eLTER

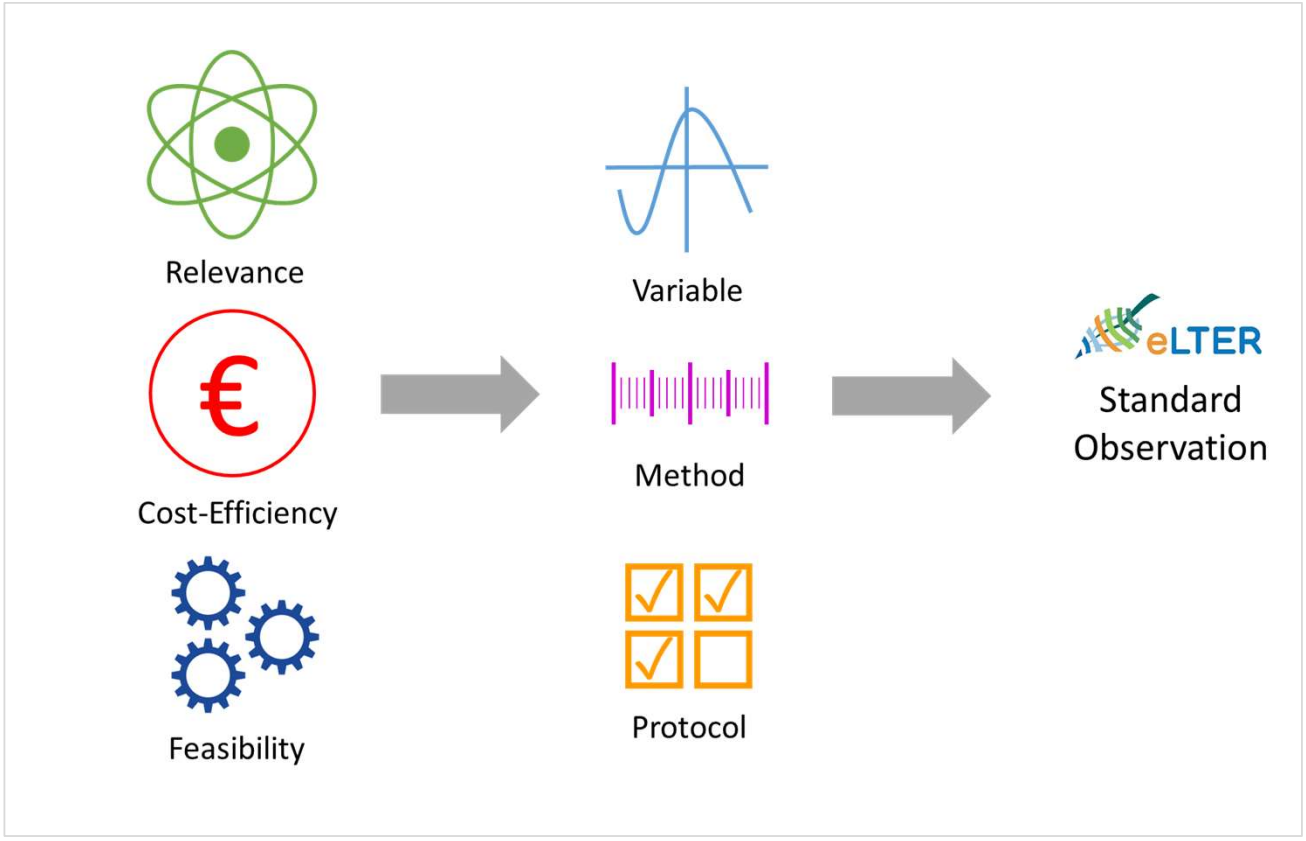
Integrated European
Long-Term Ecosystem
Critical Zone &
Socio-ecological Research
Research Infrastructure

Filling a critical gap for top-class science at the continental scale

The Discussion Paper and the process towards the eLTER's framework of standard observations

Steffen Zacharias and the teams of PLUS WP3/PPP WP6

eLTER Standard Observations



Discussion Paper on eLTER Standard Observations

- eLTER PLUS WP3 submitted the document on 8th March 2021
- document currently in final internal review
- contribution vom WP1, WP4, WP8, WP9, WP 10

1. eLTER and the process for defining Standard Observations
2. eLTER Standard Observations
3. eLTER Standard Observations for Earth Observation Cal/Val activities

eLTER PLUS

European long-term ecosystem, critical zone and socio-ecological systems research infrastructure PLUS

Discussion paper on eLTER Standard Observations (eLTER SOs)

Deliverable D3.1

8th March 2021

Editorial team:

