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# INTERACTIVE "IMAGE VIEWERS" – COMPARISON OF SELECTED TOOLS AND APPLICATION EXAMPLES

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**Summary**

The tasks carried out by public administration units include information and education. Multiple and direct transmission of information may affect the awareness of local communities. However, public administration units often struggle with the lack of skills in terms of using generally available techniques and design tools that allow relatively easy and low-cost sharing of maps on the Internet. The aim of the present research has been to analyse selected tools that enable interactive presentation of raster maps in the form of an unattended (maintenance-free) web application. Exploratory tests consisted in determining the applicability of selected tools for the presentation of spatial data, as illustrated with the example of land cover analysis of the Wolbrom Municipality (Poland). In conclusion, it was shown that the tested components aspire to be maintenance-free and they serve primarily an information function. They can be used in the presentation of environmental and socio-economic phenomena, as well as infographics or geo-infographics, which require ad hoc publication online.

**Keywords**

ad-hoc maps • image viewers • online maps • data visualization • interactive tools

## 1. Introduction

Contemporary society operates in an environment where data collection, processing and visualization play a significant role. I, being one of the most valuable resources, is immanently connected with human activity; it is generated, processed, used, and disseminated by that activity. Universal access to spatial information enables the growth of entrepreneurship; it affects the innovation and competitiveness of enterprises as well as fostering economic development [Prus et al. 2018].

Online administration and various content made available via the Internet play an increasingly important role. The dynamic development of infotechnology coupled with universal access to the Internet has changed the model of communication between citizens and the State and local government administration [Cordella and Bonina 2012]. Digital media provide information faster and cheaper than press or television; they

have a greater range, as well as the advantage of being interactive – namely, they allow the recipient to shape the format of the message.

The tasks carried out by public administration units include information and education. Multiple and direct transmission of information may affect the awareness of local communities. Information resources also include the knowledge and experience of employees who make decisions pertaining to the use of the collected information. All this leads to the necessity of effectively managing information, and effective management is here understood as proper collection, processing and sharing of data, which should result in increased effectiveness of undertaken actions [Król and Markulis 2018].

The widespread use of Internet applications, media convergence and multimedia character of the message have made it increasingly necessary for employees of public administration to be versatile and to possess skills that they had not previously needed. This is often related to the knowledge of industry software and infotechnologies [Ganapati 2011].

The availability of new technologies and computer tools has led to an increased interest in geoinformation made available on the Internet, in particular due to the possibility of quick publication, easy integration of a cartographic image with multimedia, as well as interactivity [Peterson 2007, Król and Prus 2017a]. Online maps find more and more applications in informing citizens and improving the work of public administration units [Król and Prus 2017b]. Official geoinformation portals provide large geodetic and cartographic data sets that are slowly replacing analogue maps [Król et al. 2016]. The attractiveness of online maps is primarily due to the functionality of the medium itself, the speed of access to geographic information through that medium, as well as their diversity [Król 2018a].

Maps available on the Internet are based on several types (models) of client-server interaction. In a slightly more complex model, the spatial database located on the server plays a key role [Król 2015b, Król 2015c]. In the case of a map server, the query may lead to eliciting maps, in the browser window, that will have the content and form defined by the user. The next level of advancement is connected with the use of AJAX technology (*Asynchronous JavaScript and XML*). In the simplest case, the server responds to the client (user) with a raster (static) file [Farkas 2017]. Maps are usually elicited in the browser window as part of a website (component) or an independent website (map service). While extensive map services require specialized software and proper data preparation, the map components may be in the form of a "compact set of files" – that is, various extensions or hypertext documents [Król and Szomorova 2015]. These components can be prepared so that their use is possible on an ad hoc basis whenever there is a need to publish a thematic map on the Internet.

Public administration units are still struggling with the lack of the skills that would enable them to use widely available techniques and design tools that facilitate a relatively easy and inexpensive provision of attractive maps online. The aim of the present work is to analyse selected tools that enable interactive presentation of raster maps in the form of an unattended web application.

