General topography of Prahova County, Romania

Cezar Buterez, Bogdan Olariu, Bogdan Mihai, Marina Rujoiu-Mare and Ionuț Cruceru

Faculty of Geography, University of Bucharest, Bucharest, Romania

ABSTRACT
The general topographic mapping of a territory, even at detailed scales, remains a difficult task as it is necessary to select the most representative features for an objective representation. The approach we propose tries to provide an accurate solution for mapping the key features of an administrative unit from Southern Romania (Prahova County, 4917 km²) at the scale 1:150,000. The map combines existing data (EU DEM elevation data, hydrographic network) with adapted data extracted from OpenStreetMap (road, railway and settlement networks), together with field survey data, that bring the specific landmarks together with updated information on other features. This approach attempts to bring an integrated configuration of cartographic features and so provide accurate data for scientists, businessmen and tourists, closer to similar scale remote sensing imagery.

ARTICLE HISTORY
Received 11 May 2015
Revised 20 May 2016
Accepted 31 May 2016

KEYWORDS
General map; Prahova; cartographic representation; GIS; landmarks

1. Introduction
General topographic maps covering regions and national territories remain an important product in the context of digital cartography (Committee to Review the United States Geological Survey Concept of the National Map, 2003). The main mapping problems associated with this are similar to those encountered in classic cartography; however, new technologies can provide solutions to finding new map styles and improving the information content and its relevance at different scales (Kimerling, 2008; Perkins, 2008). The increasing demand for detailed geographic data that can be tailored to different spatial coverages created using contemporary datasets in vector and raster formats, especially at a national scale (e.g. Strategy Vector Map Dataset from Ordnance Survey).

In Romania, only topographic maps and some school maps provide the essential information for a general map at different scales. The idea to produce a regional scale map at county level was a part of a larger context involving writing a monograph on Prahova County (Mihai et al., 2016, in press). The general map tries to represent a typical cartographic synthesis of the volume at a scale of 1:150,000. It can be problematic finding the best solution for integrating the key features of the territory, in order to understand the text together with the thematic maps which are provided.

Prahova County was the subject of different thematic maps due to a range of geographic topics: landslide mapping and landslide susceptibility analysis (Șandric & Chițu, 2009; Șandric, Chițu, Mihai, & Săvulescu, 2011), geomorphological mapping for practical use (geomorphotechnical map by Dobre, Mihai, & Săvulescu, 2011) and historical urban development (Pătru-Stupariu, Stupariu, Cuculici, & Huzui, 2011). The main tasks of our approach were:

- To identify and evaluate the available geographic data sources in order to find the most reliable ones according to map scale and accuracy.
- To build an up-to-date geographic information system (GIS) database with all the representative features of the territory, in parallel with the geographic monograph chapters.
- To update the features from previous Prahova County maps in terms of spatial features as well as geographical names.
- To integrate older and newer landmarks that outline the individuality of the territory in order to offer a cartographic expression of scientific and cultural values.
- To find the optimal solutions for cartographic representation of all features in terms of semantics, style, accuracy and visual hierarchy.
- To develop a modern and attractive design for a general topographic map that can be a possible starting point for thematic representations like tourist and road maps.

2. Methods
The general topographic map of Prahova County is a new and completely updated version of the first edition from 1973 (Niculescu & Velcea, 1973). The first issue was to identify the available digital datasets, to resize.
Table 1. Map themes and data layers integrated in the Prahova County map production.

