

Thematic Maps in Browser

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Abstrakt. Geoprostorová data jsou velice často vizualizována ve formě jednoduchých tematických map. Tento způsob je přehledný a srozumitelný i pro laického uživatele map. Tento příspěvek představuje metodu generování některých typů tematických map přímo v prohlížeči webových stránek. Princip je podobný jako v případě běžných webových stránek - uživatel pouze zadá jednoznačný identifikátor souboru se vstupními daty. Díky vytvořeným stylům s možností definování mapových kompozic se v okně prohlížeče již neobjeví data, ale tematická mapa. Tento proces probíhá pouze s využitím funkcí prohlížeče bez potřeby jiného software.

Klíčová slova: Tematická mapa, XML technologie, prohlížeče www stránek, heterogenita.

Abstract. Geospatial data are very often visualized as simple thematic maps. This way is transparent and intelligible for lay user of maps. This paper introduces the method of generating of some types of thematic maps in a browser of web pages. The principle is analogous to common web pages - a user enters the unique identifier of a file of source data. These data are visualized as thematic maps by prepared transformation styles and possibility of definition of map composition. Therefore there are not any data in browser window just thematic map. This process works only by using of function of common browser without other software.

Keywords: Thematic map, XML technologies, browsers of web pages, heterogeneity.

1 Introduction – Cartographic visualisation of geospatial data sets as their direct travel to users

Geospatial data represent the most common form of a description of geographical space on the present. But raw geospatial data are very complicated for the majority of users. They do not orientate in the labyrinth of different coordinates and attributes. In addition there are problems connected with an absence of metadata, data models, data schemas, ontologies and other descriptive and semantic information. Therefore the one of the most used and also oldest methods of representation of geospatial data sets are maps and other cartographic products (i.e. plans, globes etc.), because data are presenting in graphic form. Everyone is meet with maps everyday. The maps are offered in TV, papers, handouts, information boards, Internet etc.

Thematic maps are one of the most popular types of maps because they make possible to present statistical data relating to spatial units and items. This way is transparent and intelligible for lay user of maps.

Especially the increasing number of thematic maps on the Internet puts the accent on work of cartographers. Cartographers are more commonly meet with the job to create a presentation of attribute or time component of geospatial data on the Internet by virtue of interpretation methods of thematic cartography. The accent is placed on the topicality of visualisation or data, quality of final product, its accessibility and interactivity. Very often there are put limits on some basic attributes of "classic" maps (e.g. cartometric characteristics) especially in cases of small-scales maps. It is necessary to awake to the importance automated real-time generating of the map however at the expense of cartographic quality.

The presentation of geospatial data on the Internet by the virtue of a cartographic interpretation method is possible through many different ways. The maps in static raster form are ranked among the simplest variants. These maps could be created by some type of GIS (Geographic Information System) tools or mapping software. The second possibility is to use a digitalized, originally printed maps. The link to such raster graphics is inserted in a code of web page written in the HTML (HyperText Markup Language) or XHTML (eXtensible HyperText Markup Language). The page is visualised by some type of web page browsers (e.g. Microsoft Internet Explorer, Mozilla Firefox, Opera, Safari, Google Chrome etc.). The other more advanced method consists in a presentation by

some vector format, which is able to be presented on web page browser directly or by some plug-in. There are available formats like SVG (Scalable Vector Graphics), VML (Vector Markup Language), Adobe Flash or GeoPDF (Geo- Portable Document Format). There is the third variant of a delivering maps through the Internet – to use database tool and some type of standardised web services like WMS (Web Map Service), WFS (Web Feature Service) or WCS (Web Coverage Service).

