

Creating thematic maps online using PHP, KML and Google Earth, an example of visualizing selected indicators for the Slovak republic

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Thematic mapping is one of the most common cartographic methods used to identify spatial interrelated phenomena, which are observed in another form to a limited extent. Cartographic expression helps to identify the exact context in space. Nowadays, there exist a number of specialized products for the creation of thematic maps, in the form of software applications, or applications using services from the World Wide Web. In our paper we will try to explain the possibility of vector format KML and its properties for thematic mapping in Google Earth closer, which is used to display the resulting map outputs. Maps alone are compiled by the client using the Web site browser for transferring input variables to the server, where they are processed and map data is subsequently generated according to client requirements. As well as KML format the application also uses the MySQL database system, which serves for storing the geometry of entities in the form of single points forming the boundaries of administrative units (communities), as well as attributes from the official census of population and housing in 2001 for these spatial units.

Keywords: Thematic Mapping, Google Earth, KML, PHP, Database System

1. Introduction

Thematic mapping is used to visualize the results of geographic research, thereby helping to observe the spatial dimension of achievements and thus also aid their better understanding in the context of the evaluation of spatial relationships between studied phenomena. There exist a number of specialized programs and tools for creating thematic maps using a variety of standard as well as advanced processing techniques. Solutions are usually available as complex software solutions operating in offline mode on the local computer or as procedures using the services of map servers, which generate cartographic outputs on the Internet and they are thus available to a wide range of users, from candidates and enthusiasts to specialized researchers, dealing with this topic. Intensive improvement of Internet technologies and formats helps to increase the amount of online applications aimed at the creation of thematic maps on the Internet. It can be concluded that, from the cartographical point of view, vector formats based on XML - SVG and KML are preferred for the purpose of publishing thematic maps via the Internet. Vector Format SVG is a W3C standard and is very popular especially in the field of graphics and design. It has very suitable properties for working with cartographic outputs; while graphical interpretation alone succumbs to SVG format standards, interactivity on the client side is implemented by using the scripting languages ECMAScript and Java Script. On the Internet, numbers of very valuable applications were created which focus on the distribution of thematic maps (e.g. Sri Lanka Atlas, Vienna, OECD Atlas etc.). The issue of SVG format and its use is described in detail in the work of many authors dealing with the distribution of geographic data on the Internet using SVG format. Even if the emphasis in literature is given to the graphical aspects of this format, there are works in which the crux of the problem is devoted to the cartographic aspects of the use of SVG in the field of webmapping (Ueberschär and Winter 2006, Hu 2008, Li *et al.* 2008, Xi and Wu 2008). Significant works from the perspective of this paper are also publications devoted to the utilization of this format for thematic mapping (Held *et al.* 2003), since the application we will discuss in the next section uses just those procedures and tools typical for thematic mapping.

We will focus in detail on the more widespread vector format KML in our paper, which is a universal format supported by the globally spread geobrowser Google Earth from Google, Inc. Functionality is demonstrated in the example of the Atlas of thematic maps for the Slovak Republic. The spatial extent of the atlas, as well as its attribute component, is defined by data stored in a database system on the server, and therefore all the procedures and methods are applicable to any territory and attributes of individual entities.

2. KML and Google Earth

Google might be considered a world leader in the organization of unordered data in the World Wide Web through its search mechanism, which was a stimulus in the establishment process of this company. In many ways Google's expansion activities now play a key role in the further development of Internet technologies. One of the most successful products is Google Earth (GE), purchased in 2004 from a Keyhole company called also Keyhole Earth Viewer. Currently, this can be considered as the most widely used geobrowser in a global context.

Thanks to its functionality, engine and global popularity it is becoming an important tool for the distribution of scientific results, which are characterized (among other things) through their spatial dimension. First it should be noted that Google Earth is not a traditional GIS application in the context of the evaluation of Geoinformatics as a scientific discipline. However due to its intuitive controls and features it has become a very useful tool not only in cartographic visualization but also in the educational process at all levels of the education system and not only from the perspective of geographical sciences. The advantage of this product is its independence from the operating system, which is the limiting factor for usage in many applications and also in compatibility with other Google products, thanks to which it is possible to create complex solutions with multiple focus.