## 2. Online maps

Maps as a medium of communication quickly gained importance – on the one hand, users intensively use the public mapping resources, on the other hand, they create and share their own. This is possible, among other things, thanks to numerous and diverse techniques and tools that allow the publication of maps on the Internet [Król and Szomorova 2015, Bouattou et al. 2016].

The use of the Internet for the dissemination of map resources has led to significant progress in cartography and opened up many new possibilities [Brovelli et al. 2015]. Maps available on the Internet are often created by the user community (volunteered geographic information, VGI) [Goodchild 2007, Król 2015a]. Industry software, often provided free of charge, facilitates the creation of personalized maps, the use of dispersed data sources, and the exchange of geographic information. In addition, more and more tools are available to automate the process of map creation [Król and Prus 2016].

The dynamics of software development for map generation is robust. An increasing number of mapping applications are providing vector data with an increasing amount of semantic information. Their functionality, usability but also hardware requirements are growing [Huang et al. 2016]. Projecting vector data is possible with web mapping libraries although it is infrequently used. Web browsers can project and render vector map data in real time using the JavaScript programming language and a dedicated projection pipeline (for example D3 JavaScript library). The projection of raster data and associated resampling and aliasing issues causing information loss and creating visual artifacts are a classical problem in GIScience. In addition, high-quality projection of raster data is computationally expensive and therefore, generally, it remains slow [Jenny et al. 2016, Król 2018b]. The raster publications constitute an alternative to technologies based on spatial databases, and despite their limitations, they may be used in the presentation of various data, in particular when there is an urgent need for their publication, whereas the use of advanced technologies would not be justified or financially feasible.

## 3. Material and methods

The comparative analysis was carried out in relation to selected techniques and design tools that allow viewing raster maps in the browser window. The tools were chosen so that their use would not require programming knowledge. The analysis was based on the results of exploratory (cognitive) tests [Afzal et al. 2009, Król 2016], which were carried out during the creation, implementation and use of the components, created in accordance with the adopted design assumptions. In the test scenario, observation and recording of insights made during project work were envisaged.

### Main project assumptions and operations

The main assumption of the project was to create an interactive map browser in the form of an independent, free-standing component (extension) of the website, which would take the form of a compact set of files or a uniform code (string of characters

stored in a hypertext document). It was assumed that the graphic form of the component can be random, but the basis of its operation will be raster maps presented in a dynamic, interactive way, also without access to the Internet (off-line).

Developing the application was preceded by the collection and processing of data in the spatial information system. Subsequently, the data was analysed and transformed into a raster background (base) map. Then the map prepared in this manner was presented in the browser window using selected JavaScript tools [Smith 2016].

## 4. Description of the tested design tools

A comparative analysis was performed on selected plugins developed using the jQuery JavaScript library and made available under the MIT license, one of the most liberal open source software licenses. The Zoomify plug-in was also analysed, in its version made available free of charge (Table 1). The basic functionality of each of the tested tools is the ability to view raster graphics. This effect is, however, in each case achieved in a different way (Table 2).

**Table 1.** Main functionalities of the tested plugins

| Tool | Major functionality |
|---|---|
| Mapbox: Zoomable jQuery Map Plugin | Zoom and pan map with several image layers. The plugin uses several images (from 2 or more) with different resolution. Map window with control panel. |
| CraftMap | Interactive map based on any image. The markers on the map with pop-up windows. |
| Zoomify Viewer | Zooming and panning map, dicing an image into many pieces or "tiles" – as in a mosaic. |
| ImageViewer | Zooming and smooth panning plugin, support touch devices. Double tap to zoom in/zoom out. Pinch in/pinch out to zoom in/out. |
| ImageTrans | Displays any images in an image viewer interface with zooming, flipping and rotating features. Plugin based on HTML5 canvas and CSS3 3D transforms. |