2 Proposed solution as attempt at limit of heterogeneity

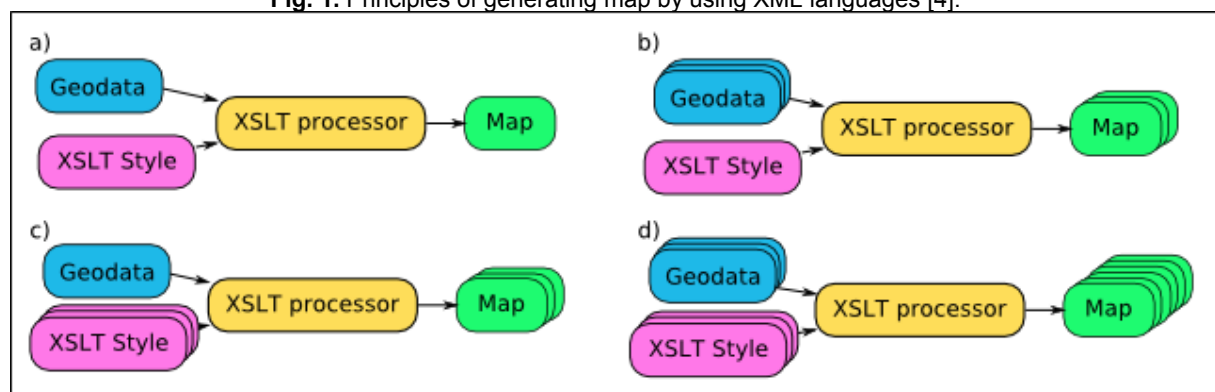
The main problem of a publishing of the maps on the Internet is heterogeneity, which is concerned in sphere of technologies and cartographic rules. The heterogeneity is the cause of poor adherence to rules, standards and specifications, eventually implementing of new proprietary standards or new proprietary rules to existing standards [2]. Users are not able to work with all types of cartographic products, because they use different

- software products,
- hardware platforms,
- file formats,
- data models,
- cartographic rules,
- legislative standards etc.

The following publications of author of this paper attend to aspects of heterogeneity in cartography on the Internet: [1], [2], [3].

From the view of information technologies and cartography is very important the adherence of vast number of standards, rules, methodologies etc. Therefore the solution based on common used software and technologies (formats) could be useful. In this paper there is described the process of generating of thematic maps on the Internet. Analogous to other web solution this method use the browser of web pages as the main software tool. But the browser is not just the visualisation tools, because this software is used as computing instrument too. Current web page browsers contain many different tools, which are not very good known – users work with this component unwittingly. By the one of these tools there are transformation processors. The transformation processors make possible to convert different types of XML (Extensible Markup Language), but also some non-XML, formats. Processors use the language XSLT (Extensible Stylesheet Language Transformations). The web page browser can fetch the data in GML (Geography Markup Language) format, process this data by using XSLT styles and generate the thematic map in SVG format. This procedure connect the simplicity of browsers using, quality of vector visualisation and standardisation of XML formats, because the languages GML, XSLT and SVG are ranked among XML derivatives.

Fig. 1. Principles of generating map by using XML languages [4].



User just write the URL (Uniform Resource Locator) of the required GML (or other XML based) data file to address line of web page browser. To this file the transformation style must be connected. The connection mean inserting of one line to the source data file. The transformation style provides:

- source data processing (e.g. calculations of data classing),
- GML to SVG conversion (map generating),
- portrayal of final map and the interface of control of the map.

Except above-mentioned formats there are used CSS (Cascading Style Sheets) for map design and

ECMAScript (European Computer Manufacturers Association) for operating elements.

This paper is focused on brief description of selected technologies, transform styles, structure of application, application possibility, problems of application, proposed solutions and further trends.

3 Description of the application

3.1 Selection of markup languages

The following requirements must be met to visualise geospatial data by the web sites browser (analogous to text data in HTML or XHTML form):

1. Source data are coded by some markup language.
2. Style language (or languages) is (are) able to define visualisation rules for elements and to describe a transformation templates for conversion of geospatial data to graphical form.
3. The format of final thematic map is based on markup languages.
4. All used technologies, formats or languages are implemented in common web browsers.

From the view of markup languages there are required two formats – first format for geospatial data coding and describing, second format used for vector graphic data. Minimally one language from the group of transformation and style languages (XML Transducers) is intended for the mutual conversion of source and output formats. The publication “Application of Markup Languages in Cartography” [3] specifies the list of markup languages or relative formats suitable for cartography. From this list there is possible to select following languages to above-mentioned groups:

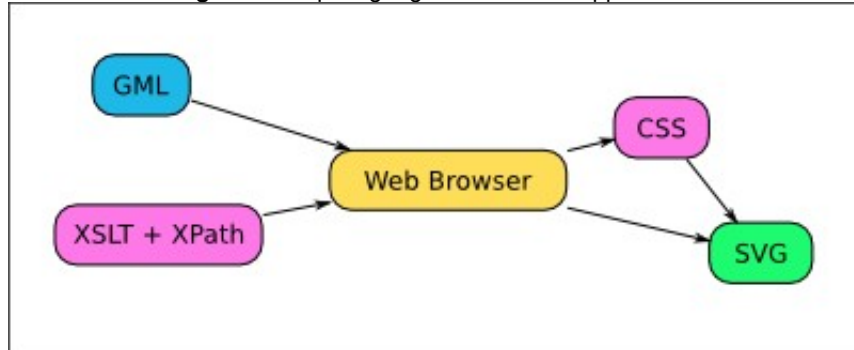
- Formats for describing and coding of geospatial data
 - GML
 - cGML (compact GML)
 - JML (JUMP GML)
 - KML (Keyhole Markup Language)
 - LandXML
 - G-XML
 - SOTF (Spatial Object Transfer Format)
 - TML (Terrain ML)
 - cityGML etc.
- Formats for describing and coding of vector graphical data
 - SVG
 - VML
 - WebCGM (Web Computer Graphics Metafile)
 - DrawML (Drawing Meta Language)
 - PGML (Precision Graphics Markup Language) etc.
- Transformation and style languages (XML Transducers)
 - CSS
 - XSL (Extensible Stylesheet Language) – this language is composed from languages XSLT and XSL-FO (Extensible Stylesheet Language - Formatting Objects)
 - DSSSL (Document Style Semantics and Specification Language)
 - FOSI (Formatted Output Specification Instance) etc.

If we base the selection of most suitable technologies on the above-mentioned four conditions for the visualisation of geospatial data by using web browsers, we can choose following formats:

- Source data are coded in GML format, because this format is guaranteed by the organisation OGC (Open Geospatial Consortium) and represents the fundamental standard for geospatial data description.
- Source data are transformed to format SVG. Because SVG is the most used and most supported format for describing and sharing of vector graphics on the Internet. The same way as following formats SVG is standardised by the most important organisation in the world of web – W3C (World Wide Web Consortium).

- The more complicated situation is in the case of transformation and style languages. There are required a transformation language from GML to SVG. The language XSLT and the simple query language XPath are the most suitable for this purpose. The other language is necessary for a defining of visualisation rules of separate elements. As the optimal choice there is the language CSS known from the world of creating of web pages.

Fig. 2. Markup languages used in the application.

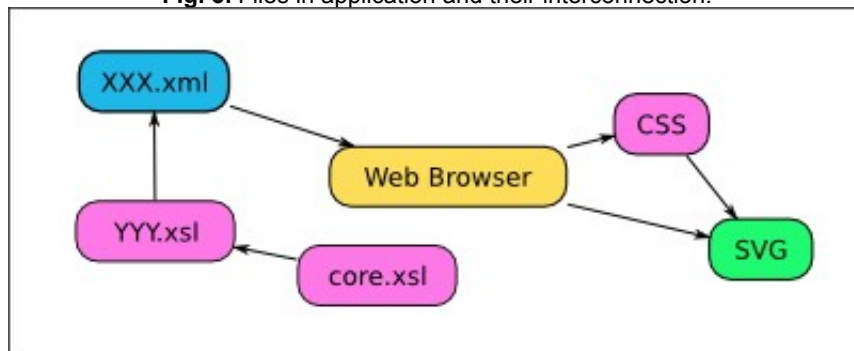


3.2 Structure of application and transformation styles

There are three interconnected files for the generating of SVG map in browser of web pages – source data file and two style files converting geospatial data to cartographic form.

1. XXX.xml – the source data file in the GML format represents the base input data set of elements transforming to a cartographic product. There is the open-source program ogr2ogr used for converting from other data formats (e.g. shapefile) to the GML standard. Therefore the transformation styles work with XML Namespace ogr:. The application is optimized for the utf-8 (Unicode Transformation Format) encoding of characters, but other encodings could be specified in XML declaration.
To this file the following style (YYY.xsl) file is attached by means of processing instruction `<?xml-stylesheet type="text/xsl" href="YYY.xsl"?>`.
2. YYY.xsl – style file connected to the source document. Presently this file contents
 1. Element ensuring the link and the true link to the nested transformation style (file core.xsl).
 2. Definition of map composition.
 3. Description of possibilities of the application (allowed attributes of interpretation methods, data types, lists of admissible value etc.). This description is written in the compact syntax of schema language RELAX NG (REgular LAnguage for XML Next Generation). Compact variant of RELAX NG is not XML based (therefore the RELAX NG definition is presented as XML comment), but it is shorter and the conversion to XML based variant of RELAX NG is very simple.
 4. Loading the source file to the parameter of transformation style for reason of more simple and faster transformation.
3. core.xsl – XSLT style file common to all data visualisations. This file contain the fundamental template processing all map composition defined in style file YYY.xsl in sequence.