KML¹ itself is, according to Google documentation, defined as a file format used to display geographic data in an earth browser, such as Google Earth, Google Maps, and Google Maps for mobile. A KML file is processed in much the same way that HTML (and XML) files are processed by web browsers. Like HTML, KML has a tag-based structure with names and attributes used for specific display purposes. Thus, Google Earth and Maps act as browsers for KML files (KML Documentation 2011). KML files are very often distributed in KMZ files, which are zipped files with a .kmz extension. These must be legacy (ZIP 2.0) compression compatible (e.g. deflate method), otherwise the .kmz file might not uncompress in all geobrowsers. The contents of a KMZ file are a single root KML document (notionally "doc.kml") and optionally any overlays, images, icons, and collada 3D models referenced in the KML including network-linked KML files. Complete reference of all KML elements is available on the website <http://code.google.com/intl/sk/apis/kml/documentation/kmlreference.html>. A very valuable source of information about this format is the Handbook from Josie Wernecke (2009). In 2008 KML 2.2. was accepted as an OGC standard. KML is complementary to most of the key existing OGC standards including GML (Geography Markup Language), WFS (Web Feature Service) and WMS (Web Map Service). Currently, KML 2.2 utilizes certain geometric elements derived from GML 2.1.2. These elements include point, line string, linear ring, and polygon. The OGC and Google have agreed that there can be additional harmonization of KML with GML (e.g. to use the same geometry representation) in the future (<http://www.opengeospatial.org/standards/kml/>).

The usability of KML format in different geobrowsers' environments is very diversified, ranging from simple static display of selected objects to extensive dynamic solutions based on the time cross sections. In our application we focused on the use of this format for thematic mapping, which plays a key role in the process of visualization of Human-geographical phenomena in space. There is a large number of procedures and methods of thematic mapping, which is given close attention in literature (Kaňok 1999, Dobešová and Kusendová 2009, Slocum *et al.* 2004, Sandvik 2008). Especially works from B. Sandvik were very inspired in the preparation phase of resulting applications. In our applications, we focused on the use of those methods, which can be considered due to their usefulness and frequency most importantly, as well as clearly interpreted not only by professionals, but also by the lay community. The second important moment (in selection of methods used by generating thematic maps) is the use of more Google tools, through which a very interesting combination can be created: user attractive and professionally correctly map outputs. In the final phase we have created a graphical interface through which it is possible to generate thematic maps based on the cartogram method, pie chart method, graduated symbol, 3D prism maps and bar charts (Google SketchUp was used due to its ability to export so-called Collada objects).

3. Used methods

The aim of the project was distribution of census data in an attractive form for the GE environment. For this purpose, the methods can be divided into two main parts. At first we focused on the possibilities of PHP scripting language and MySQL database system to generate map outputs (in GE). The second, equally important, point was a question of how the original spatial data could be transformed into a suitable form, usable in the final internet application. Given the focus of the resulting application it is not desirable to transmit the original data with a maximum spatial accuracy, so it is important to use the appropriate algorithm for geometry generalization.

3.1 Use of PHP scripting language and MySQL database system for dynamic generating maps

Our paper is aimed at generating thematic maps in Google Earth, based on the use of vector format KML. While we approach the description of the existing web solution, attention is drawn to an important moment of generating own maps and thus highlight the potential uses of PHP scripting language and MySQL database system. It serves as a central storage not only for the attribute part of individual entities but also as a

¹ The complete scheme is available at <http://schemas.opengis.net/kml/2.2.0/> and a basic functionality is described on the KML documentation pages at <http://code.google.com/intl/sk/apis/kml/documentation/whatiskml.html>

data warehouse for spatial units geometry utilized by us in the form of coordinates (particular points), whose boundaries consist of the following entities.