Source: author's own study

**Table 2.** Characteristics of the selected parameters of the tested design tools

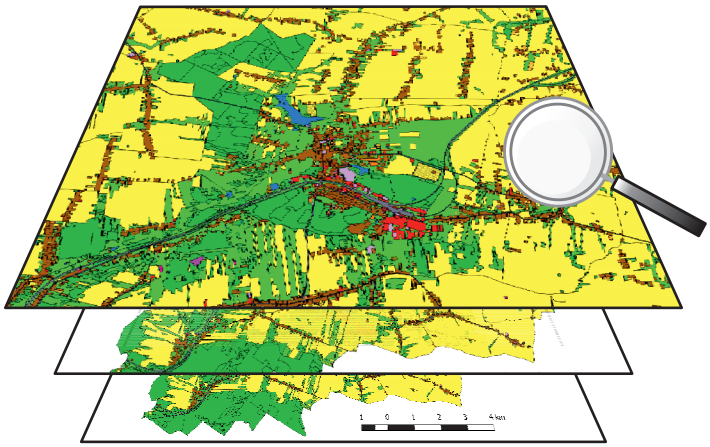
| Design tool (original spelling) | Programming techniques | Data source | License |
|---|---|---|---|
| Mapbox | jQuery JavaScript, HTML, CSS | Raster image files | MIT License |
| CraftMap | jQuery JavaScript, HTML, CSS | Raster image files | Free for non commercial use |
| Zoomify Viewer | JavaScript, HTML, CSS | Raster image files | Zoomify License Agreement |

| | | | |
|---|---|---|---|
| ImageViewer | jQuery JavaScript, HTML, CSS | Raster image files | MIT Licence |
| ImageTrans | jQuery JavaScript, HTML, CSS, canvas | Raster image files | MIT Licence |

Source: author's own study

### Mapbox: Zoomable jQuery Map Plugin

JQuery Mapbox plugin [Mohler 2017] is used to create zoomable, draggable maps with multiple layers of content. Basically, the plugin allows you to zoom in and move the map to get a better view (zoom in on the map view). Mapbox uses raster layers, which are displayed in the map presentation window. The rasters are entered into the structure of the hypertext document and displayed in the browser window one above the other. Then, as a result of the user's activity, individual raster variants are elicited, which is a kind of simulation of the approximation of the map view (Fig. 1).

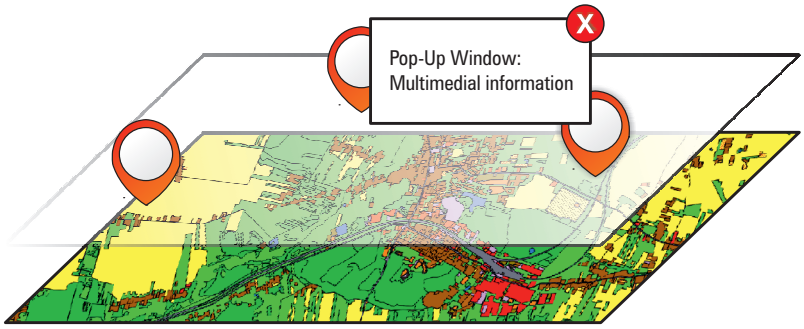


Source: author's own study

**Fig. 1.** Diagram of raster maps superimposed one on another, and then elicited using the Mapbox plugin. Land cover map of Wolbrom Municipality (Małopolska Region, Poland)

### CraftMap

The CraftMap plugin [Dziewulski 2017] enables interactive browsing of any raster graphics. It uses the location attributes of each pixel to locate the POI on the raster base, which can be the carrier of multimedia information (Fig. 2). The construction of the script does not limit the number of points that can be applied to the raster. Information accompanying the points is presented in a pop-up window.