Fig. 3. Files in application and their interconnection.



3.3 Attributes of the control file (YYY.xsl)

Every map is described in element called Map. This element contain three obligatory attributes and one obligatory element.

- Attribute title – title of concrete map.
- Attribute max – maximal value of classing of every interpretation cartographic method.
- Attribute min – minimal value of classing of every interpretation cartographic method.
- Element Method – definition of interpretation cartographic method.

Element Method is composed of attribute name (name of method) and one or more elements DataColumn representing attributes columns (in XML terminology elements). Presently the are at disposal following values of attribute name (alphabetic order) – these values make possible to create some types of diagram maps and simple choropleth map:

- AverageBar
- Bar
- Choropleth
- CompareBar
- CompositeBar
- StructureChart

There are three attributes of element DataColumn:

- Obligatory attribute name defining the name of visualised attribute.
- Optional attribute fill expressing one of graphical parameter – filling of map element. Some methods have predefined values of filling.
- Optional attribute shape describing a type of shape (rectangle – value Rect, triangle – value Triangle or cylinder – value Cylinder) in case of some types of diagram.

The following list shows some examples of the describing of cartographic data visualisation:

1. Minimal form of description – simple cartodiagram represented by “gold” rectangles.

```
<Map title="Počet obyvatel v roce 1991" max="1283271" min="0"><Method name="Bar"><DataColumn name="ogr:OB91"/></Method></Map>
```
2. The same type of the map as in previous example, just the rectangles are red.

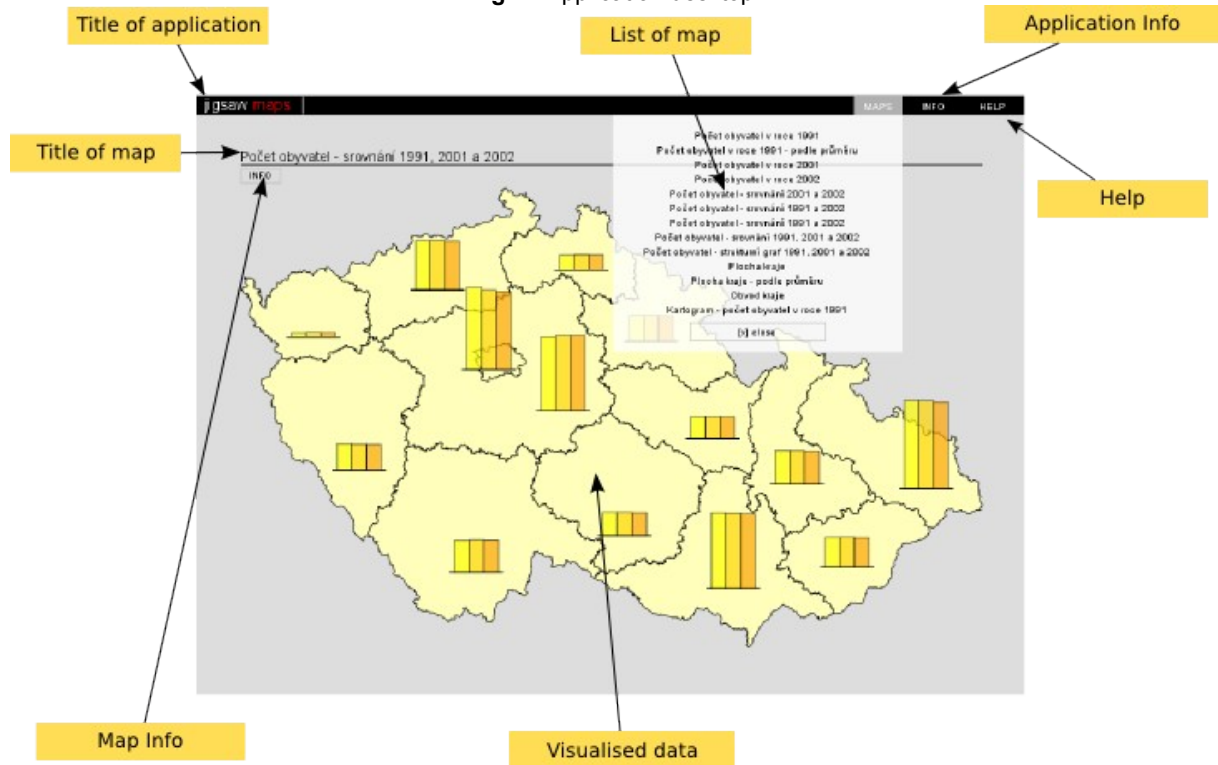
```
<Map title="Počet obyvatel v roce 1991" max="1283271" min="0"><Method name="Bar"><DataColumn name="ogr:OB91" fill="red"/></Method></Map>
```
3. In this case there are graphs represented by blue cylinders.

```
<Map title="Počet obyvatel v roce 1991" max="1283271" min="0"><Method name="Bar"><DataColumn name="ogr:OB91" fill="blue" shape="Cylinder"/></Method></Map>
```
4. This map express the visualised values in relation to average value of data column. This method have predefined colours – above-average values are red, poorer-than-average are blue.

```
<Map title="Počet obyvatel v roce 1991 - podle průměru" max="1283271" min="301985"><Method name="AverageBar"><DataColumn name="ogr:OB91"/></Method></Map>
```

