DYNAMIC PRESENTATION OF STATIC MAPS USING GIS AND JQUERY JAVASCRIPT TOOLS TAKING DATA OF SOIL MAPS IN POLAND AS AN EXAMPLE

Karol Król, Ph.D.
Department of Land Management and Landscape Architecture
University University of Agriculture in Krakow
Krakow, Poland
e-mail: k.krol@ur.krakow.pl – contact person

Barbara Prus, Ph.D.
Department of Land Management and Landscape Architecture
University University of Agriculture in Krakow
Krakow, Poland
e-mail: b.prus@ur.krakow.pl

Abstract

Users' needs in regard to mapping studies can be diverse. The internet, programmatically advanced and developed map is not always favourable from the recipient's point of view and especially in case of users of mobile devices. The aim of the paper was the comparative analysis of selected tools that allow dynamic, interactive presentation of static, raster maps. The main project assumption was to create components of websites prepared in such a way so as to avoid external data sources and to expand contents presented within the website with geoinformation. Tools available within the Open Source license – so called "plugins" created by means of jQuery JavaScript library scripts were used for that purpose. Then, they were subjected to the efficiency test. Mapping bases were prepared by means of GIS tools. Components prepared in such a way charge a user's device in a relatively slight degree (little amount of data downloaded by the Internet), although it is the size (the file's weight) of a raster map which is crucial in this case.

Key words: *web cartography, web mapping, scripting languages, interactive data presentation*

Introduction

Using the Internet to distribute mapping studies resulted in great progress in cartography and created numerous new opportunities (BROVELLI et al., 2015). Maps available in the Internet are often made by users' community (volunteered geographic information VGI, volunteer cartography) (GOODCHILD, 2007). Branch-specific software, often available free of charge, allows to create personalised maps, to use dispersed data sources and to exchange geographical information. At the same time, development of the internet cartography faces many new obstacles. The Big Data Era poses challenges connected with extremely big, diverse and complex data sets which are time-consuming in analyses and difficult or even impossible to be presented as a whole (NAIR et al., 2016). These problems are especially visible in case of mobile devices – the wireless Internet used by them can be insufficient to comfortable browsing of complex map applications. Publication of spatial data in the Internet also entails risks connected with security and complexities of copyright. On the other hand, more and more technical problems are solved thanks to data open publications, Open Source software and innovative services offered in a data cloud (SMITH, 2016; FARKAS, 2017).

Contemporary mapping is connected with sharing spatial data and services in the Internet (WebGIS, Web mapping) using open standards such as Web Map Service (WMS), Web Feature Service (WFS) and the other. Internet systems of geographical information as well as various derivative map applications take over some tasks associated so far with traditional systems of "desktop GIS" type. Internet GIS applications are widely available and helpful in many fields such as tourism, crisis management or education. They are as well often used to monitor and evaluate environmental conditions (GONZALES DEL CAMPO, 2012; KOLIOS et. al., 2015). Moreover, visualization of spatial information on the internet maps can significantly support the decisive process in managing the environment (IOSIFESCU-ENESCU et al., 2010; KULAWIAK et al., 2010; VELASCO et al., 2013).

The internet maps are more often used by territorial government units to perform public tasks. Internet city plans, location services and web browsers of planning studies which usually fulfil informative

function became widespread. Thematic maps also called "occasional" that are prepared both by territorial government units and the community of users for a specific purpose and function can be found more frequently. They can be performed using various project techniques and tools often provided free of charge (KRÓL, 2015). The example of using these tools can be the presentation of information about soils' agricultural usefulness (soil-agricultural complexes) aimed both at farmers and experts from the range of environment protection, at local governments, planners, town planners or within the limits of landscape and botanical information (within tourist information). The aim of the paper was to analyse abilities of interactive presentation of raster soil-agricultural maps by means of selected project tools.

The origins and content of soil-agricultural maps in Poland

The soil-agricultural maps in scale 1:5000 were elaborated for the area of Poland together with descriptive annexes in the years 1966-1972 (FEDOROWSKI, 1974; SUROWIEC, 1987). They were prepared on the basis of maps of soils' classification and also by means of field and laboratory surveys preceded by the analysis of air photographs (BIELSKA, 2014). These maps are the source of data about soil conditions, they present information about spatial arrangement of farm dwellings (complexes of agricultural usefulness of soils) and also contain information about soils' physical properties (CZARNECKI, PAPROCKI, 1997). Next to soil-agricultural complexes, the content of a soil-agricultural map also involves soils' types and sub-types, mechanical composition of surface and deeper layers as well as the depth of soil accumulation.