Steffen Zacharias[1], Saku Anttila[2], Jaana Bäck[3], Kristin Böttcher[2], Ulf Mallast[1], Michael Mirtl[1], Marcus Schaub[4], Volodymyr Trotsiuk[4],

[1] UFZ Helmholtz Centre for Environmental Research, Germany
[2] Finnish Environment Institute, Finland
[3] Department of Forest Sciences, University of Helsinki, Finland
[4] Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Switzerland

Contributing authors:

Roland Baatz, Ilona Bärlund, Mario Brauns, Ricardo Díaz-Delgado, Jan Dick, Thomas Dirnböck, Martyn Futter, Peter Haase, Ingolf Kühn, Christin Müller, Nikolaos Nikolaidis, Daniel Orenstein, Alessandra Pugnetti, Karsten Rinke, Christian Siebert, Ute Skiba, Harry Vereecken, Joana Vicente

The different perspectives of research on standardization

Predictive research
- Modelling
- Systems analysis

Process research
- Experiments
- Mechanisms

Descriptive research
- Observations
- Monitoring

Operational (predictive) Monitoring
- Systems behaviour
- Amalgamating Monitoring & Models
- Key system properties

Functional Monitoring
- Functions & process rates
- System dynamics = higher sampling frequencies
- Ecosystem services

Status Monitoring
- State variables
- Value = state
- Bioindication
- Low sampling frequencies
- e.g. EU-WFD

Discussion Paper on eLTER Standard Observations

- 173 variable have been proposed and evaluated regarding (i) scientific impact, (ii) cost-efficieny, and (iii) feasibility

- Variables to describe:
  - Abiotic site characteristics
  - Socio-ecology
  - Biotic heterogeneity
  - Energy budget
  - Water balance
  - Matter budget

Classification of priority:

A = „goes without saying“: 73 variables
B = „important, but needs further discussion“: 94 variables

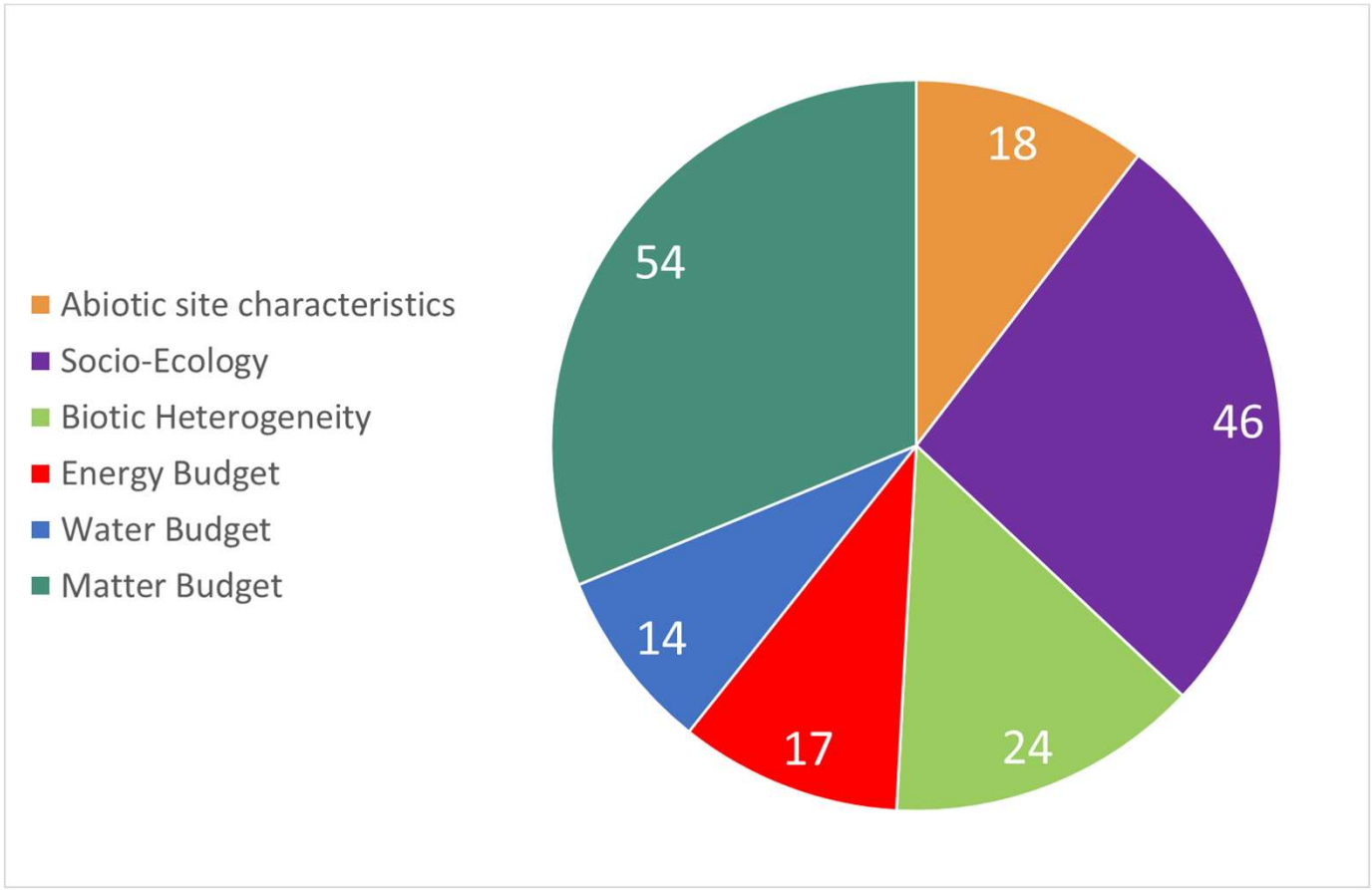
Table 2: Proposed variables for the description of the abiotic site characteristics