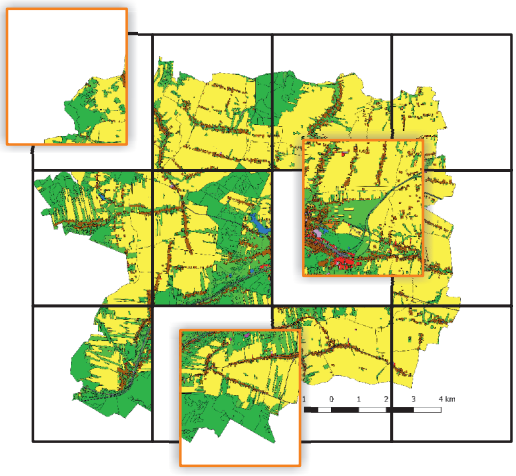



Source: author's own study

**Fig. 2.** Diagram of POI points location on the layer elicited using CraftMap plugin

## Zoomify Viewer

Zoomify Viewer plug-in [Zoomify 2017] is a tool that enables presentation of a raster file in the browser window. Graphic files presented by Zoomify Viewer must be prepared in advance, that is, they must be divided into "tiles" (Fig. 3). They come together, like a jigsaw puzzle, to form the final image. The zoom effect of the map view is implemented here by a gradual presentation of multiple raster files imposed on each other, and at the same time divided into tiles. Accordingly, the end result is a specific "pyramid of tiles". Along with the map software, the plug-in provider also provides a tool (Zoomify Free Converter) that allows automated splitting of the source file.



Source: author's own study

**Fig. 3.** Zoomify Viewer – diagram of raster map division into tiles, which are then stacked to form a map in real time

ImageViewer [Yadav 2015] and ImageTrans [Yu 2016] are raster browsers based on jQuery JavaScript. Their functionality comes down to the presentation of graphic files in a defined workspace.

### jQuery MapHilight Plugin (MapHilight)

MapHilight [Lynch 2017] is a tool that uses an HTML tag – <area> to generate an interactive map of objects. You can associate text data with objects. The effect of border and shading of objects of any shape is generated on the layer created directly above the raster in real time. The plugin allows the user to mark and read data related to the selected object on the map.

### MouseWheel Extension jQuery Plugin (MouseWheel)

The MouseWheel plugin facilitates the presentation of a limited number of raster graphics in a window with defined sizes, allowing to "capture and drag graphics". Simulation of the map view zoom effect is achieved here by overlapping several raster layers. Each raster layer has a different size in pixels and presents a more detailed image. The differences in raster sizes are eliminated by the map presentation window, in which only a limited area of the map is displayed, for instance, 600 × 500 px. By using a computer mouse wheel ("scroll"), subsequent layers are selected and displayed in the vertical hierarchy, which the user perceives as the effect of zooming in or out of the map view.

## 5. Land use/land cover – Wolbrom Municipality

In the landscape of southern Poland, characteristic mosaic of arable land in connection with grasslands, forests and settlement units prevails. This image is the result of the conditions resulting from the terrain and the overlap of socio-economic conditions. This cultural mosaic contains evidence of the human presence and way of life. The rural landscape of southern Poland, shaped by agriculture, is typified by rich natural diversity. Socio-economic changes taking place in recent decades and the intensification of agriculture bring with them the introduction of new crops, and thus changes to the structure of land use and to the traditional mosaic of land. Transformation of land use drives global changes in the environment [Druga and Faltan 2014]. Land use impacts multiple environmental factors, including water, soil and air quality, which in turn are related to the local climate and ecosystem [Bartoszek et al. 2015, Louca et al. 2015] The land use structure is analysed based on land cover data from, among others, CORINE Land Cover, orthophoto, or BDOT10k photos [Szostak et al. 2014]. In recent years statistical models have been widely used to study changes in land use and its modelling [Indarová and Kupková 2015, Molowny-Horas et al. 2015]. Environmental analyses of changes in land use are particularly important from the point of view of environmental management.

The analysis of land cover of the Wolbrom Municipality was made on the basis of data on land cover derived from the BDOT10k database. Wolbrom is a municipality located in the north-western part of the Małopolska Region, at the border with the Silesia Region, in the Krakow-Częstochowa Upland (Fig. 4).


