

# **ILP regional coordinating committee Europe (2016-2020)**

## **TOPO-EUROPE: 4D Topography Evolution in Europe: Uplift, Subsidence and Sea Level Rise**

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Scientific rationale - continental topography: a new frontier in solid-Earth science  
Continental topography is at the interface of processes taking place at depth in the Earth, at Earth's surface, and in the atmosphere above it. During the last 20 Myr plate-tectonic and other geodynamic processes in the Earth's interior have caused many changes in the Earth's surface topography. The lithosphere responds to forces exerted by these processes, creating mountain belts (e.g. the Alps), elongated rift zones (e.g. the Rhine rift system) and large sedimentary basins (e.g. the North Sea, Paris and Pannonian Basins). Improved knowledge of the Earth's mantle and its coupling to the lithosphere and its surface is key to understanding the enormous forces that generate these features. The impact of Solid-Earth processes on surface topography at plate boundaries has been known for several decades, but their influence in intraplate areas, in particular coastal regions, is only just being appreciated. Furthermore, we now recognise that there are critical feedback mechanisms between Solid-Earth processes and topography.

The present state and behaviour of the shallow Earth system is a consequence of processes operating over a wide range of time and spatial scales. Time-varying phenomena include long-term tectonic effects on subsidence, uplift and river systems, residual effects of the ice ages on crustal movements, natural climatic and environmental changes over the last millennia and up to the present, and the powerful anthropogenic impacts of the last century. Relevant spatial phenomena include huge convection cells in the mantle, mantle plumes, major variations in the structure of deep Solid-Earth interfaces (e.g. crust-mantle and lithosphere-asthenosphere boundaries), ocean currents, major rivers, and streams.

### *Societal relevance*

Topography influences society, not only as a result of slow landscape changes but also in terms of how it impacts on geohazards and environment. When sea-, lake- or ground-water levels rise, or land subsides, the risk of flooding increases, directly affecting the sustainability of local ecosystems and human habitats. On the other hand, declining water levels and uplifting land may lead to higher risks of erosion and desertification. Catastrophic landslides and rock falls in Europe have caused heavy damage and numerous fatalities in the recent past. Rapid population growth in mountainous regions and global warming and associated increases in the number of exceptional weather events, are likely to exacerbate the risk of devastating rock failures. Along active deformation zones, earthquakes and volcanic eruptions cause short-term and localized topography changes. Although natural processes and human activities cause geohazards and environmental changes, the relative contributions of the respective components are still poorly understood. That topography influences climate is known since the beginning of civilization, but it is only recently that we are able to model its effects in regions where good topographic and (paleo)climatologic data are available.

### *Paleo-topography*

Paleo-topography poses some complex problems. Apart from the technical problem of dealing with topography that no longer exists, the size and timing of events and the evolution of the topographic life cycle proves to be a challenge to all scientists. This complexity means that no single sub-discipline is able to solve all the problems involved and therefore must look for assistance by other disciplines. The geographic scope of the proposed project demands co-operation on a European scale to avoid a fragmented approach. Mountain ranges (increasing surface topography) and adjacent sedimentary basins (decreasing surface topography) record signals and proxies that tell the story of the topographic life cycle. The source to sink relationship is key to this issue. However, the signals and proxies are poorly known and we only have started to decipher the few we are aware of. A major challenge is to extract all available information contained in the system and to interpret it in terms of processes. Innovative analytical techniques, improvements of methodology back-to-back with innovative conceptual and quantitative modelling are required to resolve this issue. If we are to understand the present state of the Earth system, to predict its future and to engineer our use of it, the spectrum of processes, operating concurrently but on different time and spatial scales, needs to be understood. The challenge is to describe the state of the system, monitor its changes, forecast its evolution and, in collaboration with others, evaluate modes of its sustainable use by society.

### *Partnerships and impact*

TOPO-EUROPE has served as an important mechanism to integrate research efforts on a national level conducted in different countries in a pan-European framework. An example has been the EUROCORES TOPO-EUROPE coordinated by the European science foundation bringing together 23 different European countries and creating research opportunities and funding for more than 60 young researchers. TOPO-EUROPE has also provided the research motivation for the European plate observing system (EPOS) currently in the implementation phase of the European strategy forum for large-scale scientific infrastructure (ESFRI). EPOS brings together for more than 500 million euro in scientific infrastructure for the solid earth, offering novel unique research opportunities for integrated solid earth research in Europe. A continuation and further expansion of TOPO-EUROPE as a research platform is therefore a must. In a similar spirit and already starting in 2015 with the TOPO-EUROPE annual meeting in Antibes (South of France) hosted by GEO-AZUR, ILP-TOPO-EUROPE will be teaming up with the European Space Agency (ESA), for coordinating future use of satellite data coming from the upcoming ESA satellite missions. Further expansion of the role of solid earth research is aimed for the domain of geo-energy and natural hazards. This applies in particular in the fields of geothermal energy research and participation in research programs in the field of sustainability and resilience. In this context, TOPO-EUROPE will operate in close coordination with organizations such as the European Energy Research Alliance (EERA) and ACADEMIA EUROPEA, the European academy of science. Planned activities include annual workshops, special thematic volumes of international peer reviewed journals such as *Global and Planetary Change*, summer schools and thematic short courses. Training new generations of young researchers at the interface of geology, geophysics, geomorphology will be a priority for TOPO-EUROPE. The TOPO-EUROPE community has also succeeded to obtain funding for a European training network (ETN) on modeling the topographic expression of subduction zones (SUBITOP), coordinated by N. Hovius (GFZ) starting its activities in early 2016.

### *Budget*

The ILP contribution to the financing of TOPO-EUROPE activities will serve as seed money supplementing major funding from other sources. The latter include financial contributions from ESA, ACADEMIA EUROPEA, the European commission, ERA and others. The budget requested as the contribution from ILP is as follows.

Annual conference	2000 Euro/yr
Publications / Special volumes	1000 Euro/yr
Short courses / Summer schools	1000 Euro/yr