Implementing in 2007 the Directive of the European Parliament and Council, so-called INSPIRE (DIRECTIVE, 2007) that creates infrastructure for spatial information in the European Union influenced setting up national infrastructures for spatial information (KRÓL et al., 2016). Enacted in Poland on 4 March 2010, the Act of infrastructure for spatial information (ACT, 2010) determined the rules of creating and using metadata resources and also qualifications of authorities responsible for leading it.

One of thematic elaborations included in spatial information infrastructure in Poland, according to the recommendations of the INSPIRE Directive are soil maps. Created in such a way database is a data source for local spatial planning needs including elaboration of planning documents, development strategy for rural areas, projects of merging and meliorative works, programmes of farmland protection (PRUS, SALATA, 2014) against their quantitative and qualitative devastation (DRZEWIECKI et al., 2014; BUCHI et al., 2016), programmes of land reclamation and also scientific papers (PORĘBSKA et al., 2008). The soil-agricultural maps are the valuable source of information for farmers, agricultural consultants, planners and experts from the equipment and agricultural branch.

The main content of a soil-agricultural map includes complexes of agricultural usefulness which are structures of various and diversely located soils (in climatic and geomorphologic terms) which can be used in a similar way and demonstrate similar agricultural properties. The complexes are habitat types of agricultural productive space. There are 14 complexes of arable land and 3 ones of grassland that can be distinguished.

The names of arable land complexes derive from the names of cereal species – wheat and rye (in regard to soils of flat areas) and additionally oat – in regard to soils of mountainous areas. In Polish climatic conditions, cereals are the best indicative plants and they predominate in the cropping structure. Within arable land, the following complexes of soils' agricultural usefulness can be distinguished:
1. the very good wheat complex,
2. the good wheat complex,
3. the defective wheat complex,
4. the very good rye complex,
5. the good rye complex,
6. the weak rye complex,
7. the very weak rye complex,
8. the strong cereal-fodder complex,
9. the weak cereal-fodder complex,
10. the mountainous wheat complex,
11. the mountainous cereal complex,
12. the mountainous oat-potato complex,
13. the mountainous oat-fodder complex,
14. the complex of arable land useful for grasslands.

While preparing a soil-agricultural map, the complexes of soils' agricultural usefulness were assigned on the basis of character and properties of the soil itself (type, sub-type, kind, soil texture, physical and physicochemical properties, soil structure's grade), soil's climatic location, its location in the relief and also composition of humidity relations. Outlines of soils agriculturally useless RN and agricultural

wastelands N were also distinguished. Three complexes of grassland were distinguished within the grazing lands on the basis of valuation criteria (soil quality):

    1z – the very good and good grassland,
    2z – the average grassland,
    3z – the weak and very weak grassland.

The analysis of data included in soil-agricultural maps and analyses of area usefulness to perform specific functions in local plan of spatial development in particular are important tools for spatial planning process in Poland. It allows to obtain information which is necessary to manage space properly and avoid wrong decisions about investment location. Knowledge of soil-agricultural maps' content makes easier environment protection mainly by protection of soils of the highest quality that are characterized by high productivity of yield (PRUS et al., 2016). It also helps to avoid financial losses preventing, for example, from development of areas with excessive humidity (PORĘBSKA, 2008).

Material and methods

Selected project techniques and tools that allow dynamic presentation of maps in a web browser's window were subjected to the comparative analysis of functionality and efficiency. The subject of the presentation was the map of soils' agricultural usefulness in Proszowice commune (Małopolska province, Poland). The subject of presentation was chosen in view of data availability, their presentation's form (a complex mosaic of objects) and their meaning in the planning process.

The analysis was performed on the basis of the results of explorative (cognitive) tests (AFZAL et. al., 2009) which were carried out while creating, implementation and using of components created in accordance with accepted project assumptions. Observation and recording of remarks made in the process of project works were anticipated in the scenario of the tests (KRÓL, PRUS, 2016).

