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GEOMORPHOLOGICAL AND SOIL-GEOLOGICAL STRUCTURE OF THE SURFACE LAYER AS A BASIS FOR DETERMINING PERMEABILITY OF SOILS IN THE POZNAŃ AREA



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INTRODUCTION

The development of the urban fabric has meant that infrastructure that had functioned efficiently for years has become inefficient. In order to prevent ecological risks, local authorities have started to work on improving climatic conditions. One effective solution has been blue-green infrastructure, i.e. solutions based on natural resources that make it possible, among other things, to retain rainwater where it falls. Location decisions by local authorities must be preceded by a site assessment in order to optimise the provision of ecosystem services in these locations. Modules must be developed to support and enable the best decisions in urban green space planning. The presented research is part of the implementation of the project POIR.04.01.04-00-0023/18 under the Operational Programme Intelligent Development carried out by Wroclaw University of Science and Technology and companies: SHH Ltd. and ATMOTERM S.C. The aim of the project is to develop an innovative IT system for the evaluation of ecosystem services of urban greenery "SekoZ".

RESEARCH AREA

Poznań is situated in central-western Poland, in the central part of Wielkopolskie Voivodeship (Greater Poland Province). The city is located in three physiographic mesoregions: the western part in the Poznań Lakeland, the eastern part in the Września Plain, and the oldest part of the city is located at the bottom of the north-south oriented Poznań Gorge of the Warta River. These three areas are part of the Greater Poland Lake District macroregion. Poznań is located in the valley of the river Warta, as well as in the valleys of smaller watercourses: Bogdanka, Cybina and Główna. According to data from 1 January 2012, the city area is 261.91 km². The distance between the administrative borders of Poznan on the north-south axis is about 22 km, and on the east-west axis about 21 km. Poznań is the central part of the Poznań agglomeration. The city borders with 11 communes of the Poznań district, including two towns - Luboń and Swarzędz. More than 56% of the area of Poznan lies on uplands, located above 80 m above sea level. - About 36% of the area is on higher river terraces and within glacial gullies and about 8% on the floodplain of the Warta valley. The highest point in the city is Moraska Hill (154 m), which is located in the northern part of the city. The lowest point is the Warta Valley (50 m). The terrain of Poznan and its surroundings is characterised by a relief of lukewarm, fossiliferous origin. Most of the city is covered by glacial till and ground moraines of the Poznań stage of the Baltic glaciation.

MATERIALS AND METHODS

The majority of groundwater resources originate from rainwater. In Europe 16-27% of precipitation water infiltrates to the ground, in Poland approximately 18% on average. The outflow of water of atmospheric origin from the catchment area includes the surface, subsurface and underground outflow. The division into surface and subsurface runoff is often overlooked due to the fact that underground runoff also enters surface waters. A schematic representation of the hydrological balance is given in figure 1.

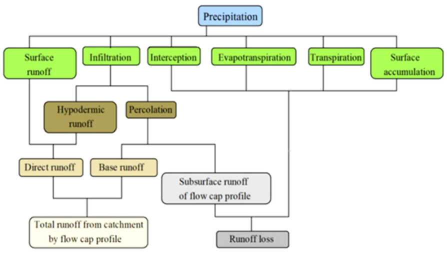

Fig. 1. Catchment outflow scheme

As a result of urbanization processes, the character of water flow changes from subsurface to surface - most of the precipitation is discharged into the sewage system, while a small amount infiltrates into the ground. The consequence of urbanisation processes is therefore a decrease in the water table and retention.

A number of factors influence the amount of water infiltrating into the ground. These include:
- soil type,
- relief and slopes,
- Land cover,
- soil moisture in the aeration zone,
- soil penetration by roots,
- ground freezing,
- precipitation intensity and duration,
- temperature and moisture deficiency,
- human activity.

RESULTS

The cartographic editing of the soil-agricultural map consisted in importing, calibrating (affine) the scans of the soil-agricultural map at a scale of 1:5000 to the mapping and scale of the land and building register map, sheets for the city of Poznań. All calibrated sheets were truncated with geodetic district boundaries and assembled (mosaicked) into one representation (map). RMS calibration error was between 2 and 4 metres. The map thus obtained was illuminated against the land and building register map. Cartographic editing of the soil and agricultural map was carried out in the land and building register map. Due to the fact that the original soil and agricultural map was edited on the land and building register from the 1960s, the contemporary register was used as the cartographic base. Soil-agricultural divisions (pedons) are in most cases based on plot boundaries and land use classes (bonitations). The same evidential, bonitification and soil boundaries as in the 1960s were assigned to the contemporary evidential boundaries (e.g. by shifting or internal dividing the evidential and bonitification polygons). Once these polygons were created, they were described according to the methodology of the soil-agricultural map legend. In a separate description in the attribute table of the digital soil-agricultural map, in addition to the use as a bonitation, the soil-agricultural complexes of arable land and grassland were introduced, and changes in land use between the 1970s and the present were presented.

The soil map provides information on soils to a depth of 150cm The basis for the final classification was the soil lying near the surface, also the soils lying below were taken into account. In the end, 7 classes were adopted for the land occurring in Poznań:
- on the surface poorly permeable soil,
- on the surface the ground is moderately permeable, below the ground poorly permeable (subsurface drainage may occur),
- moderately permeable ground,
- moderately permeable soils drained by better permeable soils below,
- very well permeable soils,
- organic soils,
- organic soils in the upper soil layer with moderately permeable soils below.

As a result of the permeability analysis, based on literature and cartographic databases by assigning permeability classes to individual species as a result of the assemblage of species in the soil profile, sequences of permeability class occurrences were determined and grouped into 7 complexes of resulting permeability (Tab. 1.).

Tab. 1. Permeability classes of soils

permeability classes of soils	**area of the western area [m²]**	**odest of the western area [%]**	**area of the eastern area [%]**	**odest of the eastern area [m²]**
impermeable soils			1002217	1.54
semi-permeable on impermeable soils	11186000	40.28	39052830	60.07
medium permeable soils	1277850	4.60	5028969	7.74
medium permeable to permeable soils	14404280	51.86	17178000	26.42
permeable soils			103507	0.16
organic soils	370046	1.33	5853	0.01
organic soils on permeable soils	534611	1.92	2636890	4.06
total	27772789	100	65008275	100

DISCUSSION AND CONCLUSIONS

Sustainable urban development - facing significant infrastructure deficits and climate challenges - depends on effective, data-driven decision-making, planning and investment management to build smart cities. Building appropriate locational decision-making mechanisms to stop the displacement of greenery and water from the landscape by urban development and infrastructure requires the use of systems based on 3D GIS technology and the OGC CityGML standard. Retention of any type is needed. Water should be retained as close as possible to where it falls. It is important to slow down runoff from catchments using ground retention, channel retention, as well as wetlands, ponds, ditches and small reservoirs. Cities and agglomerations have problems with overloaded drainage systems, so many of these problems can be solved by implementing blue-green infrastructure and regenerating small watercourses and draining stormwater drains into periodically flooded areas.