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Automated system of generating military maps of passability

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Abstract:

The classification of terrain in terms of passability plays a significant role in the process of military terrain assessment. It involves classifying selected terrain to specific classes (GO, SLOW-GO, NO-GO). The Military University of Technology has been working for many years on a system which automatically conducts terrain classification to the respective category of passability on various resolutions and generates optimal routes between two points in different variants on the basis of passability maps.

The main methodological assumption of the conducted research was to refer the index of passability (IOP) of the terrain to the square primary fields of various sizes. So on the research area, a grid of squares is generated (Fig. 1A). Then, for each primary field, using the developed software and spatial data on land cover and relief elements (as well as taking into account weather data and soil conditions), information was extracted about which elements of the land cover are located inside each primary field (e.g. length of roads, area of forest etc., Fig. 1B) The system enables the use of various spatial data sources, that is why in research have been generated maps of passability using military, public and social spatial databases (VMap Level 2, OpenStreetMap, VMap Level 1, Corine Land Cover and many others). The final result of this operation was the assigning to each primary field descriptive attributes (Fig. 1C). Using such a data model, they proceeded to determine the index of passability for each primary field. For this purpose, a number of methods were developed, which are described in the articles (Pokonieczny, 2017b, 2017a, 2018). They are based on the use of artificial neural networks and GIS multi-criteria analyses (Fig. 1D). They allow the determination of IOP values which may take a continuous value from 0 to 1, where 0 indicates completely impassable terrain and 1 wholly passable terrain with excellent tractive properties. The final result of the system activity is the visualization of the generated maps of passability using the chronopleth method (Fig. 1E), thanks to which, after the application of background data, such generated maps can be used in the process of military terrain analysis.

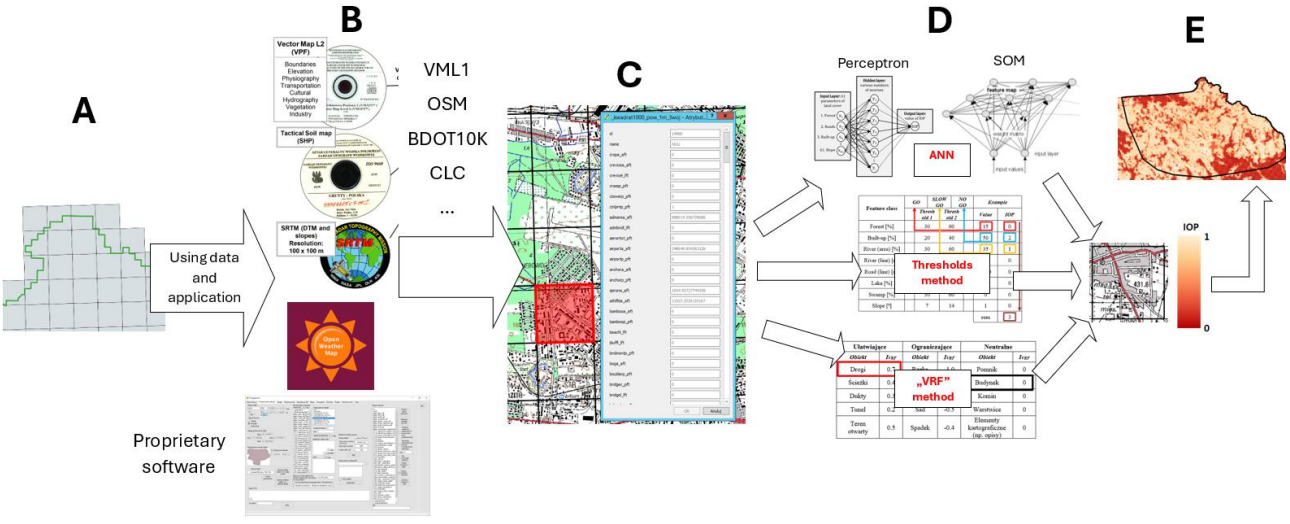

Figure 1. Schemat funkcjonowania systemy generującego mapy przejezdności.

The Author assumed that the values of indices of passability obtained with use of the various algorithms may differ, even if the same methods and source data are used, depending on the type of the primary field used, i.e. its shape and size. Considering the above, the Author analysed the influence of the shape and size of the primary field on the results

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of automated terrain classification for the purposes of developing passability maps. The analyses of the influence of various shapes of primary fields on terrain classification results were conducted for square, triangular and hexagonal primary fields. In order to analyse the influence of the primary field size on the terrain classification results, the Author determined indices of passability for square primary fields of side lengths ranging from 25 m to 10 km (Pokonieczny & Mościcka, 2018; Pokonieczny & Rybansky, 2018). Moreover, the system is able to generate optimal routes between two points in various variants (Fig 2.) - a more secure route that avoids all terrain obstacles with a wide curve, or a shorter route, which is, however, more difficult to pass (Pokonieczny et al., 2023).

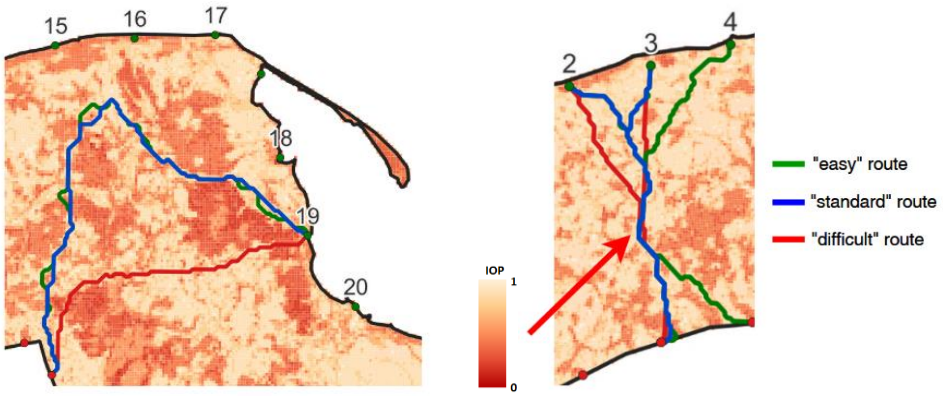

Figure 2. Examples of automatically generated routes on the background maps of passability.

The presented methods of creating passability maps have been implemented in proprietary software developed by the Author. It enables full realisation and automation of all elements of cartographic modelling, from the preparation and initial processing of input spatial data, to the visualisation of the resulting map in the geoportal. Major part of the system consists of software written in the .NET programming environment. Apart from applications developed by the Author, certain modules were created with use of Open Source, generally available software (PostgreSQL databases, QGIS spatial information system). What is important, developed software will be used by Polish Directorate of Military Geography.

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