The efficiency tests were carried out using PageSpeed Insights application (PSI, Google Developers). The application estimates the website's efficiency in stationary and mobile devices. The PSI test is performed in some planes (among other things in the range of possibility of compression of graphic files or code's minification) and its result is presented in a synthetic form of punctual note which takes place in the scale from 0 to 100 points. Moreover, the application shows critical points of the website which should be optimized. The grade at the level of at least 85 points means that the tested website works relatively well, however, its selected parameters should be optimized.

Main assumptions and project operations

The main project assumption was to create an interactive map (a web map) in the form of independent and individual component (extension) of a website which would take the form of a compact set of files or a uniform code (a string recorded in a hypertext document). It was assumed that a graphic form of the component can be optional but the basis of its operation will be raster maps presented in a dynamic, interactive way, in an offline mode as well.

Map components were performed in project stages according to SMITH (2016). Applications were created as a final product and their creation was preceded by data collecting and processing in the spatial information system (so called the stage of computer software). Then the data were analysed and transformed into a raster map base (so called "desktop-server" stage). The map prepared in such a way was used in „the process of creating the mapping service" which is basically the process of website's preparation. The application's architecture including the interface of map's service was elaborated at this stage. This phase is essential in designing functionalities and map's general usefulness.

In accordance with accepted assumptions, input data in the form of the vector map of soil complexes of individual districts of Proszowice commune were transformed into raster maps. Their invoking in a browser's window was programmed with use of jQuery, one of the world's most popular programmatic libraries (KRÓL, SZOMOROVA, 2015; BRYANT, WILDFIRE, 2016).

The profile of tested project tools

Three plugins performed with use of jQuery JavaScript library and available within MIT Licence which is one of the simplest and most liberal licences of open software were subjected to the comparative analysis. MIT Licence gives users unlimited right to using, copying, modifying and distribution (including sale) of the original or modified programme. The basic functionality of every tested plugin is zooming of a map's view. However, this effect is in every case realized in a different way (Table 1).

Table1. Basic functionalities of tested plugins.

Tool	Basic functionality
jQuery Plugin for Zoomable Interactive Maps (ZIM)	Zooming (smooth zoom), Pop-up windows. The main map is in front of the website window. Sub-region background maps grow to fill the entire map area.
MapHilight, ImageMapster	Dynamic resizing of the map. Pop-up Windows. Interactive map with highlighted regions.
Jquery Iviewer (iviewer Widget for jQuery UI)	Zooming (smooth zoom), image view control with zoom control and a possibility to move an image in the area by the mouse.

Source: own study.

JQuery Plugin for Zoomable Interactive Maps (ZIM) (SUTHERLAND, 2009) is based on raster bases. The zooming effect of the main (basic) map's view consists in evoking earlier prepared regions' maps in a window of map's presentation. Plugin does not refer to the database but it presents the following raster maps in a browser's window. POI points with possible information of multimedia character presented in a pop-up type window are applied on these maps. The whole is integrated in layers invisible for a user (Fig. 1). The default version of the script was transformed adjusting it to project assumptions together with preparing the images which improve navigation. Maps' presentation in a browser's window takes place asynchronously i.e. without re-loading the application in a browser's window.
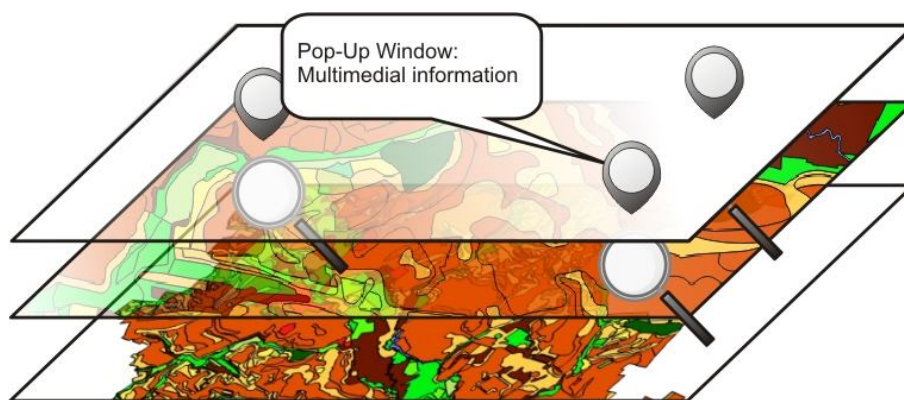

