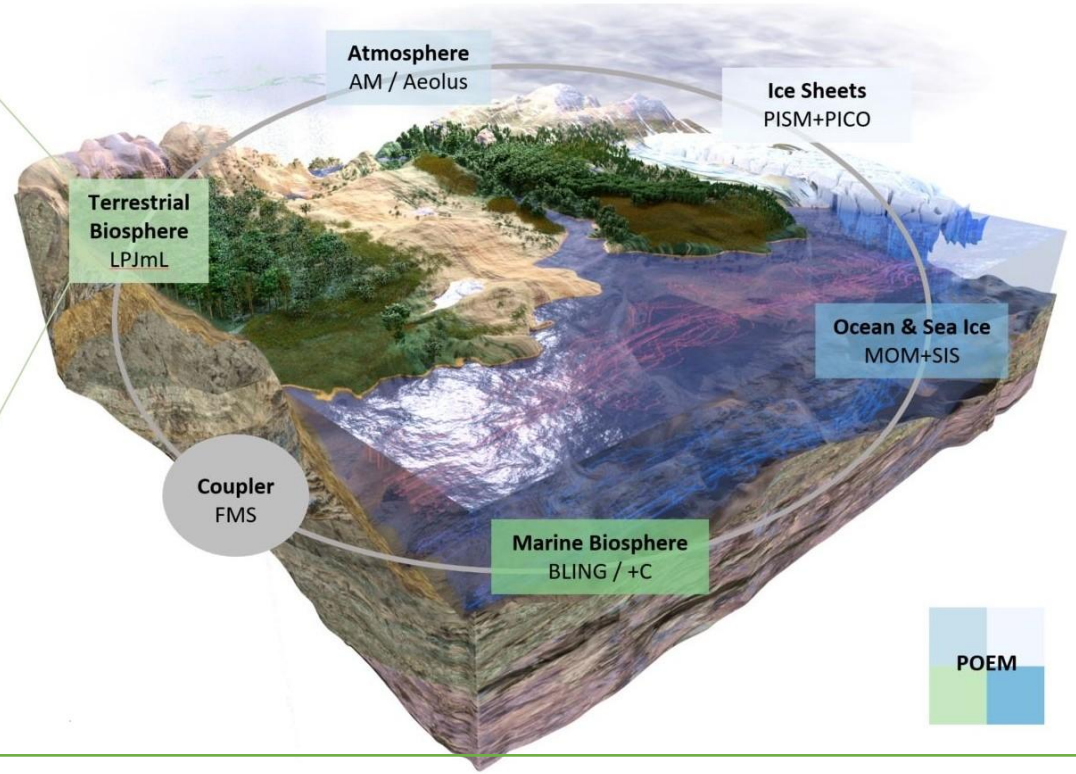
Modeling framework

- State-of-the-art process-based dynamic global **vegetation model**
- Can be run standalone or as part of POEM ESM, but requires **scenario input for climate, management, ...**
- Simulates **natural vegetation** (forests/grasslands) and **managed vegetation** (crops, pastures, orchards)
- Full carbon, water and nitrogen **cycles**

LPJmL





Schaphoff et al. 2018, Von Bloh et al. 2018

rendering by Boris Sakschewski

Forest types in LPJmL

Natural forest

Managed forest

Biomass plantation

Forest types in LPJmL

Natural forest

establishment based on succession

herbaceous Vegetation

Pionier trees (fast growing, light demanding)

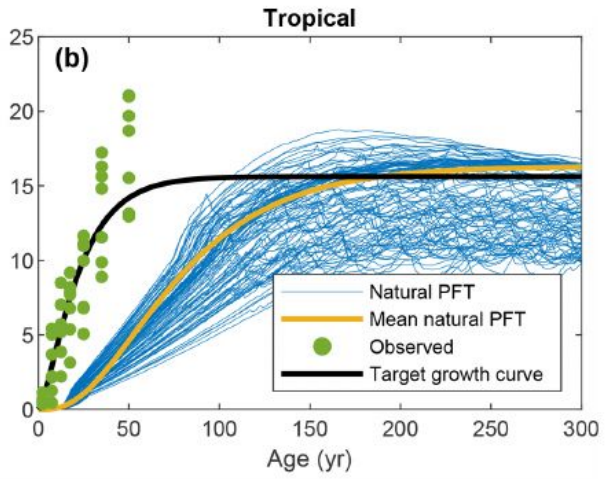
Late successional trees (needle-leaved)

Broadleaved trees mix in

Mortality opens spots for new succession

Forest types in LPJmL

- Larger saplings planted
- No competition
- Designed to match growth curves



Braakhekke et al. 2019

Managed forest

Forest types in LPJmL

- Plantation of fast growing tree species
- Designed to produce maximum biomass (e.g. for BECCS)
- High management (irrigation, fertilization)