The core of the application is a combined use of PHP scripting language properties, MySQL database system and KML format, whose standards are currently used for the displaying of thematic maps on the client side. Each thematic mapping method uses the specific properties of KML elements. Before we proceed to the description of referred methods, let us return to the basic moment of generating map layouts by extract data from a MySQL database, which stores the individual attributes, as well as the geometry of entities in the form of coordinates of points. Graphical display itself is carried out in two cycles, while in the first cycle it comes to a listing of individual attributes (description element) and in the second cycle it comes to displaying geometry, and the extraction of coordinates of points forming a given territorial unit. Let's have a look at a simple listing mechanism of an individual municipality with the code 512842 (Považská Bystrica). The result may then look as follows (modified according to source code by Google, 2007):

```
// selecting attributes from database table.
$result=MySQL_Query("SELECT*FROM `municipalitiesSR` WHERE mun_code='512842'");

$kml = array('<?xml version="1.0" encoding="UTF-8"?>');

// first cycle for displaying attributes
while ($row = mysql_fetch_array($result)) {

    $kml[] = '<Placemark id="placemark'.$row['id'].'">';
    ... // corresponding KML code for polygons
    $kml[] = '<polygon><outerBoundaryIs><LinearRing><coordinates>';

    // selecting coordinates from database table.
    $coord = "SELECT * FROM coordinatesSR WHERE coordinatesSR.mun_code = ". $row["mun_code"];

    $list= MySQL_Query($coord);

    // second cycle for displaying coordinates
    while($coord = mysql_fetch_array($list)){

        $kml[] = $coord["long"].",".$coord["lat"].",".$coord["z"].";"
    } // end of the second cycle

    $kml[] = '</coordinates></LinearRing></outerBoundaryIs></polygon>';
    $kml[] = '</Placemark>';

} // end of the first cycle
```

The server processes the request for displaying an area with a given code and by using PHP code it will generate a list of individual attributes that appear in the <description> element. Before the end of the entire cycle occurs, even to listing the coordinates (second cycle), these are printed to the municipality with the same code that was used to extract individual attributes in the first cycle. The result is a display of the defined area in Google Earth on the client-side. Output generated in the form of maps in KML should be replaced due to its potential size, and handled in its compressed form as a KMZ file. For this purpose it is possible to use for example a phpzip function.

3.2 Preparation of input data

MySQL database system can be considered as the core of the entire application. Considerable attention is devoted to the issues of its use in literature - mainly from the IT area (Connolly and Begg, 2002, Ullman 2004). Attributes of individual municipalities represent selected data from the Census of Population and Housing in 2001 (total 25, with the possibility of an extension following and additions from forthcoming data from last year's census). The issue of saving the geometry of the objects relates to the possibilities of used geoinformation technologies (in our case MapInfo Professional and ArcGIS). From the point of view of the resulting applications (thematic maps) it is not so important to devote attention to the accuracy of the geometry of input data. According to Maceachren (1985), spatial data accuracy can be considered to be less relevant in comparison to accuracy of attribute data of these spatial units.

In the case of applications based on a client-server principle, an important role is played by the amount of data transferred between the server and the client's side. For that reason it is appropriate to use the generalization process of map data, which is the process of reducing the information content of maps due to scale change, map purpose, intended audience, and/or technical constraints (Slocum et al. 2005). In the ArcGIS environment, it is

possible to perform two basic types of generalization geometry– Point Remove method (adaptation of the Douglas – Peucker algorithm) and Bend Simplify method (adaptation of the Wang Algorithm). We preferred the first one (Point Remove), in which we have a larger decrease of the vertices, so we can reduce the size of the final map output (Santo et al. 2008)

Since a created database table contains the coordinates of each point, which make up the boundary of each municipality, it was necessary to convert the polygons, which means linear objects into individual points. For this purpose we used the All2points tool, which is a free map basic application (*.mbx file) functioning in MapInfo Professional. The original map layer contained 369,447 nodes. Using the generalization method, we reduced the total number of nodes to 94,077. This layer was transformed into a simple text file and imported into the pre-created database table “coordinatesSR” of a simple structure – id, mun_code, lat, long.

The same SQL commands (Data Definition Language) were applied by creating another database table (municipalitiesSR), which contains the attributes of municipalities pertaining to the population and housing census 2001 in the Slovak Republic. The application itself can be extended to any number of attributes bound to a different point of time as well as spatial units. The relation between these tables (municipalitiesSR, coordinatesSR) is realized by the column "mun_code", which is part of both tables.