Fig. 1. Individual layers of the map component performed on the basis of jQuery Plugin for Zoomable Interactive Maps – 1) the layer with applied POI points (evoking information in a pop-up window), 2) the layer divided into sectors marked with a magnifying glass icon (evoking detailed maps), 3) fundamental raster base. *Source: own study.*

MapHilight (LYNCH, 2013) is a tool which uses HTML – <area> index to generate an interactive map of objects with which text data can be related (Table 2), (KRÓL, 2016). The effect of framing and shading of elements with any shape is generated through the user's activity on the layer created directly above the raster in real time. The plugin allows a user to tag and read the data connected with the object selected on the map (Fig. 2).
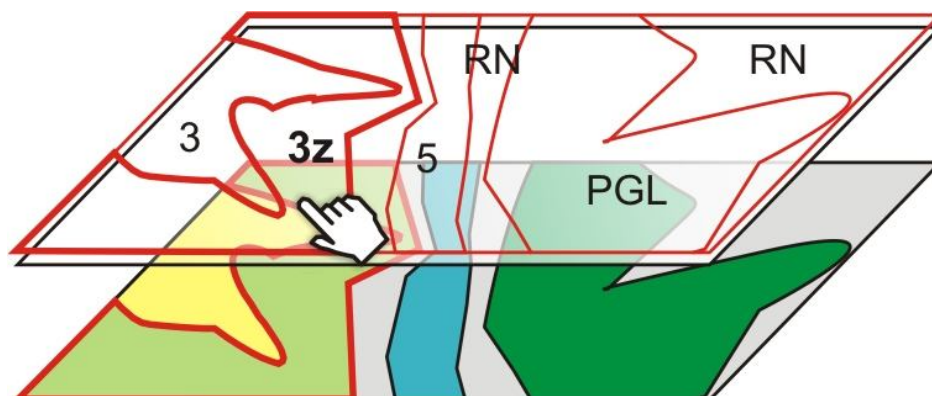

Fig. 2. The active map of links generated in the form of a layer, over the raster base. *Source: own study.*

ImageMapster (TREWORGY, 2013), a tool which allows to zoom in and out the map's view accompanied by scaling of the objects' net created above the raster base cooperates with MapHilight plugin.

Table 2. The example of coordinates of the object (polygon) presented on the interactive layer.

<area shape="poly" onMouseOver="mapOnMouseOver('Kompleks glebowy – 3z')"* coords="760,520,764,513,767,513,770,511,777,510,783,510,784,513,786,517,787,522,786,525,784,527,781,524,777,527,776,526 ,773,524,770,523,768,522,766,522,765,522,764,523,763,523,762,522,761,521,760,520" alt="3z">

* Text data of „mapOnMouseOver" attribute are presented after placing the mouse pointer over the object. Using basic HTML indexes is allowed in the area of values of the mapOnMouseOver attribute.

Source: own study.

Jquery Iviewer (iviewer Widget for jQuery UI), (PETROV, 2012) is distinguished by interactive navigation menu with help of which the way of map's presentation can be managed. The grade of zooming in the map depends in this case on the raster's size expressed in pixels. All tested plugins are implemented in the structure of the hypertext document (Table 3) and cascading style sheets CSS and earlier created graphic files are responsible for the graphical layout.

Table 3. Project techniques and tools subjected to the comparative analysis.

Design tool (original spelling)	Programming techniques	Data source	License
jQuery Plugin for Zoomable Interactive Maps (ZIM)	jQuery JavaScript (jQuery zoommap plugin), HTML, CSS, AJAX	Raster map (main map), sub-region maps – (background image), multimedia materials	MIT License
ImageMapster	jQuery JavaScript, HTML, CSS	Raster map, text data from <area> html marker	MIT License
Jquery Iviewer (iviewer Widget for jQuery UI)	jQuery JavaScript, HTML, CSS	Raster map	MIT License

Source: own study.