| Map theme(s)                  | Data layer topology | Data source                                      | Data processing/GIS analysis                                      | Update and validation |
|------------------------------|---------------------|-------------------------------------------------|-----------------------------------------------------------------|-----------------------|
| Terrain elevation            | Vector (contour lines) Raster (shaded relief model) | EU DEM digital model 25 m (accessed 02/2014)    | Data query and generalization for selected altitude zones       | Topographic map 1:25,000 Field validation |
| Height points                | Vector (points)     | Topographic map 1:25,000 (1982), Military maps 1:20,000 (1914–1950) | Data selection and place names extraction | Bibliography (including historical maps and documents) Field validation |
| Hydrography                  | Vector – line, polygon (streams, lakes) | Hydrographic cadastre atlas (2004) | Topological model correction, generalization | Orthophotos by ANCPI Bucharest 1:5000 (2005) |
| Forest cover                 | Vector (polygon)    | Corine Land Cover CLC 2006 (accessed March 2013) | Database query and generalization | Landsat OLI (2013/04/30) 30 m resolution satellite image analysis |
| Vineyard cover               | Vector (polygon)    | Corine Land Cover CLC 2006 (accessed March 2013) | Database query and generalization | Landsat OLI (2013/04/30) 30 m resolution satellite image analysis |
| Road network                 | Vector (line)       | Open Street Map (accessed January 2014) through Overpass API Ministry of Transports (2014) | Database query and generalization | Field validation |
| Railway network (active, inactive) | Vector (line) | ANCPI vector database | Database query and generalization | Field validation |
| Settlements built-up area   | Vector (polygon)    | Corine Land Cover CLC 2006 (accessed March 2013) ANCPI vector database (accesses March 2014) | Database query and generalization | Orthophotos by ANCPI Bucharest 1:5000 (2005–2012) Field validation |
| Natural geomorphic features (geomorphosites) | Vectors (line, point) | Orthophotos by ANCPI, 1:5000 Field mapping Bibliography | Digitization | Field validation |
| Historical/cultural features (monuments, churches, sites) | Vector (point) | Bibliography (including historical documents) Field mapping | Digitization | Field validation |
| Industrial features (industrial parks, plants, quarries and mines) | Vector (point) | Orthophotos by ANCPI Bucharest 1:5000 Historical maps Field mapping | Digitization | Landsat OLI (2013/04/30) 30 m resolution satellite image analysis Field validation |
| Agricultural features (shepherd huts, farms and farming facilities) | Vector (point) | Orthophotos by ANCPI Bucharest 1:5000 Historical maps Field mapping | Digitization | Field validation |
| Social and tourist infrastructures (huts, communications facilities, etc.) | Vectors (line, point) | Prahova County Master Plan (2002, update 2012) Urban master plans Field mapping | Digitization | Orthophotos by ANCPI Bucharest 1:5000 (2005–2013) Field validation |
| Place names                  | Field in attribute table | Topographic map 1:25,000 (1982), Military maps 1:20,000 (1914–1950) | Data selection and database creation | Bibliography (including historical maps and documents) Field validation |
| Administrative boundaries (county limit) | Vector (point) | ANCPI vector database (accessed December 2012) | Database query and generalization | Google Maps INIS Viewer – INSPIRE Romania Geoporal Field validation |

them to the regional level and evaluate their accuracy. Table 1 provides an overview of the data features: theme name, topological features and short explanations of the processing and validation of each layer.

The digital version of the map starts from the idea of the integration of the basic data (similar to the first edition) with special data, in order to produce a new cartographic expression. Elevation, hydrography and settlements, together with basic geographical names are not enough to provide a complete view of the regional landscape. This approach needed the creation of a new symbol library as the available symbols were limited (Beconytė, Eismontaitė, & Žemaitytė, 2013; Buterez, 2012).

The map followed three stages of production: database development and primary data visualization, GIS data processing and final data cartographic processing (Gretchen, 2014). This approach was used to integrate at the same time map accuracy with map editing and map style production. Data integration (Table 1) was a longer process, as the topological data models were not accurate at all times. The level of detail varied spatially and temporal updating was not the same everywhere. Another problem was to ensure consistent data coverage in order to fill the map with features and geographical names. For this purpose a global positioning system (GPS) survey was necessary. The points and tracks were transformed into geographical features and attributes.

Database development and data primary visualization needed a special approach because of the diverse
data sources (Table 1). Another problem was that the data sources were not complete (spatial coverage at the same scale) and up-to-date in the context of the most dynamic areas. The application first integrated the open data available, which needed to be downloaded and validated with other data. For example, road network data from OpenStreetMap needed accuracy improvement, by selecting the classified roads together with street networks. For this purpose, it was necessary to compare the database with the Romanian Road Network List (Roads National Administration, 2015) and on orthophotos from the ANCPI Geoportal (http://geoportal.ancpi.ro/geoportal/viewer/index.html). Field observation and digital photography helped the update of attributes for these features, while topological features were adapted in order to be visible at the established map scale.

GIS primary cartographic data processing was developed in ESRI ArcGIS 10.1 by combining data layers and searching for a solution to complete the map in a shorter time. This was not possible as map themes were at different scales in their original format (1:5000 to 1:20,000) and the automatic generalization at the map scale (1:150,000) introduced many conflicts and incorrect representation of the superposing features of point, line and polygon type along the river and road networks (Figure 1(a)). Another issue was the limited symbol library that introduced the visualization of small features as important features (e.g. point type features such as huts, shepherd huts and castles), obscuring other elements of the mapped area (e.g. built-up areas, roads, railways). In this respect, further cartographic work was needed in order to produce a map with a correct and complete visualization of the main geographical features, according to common cartographic generalization principles (Mackaness & Chaudhry, 2008).