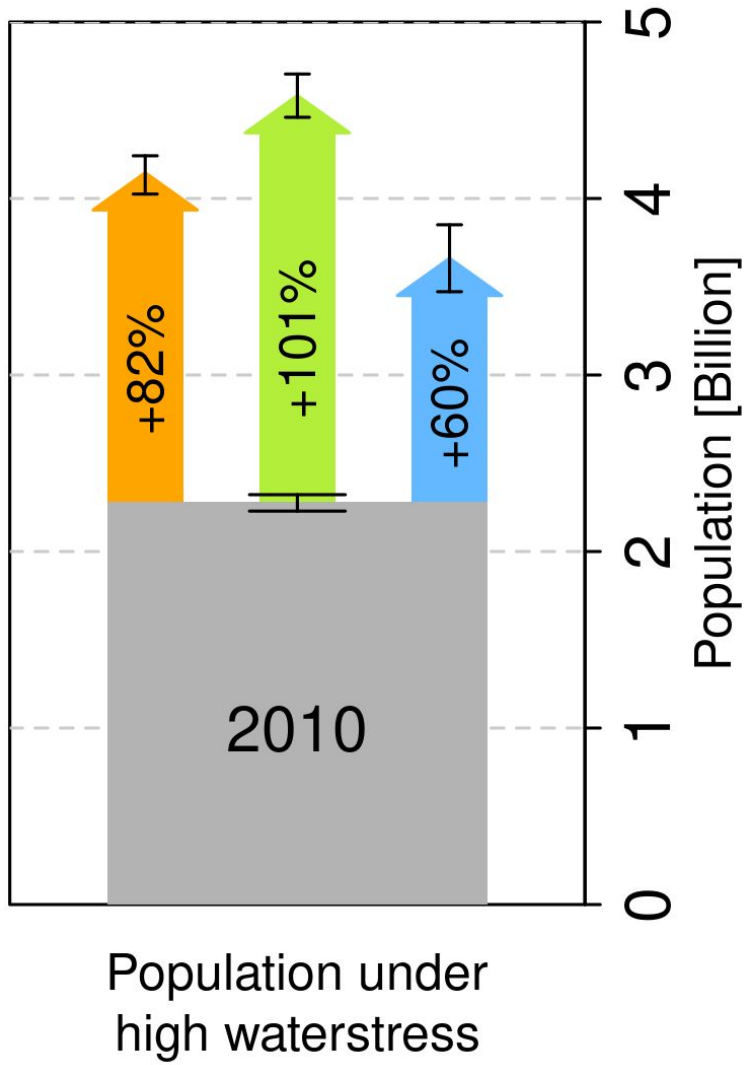
Biomass plantation

Case study

Research question:
What will result in higher water stress – unmitigated climate change, or large scale bioenergy with irrigation?

Scenario choices:

climate change in 2100	3°C (RCP6.0)	1.5°C (RCP2.6)	1.5°C (RCP2.6)
Biomass plantation area (2090-2100)	30 Mha	600 Mha	600 Mha
of which irrigated	30%	30%	45%
Sustainable water management	No	No	Yes



Stenzel *et al.*, 2021, Nat Comm

What's in it for you as a stakeholder?

- Influence on the scientific process by providing knowledge
- Opportunity to co-create knowledge and get in contact with a state-of-the-art global vegetation model
- Opportunity to interact with other stakeholders
- Receive regular information about our status
- Opportunity to participate in a common report/paper about our stakeholder process in this project

What can you contribute?

- Help up build useful **scenarios** about **forest type, management, climate**

To get notified how and when to contribute, subscribe here:
https://survey.pik-potsdam.de/reformit/

ReForMit: Social-ecological resilience assessment

Presenter: Sara Anamaghi (KTH Royal Institute of Technology)

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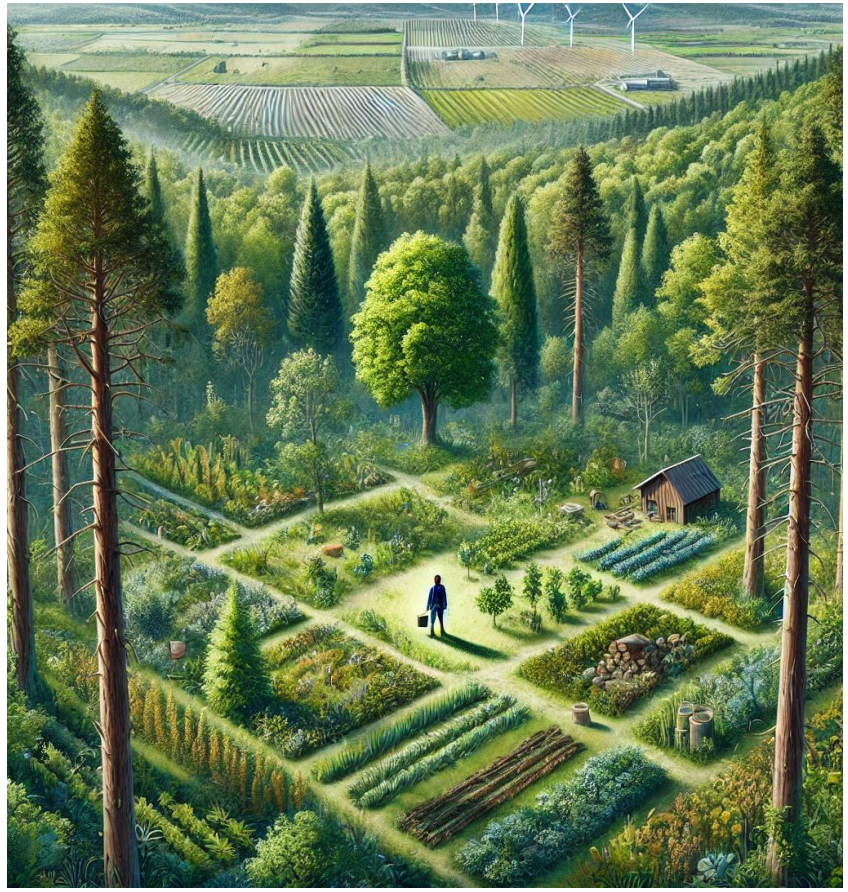
Why we should evaluate forest resilience?



- Increase in forest resource exploitation
- Increase in forest disturbances (e.g., drought, fires)

⇩

Adversely impact forests and their ability to provide benefits for humans (i.e., ecosystem services)

Resilience provides a means to ensure a stable provision of ecosystem services and well-being of society

Forests as a social-ecological system

- Social-ecological systems → Systems where there are interactions between human societies and natural environments.