Agricultural usefulness of soils in Proszowice commune in Małopolska province

Proszowice commune is located in the northern part of Małopolska province next to the border with Świętokrzyskie province at the area of Proszowice Upland (Fig. 3). This region is bounded on the south by the Vistula River valley and on the northern east by the Nida River valley. Miocene sea sediments and marls covered with loesses and chernozems occur in the soil.

Fig. 3. Administrative location of Proszowice commune – Małopolska province, Poland. *Source: own study.*

The analysis of percent share of complexes of soil agricultural usefulness in Proszowice commune reveals that soils of very good complexes (1 – very good wheat and 2 – good wheat) dominate at the area of most districts and they constitute 70.9% of total area among arable land altogether in the commune. There are also soils of complex 3 – the defective wheat – at the area of this commune. Its percent share in individual districts is from 0 to 10.8%. The biggest percent share of soils with the best agricultural usefulness (complex 1 – very good wheat) occurs in Opatkowice (70.8% of total district area) and Makocice (66.8%) districts. Over 50% of arable land in complex 1 is situated in the following seven districts: Teresin (58.2%), Mysławczyce (56.6%), Więckowice (56.0%), Górka Stogniowska (55.2%), Wolwanowice (54.9%), Stogniowice (52.1%) and Łaganów (50.03%). However, among relatively small are of grassland (1,389.2 ha) complex 2z – good dominates which constitutes 66.4% of their area.

Soils of complexes 7 – weak rye and 9 – weak cereal-fodder do not occur in Proszowice commune. Due to the location beyond the area of the Carpathian Foothills, soils of mountainous complexes (10-13) do not occur as well. However, lands of complex 4 – very good rye, 5 – good rye and 6 – weak rye appear at the small area in some districts. Little share of lands of complex 8 – strong cereal-fodder was also noted in

individual districts. The area of forests being the property of the State Treasury (14.3% of total district area) steps out in one of districts (Bobin).

Usefulness and project possibilities of tested tools

The effect of zooming in of the map's view in case of tested tools is only simulated and achieved through presentation of earlier prepared raster bases. Moreover, this effect is in a website often realized in steps with fluency disorders. It results from relatively big sizes of graphic files which are downloaded on demand of a user. Moreover, realization of the functionality of dynamic change of thematic layers turned on and off on demand of a user without necessity of reloading application in a browser's window is also restricted in this case.

JQuery Plugin for Zoomable Interactive Maps

Project possibilities of jQuery Plugin for Zoomable Interactive Maps plugin allowed to divide the map of Proszowice into sectors which were labelled with magnifying glass icon and enclosed in interactive selection. The detailed map exposed over the general map is evoked fluently on demand of a user. Moreover, the general map was labelled with interactive markers accompanied by short text information (Fig. 4).
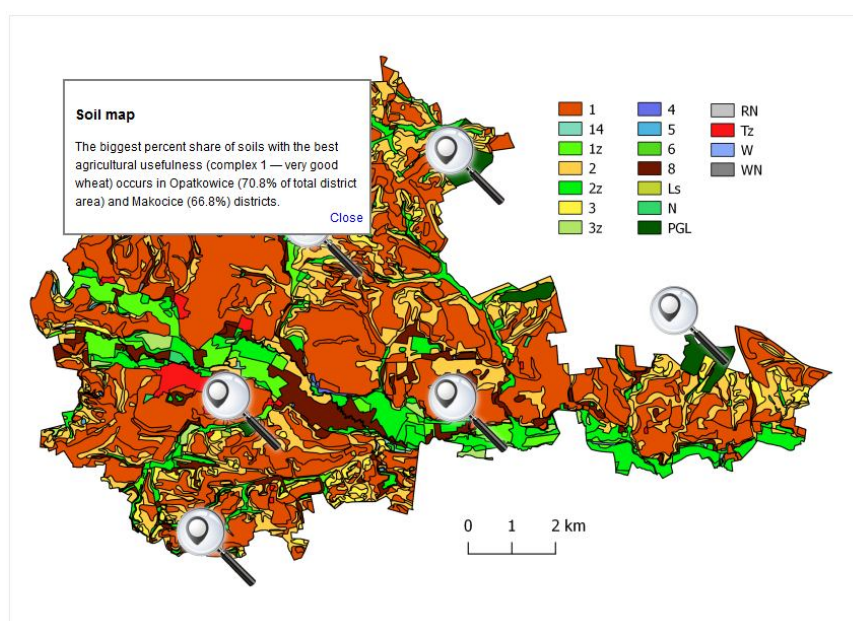

Fig. 4. Presentation in a browser's window of the interface of the map component created by means of jQuery Plugin for Zoomable Interactive Maps. Interactive presentation of soil complexes of Proszowice commune, "screenshot".
Source: own study with use of jQuery Plugin for Zoomable Interactive Maps (SUTHERLAND, 2009).