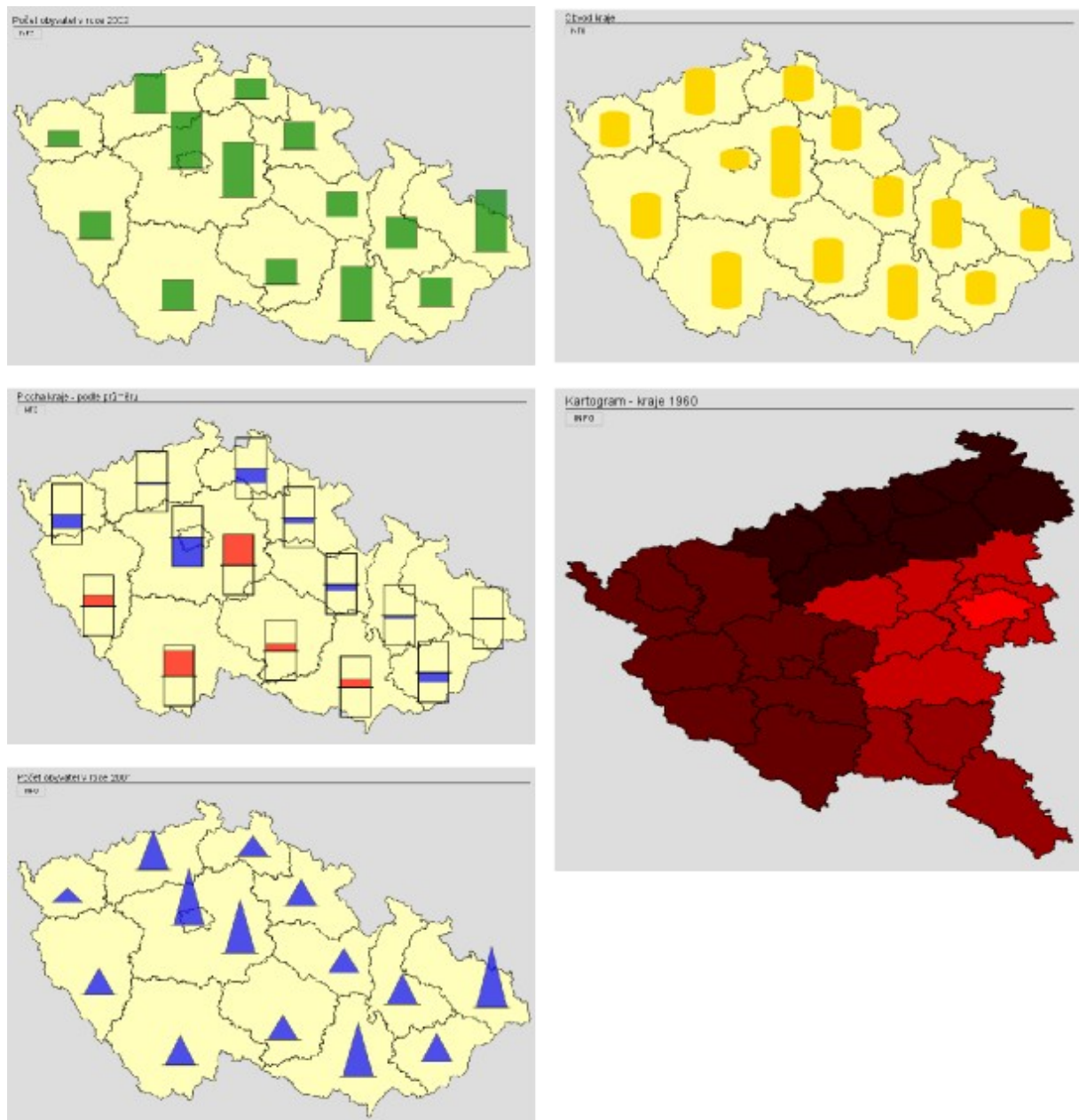
3.4 Preview of application

Fig. 4. Application desktop.



All application (maps and user interface including control elements) are created in SVG language. The advantages of this approach are compact look, using of transparent elements and more simple and clear coding of scripts making possible a control of application. The application offers touch control elements (without a necessity of clicks) and flexible width of application desktop depending on map dimensions.

Fig. 5. Examples of data visualisation.



4 Advantages and disadvantages of described approach

The main problem and disadvantage of this application is not caused by a design of transformation styles or by the description of map composition. The main problem of this application corresponds with the current situation in world of information technologies, including geoinformatics and digital cartography. It is a poor support of standards in software tools. In this case there is not quality support of web standards (XSLT, XPath and SVG) by browsers of web pages. The application was tested in seven different browsers (Konqueror 3.5.9, Amaya 9.55, Firefox 3.0.1., Internet Explorer 7, Safari 3.1.2, Opera 9.52, Google Chrome 0.2.149.29.), but only the Opera offers the right results. Therefore the styles are optimized for Opera browser now. The Opera browser was selected pursuant the experience with creation of accessible maps of the University of