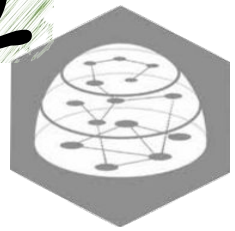
- Forests are social-ecological systems → Provide different benefits for humans and humans change forests

  - Forest products
  - Carbon sequestration
  - Flood mitigation
  - Tourism and recreation

7 Resilience Principles

Ecological

1  Diversity & Redundancy

2  Connectivity

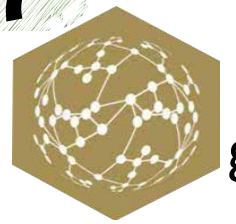
3  Slow variables & feedback

4  Complex adaptive system thinking

Social

5  Learning & experimentation

6  Participation

7  Polycentric governance

Diversity and Redundancy

- Having different components makes the system resilient.
- Diversity allows for some components to compensate for the loss of others

More resilient

Diverse tree species can provide food and shelter for a bigger range of consumers.

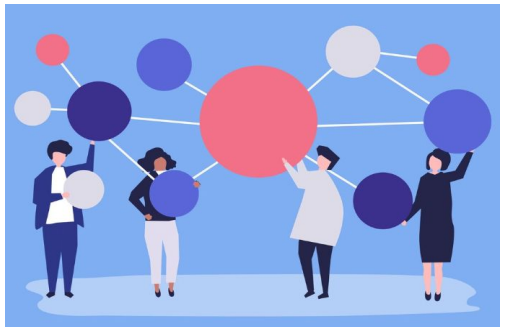
Less resilient

Forests with uniform tree cover are more vulnerable to disturbances.

Learning & experimentation

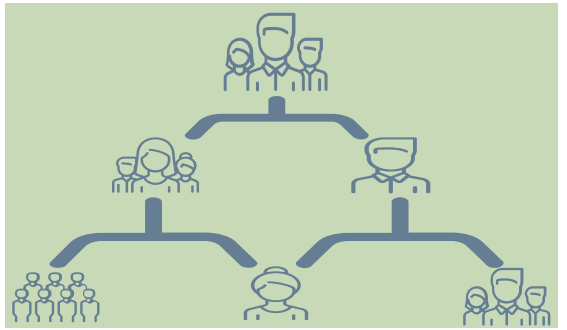
Higher levels of information exchange

Participation



Higher Interest in cooperation

Polycentric governance



Multiple governance levels

- Better responses for future challenges
- Enable adaptive management

Social principles

Learning & experimentation

Participation

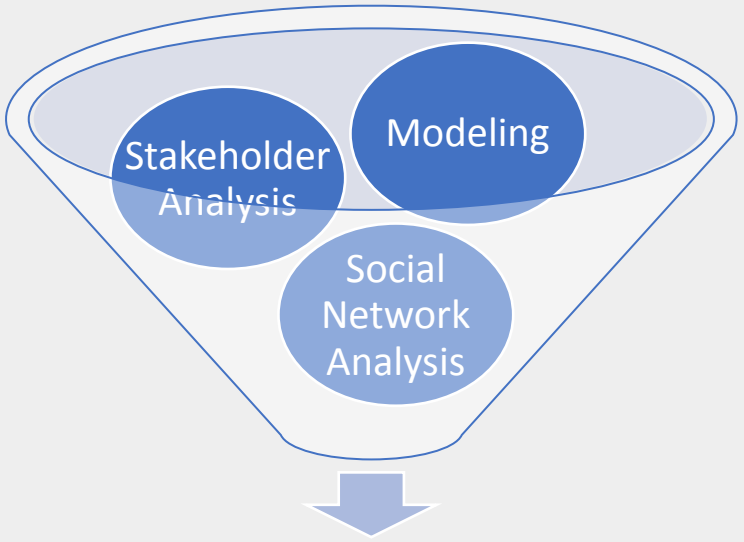
Polycentric governance

- **Community-Based Forest Management in Nepal** (Ghimire & Lamichhane, 2020)
  - Granting legal rights to local communities to manage national forests
  - Incorporating traditional knowledge
  - Ongoing learning through participatory planning and adaptive management

Potential outcomes of social-ecological resilience assessment

- A framework for assessing social-ecological forest resilience globally
- Spatio-temporal time series of social-ecological forest resilience under different scenarios

1. Resilience time series



2. Identify low resilience spots across forest landscape

3. Inform decision-makers (e.g., FLR) about the best management practices

ReForMit: Stakeholder survey - results

presenter: Anna Tengberg (Stockholm International Water Institute)