3.3 Data transfer using a web site with HTML forms

During designing a graphical interface and functionality of the presented application, we tried to take into account the basic needs of the users of standard GIS applications for handling a thematic map. Individual variables, respectively generated thematic maps, can be modified in terms of basic procedures, i.e. clients can modify the basic size of the symbols, defining ranges, colour range, etc., taking into account cartographic and aesthetic criteria (Brewer 2005). The spatial extent of the Atlas covers the entire territory of the Slovak Republic, whereas in the database are stored coordinates of all points, of which consist individual municipalities, i.e. the lowest administrative units of the Slovak Republic. We have concluded that it will be much more preferable to define territorial units for the individual client. Therefore a graphical interface is designed such that each client can choose an indicator on the municipal level for each district (79), region (8), or the whole Slovak republic. When selecting the appropriate type of thematic map (web page) it is possible to modify the basic properties of the resulting maps using simple HTML forms with concrete modifying possibilities for specified map types (breaking values of ranges, colour schemes, size and shape of diagrams, etc.). The client specified modifications are transferred as variables using the standard POST method to a file that is used to generate thematic maps itself.

4. Resulting thematic maps

Generally speaking, there are two main groups of thematic maps – qualitative and quantitative maps. The main principle of these maps is a graphical representation of the size, number, structure, height, etc. of observed phenomenon. Each method has well-defined rules, compliance with which enables the creation of cartographically correct outputs. We used five basic methods of thematic maps in our application that are appropriate for their displaying in GE – Choropleth maps, Pie chart maps, Proportional symbol maps, Prism maps, Collada objects²

4.1 Choropleth maps

The common denominator of all used methods of thematic mapping is the transmission of variables defining the final form of maps through the Internet to the server, where they are subsequently processed by PHP module, while the resulting thematic map is based on the KML standard and the client gets the map in the form of a compressed KMZ file. Most standard thematic maps are made by using the choropleth mapping method. With this method each data collection area is given a particular colour lightness, colour saturation, or pattern texture depending on its magnitude (Kimerling *et. al.* 2009). In this method, we have chosen standard possibilities of modification of the resulting maps. They are well known from desktop applications, i.e. they have the possibility to define their own custom ranges (with a fixed number – 5), as well as a choice of five sequential colour schemes. The essence of this method is assigning particular styles to individual statistical units (municipalities) based on the value of a monitored indicator. An example is shown in the following extract:

```
// $h1-$h5 are breaking values for each interval transferred from HTML form
// $map is variable expressing what indicator will be displayed on a map
if (isset($h1) AND $h1 != '' AND $map=='p_odchadza') {
    $h1 = $br1; // $br1 is send through web form with another breaking values(1-5)
```

² Created application is available at: <http://www.sodbtn.sk/kml/obcesr2/eng/index.html>

```

// based on values $h1-$h5 are assigned defined styles
if ($indicator<=$h1) {$style='1';}
if ($indicator>$h1 AND $indicator<=$h2) {$style='2';}
if ($indicator>$h2 AND $indicator<=$h3) {$style='3';}
if ($indicator>$h3 AND $indicator<=$h4) {$style='4';}
if ($indicator>$h4 AND $indicator<=$h5) {$style='5';}

// applying a particular style to the spatial unit
$kml[] = '<styleUrl>#' . 'Style_'. $style . '</styleUrl>';

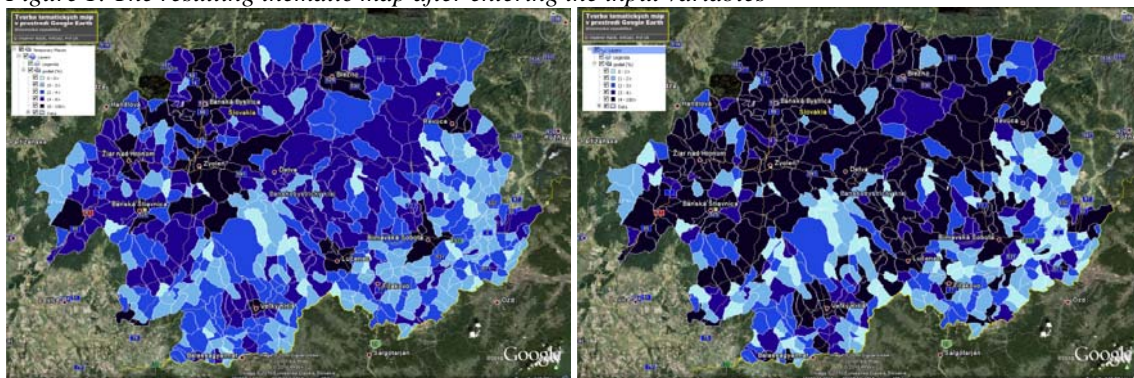
// predefined color values of the intervals
// $color is variable send through a form expressing shade
// $col1-$col5 is a hexadecimal notation of colors
if ($color=='f1') {$col1='ffbeffff' ... $col5='ff0004f';}
... // color ramps for other values

// defining a particular style according to KML reference, Style_1 to Style_5
$kml[] = '<Style id="Style_1">';
$kml[] = '<PolyStyle><fill>1</fill><color>' . $col1 . '</color>';
$kml[] = '<outline>1</outline></PolyStyle>';
$kml[] = '<LineStyle><color>ffffffff</color><width>1</width></LineStyle>';