Source: author's own study

**Fig. 4.** Administrative location of Wolbrom Municipality – Małopolska Region, Poland

The geographical location determines the manner of land use in the area. In the area of 29 precincts (towns) included in the municipality, arable land dominates, accounting for an average of 64.5% of land cover, with a maximum arable land area of 91.7% within Budzyń and a minimum of 16.6% in Zabagnie. Grassy vegetation occurs on an average in 13.5% of the surface of precincts, with a maximum value of 34.9% within Wolbrom and a minimum of 0.7% within Budzyń precinct. Forests occupy an average of 12.3% in the Wolbrom municipality, and their largest share – that is 59.4% – is found in Zabagnie. Among the built-up and urbanized areas, the largest share is occupied by single-family housing. Orchards occupy on average 0.7% of the area, with the largest share to be found within Podlesice II (2.1%).

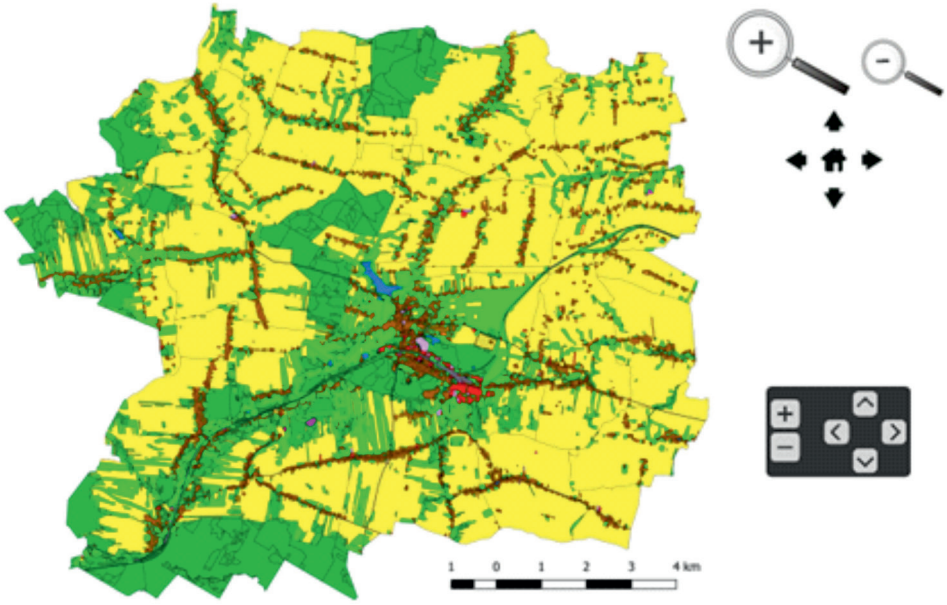
The vector format of the data obtained from BDOT10k as well as the data collected in the spatial information system was transformed into a raster map, which was then presented in the form of an online map, being a component of a hypertext document.

## 6. Usability and design capacity of the tested tools

None of the tested tools places the limitations on the users, as to the maximum size of the raster graphics. It is therefore possible to present graphic files of any size in the browser window (both in pixels and in megabytes). Having said that, the usability of the component that will be given a raster presentation (in the form of a single, uniform graphic, i.e. one file) of too large size will be quickly verified, especially when it is made available on the data server. Large raster files can be displayed with a long delay or not at all. Some of the tested solutions propose to rectify this inconvenience.

### Mapbox: Zoomable jQuery Map Plugin

The Mapbox plugin makes it possible to view raster files. The components formed by it perform essentially the information function (Fig. 5). The plugin makes it possible to extend the map presentation window with a graphical user interface. This interface can accept any graphics and it is used to manage the presentation of the map. Mapbox not only allows viewing raster graphics horizontally (capturing and dragging the map area). It also simulates the effect of zooming the map view by overlapping appropriately prepared vertical rasters. This effect, however, is implemented "step by step", which is further compounded in the case of large-sized screens.