Compartment Component	Variable	Relevance 1 = low 3 = medium 5 = high	Costs 1 = high 3 = medium 5 = low	Feasibility 1 = low 3 = medium 5 = high	Priority A = very high B = further discussion
Climate	Relative air humidity	5	3	5	A
Climate	Precipitation	5	3	5	A
Climate	Air temperature	5	3	5	A

Table 3: Information on methods and protocols for variables on abiotic site characteristics

Variable	Optimal frequency of measurement	Field Laboratory Model	Remarks on method	Available protocols (examples)
Relative air humidity	30 min	Field	Standard climate station	WMO, ICPF, ICOS,
Precipitation	30 min	Field	Standard climate station	WMO, ICPF, ICOS,
Air temperature	30 min	Field	Standard climate station	WMO, ICPF, ICOS,

The Variables proposed

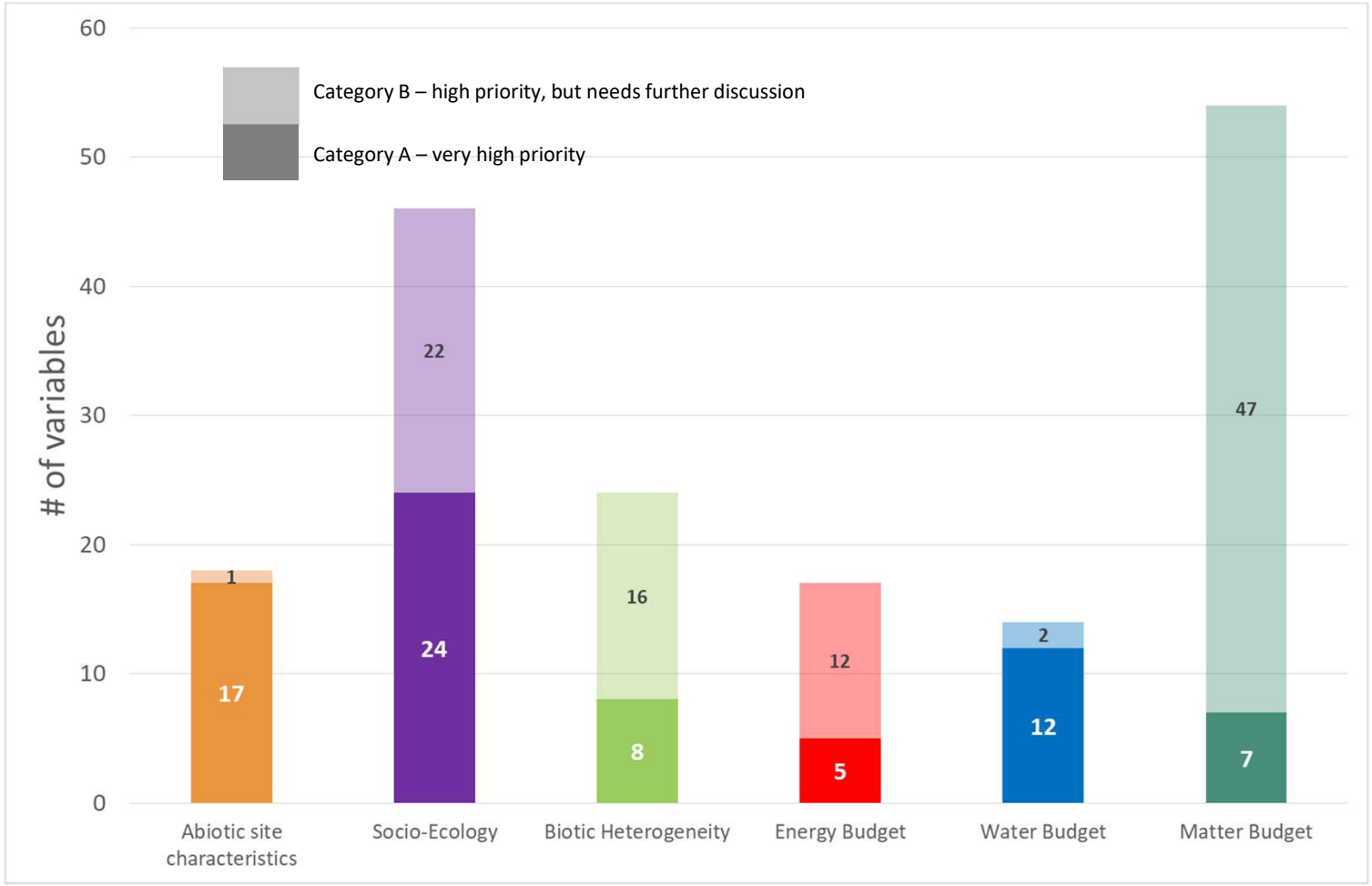


Ranking principles for the criteria for the selection of variables

criteria following and adapted from Costa et al., 2016; GEOBON, 2017

		high	low
Relevance	The degree to which the variables represent key elements of the ecosystem integrity concept; Response to drivers of environmental change	Based on expert judgment from eLTER theme lead; the variable is highly relevant for many research themes/disciplines; variable responds highly sensitive for detecting/measuring current and potential future drivers of environmental change	Relevant only for one or few research themes/ disciplines or not highly sensitive for detecting/measuring environmental change