```

The number of maps that can be constructed as follows is unlimited, since the displaying of the resulting map is influenced by defined input variables (area, indicator, colour scheme, range). A simple example of a map based on the described method is in Figure 1.

Figure 1: The resulting thematic map after entering the input variables



Automatically generated ranges

Manually defined break values of the ranges

4.2 Proportional symbols

Proportional symbols are used to represent the exact data values because the visual variable of each symbol is scaled proportional to its data value (Cabello *et. al.* 2008). The symbols are located at the centroid of the spatial unit, the coordinates of which are stored in database table "municipalitiesSR". With this method the client has the possibility to choose the symbol of two basic shapes – a circle or a square. The extension of any other symbol is only a question of exporting an image with a transparent background. Displaying the symbol is once again the result of the defined style however, in this case, values are not classified into ranges, but each indicator is shown by the symbol of a specific size, while appropriate size is based on the general relationship:

```

$symbolSize = sqrt($value/$number);
// $value - value of given indicator
// $number - value of economic scale transmitted through the form

```

Each variable has a predefined value of the economic scale "\$number". However, it can be modified when necessary so that the resulting map output can be visually interpreted well.

```

$kml[] = '<Style>';
$kml[] = '<IconStyle id="voIcon">';

// symbol selection

```

```

if ($s=='s1') {$symbol='circle.png';} // if ($s=='s2') {$symbol='square.png';}
if (isset($scale) AND $scale != '') {$number = $scale;}
if (isset($scale) AND $scale == '') {$number = '2000';}
$symbolSize = sqrt($value/$number);

// resulting size of the symbol
$kml[] = '<scale>'.$symbolSize.</scale>';
$kml[] = '<Icon>';

// link to a picture representing the symbol
$kml[] = '<href>pictures/'.$symbol.</href>';
$kml[] = '</Icon>';
$kml[] = '</IconStyle>';

// centroid coordinates of the commune, which is lashed symbol location
$kml[] = '<Point>';
$kml[] = '<coordinates>' . $row['long'] . ',' . $row['lat'] . '</coordinates>';
$kml[] = '</Point>';

```

Since the size of the symbol is defined by the mathematical expressions in PHP scripting language, it is possible to modify this size with any mathematical expression used in the field of thematic cartography..

4.3 Pie chart method

Application of this method is very similar to the previous method, when each variable has a precisely defined size of displayed diagram (pie chart), while this diagram shows the segments complying with the relevant characteristics. KML primarily does not support pie charts, unlike SVG. Even in this case, the properties of element <Icon> can be used and thus enable the transfer of picture files via the Internet. For this purpose we have used the internet service Google Charts API. This service returns an image to the client in PNG format, depending on the particular requirements, and it is possible to combine several types of graphs (Sandvik 2008). The values of indicators that creating the final form of the pie chart are stored in an attribute database table. Each type of chart can be modified according to the relevant properties of used chart type. The task was to show the simplest form of this chart, with definition of transparency and setting the beginning angle of displayed individual values (the specification of the angle in radians). Localization of the chart was, as in the case of proportional symbol, related to the centroid of the administrative unit.

```

$kml[] = '<Style>';
$kml[] = '<IconStyle id="voIcon">';

// series of conditions for displaying indicators depending on the selected map
if ($map=='pie') {$value = ($row['pred'])+($row['pro'])+($row['po']);}

// define the size of the chart
if (isset($scale) AND $scale != '' AND $map=='pie') {$number = $scale;}
if (isset($scale) AND $scale == '' AND $map=='pie') {$number = '1000';}
$symbolSize = sqrt($value/$number);

// resulting size of the chart
$kml[] = '<scale>'.$symbolSize.</scale>';
$kml[] = '<Icon>';

// link to a picture (diagram) generated with Google Charts API, based on transmitted values
if ($map=='pie') {$kml [] =
'<href>http://chart.apis.google.com/chart?chf=bg,s,65432100&chd=t:'.$pred.','.$pro.','.$p
o.'&cht='.$graft.'&chco=9c0000,6666ff,009900&chp=4.71238898038469</href>';}
$kml[] = '</Icon>';
$kml[] = '</IconStyle>';

// centroid coordinates of the municipality, which is lashed chart location
$kml[] = '<Point>';
$kml[] = '<coordinates>' . $row['long'] . ',' . $row['lat'] . '</coordinates>';
$kml[] = '</Point>';