Source: author's own elaboration using Mapbox

**Fig. 5.** Mapbox – map presentation and two different graphic formats of the navigation menu; presentation in the browser window; land cover map of Wolbrom Municipality (Małopolska Region, Poland)

### CraftMap

In addition to allowing you to view raster graphics, The CraftMap plugin makes it possible to share other data in a pop-up window. This significantly extends the functionality of the tool, because it facilitates linking multimedia information with a POI, which can be located in any raster area. CraftMap provides smooth browsing of raster graphics, but it does not enable interactive zooming of the map. The main disadvantage

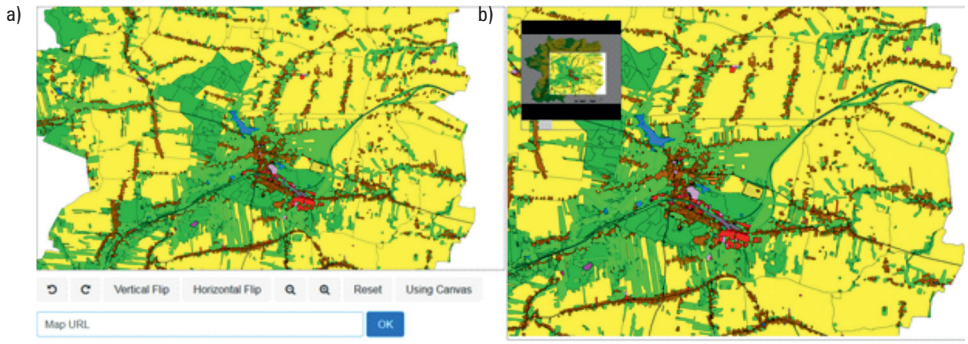
of the CraftMap plugin is the need to manually program the location of the information points. This requires interference with the source code.

### Zoomify Viewer

The Zoomify [2017] browser enables comfortable presentation and viewing of raster graphics regardless of their size. The service provider provides tools to transform graphic files with high resolutions and adapt them so that they can be used by the Zoomify plug-in. In the basic version, Zoomify allows viewing, zooming in and out of the raster map view prepared in any resolution, including files with the size of several or even several dozen megabytes.

### ImageViewer and ImageTrans

ImageViewer and ImageTrans are typical browser raster graphics. In terms of functionality, they differ in the navigation interface (Fig. 6). This in turn, in the case of the ImageViewer plug, basically boils down to mouse buttons and a mouse scroll. With their help, you can capture, enlarge and smoothly drag the image. The situation is different with the ImageTrans plug-in. Browsing raster graphics is possible thanks to the graphical user interface. At the same time, it is also possible with the help of computer mouse buttons, but this functionality is poorer compared to the ImageViewer plugin. Both plugins use only one raster file. The zoom effect of the map view (the degree of approximation and the quality of the presentation after approximation) depends on the quality of the raster.




Source: author's own study

**Fig. 6.** ImageViewer – graphic interface for map operations (a) and map viewing using the mouse buttons – ImageTrans (b); land cover map of Wolbrom Municipality (Małopolska Region, Poland)

Each of the tested solutions performs an information function in a slightly different way. Differences are marked in the way the map is handled and in the format of its pres-

entation. Only Mapbox and Zoomify Viewer enable interactive zooming of the map view, although this effect is carried out in a completely different way in each case. The CraftMap plugin is distinguished, among other things, with the ability to map information points on the map. On the other hand, Mapbox, Image Viewer and ImageTrans are typical browsers of raster graphics, which differ in the way the maps are handled (Table 3).

**Table 3.** Comparative analysis of the selected design tools

| Design possibilities | Mapbox | Craft Map | Zoomify Viewer* | Image Viewer | Image Trans | Map Hilight | Mouse Wheel |
|---|---|---|---|---|---|---|---|
| Possibility of presenting map without internet access (offline) | + | + | + | + | + | + | + |
| Number of raster layers used | 2 or more | 1 | Multiple | 1 | 1 | 1 | Multiple |
| Graphic user interface | + | + | + | + | – | – | + |
| Possibility of plotting point objects on the map | – | + | – | – | – | – | – |
| Possibility of presenting data in a pop-up window | – | + | – | – | – | – | – |
| Smooth zooming in on the map vie using mouse scroll (smooth zoom) | – | – | + | + | – | – | – |
| Dragging the map after it is captured with the mouse cursor | + | + | + | + | – | – | + |