Cost efficiency	Describes required investment and operation costs	Measurement is already available at many locations; instrumentation can be implemented at low cost; fully automated measurements (low personnel costs) possible; low follow-up costs; high durability	Very expensive instrumentation; High follow-up costs (laboratory, cooling costs etc.); labour-intensive; low durability
Operative feasibility	Describes potential for routine measurements at a large number of sites based on standardized methods	Well established standards available, part of routine measurements in international networks; easy to apply; high probability of being harmonised	Extensive expertise needed for operation; logistically difficult, e.g. complex measurement campaigns needed; lack of widely accepted/applied protocol; low probability of being harmonised

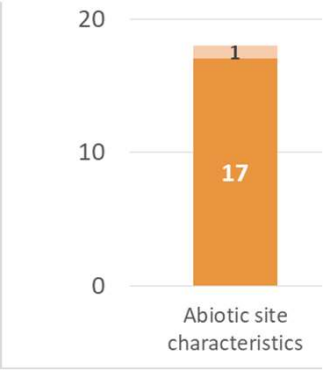
The Variables proposed



Abiotic site charactistics – category A variables

Climate	Relative air humidity
Climate	Precipitation
Climate	Air temperature
Climate	Wind speed / Wind direction
Climate	Surface atmospheric pressure
Groundwater	water temperature
Lake	Vertical profiles of water temperature, pH, EC, turbidity
Soil	Soil inventory
Soil	Soil temperature
Soil	Soil organic C content (per horizon)
Soil	Soil total N content (per horizon)
Soil	Soil total P content (per horizon)
Soil	Soil pH (in H2O/KCl/CaCl2)
Soil	Soil cation exchange capacity
Soil	Soil base saturation
Streams/Rivers	Stream sinuosity
Streams/Rivers	pH, EC, water temperature