```

In similar solutions, several types of charts can be used the use of which is in accordance with cartographic rules for the creation of thematic maps. Google Charts API is also suitable for graphically displaying monitored indicators in the info window that appears when the client highlights a particular municipality. All necessary information associated with a particular unit is included in element <description>. Also in this case, the size of

the chart can be modified, respectively it can display the 3D shape of the chart, which is a popular expression of monitored phenomenon especially in the lay public community.

4.4 Prism maps

The method of prism maps, sometimes also called oblique stepped surface maps, is very attractive from a user's perspective and also very easily applicable to Google Earth environment functionality. A prism map is made by dividing the mapped region into data collection areas (in our case municipalities) and showing the magnitude by varying the heights of the areas. The resulting map looks like a three-dimensional stepped surface (Kimerling *et al*, 2009). It is very important to display the order of the coordinates forming individual regions in the case of prism maps creation in Google Earth. For correct displaying of colours of the selected regions, it is necessary to display coordinates counter clockwise, which was achieved by using a standard SQL clause ORDER BY "attribute" DESC.

```
// list of polygons coordinates displaying counterclockwise
$coord = "SELECT * FROM coordinatesSR WHERE coordinatesSR.mun_code = " . $row["mun_code"] . "
ORDER BY id DESC ";
```

Individual areas are integrated into classes by using the value of the relevant indicator, as we can see in a combined prism map, with the displaying of indicators in classes, the height of the entity is unique for each individual object. A key element `<altitudeMode>` is for displaying the height of the entity, which is a part of `<coordinates>` element. It is possible to choose from three basic values (absolute, clampToGround, relativeToGround), we have used „relativeToGround“, which sets the altitude of the element relative to the actual ground elevation of a particular location (KML reference). Some conditions that enter into the final output are shown in the following list:

```
$mode='relativeToGround';

$kml[] = '<Polygon id="' . $row['id'] . '">';
$kml[] = '<altitudeMode>'.$mode.</altitudeMode><extrude>1</extrude>';
$kml[] = '<outerBoundaryIs><LinearRing><coordinates>';

// list of polygons coordinates from database displaying counterclockwise
$coord = "SELECT * FROM coordinatesSR WHERE coordinatesSR.mun_code = " . $row["mun_code"] . "
ORDER BY id DESC ";
$list= MySQL_Query($coord);

// value of axis „z“ (predefined, or transfered through the form)
if (isset($scale) AND $scale != '' AND $map=='population') {$z=$value*$scale;}
if (isset($scale) AND $scale == '' AND $map=='population') {$z=$value*1;}

if ($extrude=='on') {$coordz=$z;}

// displaying of coordinates in output map file
while($coord = mysql_fetch_array($list)){
$kml[] = $coord["long"] . ", " . $coord["lat"] . ", " . $coordz . ",";
$kml[] = '</coordinates></LinearRing></outerBoundaryIs></Polygon>';
```

4.5 Using COLLADA objects for displaying objects

In the case of displaying collada objects as bearers of information about a monitored indicator, it is possible to combine several Google products in one application, as in the case of maps generated by the pie chart method, where Google Charts service was used. This method is also based on the possibilities of displaying 3D objects created by Google SketchUp, which is a 3D software tool that combines a tool-set with an intelligent drawing system. This enables models to be placed using real-world coordinates and share them with other people via the Internet environment (<http://sketchup.google.com/>). Due to its simplicity, intuitive controls and amount of features, this program is currently the most popular tool for creating 3D objects in the world. Any 3D object created using this program (*.skp) can be exported as a file with *.dae extension (COLLADA file) and then this model can be incorporated into the resulting KML file using `<link>`, which is a part of the element `<model>`. The primary step was the creation of 3 basic objects of a one unit height parameter (block, cone, and cylinder) as well

