The primary purpose of 'The pioneering exploration of the Puck Lagoon based on high-resolution airborne and acoustic remote sensing' research project is to generate the first high-resolution bathymetry DEM (Digital Elevation Model) of the Puck Lagoon. Unfortunately, up to now, the Puck Lagoon does not have precise, high-resolution bathymetry. The only existing DEM of this area was developed due to interpolation between singlebeam echosounder measurements every 25 m. This project aims to change this state of knowledge by utilizing airborne bathymetric LiDAR, airborne photogrammetry, and multibeam echosounder. The integration of these methods in the GIS environment will allow to development of the first DEM for the whole Puck Lagoon, which will be hundreds of times more accurate than existing data.

Bearing in mind the primary purpose of this study, the four overreaching research objectives were formulated: **RO1**: Generation of the first high-resolution bathymetric model of the Puck Lagoon. **RO2**: Testing the utilization of airborne photogrammetry to generate a high-quality seafloor DEM in the Polish coastal zone, meeting IHO standards. **RO3**: Analysis and interpretation of the area based on secondary features of DEM and backscatter of the seafloor. **RO4**: Determination of suitable processing workflows for automatic classification of benthic habitats and underwater archaeology sites based on high-resolution remote sensing datasets.

Among others, the Puck Lagoon's high-resolution bathymetry is of great significance for hydrographical, ecological, geological, and archaeological purposes. The Puck Lagoon is considered to be the most valuable area in terms of biodiversity on the Polish coast of the Baltic Sea. Seabed habitats of this area consist of valuable phytobenthic meadows of *Zoostera marina*, *Charophyceae*, or *Potamogeton*. Moreover, Puck Lagoon is of great archaeological potential. For example, the Middle Ages were a period of dynamic development of Puck's port at the mouth of the Plutnica river. At that time, the Puck Lagoon was used economically and was a route for intercultural contacts, as evidenced by one of the wrecks with Scandinavian features found in the basin. These activities certainly left traces that may have been deposited on the bottom of the basin. We should also not forget about objects whose chronology is unknown but may have an anthropogenic character. Much remains to be discovered - submerged human settlements, the submerged forests, and unusual seabed anomalies. One such large anomaly is an oval seabed rise near the village of Beka with an object that looks like a dyke. The oval shape of the rise and the underwater dyke connecting it to the shore suggests a submerged settlement dating back several thousand years. However, so far, no sufficient expertise has been done. Due to the lack of proper identification of this water area, the underwater cultural heritage mentioned above is exposed to many dangers.

Although the utilization of airborne photogrammetry as a low-cost determination of shallow bathymetry DEM is currently rapidly growing, up to now, it has been developed for limited areas worldwide. This research will provide the first insights into bathymetry generation in the Polish shallow marine waters based on airborne photogrammetry techniques.

The work plan assumes two remote sensing surveys and two ground-truth sampling campaigns. Whereas remote sensing surveys will consist of airborne and marine surveys, ground-truth campaigns will include seabed sampling and archaeological prospections. The airborne survey will be performed from a manned plane or helicopter equipped with bathymetric LiDAR and RGB photogrammetric aerial camera. The primary measuring device for hydroacoustic surveys will be portable Teledyne Reson Seabat T50-P MBES allowing to collect up to 512 beams, working on 190-420 kHz frequency. This project will also address the determination of suitable processing workflows for the automatic classification of benthic habitats and underwater archaeology sites based on high-resolution remote sensing datasets. The automatic methodology for exploring benthic habitats and archaeological sites will be developed based on feature selection, object-based image analysis, supervised classification, and machine learning algorithms.

This project aims to produce the first high-resolution DEM of the Puck Lagoon based on ALB, MBES and aerial photogrammetry techniques. Among others, the Puck Lagoon's high-resolution bathymetry is of great significance for oceanographical, ecological, geological, and archaeological purposes. It will provide the foundation for proper sustainable management and decision-making. Moreover, it is expected to discover new archaeological objects lying on the Puck Lagoon's bottom. Results of the project will possibly be published in at least three high-impact scientific publications.