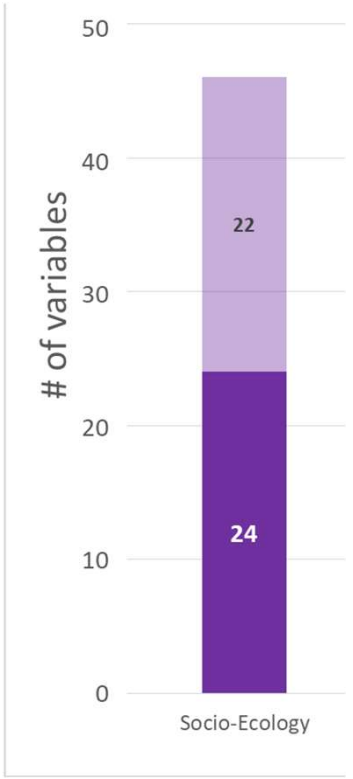
Source: UFZ, André Künzelmann



Socio-Ecology – category A variables

Agriculture and Forestry	Area under tillage
Agriculture and Forestry	Land-based income
Agriculture and Forestry	Livestock feed management
Agriculture and Forestry	Agricultural products
Agriculture and Forestry	Harvest (cropland, grassland, forest) (t/ha)
Governance and stakeholders	Governance structure and character
Governance and stakeholders	Stakeholder engagement process indicators and profile of engaged stakeholders
Governance and stakeholders	Basic services provision: health & education
Land use and land cover change	Land use (historic)
Land use and land cover change	Land cover (CORINE)
Land use and land cover change	Land use change (CORINE)
Land use and land cover change	Land use (Statistics)
Land use and land cover change	Land cover (Orthophotos)
Platform characteristics	General information (DIEMS)
Platform characteristics	Ecosystem services profile
Platform characteristics	NUTS3 and Local Administrative Units (LAU) spatial databases
Platform characteristics	Per capita income / GDP per capita
Population	Population age profile
Population	Population status of employment
Population	Population education attainment
Population	Population residential profile/density
Resource use	Resource use (biomass, construction, iron/steel, fossil fuels), trade of resources
Resource Use	Subsidies programs / schemes
Resource use	Population consumption statistics

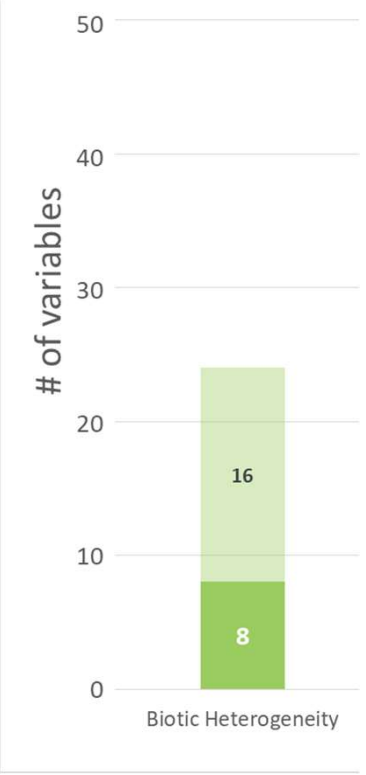
Source: UFZ, André Künzelmann



Biotic heterogeneity – category A variables

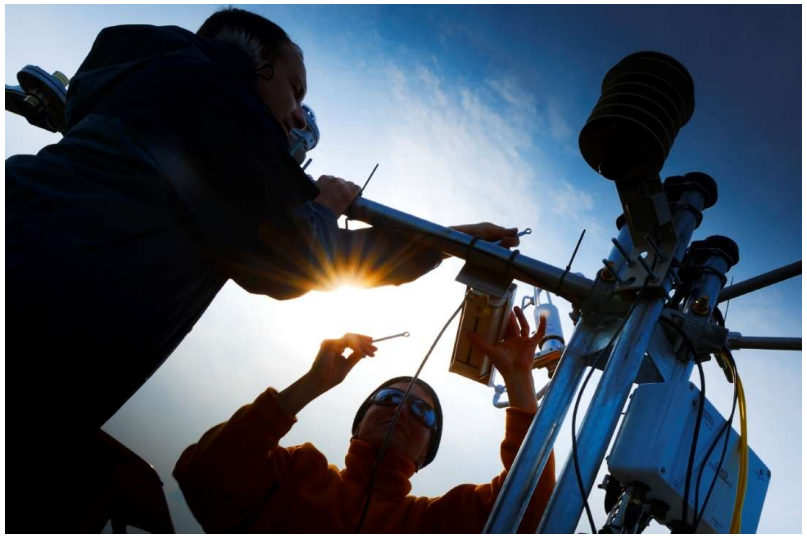
Terrestrial	Flying insects
Terrestrial	Habitat Structure, vegetation/plant phenology based on satellite remote sensing (European extent)
Terrestrial	Birds, bats, frogs, some insects (e.g., grasshoppers) using acoustic recording
Terrestrial	Pollen and spores from air
Terrestrial	Ground-dwelling animals
Terrestrial	Plant phenology
Terrestrial/ Aquatic	eDNA
Streams/Rivers	Instream habitat distribution (incl. sediment grain size distribution)

