Analysis of a Workflow for the Automated Generalization of Geological Maps

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This thesis attempts to analyze and evaluate an automatic procedure for the generalization of geological maps from a 1:25,000 scale (source) to 1:150,000, 1:500,000, and 1:1,000,000 scales (target) based on an existing workflow. The procedure was implemented in a study area in southern Bavaria, Germany, to produce geological maps at the three target scales. A qualitative evaluation was performed to identify the advantages and disadvantages of the workflow.

The results showed that the workflow has the potential to be used for future generalizations of geological maps at Bayerisches Landesamt für Umwelt (LfU). However, limitations found need adjustments to achieve the desired outputs.

OBJECTIVES

- Execution of the generalization process of geological maps scaled at 1:150,000, 1:500,000, and 1:1,000,000 (target scales) from a 1:25,000 scale geological database (source scale).
- Evaluation of the results considering different target scales.
- Orchestration of the workflow to ensure its use at the Bayerisches Landesamt für Umwelt (LfU).

METHODOLOGY

The LfU provided the workflow for its analysis and evaluation. This workflow was proposed at its base by Schuff (2019) and further developed by Landesamt für Geologie, Rohstoffe und Bergbau (LGRB) in cooperation with the company con terra GmbH (Münster). This workflow provides the generalization of categorical data focused on areal objects based

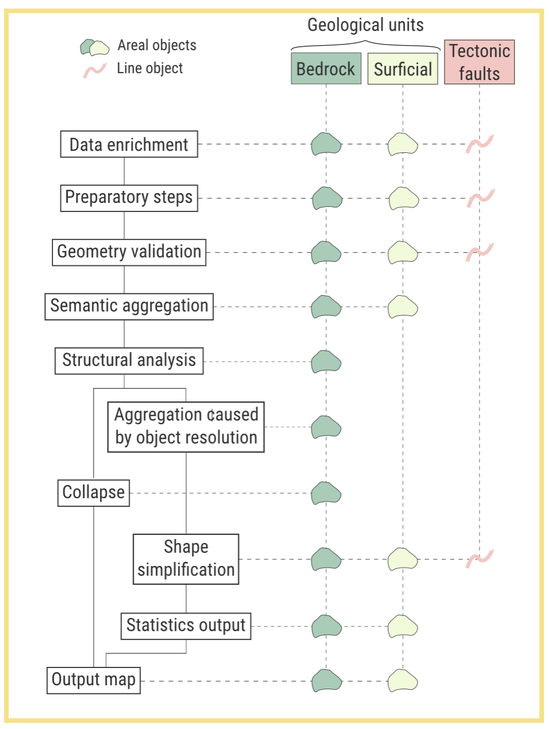

Figure 1. Diagram of the generalization process. To the left is the step-by-step workflow. On the right is the data, either polygons or lines, for which each step applies.

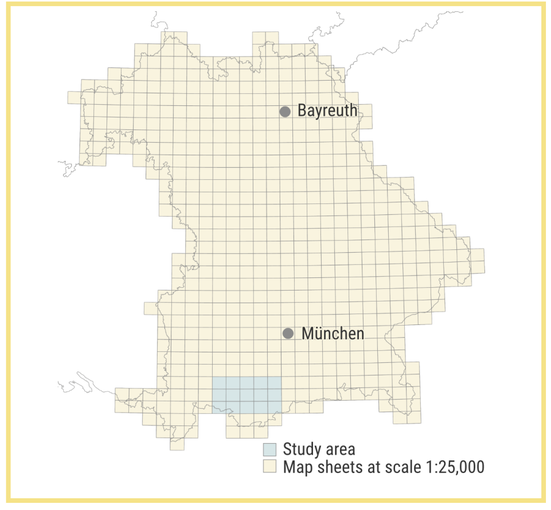

Figure 2. Study area.

on geometric and semantic criteria. Figure 1 displays a schematic overview in which the terms bedrock and surficial correspond to the definition given in the context of GeoScaler.

IMPLEMENTATION

The implementation of the workflow was made in an area in the south of Bavaria, Germany (see Figure 2). The criteria for choosing this region were

- the completeness of the input data regarding especially the parameter "flag" related to geological faults and
- the geological complexity that this area represents makes it interesting to analyze.