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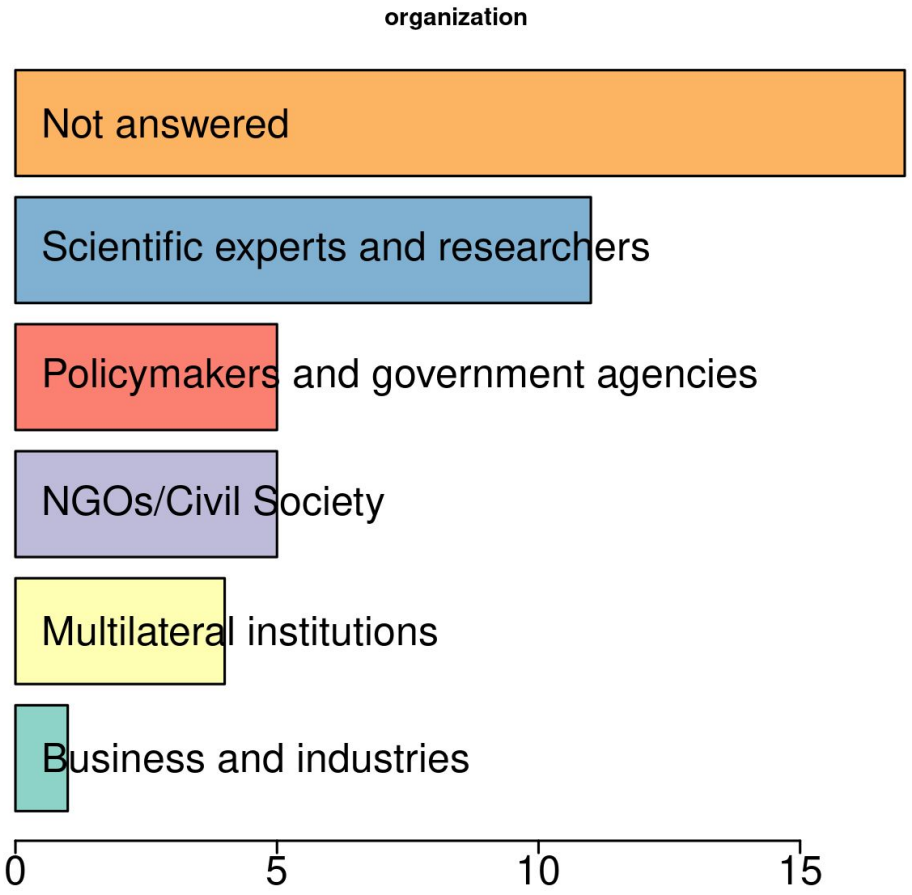
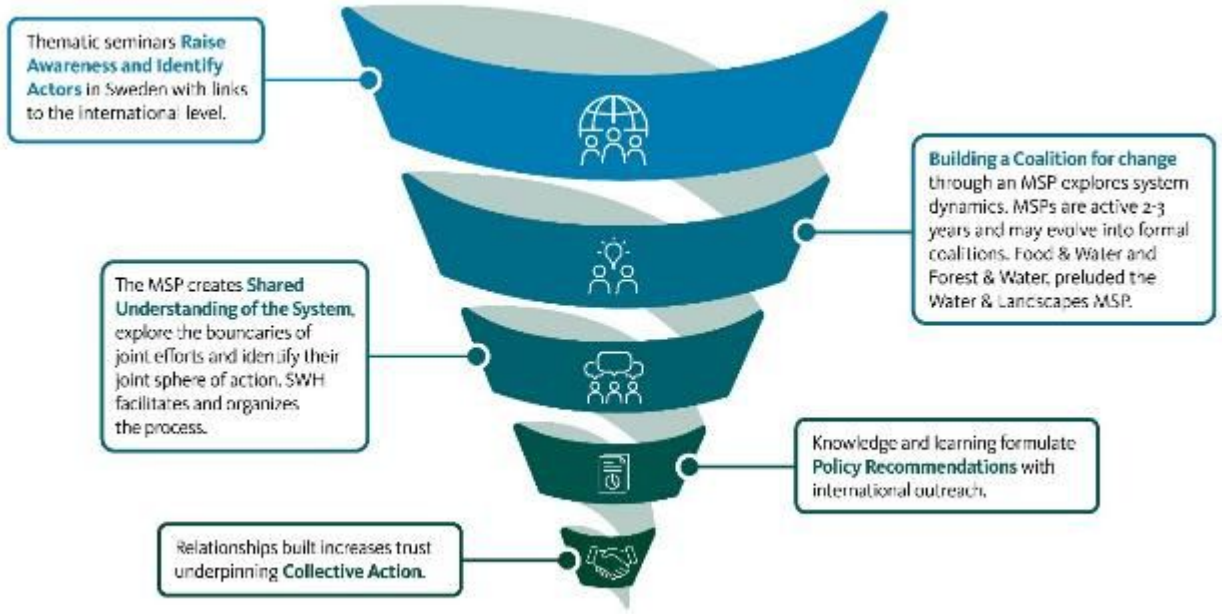
Initial Stakeholder Survey