as a single figure, utilized to display number of population. 3D models exported in *.dae files were stored on servers, where it is possible to find them using the reference in the form of element <href>³.

```
$kml[] = '<Model>';
$kml[] = '<Link>';

// selecting appropriate collada object
if ($chart=='cylinder') {$col='cylinder.dae';}
if ($chart=='figure') {$col='figure.dae';}

// link to a directory on the server with stored objects
$kml[] = '<href>link_to_a_file/' . $col . '</href>';
$kml[] = '</Link>';

$kml[] = '<Location>';
$kml[] = '<longitude>'. $row['long'] . '</longitude>';
$kml[] = '<latitude>'. $row['lat'] . '</latitude>';
$kml[] = '<altitude>0</altitude>';
$kml[] = '</Location>';

// scaling of object in the Z-axis
if (isset($scale) AND $scale != '' AND $map=='population') {$z=$value*$scale;}
if (isset($scale) AND $scale == '' AND $map=='population') {$z=$value*6;}

// scaling of object in the X and Y-axis
if ($chart=='cylinder') {$x=2000 AND $y=2000;}
if ($chart=='figure') {$x=$z AND $y=$z;}

$kml[] = '<Scale>';
$kml[] = '<x>'. $x . '</x>';
$kml[] = '<y>'. $y . '</y>';
$kml[] = '<z>'. $z . '</z>';
$kml[] = '</Scale>';
$kml[] = '</Model>';
```

In case of simple objects such as a block, cone or cylinder, it is appropriate, respecting the small size of spatial units, to define the exact dimensions in direction of axes X and Y. For more complex objects (figure) there is a scaling in all directions (X,Y,Z) to avoid significant distortions of the object. For larger administrative units (regions, states, continents), this moment is negligible and it is usually used for the possibility of scaling the objects in all directions. Obviously, this depends on the character of the pursued indicator.

5. Discussion

The imaging of an event in the form of a thematic map is one of the most commonly used cartographic techniques in geographic research. The presented solution is intended most of all for persons interested in the creation of similar outputs in the GE environment. Thematic maps created in standard map products (MapInfo, ArcGIS, Geomedia) can be exported to KML format using a conversion solution intended for this purpose. Regardless, their definitive version is precisely defined and a client has no direct access to its modification. The possibility of creating a map output corresponding to client's requirements can be considered the main added value of the resulting application. Such services are optimal for companies and organizations distributing large amounts of statistical data.

The spatial extent of an atlas is limited by the coordinates of points saved in a database and obtained through the simple conversion of the appropriate map layer in a random GIS programme using appropriate processes. In our case we preferred the separate location of individual points; the second option is the location of coordinates of the whole object as one record. We preferred the mentioned record due to the simple listing of „Z“ coordinate in the cases of prism maps where we imaged the value of the relevant indicator, such as the mentioned value. There is a problem in the case of such recording of coordinates into a database table: if a polygon contains „gap“ it means some smaller objects are localized inside it.

The table „coordinatesSR“ created by us contains the coordinates of points forming the main boundary of a village (<outerBoundaryIs>). If there are some “hollow polygons”, it would be appropriate to create another table containing just the coordinates of points forming the inner boundary of such an object (<innerBoundaryIs>). In the case of maps, imaging characteristics expressed by points (pie chart, proportional symbol, collada objects) the objects were recorded using the element <MultiGeometry>. Given symbols are

³ For collada objects, any object can be used from the already established Google gallery, which is available from the company website devoted to this product.

localized in a centroid of a given village <point>, the coordinates of which were extracted in the primary phase of the map base conversion.

Considering the number of statistical units (2,928 Slovak villages) it is not appropriate to image relevant thematic maps for the whole territory of the Slovak Republic. First of all, in the case of a map constructed using the proportional symbol map method, there is a time problem concerning the loading of a diagram for each object, as the Google Charts API service is used and for each village it is necessary to generate each appropriate diagram individually. The rate of map output drafting is related to the degree of input spatial data generalization. For a smaller spatial extent of an atlas, an original geometry can be used; as the number of units grows it is necessary to start with input layer generalization so that the result will be clearly spatially as well as statistically interpretable.

