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

eLTER PLUS Use cases

Task 8.1 – High resolution biodiversity data to assess environmental change (Leader: Joana Vincente)

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Task aims to determine and prioritise the stressors affecting long-term changes in biodiversity and identify indicators for characterising short-term variability and long-term trends in biodiversity. We make use of a relevant subset of data-rich eLTER Sites to quantify long-term trends and short-term variability in biodiversity, and relate both to changes in abiotic variables and socio-ecological parameters in order to a) explain trends and patterns in biodiversity, b) determine and rank the stressors affecting long-term changes in biodiversity trends, and explain short-term variability in response to pulse disturbance across major European ecosystems and c) identify appropriate indicators of ecosystem response. We will use state-of-the-art modelling techniques (e.g. biomod2, INLA-system-dynamic modelling) that are capable of dealing with short-term as well as long-term temporal trends in a spatially non-independent context, and consider gaps in datasets. This approach allows us to evaluate the strength and added value of these unique eLTER datasets to (i) improve our understanding of how and why these ecosystems are changing, (ii) determine implications for ecosystem resilience and (iii) develop mitigation/adaptation measures.

Task 8.2 – Plot scale ecosystem process understanding (Leader: Eugenio Diaz-Pines)

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Task aims to increase process understanding of the impact of climate change and extreme weather events on C & N cycling and feedbacks in a broad range of ecosystems. Data on C and nutrient stocks & fluxes, climate, N deposition & management from eLTER Sites will be analysed; gap-filled using available models, such as EMEP for N deposition; and time series analyses will be applied. Extreme weather events (e.g. drought) will be characterised. Normalisation approaches, such as empirical probability density functions, will be used for cross-site comparisons. This will facilitate (i) identification of critical environmental thresholds and tipping points in C and N turnover and fluxes across the eLTER spectrum of ecosystems, climate zones and socio-ecological context and (ii) improvement of our understanding of the impact of extreme weather events and climate change on ecosystem processes. eLTER Site data will be complemented with remote sensing data from WP4, in order to evaluate the added value and the suitability of eLTER long-term data series to provide signals reflecting the influence of climate change on ecosystem processes.

Task 8.3 – Water use efficiency (WUE) of ecosystems and resilience to drought (Leader: Nikos Nikolaides)

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Task aims to improve knowledge of the impact of drought events on ecosystem water-use efficiency (WUE) and resilience, and to understand relationships between WUE, soil structure, plant productivity and ecosystem resilience. Data from 10 well-instrumented sites that cross climatic, geological and socio-ecological regions will be used to test resilience indicators, such as WUE, nutrient use efficiency, soil structure and function. This analysis will use1D (plot) or catchment scale integrated models that consider water-soil-plant system. Key variables that control WUE and reflect drought stress (several regional drought events) will be selected for the modelling. An integrated model will be used to calculate WUE and simulate a climate series of at least 30 years in order to (1) assess the impact of drought events on the WUE of ecosystems, (2) analyse the resilience of the ecosystems with respect to their ability to recover single & multiple droughts, (3) understand the relationship between WUE, soil structure, plant productivity and ecosystem resilience and develop mitigation measures for drought adverse impacts, and (4) assess strengths and weaknesses of the RI-design to derive resilience indicators.

Task 9.1 – Representativeness towards pan-European biodiversity pressures and trends (Leader: Ingolf Kühn)

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The Task aims to compare long-term trends and drivers of biodiversity based on low sample size, high resolution eLTER data with high sample size, low resolution non-eLTER data (based on space-for-time substitution) at a pan- European scale. We will analyse biodiversity trends and relate these trends to abiotic drivers retrieved from climate models, remote sensing, land-use maps, and socio-economic parameters (GDP, demography, etc.) using two different datasets: a) > 200 long-term biodiversity datasets from > 100 eLTER sites across Europe covering terrestrial, freshwater and coastal ecosystems and b) data compiled from non-eLTER sources (> 10,000 sites, derived from e.g. EU Water Framework or Habitat Directive). We aim to disentangle the roles of large-scale alterations in climate, air pollution and land use changes, and local changes in habitat composition, structure, function, and pollution patterns, in determining trends in biodiversity of various taxonomic groups. We will test a wide range of possible indicators, including individual species, biodiversity metrics, selected metrics of functional and phylogenetic diversity and trait composition, to determine which are best suited as indicators of long-term changes in various regions and ecosystem types. By integrating these two datasets, we will assess the value of, and potential improvements for, the pan-European long-term time series provided by eLTER.

Task 9.2 – The Water-Climate-GHG Nexus at the pan-European scale (Task leader: Martyn Futter)

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The Task aims to test and pilot the co-location of eLTER and ICOS RIs so as to gain new insights into the pan- European water-climate-GHG nexus, better constrain estimates of the pan-European GHG emission and carbon footprint, and develop complementary mechanistic understanding. First, we will scope the water-climate-GHG nexus across eLTER catchments.

To do so, the relevant DEIMS-SDR metadata will be updated with site PIs (including ICOS sites). In addition, large-scale modelled data (e.g. from Task 9.3, Copernicus products in WP4, ICOS products, etc.) will be identified. In collaboration with WP8 (Task 8.2), site specific estimates of GHG emission and carbon sequestration will be cross-validated against data from an independent set of eLTER sites, regionalised and up-scaled based on e.g. CORINE land cover data, climate information etc., and matched to GHG emission inventories from relevant ICOS sites. Second, a catchment-scale conceptual model of the water-climate-GHG nexus will be elaborated to better constrain estimates of the pan- European GHG emission and carbon footprint and add complementary mechanistic understanding to ICOS measurements. This will be achieved through a literature review identifying current approaches to site-scale modelling of the water-climate-GHG nexus that will then be used in a workshop with invited experts from eLTER/ICOS RIs, leaders of relevant Tasks in the project, and external researchers.

Task 9.3 – Testing eLTER network for a pan-European terrestrial ecosystem model (Task leader: Harry Vereecken)

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The Task aims to establish a validated pan-European scale terrestrial ecosystem model using eLTER network data, assess the impact of climate extremes on water related ecosystem services, and provide 30 years of reanalysed time series of hydrological fluxes. First, we will set-up the TerrSysMP (TSMP) model (with PARFLOW-CLM) for the pan-European domain at a 3 km resolution and run it for 30 years simulations. Second, we will validate the model runs against eLTER site's time series (Task 8.3). We will obtain the climatic forcing at this resolution by using a disaggregation scheme from large scale re-analyses. In addition to available time series from the eLTER network, we will use remotely sensed time series in cooperation with WP4 (e.g. SMOS, SMAP, Copernicus Hub services e.g. Sentinel data) and global soil moisture products (e.g. ESA CCI). The approach allows us to demonstrate the concept of ecosystem reanalysis for soil moisture time series, and the assessment of the strengths and weaknesses of the current eLTER network design regarding the impact of climate extremes on water related ecosystem services.