total number of participants: 43

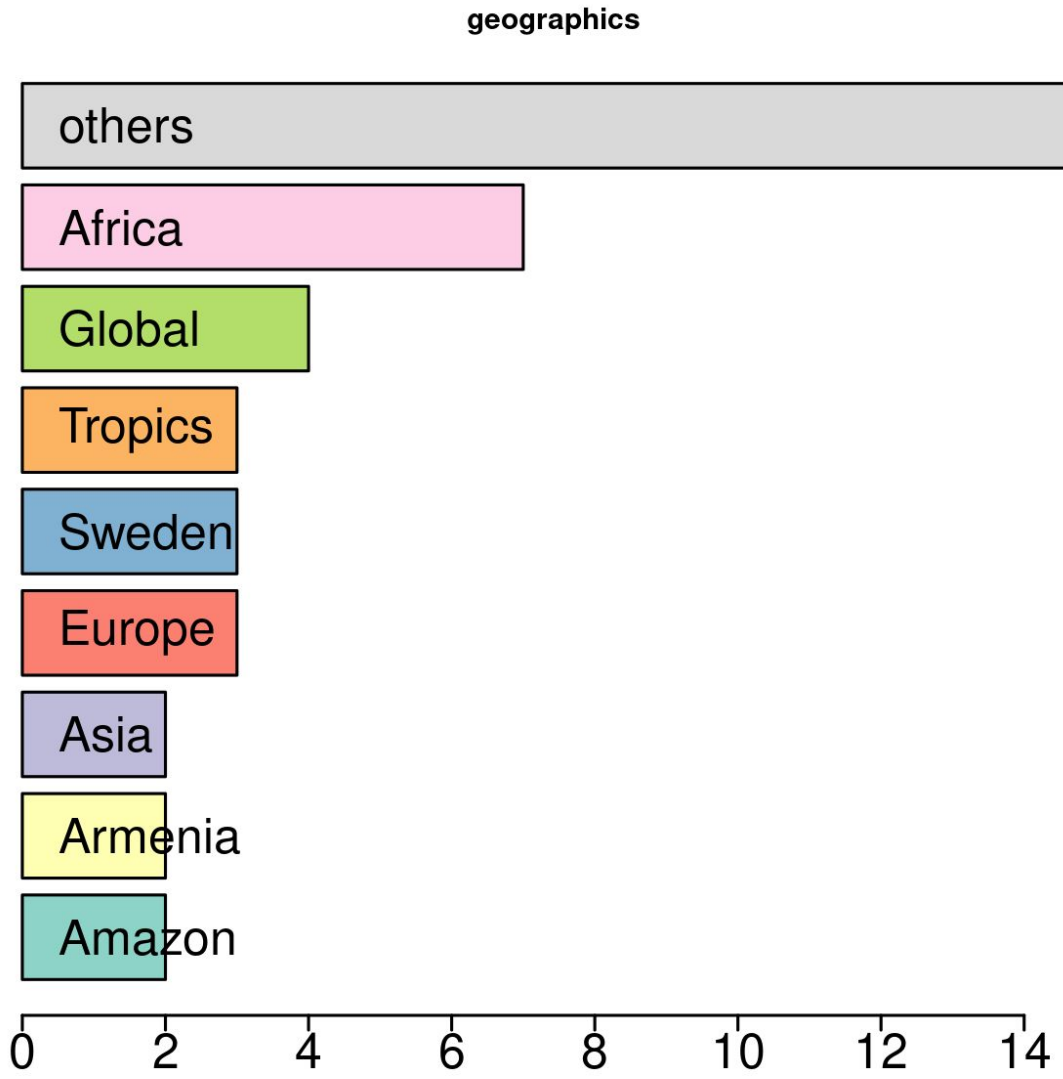


Tengberg et al (2021). Forests 2021,12, 1. https://dx.doi.org/10.3390

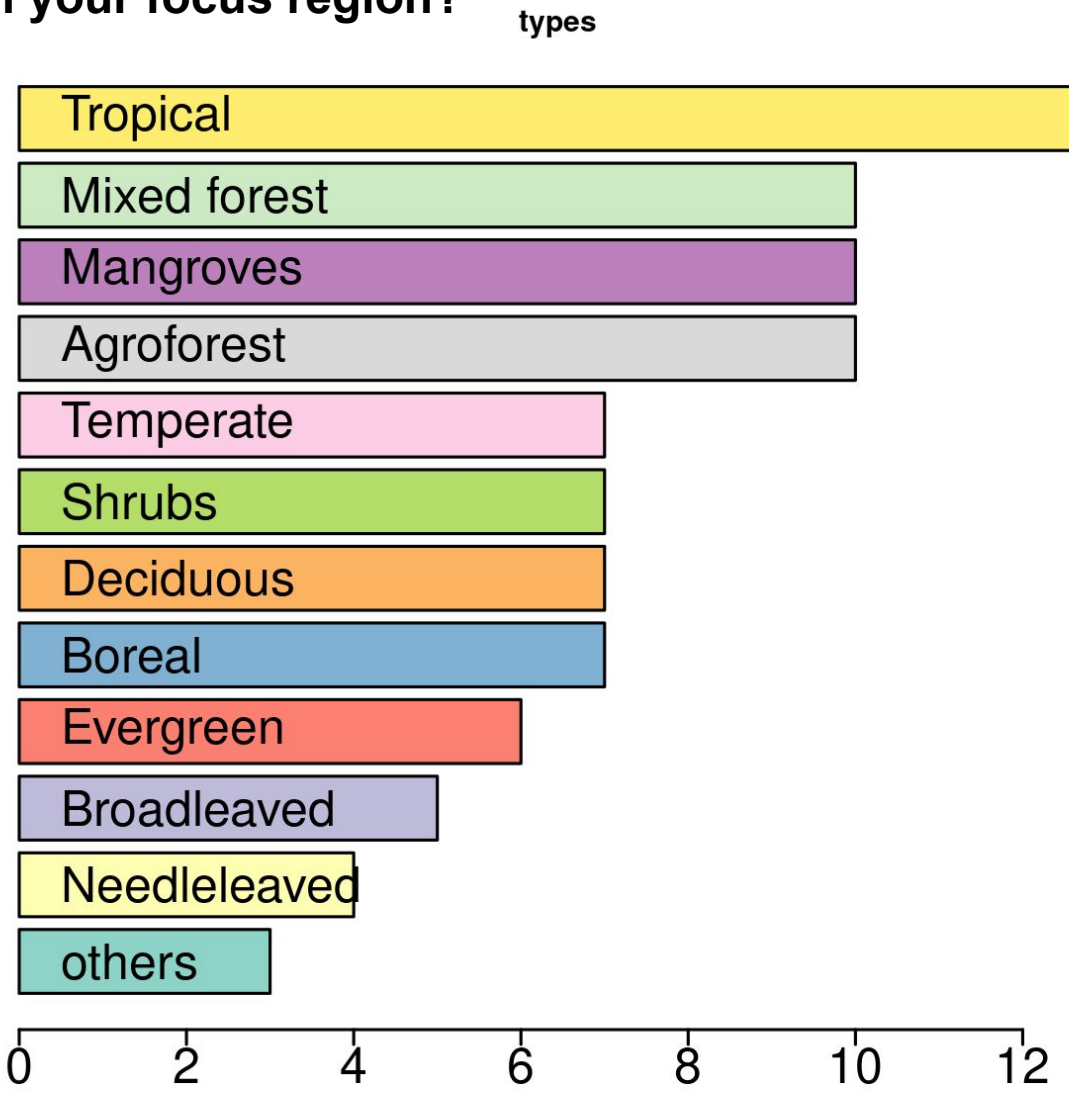
What is your role/responsibility within your organization?

