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Semi-automatic development of thematic tactile maps

Jakub Wabiński[a,*], Guillaume Touya[b], Albina Mościcka[a]

[a] *Military University of Technology, Warsaw, Poland, jakub.wabinski@wat.edu.pl, albina.moscicka@wat.edu.pl*
[b] *LASTIG, Univ Gustave Eiffel, ENSG, IGN, guillaume.touya@ign.fr*

* Corresponding author

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Abstract:

Tactile maps development is a complicated task. This results mainly from the lack of explicit guidelines and specific characteristics of tactile perception. Besides, creating tactile maps requires manual work of a number of specialists, which results in high costs of their production.

Tactile cartography has been a niche topic for many years. But if we consider the number of people with visual impairment (PVI), i.e. 285 million as estimated by the WHO (out of which 39 million completely blind), this research field should, in our opinion, drive more attention. Moreover, even among tactile cartographers, very little consideration has been given to thematic tactile maps. Such maps are used in education and their lack makes it difficult to properly teach geography or history among pupils with visual impairments.

For this reason, we have undertaken the research, whose **aim was to develop a methodology for semi-automatic development of legible and cartographically sound thematic tactile maps**. The research was motivated by two research questions:

1. What procedures and rules allow automation and repeatability of the thematic tactile map development process?
2. Which steps in this process can be fully automated?

While developing the methodology, we based on our previous research regarding guidelines for standardizing tactile maps design in order to parametrize the process and avoid subjectivity. The methodology bases on the concept of anchor layers and parametrization of the generalization operators. It can be divided into 5 main stages:

1. anchor layers selection and their hierarchization,
2. generalization constraints determination,
3. basemap development,
4. thematic content selection and its generalization,
5. symbolization and labelling.

Anchor layers are the layers that form a common basemap content that remains unchanged for every map in an atlas or map series. They can also be used in situations, where a lot of content is not suitable to fit onto one map sheet. Particular thematic layers can be split into a number of map sheets that share the common background content, i.e. the anchor layers, for a faster and easier orientation in thematic content.

The methodology can be used along with various production techniques but for the purpose of this research, the 3D printing technique was used. This choice results from the properties of 3D printing, i.e. the ability of fast prototyping.

Although not fully automatic at this point, we have managed to automate the most complex stages of thematic tactile maps development process related mainly to cartographic generalization, that is: selection, smoothing, alignment and displacement (Figure 1a). The generalization procedure bases on proprietary algorithms that have been implemented in the existing software, i.e. ArcGIS and CartAGen. Besides, the stages of anchor layers selection and their hierarchization, map symbolization, as well as labelling, have been thoroughly described so that the methodology can be easily adapted for future applications.

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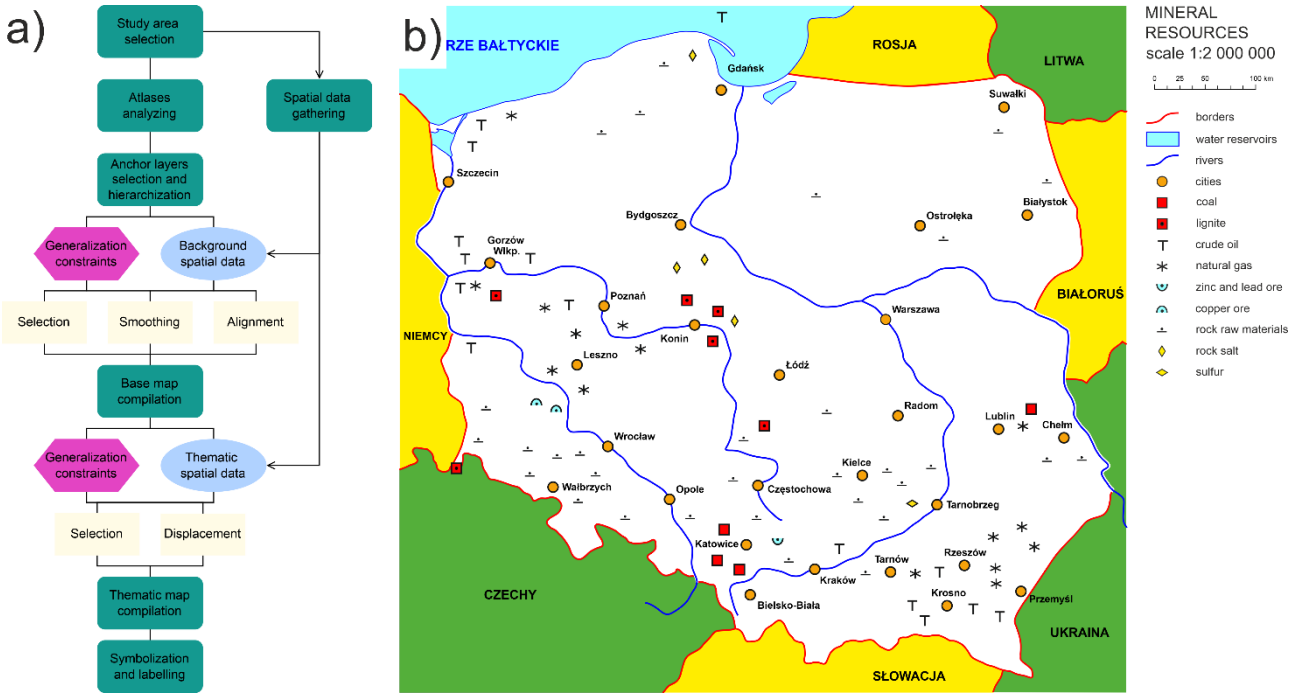

