Workshops to prepare POF V

Please find a brief text prepared for the Helmholtz strategy paper below:

Dynamics in hydrological, and biogeochemical cycles, as well as biodiversity and associated ecosystem functions of the land surface interact and form essential feedback loops, shaping terrestrial systems. We will analyze natural processes driving critical changes in terrestrial environments since the origin of life to today's "Anthropocene", including novel stressors. We will quantify human impacts by integrating analytical, innovative Earth observation technologies, and monitoring platforms with models and experiments. **We will generate impact** by using improved fundamental knowledge on the functioning of dynamic land surface (and ecosystems) processes, with its abiotic and biotic components, to develop and evaluate strategies for mitigating human-induced changes. We will identify and quantify fundamental processes that keep the terrestrial systems within sustainable limits and deliver scientific knowledge to help restore, maintain and improve the integrity of ecosystems and their functions, and to halt and reverse the loss of biodiversity and carbon.

There will be another topic (new T6) emerging from our current topic 5, which will be called "**Multifunctional landscape management for sustainable resource uses**". While in new T5, a focus will be on process understanding of ecosystems and biodiversity dynamics, T6 will focus especially on management of resources in the landscapes and related governance issues. We hope that this, at least for the time being, will clarify a little bit where to draw the line between the different new Topics.

Workshop contents

(Please note that they are not exhaustive)

1. Impacts of multiple stressors at various scales

What are the challenges?

- Ecosystems are being impacted by many simultaneous changes (physical, biological, chemical); i.e. the "reality" of the problem is that it is complex and causally high-dimensional
 - e.g. non-linear responses, especially interactions are expected
- masked responses (by interactions), or hidden (latent) factors that are not considered
- most experimental evidence comes from <= 2 factors studied, at high treatment levels, and only subset of the system level responses
- experiments are much smaller scale than the systems we need to understand and proactively manage or adapt, anticipating forecasted changes; e.g. need to understand catchment scale, but N=1 problem (no controls or replicates), pointing need for more observational and gradient type approaches, or comparative methods (see common index below): what works where?
- site comparison / need for multi-stressor index? -> review on earlier approaches needed, e.g. Water Framework Directive
- comparability of the impact strength of various stressors
- various spatial and temporal scales of responses
- emerging stressors, e.g. new diseases, adding further complexity

- variation in methodology of data collection
- some management efforts might cause negative interaction, or affect different responses oppositely.

2. Time lags and legacy effects

What are the challenges?

- Together develop a concept of legacy effects on biodiversity and ecosystem function that works across spatial and temporal scales. What do legacy effects mean for **future** biodiversity and ecosystem functioning? Which effects are positive and which negative? How many years does it take in different systems that legacy effects can be seen? Accordingly, how fast will management / restoration measures show the anticipated effects for different processes? How do management / restoration measures have to be designed to reach their aim? → All questions in different systems and for different processes
- Develop best practice examples of ecosystem management / restoration (in co-design with stakeholders? → We might not do this ourselves but it might be a bridge to other TBs at UFZ)
- Connect below- and above-ground
- Different time scales in different systems (< 1 year or few years in microbial systems and some agricultural system, decades in restoration and conservation, 100 years in biological invasions at biogeographical scales, millenia in colonization processes after the last glaciation, soil-plant interactions with soil pore development over the years, ...)

3. Methodological Toolbox

Biodiversity Monitoring

- TERENO, eLTER
- Utilize AI for semi-automatic monitoring
- Improved/Extended toolbox for (soil) biodiversity assessment (indicator species, key taxa, proper diversity indicators that are easy to measure for large scale/global assessments, utilize AI for examining omics datasets)
- ETC European Topic Centre (UFZ/iDiv) EEA state of nature report citizen science & novel technologies (Sheard et al 2024)/ TagfalterMonitoring, FLOW links with NMZB
- UBA umwelt.info
- Link to NMZB / BfN and monitoring

Process-based Modelling (for projections)

- Process-based, integrated / statistical modelling?

- Foundation models
- ...

4. Other topics

Any topic you feel is lacking and where you can provide input. Please let us know as soon as possible to schedule a respective meeting.