- Support governments to improve management and monitoring of their forests for water-related benefits
- Senior Learning Officer and Advisor
- Board Chair
- Lead researcher
- Director of RDI (Research, Data and Impact) for Africa
- scientist
- National secretary/CEO
- Scientist
- Programme Director
- Junior Researcher
- Policy advisor
- Director of RDI (Research Data and Innovation)
- Director General del Instituto Nacional para la Conservación del Medio Ambiente (INCOMA)
- Assistant Professor
- Lead scientist, executive director
- Lead scientist
- technical support provides technical support in mainstreaming and cascading climate change in programs and plans of the Department
- Forest policy
- Capacity building, competence development
- Senior Environment Specialist, Program Manager
- Director of Climate Change, Desertification and Natural Disasters Directorate, policy advisor, Climate Change, Environment and Natural Resources specialist
- Scientist
- Decision maker
- Deputy Head
- Lead scientist, Policy advisor
- Top specialist in forestry
- Head of climate research and monitoring division
- Director of NEDA Agriculture, Natural Resources, and Environment Staff

6. Which is your geographical focus region?



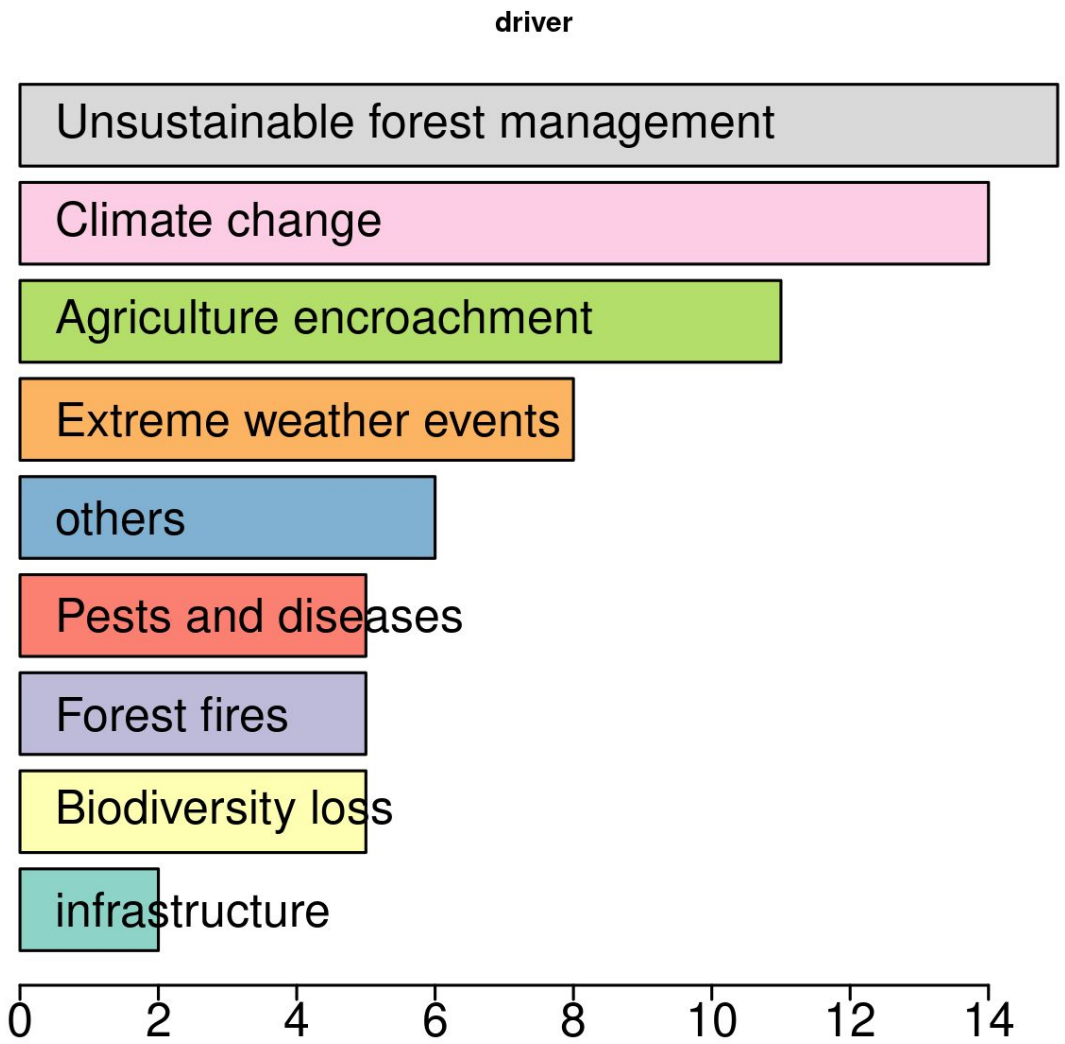
7. What types of forests or wooded landscapes exist in your focus region?