RESULTS

A qualitative visual assessment was performed after the generalization process to evaluate the quality of the generalized maps of the study area This evaluation was carried out with the help of LfU geologists and cartographers to examine the readability and the geographic and geological coherence with respect to the input data (1:25,000 scale maps).

The evaluation from a macro level perspective (i.e., the whole map) can be divided into two points of view. On the one hand, some consider this generalization could be used for visualization on the Internet in the UmweltAtlas. On the other hand, some others think that due to the errors its use is limited.

Some errors found in the output maps were related to the following categories:

- Shape simplification: increase in the number of vertices (Figure 3) and asymmetric simplification.
- Aggregation caused by object resolution: unexpected change of semantic category of some polygons (see Figure 4).
- Collapse of important features that should be preserved as polygons instead of points or lines.

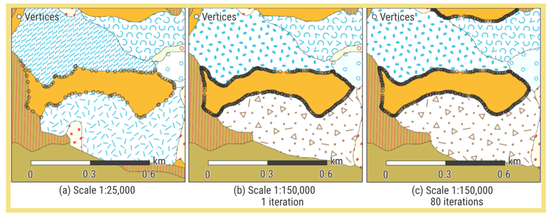

Figure 3. The number of vertices before and after the generalization process. (a) Vertices at scale 1:25,000. (b) Vertices at scale 1:150,000 with one iteration. (c) Vertices at scale 1:150,000 with 80 iterations.

- Minimum dimensions: condition on the minimum distance between border points is not implemented into the workflow.
- Geological characteristics: some geological features worth preserving in the study area fade as the scale is decreased.
- Harmonization: is a factor that determines the quality of the outputs of the generalization process.

DISCUSSION

The workflow implemented in this thesis has some limitations mentioned as follows:

- A previous learning phase on the structure and execution of the workflow is required.
- Data enrichment is time-consuming.
- Shape simplification causes an increase in the number of vertices and sometimes does not preserve original shape proportions.
- Aggregation caused by object resolution sometimes causes unexpected semantic changes.
- Collapse of relevant features.
- Conditions on minimum dimensions are required.
- Non-preservation of geological features.

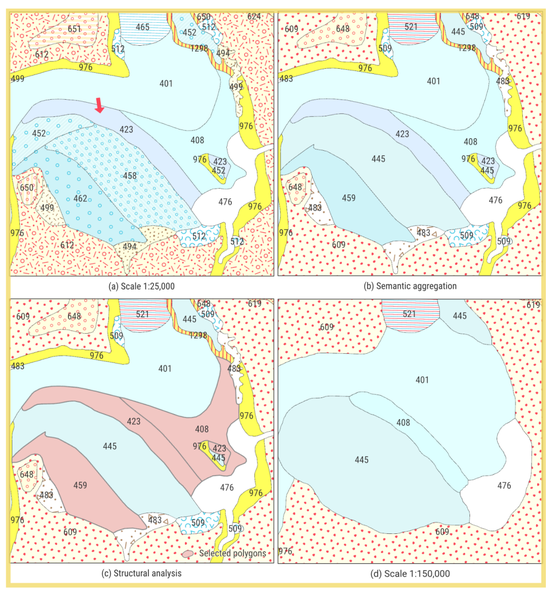

Figure 4. Example of error in aggregation caused by object resolution. (a) Input data at scale 1:25,000. (b) First semantic aggregation. (c) Structural analysis process. (d) Output at scale 1:150,000. The sizes of the figures have been adjusted for better comparability.

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geological maps, map generalization, cartography.

CONCLUSION

Based on the analysis and evaluation performed here, this thesis concludes with the overall finding that the workflow has the potential for implementation as an automatic generalization of geological maps in the LfU. However, the limitations mentioned in the previous section need solutions to provide a resulting map that ensures legibility and maintains polygon characteristics.

References

[1] Schuff, J. (2019). Verfahren zur automatisierten Generalisierung flächenhafter Geofachdaten (Master's thesis). UNIGIS. http://unigis.sbg.ac.at/files/Mastertheses/Full/104640.pdf

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