Cartographic processing (Figure 1(b)) focused on finding a new symbol collection and then a solution for generalization with data at different scales from the original format. First, new symbols were produced in Inkscape 0.91 by drawing each feature in a simplified configuration. Second, the symbols were
organized in a hierarchical format as the main goal of the general map was to offer an expression of the main landscape features, easily identifiable in the field (Figure 2). Third, a new label format and spelling was proposed for the map, in order to locate the geographic names from official documents and sometimes from historical maps (in some selected locations like villages that changed their name). This new version of the map was updated by fieldwork, including digital photography and a GPS survey, because the temporal resolution of the primary data was different (from 1982 up to 2012). The road network and settlement built-up areas were checked on orthophotos and in the field, and updated to their present-day configuration, according to official urban planning documents.

3. Conclusion

The current map of Prahova County (Main Map) proposes a new up-to-date approach for medium scale general topographic mapping in order to adapt the cartographic solutions to the field situation. The digital data available at different scales needed considerable time for validation and adaptation. GIS solutions were only part of the cartographic work as the automated generalization created map conflicts and a reverse hierarchy of features. Cartographic work continued the GIS approach with the creation of a new visual formula and a solution to the superposition of features.

The general topographic map needed a selection of cartographic objects and themes as it is impossible to create a complete cartographic product of the study area. This problem results from many small objects (mainly point themes) being intersected by infrastructure and other line themes (e.g. cable-cars). For this reason, the potential conflicts between themes and objects need a special approach in searching for a clear mapping solution.

Software

The creation of the database and data processing were conducted using Esri ArcGIS 10.1, Global Mapper 15 and QGIS 2.4. The cartographic processing was completed using CorelDRAW X3 and Inkscape 0.91. GPS data were imported and converted using MapSource 6.15.11.

Disclosure statement

No potential conflict of interest was reported by the authors.

ORCID

Cezar Buterez  http://orcid.org/0000-0002-7752-3534

References

Beconytė, G., Eismontaitė, A., & Žemaitienė, J. (2013). Mythical creatures of Europe. *Journal of Maps, 10*(1), 53–60. doi:10.1080/17445647.2013.867544

Buterez, C. (2012). Following a gentleman’s expedition: Odobescu and the crypts from northern Buzău. *Journal of Maps, 8*(1), 125–127. doi:10.1080/17445647.2012.675762

Committee to Review the United States Geological Survey Concept of the National Map. (2003). *Weaving a national map*. Washington, DC: The National Academies Press. Retrieved from http://www.nap.edu/catalog/10606/weaving-a-national-map-review-of-the-us-geological-survey

Dobre, R., Mihai, B., & Săvulescu, I. (2011). The geomorphotechnical map: A highly detailed geomorphic map for railroad infrastructure improvement. A case study for the Prahova River Defile (Curvature Carpathians, Romania). *Journal of Maps, 7*(1), 126–137. doi:10.4113/jom.2011.1155

Gretchen, N. P. (2014). *GIS cartography: A guide to effective map design* (2nd ed.). Boca Raton, FL: CRC Press Taylor & Francis Group.
Kimerling, A. J. (2008). Cartography. In K. K. Kemp (Ed.), Encyclopedia of geographic information science (pp. 24–28). Los Angeles, CA: SAGE.

Mackaness, W. A., & Chaudhry, O. (2008). Generalization and symbolization. In S. Shekhar & H. Xiong (Eds.), Encyclopedia of GIS (pp. 330–339). New York, NY: SpringerScience+Business Media LLC.

Mihai, B., Nedelcu, A., Buterez, C. (coord.), Cruceru, I., Olariu, B., Rujoiu-Mare, M., … Tudose, I. (2016). Județul Prahova – Spațiu, Societate, Economie, Mediu [Prahova County – Space, society, economy, environment]. Editura Academiei Române, București (in press).

Niculescu, Gh., & Velcea, I. (1973). Județul Prahova. Colecția Județele Patriei Editura Academiei Române, București.

Pătru-Stupariu, I., Stupariu, M. S., Cuculici, R., & Huzui, A. (2011). Understanding landscape change using historical maps. Case study Sinaia, Romania. Journal of Maps, 7(1), 206–220. doi:10.4113/jom.2011.1151

Perkins, C. (2008). Cultures of map use. The Cartographic Journal, 45(2), 150–158. doi:10.1179/174327708X305076

Roads National Administration. (2015). Romanian road network list. Bucharest: Ministry of Transportation.

Șandric, I., & Chițu, Z. (2009). Landslide inventory for the administrative area of Breaza, Curvature Subcarpathians, Romania. Journal of Maps, 5(1), 75–86. doi:10.4113/jom.2009.1051

Șandric, I., Chițu, Z., Mihai, B., & Sâvulescu, I. (2011). Landslide susceptibility for the administrative area of Breaza, Prahova County, Curvature Subcarpathians, România. Journal of Maps, 7(1), 552–563. doi:10.4113/jom.2011.1168