MapHilight and ImageMapster plugins

The hypertext document with coordinates of polygons was prepared by means of QGIS software equipped with *Html Image Map Plugin* extension. This extension allows to transform a vector map into a raster base. The key element of export is a raster-accompanying hypertext document that contains coordinates of polygons applied earlier on a vector map. The layer of polygons, linear or punctual objects, is transformed into the area of active hyperlinks which can be linked with data of textual or numerical character. The extension allows to define the map's size and to program its interactivity. The hypertext document prepared by that is format-free which gives great opportunities to its modification – in connection with MapHilight jQuery JavaScript plugin, it allows a user to label and read data connected with the object marked on the map.

ImageMapster generates in a browser's window "a passive effect" of a "zoom" type, i.e. interactive zooming in and out of the map's view that aims at improving map's browsing. The basic plugin's disadvantage is a long time of waiting for scaling the net of polygons in a browser's window. The plugin does not work with a great number of objects, e.g. with over thousand of polygons with various shapes that constitute the interactive layer which reflects the raster's structure. However, ImageMapster is predisposed to work with the maps of smaller area, less complicated phenomena or e.g. with used higher degree of generalisation (map's generalisation).

Jquery Iviewer (iviewer Widget for jQuery UI)

Jquery Iviewer plugin is equipped with navigational menu which allows to zoom in and out the map's view as well as frame and rotate it (Fig. 5). Moreover, Jquery Iviewer provides map's browsing by means of computer mouse's buttons ("catching and dragging" of a map, zooming in the map's view with the scroll). All this takes place in the window of map's presentation with earlier defined size. Together with the growth of quality and size of a raster file (in pixels and megabytes) including resolution and size (e.g. to 4000x3000px), plugin's effectiveness drastically decreases. In practice, such a big raster base is downloaded for a long time in devices with slower internet connection or it will not be downloaded at all.
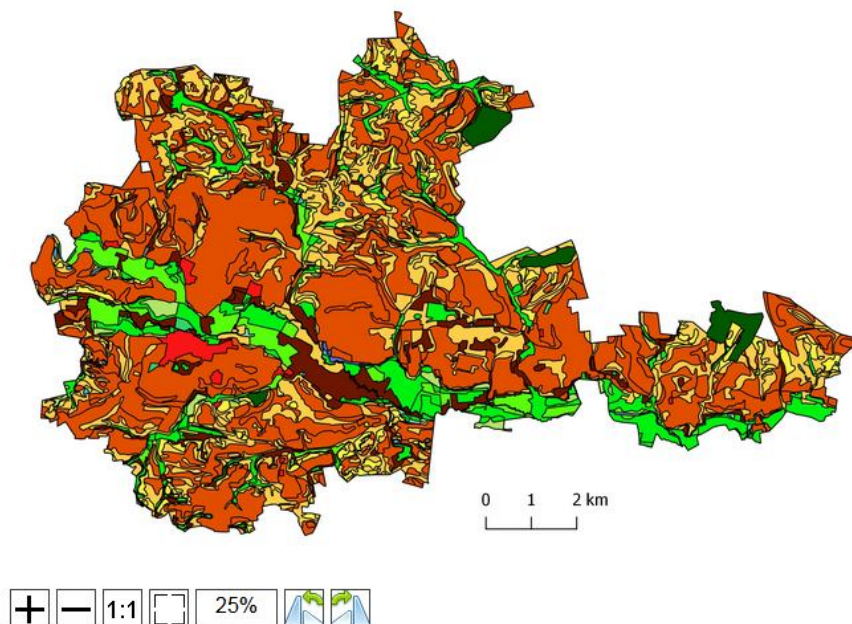
Fig. 5. Interactive presentation in a browser's window of the internet map of soil complexes of Proszowice commune, "screenshot". *Source: own study with use of Jquery Iviewer (Petrov, 2012).*