* Free version

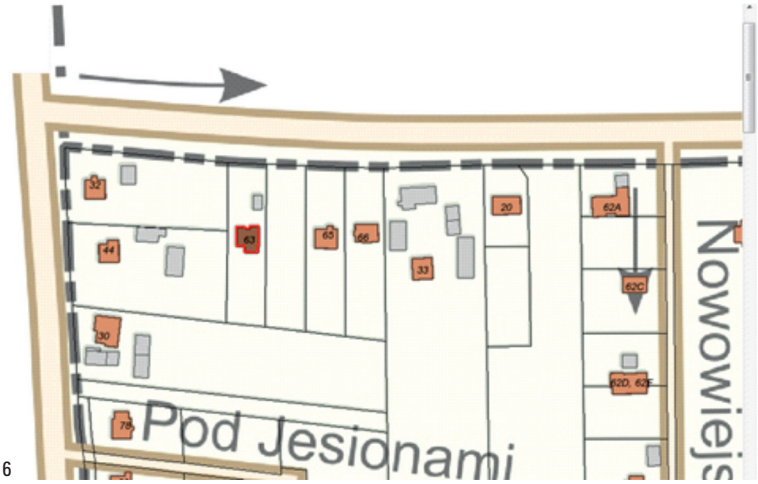
Source: author's own study

It is difficult to indicate which of the tested tools is the best (in general terms). However, it can be stated which of these would be the best for a particular project. The choice of the plugin depends on the adopted design assumptions, and the resources for their implementation.

## 7. Selected examples of applications

Examples of the applications of the tested tools include the address systems created for the village districts of Cianowice (Skała Municipality, Małopolska Region, Poland), Brzeźnica and Kozierów (Michałowice Municipality, Małopolska Region, Poland). These are the result of fieldwork, aimed at organizing the numbering of houses (also on undeveloped plots) on every street. In order to make improvements and to conduct public consultations, in connection with plans to introduce street names, an interactive application was prepared and made available to the residents of the municipality on the

Internet (Fig. 7). The application has an information function. It presents a register of changes in street naming and the numbering of houses by means of mapping the built-up areas. The basis of the online map of streets and addresses of the town of Kozierów is the jQuery Maplight Plugin plugin [Lynch 2017], which triggers the effect of border and cover for elements of any shape on the layer created over the raster in real time. The application is based on polygon coordinates and the usemap attribute properties. When user selects the object on the map with the mouse cursor, he receives feedback about the new address. The address system has been published on the website of the Michałowice Municipality.