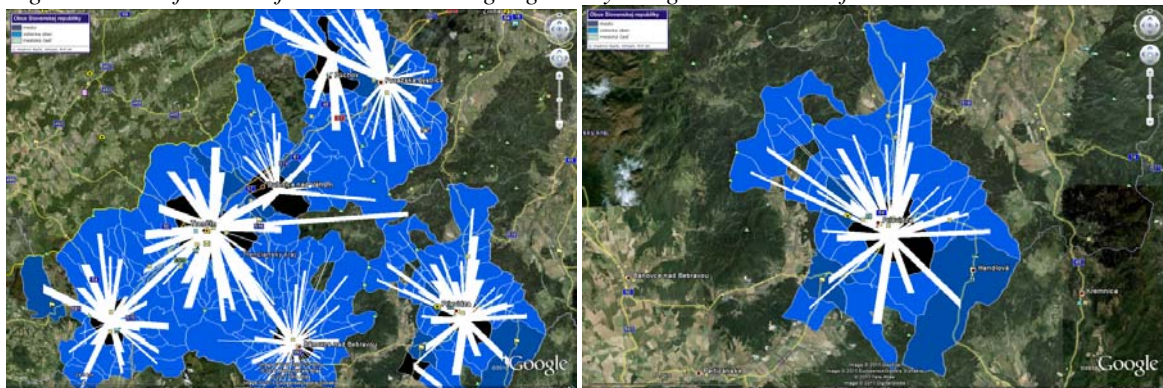
The process of generating a thematic map can be seen on two levels - on the one hand the utilization of PHP scripting language in order to generate a map itself, on the other hand the utilization of basic syntactic rules of KML format for the purpose of specific visualization of the appropriate method of a thematic map. The analyzed application uses basic rules concerning the extraction of data from a database and a simple condition order, which are easily available also for authors with less advanced programming skills. The resulting thematic maps keep the standard KML syntax based on individual elements and their characteristics. In the case of cartogram methods the defining of particular object style (colour) is based on interval values sent from the input form. The proportional symbol map method and proportional symbol method use the possibility to scale the size of a symbol in question, as well as to image such a symbol in the form of any raster image saved on the server. When using collada objects, the simplicity of the final model plays an important role once again. The complex structure of a model extends the time of drawing final map output. For such maps, the use of sophisticated 3D models is inappropriate due to time necessary for drawing the given model if there are too many spatial units.

6. Conclusion

The main objective of this paper, as well as evaluating existing Web applications, was to demonstrate the general possibilities of using PHP scripting language and KML format in the field of Thematic Mapping. The advantage of this format is its direct support for multiple applications and services generated by Google, and therefore the possibility to combine features and functionality of multiple products into one compact unit. In the process of creating the application itself, we tried to use the methods and procedures which are known to users of standard desktop GIS applications, and taking into account the standards and qualities of used KML format. Spatial possibilities of generated maps are the result of data storage in database tables, while the process of preparing the necessary data itself uses techniques that are well known to GIS users.

The most appropriate method used in similar-oriented applications is utilization of the database system MySQL and PHP scripting languages, for the purpose of manipulating data and input variables. Commands themselves are relatively simple and do not require advanced programming skills, and therefore the possibility of creating such an application is available to clients with a standard level of computer literacy. Other interesting processes can be used in the process of creating thematic maps, such as showing lines of movement (on the basis of intensity, motion can be assigned different styles with different thickness of lines (Figure 2), or on the availability of data at different time points to create interesting animated maps, which are the result of the use of the <TimeSpan> element, whereby we obtain a dynamic and very attractive user-friendly cartographic output.

Figure 2: Identification of various commuting regions by using method lines of movement



Apart from the actual cartographic display and possibilities for combining several thematic layers with other KML outputs, also highly valuable is the use of element <description> to which it is possible to write any information relating to a particular spatial unit. As follows, it is possible to further connect to external information sources, display graphical outputs generated by the Google Charts API, listing the relevant attributes and many other possibilities. Applications of this type are also suitable to supplement the educational process at different levels of the education system, starting with the lowest levels at which students familiarise themselves with maps as bearers of spatial information, up to the university level. The benefit of applying the methods of thematic mapping is also a clear visual interpretation of these maps by the general public, which has the chance to become familiar with the results of geographic research in very interesting and attractive user-friendly form.

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