Source: UFZ, André Künzelmann

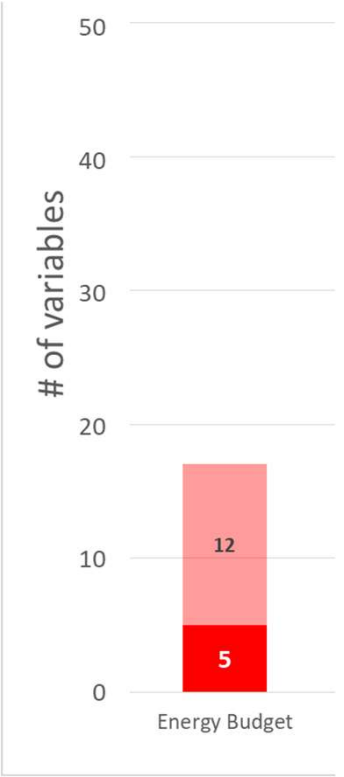


Energy budget – category A variables

Biomass	Aboveground biomass
Biomass	Leaf area Index (LAI)
Biomass	Net primary production (dendrometer)
Radiation Budget	PAR
Radiation Budget	Global solar radiation (direct shortwave incoming and diffuse radiation)



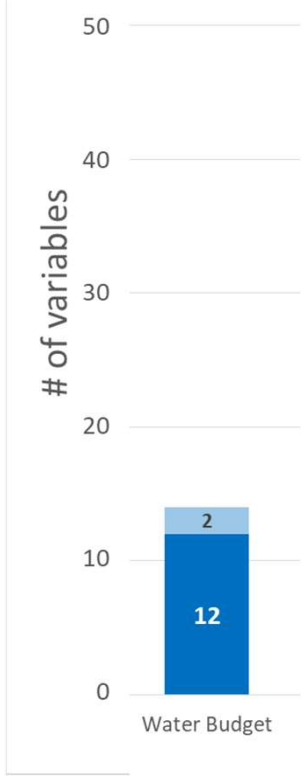
Source: UFZ, André Künzelmann



Water budget – category A variables

Groundwater	Groundwater level
Groundwater	Spring Discharge
Lake	Water level
Lake	Inflow/outflow
Lake	Ice cover
Soil	Soil water content
Streams/Rivers	Discharge
Streams/Rivers	Mean water depth
Streams/Rivers	Bed and water level slope
Streams/Rivers	Current velocity
Streams/Rivers	Streams wetted perimeter
Terrestrial	Snow cover

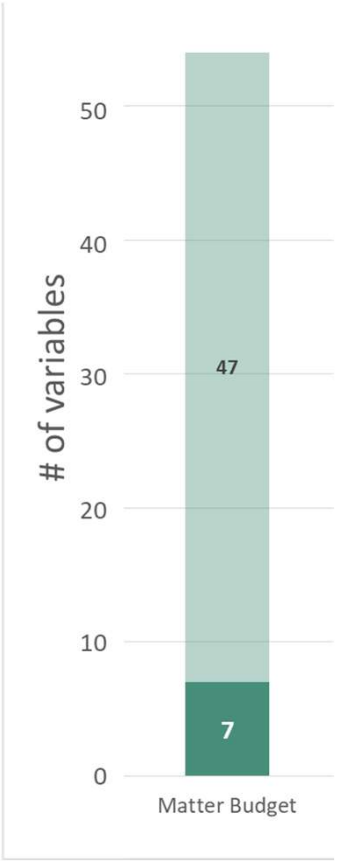
Source: UFZ, Steffen Zacharais



Matter budget – category A variables

Groundwater	Electrical conductivity
Lake	Water transparency
Lake	Vertical profiles of chl a, pigments (proxy water quality)
Lake	Vertical profiles of dissolved oxygen
Lake	In-situ vertical profiles and inflow concentrations of TP, SRP, NO3, DOC, SAC 254
Streams/Rivers	Turbidity
Streams/Rivers	TP, SRP, NO3, DOC, SAC 254

Source: UFZ, André Künzelmann



The relevance assessment of eLTER's Standard Observations for the main Earth observation data providers

Component	Variable	Exemplary relevance for EO (either for Satellite Products or for in-situ components of EO provider)
Climate	Precipitation	TRMM, SM2RAIN-ASCAT, CMORPH, GSMAP, PERSIAN etc., ancillary information for soil moisture retrieval
Climate	Air temperature	Ancillary information for quality control and soil moisture retrieval
Climate	Wind speed / Wind direction	Ancillary information for soil moisture retrieval
Climate	Surface atmospheric pressure	Ancillary information for atmospheric correction
Soil	Soil temperature	Operational Land surface temperature (LST) products exists by Copernicus and NASA; ancillary information for calibration/validation of soil freeze and thaw state
Soil	Soil water content	SMOS, SMAP, ASCAT, S1A, Copernicus Global Land: Surface Soil Moisture
Soil	Soil organic C content (per horizon)	Top-soil organic carbon content for croplands (EO product under development)
Regional Habitat	Landscape heterogeneity and composition	Sentinel imagery or equivalent 10-20m for habitat mapping, A combination of sensors and techniques can be suited to each site, with sentinel imagery supporting harmonized coverage across Europe
Lake	Vertical profiles of chl-a, pigments	Copernicus Global Land Service has a trophic state product. National services for EO chl-a for lakes exists
		Operational algal bloom products exist especially for Sea and coastal areas. Development going on for lake areas
Lake	Algal community (quantitative)	Copernicus Global Land Service has a trophic state product. National services for EO chl-a for lakes exists
		Operational algal bloom products exist especially for Sea and coastal areas. Development going on for lake areas
Lake	Water Level	Copernicus Global Land Service: Water Levels

