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Graphic map load evaluation of Estonian topographic maps

Radek Barvir [a,*]

[a] *Palacky University Olomouc, Faculty of Science, Department of Geoinformatics, Radek Barvir – radek.barvir@upol.cz*

* Corresponding author

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Abstract:

Map load is a term used in map evaluation process to quantify the amount of map content in a map. This map property is therefore used to assume about map complexity which is otherwise difficult to be measured (Ciolkosz-Styk et al., 2011). Aim of this study was to compare various topographic maps to explore trends in map complexity and its balance both in time and various biome types. For this aim, maps of Estonia were chosen to be evaluated, as this country experienced variety of topographic map styles from Soviet style through maps combining ortophoto up to currently used new-design maps. Also, a huge set of topographic maps designed in past 100 years is offered online by Estonian Land Board for the study area of Estonia. This web map portal contains Estonian digital and scanned basemaps, old topographic, historic, cadastral and ortophoto maps from various epoques becaming the primary source of evaluated map samples. To fulfill both comparing maps of similar scale and having several different maps in each set, two scale categories were defined. The first category contains five maps scaled 1:20000 and three maps scaled 1:25000 containing eight maps in total listed in Table 1. The second category contains maps scaled 1:50000 which is also the scale used commonly for topographic mapping including past Estonian maps. Moreover, two foreign maps for each scale category were examined in this case study – Czech base maps scaled 1:25000 and 1:50000 with symbology containing typical features of Soviet and German cartography, and Finnish base map 1:20000 and topographic map 1:50000 representing Nordic style of topography mapping. The Czech maps were obtained at geoportal of the Czech State Administration of Land Surveying and Cadastre while the Finnish maps were obtained from the portal of old maps run by National Land Survey of Finland. In total, 12 map sections were aimed to be obtained for all map types grouped into three landscape categories: a) Coastal – with significant coverage of water bodies, b) Natural or forested – countryside and natural areas with no large urban nor large water areas, c) Urban – with significant coverage of urban areas of largest cities and towns. This classification resulted into four map sections in each combination of scale-map-landscape categories. As not all the map types are were covering whole Estonia, an effort was put into selecting areas which are captured on all selected map types.

Country	1:20000–1:25000	1:50000
Estonia	Basic Map 2021	Estonian map 50T (1997–2003)
	Basic Map 2021 with hillshade	Base map 50T (1994–1998)
	Basic Map 2021 monochrome	Soviet o42 50T newest (1963–89)
	Basic Map 1996–2007	Soviet o42 50T intermediate (1959–73)
	Basic Map 1996–2021 scanned	Soviet o42 50T oldest (1897–1973)
	Soviet o42 25T newest (1946–88)	Estonian topo 50T (1935–1939)
	Soviet o42 25T oldest (1937–61)	-
	Estonian topo 25T (1923–35)	-
Czechia	ZM25 newest	ZM50 newest
Finland	Basic Map newest (1988–1998)	Topographic Map (1970–2003)

Table 1. Evaluated maps

Graphic Map Load Measuring Tool (GMLMT) in version 1.3 was used to evaluate graphic map load of map images. GMLMT is an open-source and easy-to-use plugin for GIMP (GNU Image Manipulation Program) software. This tool is a Python user extension applying Sobel operator for edge detection to estimate the level of map load in maps. Development of this tool was based on user experiment comparing various image processing techniques with user-perceived map load assessment (Barvir et al., 2020a). GMLMT also provides a visualisation grid (Figure 1) showing the distribution of graphic map load across evaluated map image or its selected part. GMLMT was already used in multiple case studies, e.g. for map load comparisons of school atlases (Barvir et al., 2020b) and for evaluation of various hypsometry visualisation methods (Jilkova et al., 2021). Similar studies aiming for graphic map load evaluation of either sample map samples or complex real maps were examined by Ciolkosz-Styk et al. (2021) and others within last decades.

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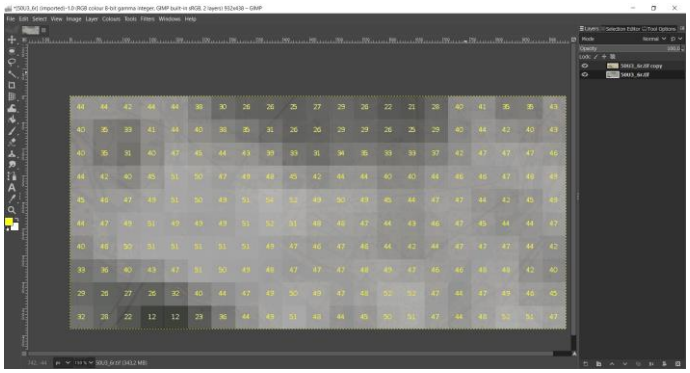

Figure 1. A map sample evaluated using GMLMT 3.0 with the graphic map load distribution grid.

GMLMT is able to evaluate maps represented by raster images in RGB (Red Green Blue) colour space. Each map image was loaded into GMLMT and overall graphic map load levels were stored in a database for further processing. Furthermore, a map load distribution grid for each of the evaluated map images was stored to be investigated when seeking reasons for low and high values of graphic map load. Measured values of map load (Ω) were also captured in a database for all evaluated map images. Besides average values of graphic map load, a distribution of map load across the map window was investigated. Visualisation grids provided by GMLMT present the less loaded parts of map images by dark shades while the overloaded parts tend to become highlighted by very light colour. In Figure 4 representing one of the coastal areas, a huge disproportion of map load between sea (left) and land (right) areas. Map load stays 0 on the homogenous area of water land barely raising to several percents due to labels or neighbourhood of more loaded areas. However, in the areas of people settlement it increases up to around 40 %. Other natural areas on the monochrome version of Estonian Basic map fluctuate between 20 and 30 %.

According to expectations, category of urban areas became the most graphically loaded across evaluated map products ranging from 27.1–72 % with average value 46.9 %. In contrary, coastal areas suffered from the lowest values of map load ranging from 5.7–48.3 % with the average value of 22.2 %. The category of natural/forested areas captured on evaluated map samples reached graphic map load 8.2–58.2 % with 34.4 % in average. However, map load of natural/forested landscape category differed a lot among maps. While in case of the modern 1 : 20 000 Estonian and both-scale Czech maps graphic load of natural/forested map sections was more similar to coastal regions, for other older Estonian, especially the Soviet style, and Finnish maps, map load of natural/forested regions was closer to the urban areas. This also supports the finding that Soviet maps are more balanced in the terms of graphic map load.

The category of Soviet maps was also found to be the most graphically loaded reaching 41.6 % in average followed by Finnish (39.3 %), old Estonian topographic maps (38.9 %), Czech (32.2 %) and finally modern Estonian maps (25.9 %). Unfortunately, it is not possible to strictly compare Czech and Finnish maps with the rest Estonian categories as different regions were captured by those maps. However, the monochrome black&white modification of Estonian Basic Map 2021 had the highest values in the urban areas category reaching up to 72 % in a map representing the city centre of Tallinn. The results show a decrease of graphic map load in time, which can be linked with the trend of simplification in design generally, with the most significant change during the transfer between Soviet-style maps. The larger differences in graphic map load distribution also reveals the processes of cartographic generalisation, currently attempted to be done automatically or semi-automatically, is not done as precisely as it happened before, when it was done manually. This issue can be related to current trends of automation and making cartographic visualisation efficient.

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