PageSpeed Insights efficiency tests

According to PSI tests, the application performed with use of Jquery Iviewer plugin is the least useful in mobile devices (Table 4). It basically results from application's architecture which is based on one big raster. So, the improvement of its efficiency depends on optimization of graphics (reducing its size). Interestingly, the highest efficiency in PSI test was achieved by the application prepared with use of ImageMapster which, paradoxically, is the least useful and the least efficient. The effect of zooming out of the map's view and at the same time scaling all objects (polygons) placed on the layer takes from a few to even several seconds which disqualifies an application prepared in such a way in the efficiency test. So, the automated measurement of efficiency can fail and a synthetic punctual grade can be misleading. PSI estimates application's efficiency on the basis of numerous criteria, however, it is unable to test its efficiency during operation so from the point of view of a user and performed diverse operations.

Table 4. Project techniques and tools subjected to the comparative analysis.

Design tool (original spelling)	Mobile	Desktop
jQuery Plugin for Zoomable Interactive Maps (ZIM)	74	86
ImageMapster	86	93
Jquery Iviewer (iviewer Widget for jQuery UI)	43	37

Source: own study.

All tested tools use jQuery JavaScript library and they keep full functionality in offline mode which means lack of access to the Internet (completing all component parts of application in the form of "a compact set of files" is required). In every case, navigation, i.e. changing of the range of map's zooming in or presenting information which accompany it takes place by means of menu or computer mouse's cursor, although only in case of the plugin of Jquery Iviewer it is possible to zoom in the map's view by means of a mouse scroll (Table 5). At the same time, the same plugin in default basic version does not allow to present additional information in the pop-up window.

Table 5. The comparative analysis of the selected design tools.

Project possibilities	ZIM	Image Mapster	Jquery Iviewer
Possibility to present a map without access to the Internet in accordance with the licence	+	+	+
Needs of external libraries (jQuery)	+	+	+
Navigational menu, navigation by means of icons	+	+	+
Possibility to decide about the number of objects presented on a map	—	+	—
Possibility to present data in pop-up type window	+	+	—
Fluent zooming in of map's view (smooth zoom)	+	—	+
Zooming in of map's view by means of mouse scroll	—	—	+
Possibility to apply on a map the layer of objects connected with additional information	+ (POI)	+ (POI, polygons)	—

Key: POI – point of interest

Source: own study.

Significant limitation of map applications created in such a way is raster's size. It is not "compiled from many small fragments" like typical dynamic maps (a tiled web map, a slippy map). It is downloaded in a browser's window as one object. So the size of a raster can prejudge the small usefulness of such created applications. Some solution which is used in case of jQuery Plugin for Zoomable Interactive Maps is preparing the elementary map in division for smaller sectors which are then, one by one, evoked in the window of map's presentation.

Summary

It is difficult to state clearly which of tested tools is the best. Solutions based on jQuery JavaScript plugins can be used in creating map services but to a limited extent. They are so sufficiently built-up, easy to use and universal that they can be the basis of small "accompanying" applications, dedicated ones as well as thematic, temporary, less detailed and less advanced ones or fragments of bigger services prepared commercially or by the users' community.

To use the tested tools fully in applications created with a view to mobile devices, it is essential to program responsiveness (Responsive Web Design, RWD) i.e. their such modification which will allow to change map's presentation form fluently and dynamically. It will provide its usefulness regardless the size of a device's screen on which it will be browsed.

Using computer techniques and tools presented in the paper is relatively simple from the programmatical point of view and it results in application's operability and its little equipment requirements. Possibility to use them in commercial projects is their advantage.

Tested tools can be used to create interactive presentations of maps that cover with their range small local objects with spatial character and phenomena with any area scope which do not require programming of functions of interactive changing of map's scale. They allow to build simple map services quickly and automatically, especially on the basis of data from the spatial information system. Moreover, the tested plugins can be used in case of sudden need of publishing a little data set in the form of information for citizens of a commune or local community, e.g. in case of changing of streets' nomenclature or buildings' numeration, in crisis situations and also in social consultations for various planning activities.

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