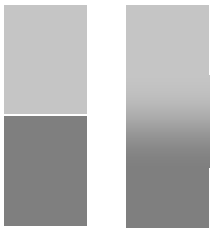
Variable	What state/flux does the variable describe or is it related to?	Current methods/recommendations/ further remarks (e.g. notes on the validity of currently used methods)
Leaf area index [m^2 m^{-2}]	Photosynthesis, respiration carbon balance, interception of precipitation	Defined as one half the total green (i.e., photosynthetically active) leaf area per unit horizontal ground surface. Destructive (ecology), radiometric (LAI2000 or TRAC), **Digital Hemispherical Photographs (DHP)** (GBOV, 2018., Fernandes et al. 2014); sites mostly in the United States
Transmission through canopy	Photosynthesis, carbon balance, FAPAR	Amount of photosynthetically active radiation (400 nm – 700 nm, PAR) that is transmitted through the canopy, quantified as photosynthetic photon flux density (PPFD) in µmol (m-2.s-1). Radiation that is absorbed by photosynthetic pigments in plants for photosynthesis. Can be either derived from direct measurements or Digital Hemispherical Photographs (GBOV, 2018). Measurements currently mostly in the United States.
Fraction of Intercepted Photosyntheticall y Active Radiation (FAPAR)	Photosynthesis, carbon balance	Defined as the fraction of photosynthetically active radiation- Derived from incoming and upcoming PAR at top and bottom of the canopy through Digital Hemispherical Photographs (GBOV, 2018) , sites mostly in

eLTER Standard Observations – Where do we go from here and how can we get involved?

- The Discussion paper on eLTER Standard Observations is a „***discussion***“ paper

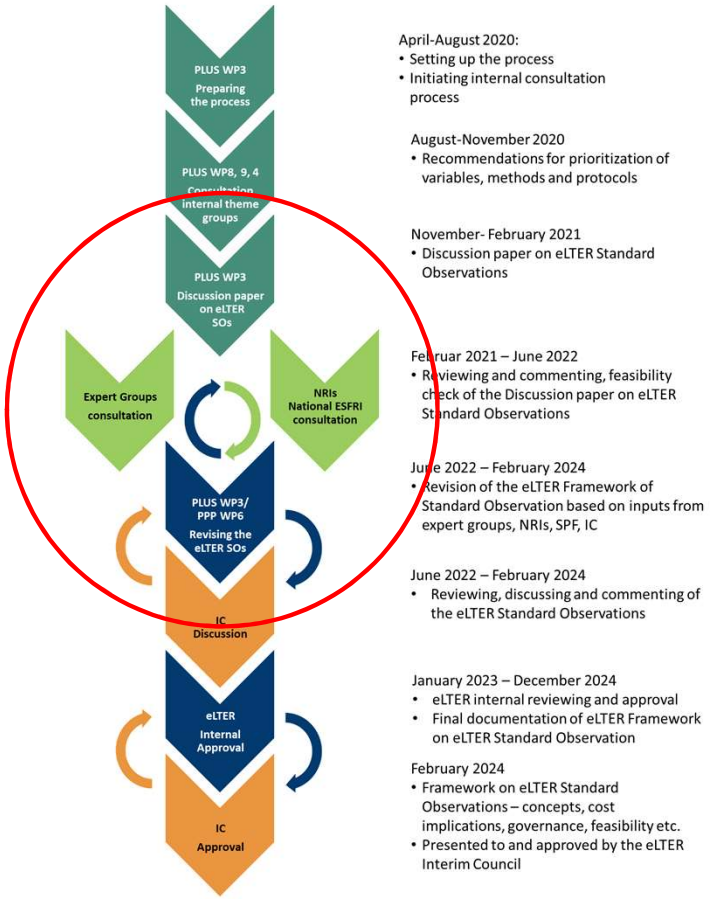
→ (i) nothing is set in stone and (ii) especially the variables of category B will go into the next process step in the next months, a consultative discussion process

