

ReBaltic: Reconstructing the Late Quaternary Evolution of the Southern Baltic Coastal Zone from a Unique Sedimentary Archive in the Żarnowiecka Tunnel Valley

The southern Baltic coast, being a low-lying area, is particularly vulnerable to the effects of contemporary sea-level rise as well as increasing storm activity and marine coastal flooding. A reliable discussion on the current and future responses of this region to global climate change requires detailed knowledge of its past evolution, especially in the context of glacial–interglacial cycles and successive phases of the Baltic Sea's development. Among the many potential archives of paleoenvironmental and paleoclimatic changes, deep and stable sedimentary basins are of particular importance, as they allow for the retrieval of continuous, well-preserved, and datable profiles. One such exceptional site is Lake Żarnowieckie, located in a deeply incised tunnel valley west of the Gulf of Gdańsk. This tunnel valley connects the coastal areas of moraine uplands with the shoreline zone, which is influenced by marine processes. Our preliminary research has revealed the presence of a more than 20-meter-thick sequence of lacustrine–marine sediments at the bottom of Lake Żarnowieckie, a significant portion of which consists of annually laminated gyttja – a unique feature for the entire southern Baltic coast. Moreover, archival geological data collected during preparations for the construction of a nuclear power plant revealed the existence of a deeply incised (to -322.9 m a.s.l.) buried tunnel valley beneath the modern lake floor. This tunnel valley was formed during the Elsterian glaciation and was reactivated several times during subsequent, younger glaciations. Its total infill of Quaternary sediments exceeds 300 meters in thickness. Beneath the Holocene and Late Glacial lacustrine–marine deposits lies a 70-meter-thick sequence of fine-grained sediments (clays, silts and lacustrine chalk), which—according to preliminary interpretations—may record glaciolacustrine–lacustrine–marine phases from the Eemian and Holsteinian interglacials. The main goal of the project is a detailed reconstruction of the development of the southern Baltic coast during the Late Glacial and Holocene periods (the last 15,000 years), using multidisciplinary analyses conducted on the unique, continuous sediment archive within the Żarnowiecka Tunnel Valley. The study will include both lake-bottom sediments and deposits from the surrounding peatlands and sand barrier. Planned activities include determining the timing and character of the initial phase of the Baltic Ice Lake, investigating the melting of dead ice in the context of the formation of Lake Żarnowieckie, reconstructing the timing and extent of the Littorina transgression, and identifying evidence of past and historical storms and tsunami waves. An additional important goal will be a pilot investigation of the deep sediment series beneath the Holocene and Late Glacial lake infill to verify two opposing hypotheses regarding their origin—interglacial or glacial. The project includes comprehensive geomorphological studies of the entire Żarnowiecka Tunnel Valley and detailed paleoenvironmental analyses of the collected sediments, using biological proxies (pollen, plant macrofossils, diatoms, cladocerans, *Pediastrum*, mollusks, chironomids), geochemical analyses (e.g., XRF scanning, carbon and oxygen isotopes, magnetic susceptibility), and a range of dating methods (radiocarbon, ^{137}Cs , ^{210}Pb , ^{10}Be , tephrochronology, OSL). A particularly important task will be to develop an independent and precise chronology of the studied profiles, enabling their synchronization with records from other Baltic regions. The final result of the project will be the integration of all findings to verify the research hypotheses and to produce a high-resolution stratotype profile of environmental and climatic changes along the southern Baltic coast since the end of the last glaciation. The project results will be made available in international paleoclimate databases (e.g., INTIMATE, PAGES), enabling their use in broader reconstructions of climate change in the Baltic Sea region and its margins.