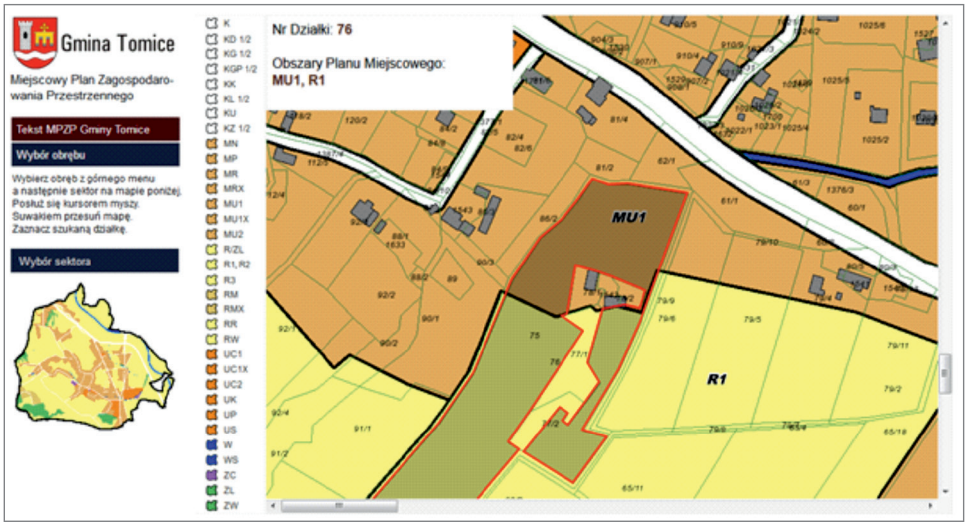

Old address: Kozierów 63
New address: Pod Sosną 6

Source: author's own elaboration using jQuery Maplight Plugin

**Fig. 7.** Online app – address system of Kozierów village (Małopolska Region, Poland)

The online map of addresses and streets of Cianowice village was made using the MouseWheel Extension jQuery Plugin [Aaron 2017] and MapBox Zoomable jQuery Map Plugin [Mohler 2017]. In this case, the information about the change of the address number is delivered by the PHP script, and the image viewer enables the presentation of the map. Having provided the previous address number, the user receives feedback in the form of the current numbering. The new numbering is written directly in the PHP file in the table of address numbers. MouseWheel Extension jQuery Plugin [Aaron 2017] and MapBox Zoomable jQuery Map Plugin [Mohler 2017] facilitate preparing web applications in a semi-automated way. Once prepared, the software can be used to present a selected problem, regardless of the area in which it occurs.

The main function of the eMPZP application of the Tomice Municipality is to present the map and to provide users with text information on the designation of parcels in the local spatial development plan for specific purposes (Fig. 8). The essential part of the application is the raster maps created as a result of exporting vector compilations.




Source: author's own elaboration using jQuery Maplight Plugin

**Fig. 8.** Online local plan for Tomice Municipality (Małopolska Region, Poland)

In the eMPZP application, for practical reasons, the area of the municipality has been divided into sectors. Each raster map has been covered with an interactive layer generated by the jQuery Maplight plugin [Lynch 2017]. The purpose of the application is to publish an accessible form of MPZP (the local plan) on the Internet, and create the opportunity to reach a wide audience with relevant information.

## 8. Conclusions

Public administration units use Internet maps increasingly often in their performance of public tasks. Web-based urban plans, location services and browsers for planning studies have generally become commonplace, and they usually perform an informative function. Increasingly often one also finds online thematic maps – the so-called "dedicated" maps, which are designed to fulfil a specific function, and are developed both by public administration and by the users themselves.

The described tools can be successfully used for the presentation of various tourist maps and maps showing forms of nature protection, maps of administrative divisions and address systems, maps of municipal records of heritage monuments, or road maps. They can be used in ad hoc publications, for instance, in the process of public participation, in online voting on a chosen concept of a civic budget or a variant of a given investment project. The described solutions are suitable for the presentation of all information maps, but also of textual and graphic information, including municipal resolutions, posters and leaflets – provided that these are prepared in the form of a raster.

The presented components are essentially of "completed, closed" character. They can extend the functionality of any hypertext document or be presented in the browser window independently. Content management and changing the map background are done manually – by interfering with the source code of the document or replacing the graphic file with another one. There is no CMS (Content Management System) here that would facilitate the management of the components in an automated way, using a graphical user interface. This may limit the usable scope of the components. It follows that the scope of the presentation is limited to previously defined map backgrounds, and the requirement to prepare a raster map with appropriate parameters may limit the general usability of the components.

The developed applications have an informative function. Presentation of environmental issues on the Internet may indirectly affect nature's protection. This phenomenon can be described as "information pressure". Multiple and direct transmission of information made available in the form of an online application may affect the awareness of various social groups. The pressure of information can be directed at changing the awareness of the recipient through education and promoting pro-ecological attitudes. The tested components could also be used in the presentation of phenomena, in particular environmental, socio-economic, infographics or geo-infographics issues, which require immediate publication on the websites of municipal offices and other public institutions.

The usability of the tested tools depends on the raster quality attributes, including its pixel size and file size (compression ratio). It also depends on the type of the raster file and the graphic method of presenting the phenomenon – its scope, colour range and scale of the map.

The presented components were created for the purpose of interactive presentation of graphic (raster) files. They constitute a form of presentation whose task is to inform. Ultimately, therefore, it depends on the quality of the graphic foundation whether this function will be duly and effectively performed.

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