West Bohemia in Pilsen. In both diploma thesis [5], [6] focused on above-mentioned map there was the format SVG described as the most suitable web browser for SVG visualisation. But neither the Opera browser does not offer the complete support of XSLT 2.0 standard, therefore in the application there were created complicated

constructions enabling reading external documents or mathematical terms (e.g. calculation of square roots by Newton's iteration method).

The following list summarises some fundamental advantages of proposed solution:

- Using of broadly respected and legitimate standards.
- The browsers of web pages are commonly used software tool. Users do not need any special training programs, tutorials etc.
- Simple possibilities of modifying of control files (in any text editor).
- Exploitation of all advantages of styles (e.g. multiple usage, different types of visualisation for one or more data set).
- Using of open technologies, therefore this solution is platform independent..

5 Conclusion

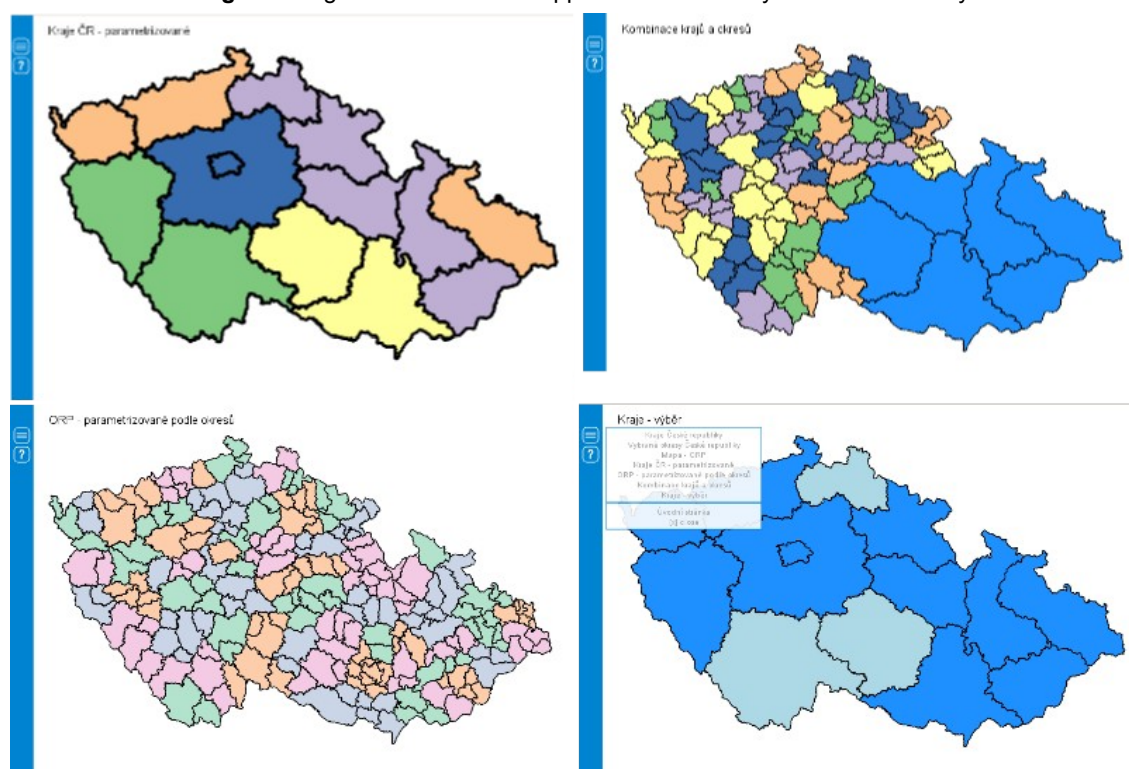
Despite the fact that the implementation of web standards in current browsers is not ideal, the proposed method based on generating of thematic maps by transformation styles in browsers of web pages could not be indicated as an absurd application or a blind alley. It is the method oriented to future, when the quality of standards, their support and implementation in software tools should be on higher level.