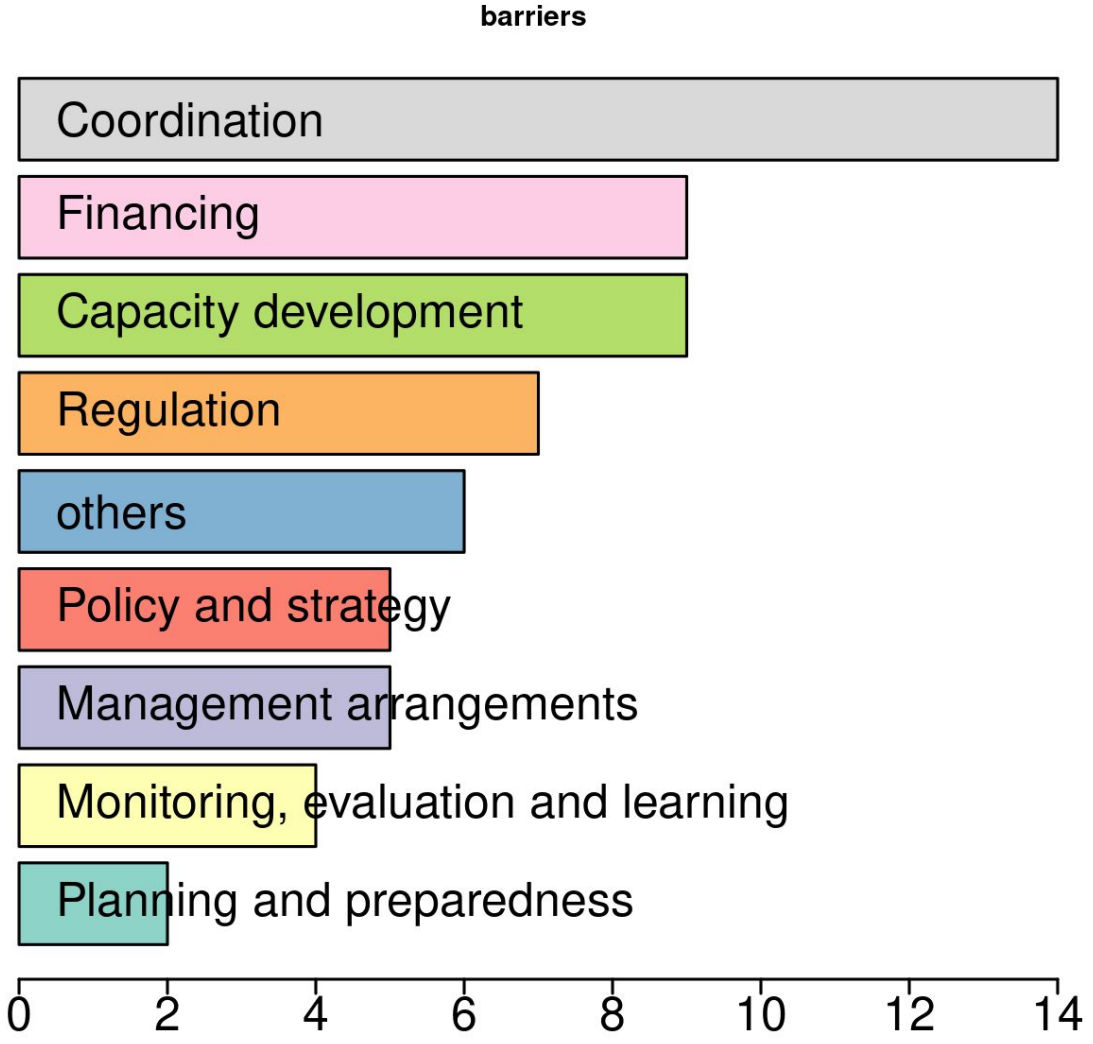
9. What characterizes, in your view, a healthy and resilient forest system?

- One that is able to provide multiple services and that can continue to provide those services in time and in the context of climate change.
- Diversity of species of flora, fauna, mushrooms
- well balance in term of structure
- mixed forest types with complex structure in age/size/leaf cover
- Long-term ability to supply ecosystem services such as timber, biodiversity, recreation, capacity to sequester and store carbon, jobs, culture
- Minimize human presence and activities
- Biodiversity: rich with plant and animal life
- Several forest layers, divers forests in terms of species and age/diameter, divers landscapes
- Biodiversity in both vegetation and animals
- Good vegetation cover, high biodiversity, structure with young plants, and the ability to quickly recover the initial structure after forest degradation.
- active management
- enhance forests ability to provide a range of ecosystem services including habitat provision, sustainable livelihood and carbon sequestration
- Connectivity
- sustainable forest management
- Biodiversity
- Support complex ecosystems that host diverse range and variety of wildlife species (e.g., flora, fauna, fungi) that contribute to ecosystem stability and adaptability
- Diversity of tree ages
- A good balance of production, conservation and Resilience
- Diverse
- presence of dead wood and different habitats
- Respect of natural cycles
- Variety of habitats
- Good topsoil health
- managing for emerging climate conditions, managing for complexity, managing for integration with social systems
- 1) Numerous trees, 2) younger trees (trees' seeds and nursery of trees' seeds for the growing/planting/nursery/regeneration of future trees), 3) The availability of groundwater.
- Depends on context, forest type, baseline condition, stakeholder objectives
- Low degradation
- Climate smart mixed forests with regular thinning, natural regeneration and re-planting (if necessary)
- Regeneration capacity
- Resilience to disturbances such as extreme weather events, forest fires, and climate change while maintaining ecosystem functions
- Healthy water systems
- high speed of recovery after perturbation
- high primary production (carbon sequestration)
- Clean water
- Forest is part of a natural and healthy water system (eg the area has not been drained)
- Low presence of exotic species
- Soil health
- Continuous provision of ecosystem services critical for sustainable and robust economic growth
- Sufficient size to allow for regeneration of species
- high ecological interactions (e.g., ecological connectivity and mutualistic relations...)
- Connectivity
- Human use does not threaten their carrying capacity

