

Seismic imaging and monitoring of environmentally induced changes in the structure of critical large scale artificial and natural objects

Climate changes are one of the main challenges of modern geosciences. Globally, its current state is well monitored in terms of sea ice and glaciers thawing or annual temperature increases. Current, state of the art technology allows precise, real-time continuous monitoring of our globe. Such precise data allows us to estimate the future evolution of the environment. However, there is still a significant lack of knowledge in terms of changes occurring under the surface. One of the key problems related to climate changes is estimation, how those factors and changing hydrological regimes in Poland impact critical infrastructure, and are potentially hazardous to society. Examples here are artificial objects like large dams and flood embankments, but also natural objects like landslides. Landslides, being sensitive to water changes can be easily triggered due to changes in monthly precipitation schemes, or changes in retention periods. Similarly, flood embankments are endangered due to more extensive precipitation, and thus a larger amount of water they have to stop.

The scientific aim of the project is to image and monitor the temporal changes in the internal structure of large scale critical earth objects with adapted state of the art seismological technologies and methods.

In the project we would like to use the most advanced seismic methods to image temporal changes in three different scale objects related to water circulation in the environment: large scale earth filled dam, massive creeping natural landslide, large flood embankment. Moreover, we would like to propose a new methodology that combines different geophysical methods and gives the most precise image of the internal structure in each case.

Surveying environmental changes using active geophysical methods is not new on a global scale. However, the idea of using the latest seismic techniques in time lapse manners is leading to the study of climate-related changes in Poland and their impact on critical zones. Currently, multiple research teams are studying climate-related changes across polar regions, where they are easy to observe. Also, the effort to monitor natural hazards in Europe is widespread. With recent developments in the high-density acquisition and advanced data interpretation techniques, it is possible to investigate those changes in places where the amplitude of climate-related factors is smaller or slower. Because of the unprecedented accuracy of imaging, thanks to the high-resolution seismic techniques, the smallest perturbation in the subsurface can be observed with great precision even at large depths. The overall data quality significantly exceeds every previously used technique and provides new insight into the subsurface of critical infrastructure and natural hazard zones. Moreover, those non-invasive techniques can be used in critical and protected objects and not cause further devastation. Additionally, our survey will be the first in Poland to use the fiber optic cables system, which is the latest development in terms of subsurface structure imaging. Similar systems will be used for studying environmental problems in the following years, and thus estimation of their limitations and possibilities in such studies is essential.

Besides of research papers and conference presentations we plan a series of popular science proceedings in the form of a website, lectures and short notes for the local population presenting main scientific findings of the project and their input for understanding the environmental seismology and dynamics of subsurface climate evolution, which will be published in open video repository. These materials, dedicated to a wide, non-scientific public will explain geohazard problems related to hydrological variations in the near-surface caused by changing climate in Poland.