- Start of consultation process with
  (i) expert groups,
  (ii) NRIs



Category B – high priority,
but needs further discussion

Category A – very high priority



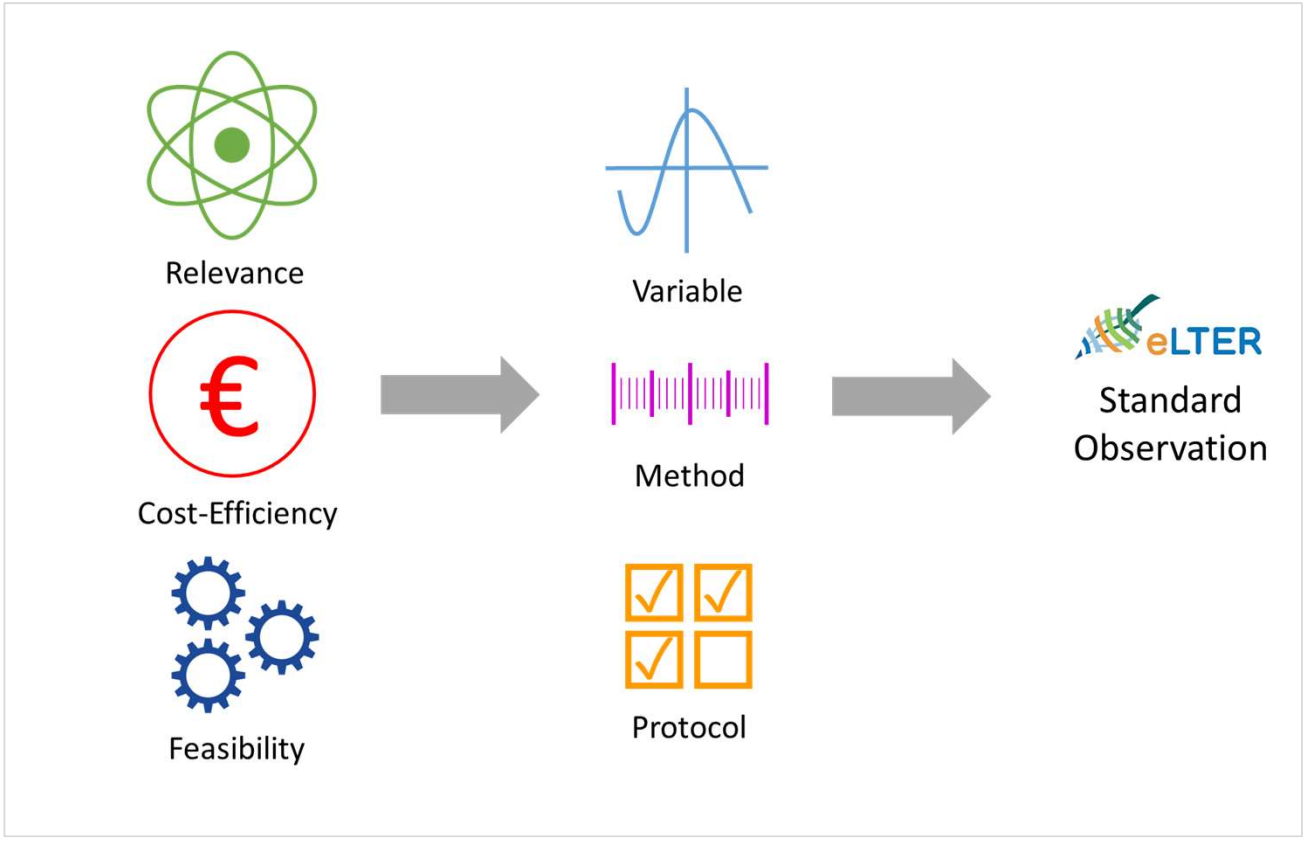
Expert Groups

- Expert Groups (EG) are platforms for an in-depth dialogue between eLTER consortium experts in the topical area and the external experts

- critical review of discussion and concept papers on the eLTER design
- bringing viewpoints of the respective potential user group of future eLTER RI services (securing buy-in and service take-up)
- raise awareness amongst user groups and collaborators of
  - the starting specification process and the window of opportunity to co-design eLTER RI
  - the potential for coordinated joint activities, including co-location and co-design of services with other RIs and networks

Topics for EGs (still under discussion):

- Critical Zone research
- Aquatic ecology
- Biodiversity
- Mountains
- Socio-Ecology and citizen science
- Hydrology and water quality
- Macroecology
- Experimental Research
- Biogeochemistry
- … other


Relevance
Cost-Efficiency
Feasibility
Variable
Method
Protocol
eLTER
Standard
Observation