10. What do you see as the most important direct driver(s) for resilience loss in forests

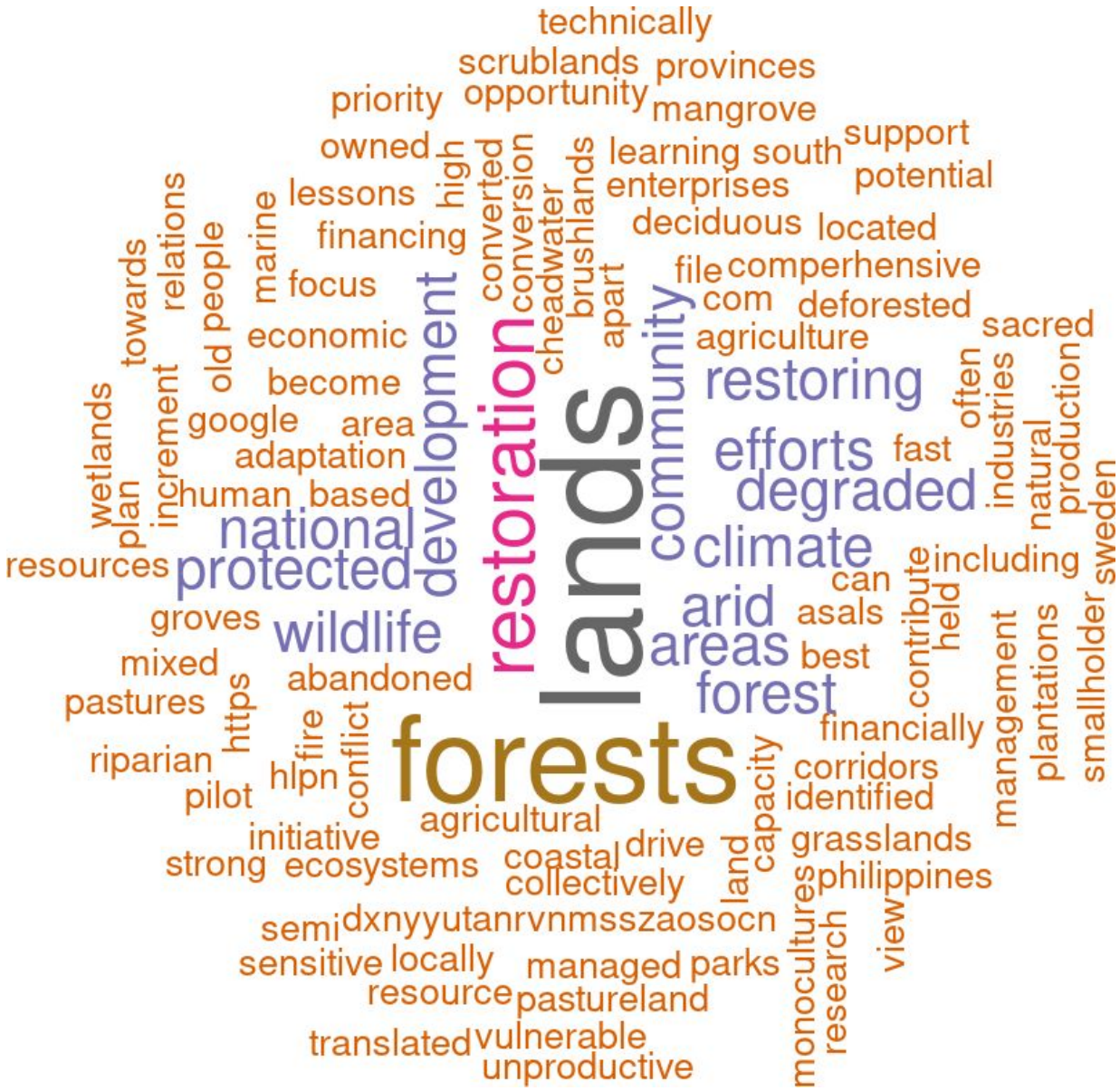


11. What do you see as the greatest policy institutional barrier(s) to safeguarding and preserving healthy and resilient forests, where you work?



14. Which areas should be prioritized for restoration where you work?

- headwater and riparian forests
- Locally owned and managed, often collectively held lands with strong relations between people and lands
- Research on restoration (learning lessons from pilot restoration initiative)
- Deciduous forests in the South of Sweden
- Wildlife corridors that are not protected, with potential for human-wildlife conflict that could be translated into an opportunity
- community and smallholder lands
- Forest that has been converted to agriculture, pastureland, or forest plantations
- fire management
- 1) The Mangrove located in the marine coastal area, 2) Wetlands, 3) Arid and Semi-Arid Lands (ASALs)
- Climate vulnerable provinces as identified in the National Adaptation Plan of the Philippines 2023-2050 https://drive.google.com/file/d/19hL1p1N-DXNyYuTanrVnMs7SZAosO7cN/view
- pastures
- Financing
- comprehensive resources; financially, technically and Capacity Development
- Degraded land including sacred groves, community lands for (climate-sensitive) production
- Restoring forests in national parks and other protected areas.
- Fast conversion of (old) monocultures into mixed forests with high increment
- Apart from degraded forests and deforested areas which have become grasslands, priority restoration efforts should focus on unproductive or abandoned agricultural lands, brushlands, and scrublands. Efforts in restoring ecosystems that can support natural resource-based industries and enterprises contribute best towards economic development.



ReForMit - Panel discussion with:

- **Amani Alfarra**, Food and Agriculture Organization of the United Nations (FAO)
- **Sara Casallas Ramirez,** Food and Agriculture Organization of the United Nations (FAO)
- **Lis Mullin Bernhardt**, United Nations Environment Programme (UNEP)
- **Vivek Shah**, United Nations Environment Programme (UNEP)
- **Fredrik Silfwerbrand**, Swedish Forest Agency

Moderated by **Zahra Kalantari**, KTH

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ReForMit: Group discussion

moderated by Massoud Behboudian, KTH

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"Think, Write, Share"

The "Think, Write, Share" methodology is a structured facilitation technique designed to promote individual reflection, idea generation, and collaborative discussion in group settings. This approach, which is based on the Crawford Slip Method, allows participants to engage deeply with a topic while ensuring that all voices are heard (Sreeletha, 2020).

Methodology Overview:

1. **Think**: Participants are first given time to reflect on a specific question or topic. This phase encourages independent thought, allowing individuals to formulate their ideas without external influence or pressure.

2. **Write**: Participants write their thoughts on Post-it notes or cards after the thinking phase. This step emphasizes clarity and brevity, intending to capture succinct ideas. Writing helps engage different cognitive pathways and creates tangible artifacts that can be reviewed later. Anonymity is often maintained by using the same type of writing instrument and color, ensuring that each idea is valued equally.

3. **Share**: Participants share their written ideas with the group in the final phase. This can be done by reading them aloud, posting them on a board, or submitting them anonymously. The sharing process allows for the identification of patterns, grouping of similar concepts, and collaborative discussion. Selected individuals to further analyze the collected ideas can also conduct this phase later.

Questions for discussion

1. List some of the main **barriers** in the field of forest **resilience** and propose your main ideas for **solutions**.
2. Which **forest types** and forest **management** options should we prioritize in the modeling?

Thank you for joining, please stay in touch!

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https://survey.pik-potsdam.de/reformit/

Welcome to continue the discussion **TODAY** in **Room 31 on Level 3 (from 13.00)**

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