At the present we must choose other technologies than web browsers for the processing of XSLT transformation styles for generating of web thematic maps. As one of possible tools there are standard XSLT transformation processors. The program called Saxon is ranked among the most quality XSLT transformation processors, moreover Saxon exists in commercial and non-commercial variants. There are two fundamental approaches of using of external XSLT transformation processors:

1. Using of external XSLT transformation processors as server application (analogously to web services) – user can transform her/his data in real time. This variant is tested in project Humboldt (www.esdi-humboldt.eu) for data models conversion.
2. Generating of cartographic outputs by XSLT transformation processors on the desktop and placing of final maps to standard web pages. This solution eliminates some problem related to complicated server technologies. This approach is used circa from the year 2003 (see publication [7]). Against preceding solutions there is possible to exploit all innovations of XSLT 2.0 standard (e.g. sequence, mathematical tools, output to more documents etc.) now.

The solution based on second variant is one of agreed results of project VisualHealth (in Czech Vizualizace zdravotních dat pro podporu interdisciplinárního vzdělávání a vztahů s veřejností, the project code 2E08028). This project is developed within the framework of Programme 2E – Human sources (2006-2011) of Ministry of Education, Youth and Sports. The project VisualHealth is focused on cartographic visualisation of public health data for their presentation and popularisation. Simple insight to this very complicated data could lead to a higher level of prevention and protection of health. Within the framework of this project there are processed different cartographic methods of geospatial data visualisation on the Internet. For one type of visualisation there was selected XML technologies. In this project there are cooperating the University of West Bohemia in Plisen, Masaryk University in Brno (leader of project) and Faculty Hospital Brno.

Fig. 6. Design of test version of application created by external XSLT styles.



This application relates to many other activities connected with implementation of markup languages in cartography, e.g. the printed publication Atlas of International Relationships [8] created by external XSLT styles too.

The main benefit of this approach is except possibility of tests of current standards and software products is the development of the new data model (written in RELAX NG language) describing separated components of the map and their relationships. This model or XML schema could be used for the XSLT transformations and generally for a sharing of maps, map compositions and all types of cartographic geospatial data visualisations. There are some motives for next development of this solution connected with the map description by markup languages:

- The development of final version of such standard and founding of a support of international organisations, e.g. ICA (International Cartographic Association), OGC etc.
- The combination with other existing formats (e.g. DiagML) or extension of some standard(s).
- Improving of cartographic quality of this type of data visualisation.

It is necessary to appreciate that the one and only way to an improving of communication between cartographers, data providers, user and technologies means the support and abundance of standards (technological, cartographic, legislative, etc.), their relationships and interoperability. If this support will be limited, modified, extended or incomplete, the best innovations (ideas, standards, software products etc.) will not find the real usage. But the development of new technologies, user requirements, legislative requirements (e.g. INSPIRE – Infrastructure for Spatial Information in the European Community) and increasing number of geospatial data sets enforce a higher level of semantic and formalised description leading to using of markup languages in geosciences.

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