Groundwater is one of the most important natural resources and a primary source of freshwater on Earth. Compared to surface water, groundwater is generally of higher quality, more resistant to possible contamination, less susceptible to seasonal and multi-year fluctuations and much more evenly distributed. Very often, groundwater is available in places where there are no large rivers or lakes, therefore putting groundwater well fields into operation in these areas is important due to the growing demand for water for consumption purposes, as well as for agriculture and industry. Any changes in precipitation, runoff or evaporation inevitably cause changes in the regime, resources and quality of groundwater. Moreover, intensive exploitation of groundwater by humans may result in a decrease in groundwater resources and subsidence of the land surface.

In response to the observed climate changes in recent years, it is crucial to continuously monitor Earth's water resources, including groundwater. To make this possible, it is essential to develop publicly accessible databases with up-to-date information on water resources in a specific area, along with forecasts of their changes. These databases could be utilized by relevant agencies for decision-making that affects the economy and society.

National hydrogeological services carry out groundwater monitoring tasks, utilizing a network of appropriate wells equipped with measuring instruments. Such measurement methods are highly accurate; however, these observations pertain to the specific location of the monitoring well. In many areas, wells are distributed unevenly, and the high costs of maintaining measurement points mean that, especially in less developed countries, these measurement networks are not dense enough.

A completely different type of observation comes from gravity measurements conducted by the satellite missions GRACE (Gravity Recovery and Climate Experiment) and GRACE Follow-On (GRACE-FO). They provide information about temporal changes in the Earth's gravity field caused by changes in the distribution of mass on our planet on a global scale. Because an increased amount of water in a particular area results in an increase in the mass of the ground, the gravity in that area also increases. Therefore, GRACE/GRACE-FO observations are particularly important for monitoring changes in water resources. An advantage of these data is their uniform coverage of observations across the entire Earth's surface and their regular monthly time interval. However, a limitation is the insufficient spatial resolution of the measurements for local studies (approximately 150,000 km2). Furthermore, the mission provides information on the total change in water mass in all its components (surface water, groundwater, water stored in soil and vegetation). Therefore, to obtain information on changes in the resources of one of these components, additional data need be used.

The aim of this project is to develop a high-resolution database on groundwater resources for the Baltic countries (Lithuania, Latvia, Estonia), Poland and Ukraine, with particular emphasis on the border areas of Ukraine. For this purpose, observational data from many sources, characterized by varying temporal and spatial resolution, will be integrated, such as: groundwater well measurements, topographic data, geological data, satellite images, meteorological data, data from the GRACE/GRACE-FO gravity missions, ground-based gravimetric measurements. The next step will be to increase the spatial resolution of the database using artificial intelligence methods. The high-resolution dataset will then be used for a detailed analysis of changes in groundwater resources in the study area and for integrated assessment of water balance and transboundary flows for the Poland-Ukraine border area.

The project will be implemented in international cooperation (Poland, Ukraine, United States, Lithuania, Latvia, Estonia). This international partnership brings together participants from the NSF AccelNet Transboundary Groundwater Resilience (TGR) project, the EU-WATERRES project funded by the EEA and Norway, and hydrogeology and hydrology experts from leading research institutions in Ukraine, Poland, and the Baltic states. The collaboration will synergize complementary strengths across institutions. TGR partners will contribute innovation in AI modeling, spatial information systems, simulation design, and participatory methods. The EU-WATERRES partners will lend regional data assets and GW expertise, and lead work on downscaling algorithms and quantitative flow assessment. Ukrainian, Polish, and Baltic partners provide critical on-the-ground knowledge and modeling capabilities. All partners will contribute to building a comprehensive spatial database of local water data.