Figure 1 Left, schematic presentation of the methodology (in yellow are the fully automatic processes). Right, the final design of the graphic variant of the case study map.

The methodology has been verified on a case study map presenting the occurrences of mineral resources in Poland (Figure 1b). Its physical copy (Figure 2) consists of a coloured flat underprint (graphic variant) and a transparent 3D printed tactile overlay (tactile variant), forming a hybrid map for both tactile and visual exploration. The map was tested by 13 students of the Secondary School for students with visual impairments in Laski. The tactile content was positively evaluated as legible and comfortable to use. However, the graphic content caused more difficulties for the study participants, mainly because of the blurry look of the graphic underlay that was caused by inappropriate post-processing of the tactile variant of the map. We have scheduled additional trials to avoid this effect on future maps and prepare fully transparent products.

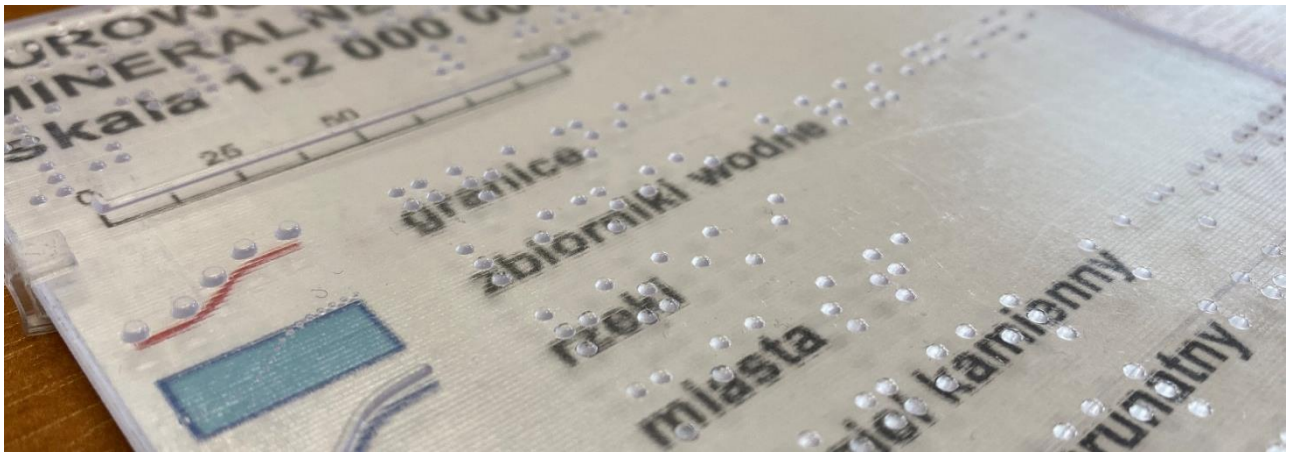

Figure 2 Assembled map legend fragment. Transparent tactile layer visible over the graphic underlay

The presented methodology proved to be useful for cheaper and faster development of legible thematic tactile maps. Since it is based on unequivocal design parameters, it can also be considered as repeatable. We plan to further develop the methodology and verify, whether it would be useful for creating maps for adults and/or presenting different phenomena by conducting a systematic human subject testing.

This research forms another step toward full automation of tactile maps development process and hopefully will broaden the access to tactile materials among PVI.

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