Abstract

The aim of this doctoral thesis is to assess landslide susceptibility, landslide hazard and associated risks in urbanized areas on the example of Gdynia. Forecasting of vulnerability zones, landslide hazard and risk assessment was carried out using statistical methods and GIS technologies. In addition, an attempt was made to reconstruct changes in the coastline of Gdynia's cliff sections over the last 200 years. The work mainly uses source data contained in the resources of the Polish Geological Institute – National Research Institute, data from the State Geodetic and Cartographic Resources, materials from the public domain and archival cartographic materials in the collection of the Gdańsk Library of the Polish Academy of Sciences and the State Library in Berlin. The extensive data set used, allowed a comprehensive approach to the problem of landslide hazard and risk in Gdynia.

In the first part of the work, the main goal and sub-objectives are defined, and research hypotheses are formulated. The previous geological studies and mass movements in Gdynia are also discussed. It points to sources of information so far unknown, documenting landslides that have been activated in historical times.

In the second part, the main trends in susceptibility, hazard and landslide risk are characterized. A wide range of currently used methods for determining landslide susceptibility and examples of their application in Europe and in the world is presented.

The third part presents the basic research methods used in the work. Landslide susceptibility modelling was performed using two-dimensional statistical methods - the landslide index method LIM, the weight of evidence method WofE and the multidimensional logistic regression method LR. In order to determine changes in the location of the shoreline of the cliff sections, the retrogression method was used. The work also uses the analysis of aerial photographs and the results of direct field research conducted by the author. The results of previous works were also used, including archival materials, typescripts and geological-engineering documentation. Research conducted by means of various methods is complementary and has been used in the final analysis of landslide risk.

The fourth chapter presents the characteristics of the research area and environmental conditions of mass movements in Gdynia. In the further part, selected examples of mass movements are characterized. The analysed cliff landslides and anthropogenic landslips inland are also evaluated in terms of the associated risks.

The sixth chapter analyses the changes in the coastline in historical times. The results were obtained on the basis of the interpretation of multi-temporal maps and analysis of the unknown contemporary science of the old German-language literature. The retrospective analysis of old maps in the scale of 1: 25,000 (*Urmesstischblätter* and *Messtischblätter*) indicates to the fact that the largest changes in the shoreline of cliff sections in Gdynia are associated with capes. The rate of abrasion in individual sections of the cliff was patchy and changeable over time. In the 19th century, Cypel Oksywski was characterized by a higher rate of abrasion than Cypel Redłowski. At the most advanced point the land loss was 160 ± 25 m, or 1.8-2.5 m / year. Later, no changes were observed because from the moment of stabilization in 1905, Cypel Oksywski was effectively protected against marine abrasion.

The seventh part presents the results of analyses of Gdynia landslide susceptibility with the use of LIM, WofE and LR methods. The applied LIM and WofE prediction models allowed to find relationships between the occurrence of landslides and passive factors. The shape of the land surface plays an important role in the formation of landslides in Gdynia. Both

landslide modelling using the landslide index method and the weight of evidence method showed that the increase in the occurrence of landslides in Gdynia increases with the slope degrees. The geological processes: abrasion and surface erosion and ablaction causing loosening and changing the soil structure are also of great importance in the formation of landslides on the Gdynia's young glacial area. The most predisposed to mass movements are the eastern slopes associated with the coastal zone. The factors strongly influencing landslide processes in Gdynia are hydrological conditions: very shallow backfilling of groundwater (0–0.5m), close location (0–100 m) of surface waters and increased values of the topographic wetness index TWI (0–3). Anthropogenic landslides in the interior of the city are often formed within embankments, which is confirmed both by the results of field research and statistical analyses.

The susceptibility map was inspected using spatial random sampling and cross-validation. As a result, the best landslide susceptibility model (LR) was chosen, which was then combined with the vulnerability of the studied area. As a result, a qualitative map of the landslide risk of Gdynia was created, where the risk was divided into five classes. This map visualizes the areas with the greatest economic, personal and natural losses caused by mass movements. It has been shown that the most sensitive areas in Gdynia are mainly districts: Babie Doły, Oksywie, Leszczynki, Działki Leśne, Kamienna Góra, Wzgórze św. Maksymiliana i Mały Kack.

The risk map has been checked using the observation method for the so-called "hot spots". As a result, the final risk map was supplemented with information on the stabilization and pace of abrasion in historical times.

The doctoral dissertation is utilitarian. The susceptibility and landslide risk maps carried out within the framework of this dissertation on a scale of 1: 10,000 can be used as an effective tool to improve the decision-making process. Risk maps point to the most critical places in the field of research, which may be the basis for the application of preventive or protective measures.