sciendo

Polish Cartographical Review
Vol. 51, 2019, no. 2, pp. 67–79
DOI: 10.2478/pcr-2019-0006
Received: 29.01.2019
Accepted: 28.05.2019

JAKUB JABŁONOWSKI, IZABELA GOŁĘBIOWSKA
University of Warsaw
Department of Geoinformatics, Cartography and Remote Sensing
Warsaw, Poland
orcid.org/0000-0002-4307-7054
kuba.jablonowski@gmail.com; i.golebiowska@uw.edu.pl

Multi-criteria assessment of the official map services of Capital City of Warsaw

Abstract. The Authors present the results of the multicriterial evaluation in 14 official map services of Capital City of Warsaw. The evaluation has been conducted in 2018 on two levels: in relation to all websites jointly (score according to one criterion) and individual mapping services (evaluation according to three criteria). The obtained results have been compared to previous analyzes of geoportals at various levels, including regional and state-owned. The Warsaw map service falls in a satisfactory manner, achieving a comparable or slightly higher rating than those previously analyzed by other authors.

Keywords: map services, INSPIRE directive, spatial data presentation, Capital City of Warsaw

1. Introduction

Granting access to shared geographic information and the development of spatial data infrastructure is one of the obligations of government and self-government administration of the countries belonging to the European Union (T. Salata et al. 2015). Due to the importance of this data and the ongoing process of adapting spatial data infrastructure elements in Poland to those designated by the EU legislator, a very important to evaluate the map services in our country.

The main purpose of this article is to evaluate and objectively describe the official map service of Warsaw.

In European cities in the 21st century, map services must be a platform for residents and tourists providing an easy and effective access to spatial data, and thus making it easier for these people to function in the city. The task of the authorities is to expand the infrastructure of this data and integrate it with other systems in accordance with the process of building a smart city.

2. Review of literature

2.1. Polish legislation regarding the functioning of spatial data infrastructure

At the turn of the 20th and 21st centuries there was an intensive development of geoinformation technology and various types of services in this field at the public and private level. Services from both sources make up so-called spatial data infrastructure (SDI) (J. Gaździcki 2005). Supporters of the SDI concept drew attention to the requirement for the improvement and standardization of spatial data management in a given area (at local, regional, national and international levels). This process resulted in a number of legal regulations at both national and supranational levels, e.g. within the European Union (J. Gaździcki 2005).

In Poland, the main document regulating the construction and functioning of spatial data infrastructure and related issues is the *Ustawa o infrastrukturze informacji przestrzennej* (Act on Spatial Information Infrastructure) (2010). It transposes another legal act – a directive of the

European Union adopted in May 2007, the so-called INSPIRE act (**In**frastructure for **Sp**atial **I**nfo**r**mation in **E**uropean Community, Directive of the European Parliament and the Commission No. 2007/2/EC) (Directive 2007/2/EC, 2007). The main output of this document is the declaration of providing citizens with access to spatial data and preparation of a well-functioning, coherent system that will facilitate this access (S. Białousz 2013).

2.2. Contemporary geoportals and their assessment

The practical dimension of adopting and implementing the legislation referred to above are websites and applications which allow the collection, processing, management and, above all, sharing of spatial data with users – so-called geoportals (G. Głowacki et al. 2005). We can distinguish geoportals operating at the national and regional level (in Poland – at the voivodship level) and local spatial information systems supporting the implementation of the tasks of municipalities and poviats − including a geoportal of Warsaw (W. Izdebski 2015).

Due to the development of information technologies and wider access to the Internet for citizens, geoportals are being developed increasingly often. The appearance of new types of data and the development of geoportal functionalities have made it possible to adapt their content to the needs of users. In addition, they are an integral part of building modern administration and facilitate the development of modern public services, for example, by supporting the development of smart cities (D. Gotlib, R. Olszewski 2016).

In Poland, portals are becoming increasingly advanced and allow universal access to spatial data. An example of a national portal is Geoportal (http://www.geoportal.gov.pl/, access 10.01.2019). At the regional level, most Polish voivodeships also developed advanced solutions in terms of spatial data sharing – there were nine voivodship geoportals in 2012 (D. Dukaczewski, A. Ciołkosz-Styk, T. Sochacki 2012). In addition, even smaller local government units increasingly support their activities and implement tasks using their own geoportals. However, there is still a lot to be done to improve the standard of local geoportals (K. Medolińska, I. Gołębiowska, I. Karsznia 2017).

In this context, assessing geoportals and introducing changes seems to be a necessity. One example is a study of 32 geoportals at the poviat level (M. Siejka, M. Ślusarski 2015) in which the authors assessed the transparency of the geoportal, its interactivity (including navigation on the site) and the availability of selected geospatial data (including viewing the geometry of polygons). The evaluation was carried out using the binary system.

Another example of an analysis of Polish geoportals is the assessment of voivodeship geoportals. The study verified application of themes of data, cartographic methods, and 45 functionalities (D. Dukaczewski 2007).

An extension of the above-mentioned research is the assessment of selected geoportals at various levels: national geoportals in European countries (D. Dukaczewski, E. Bielecka 2009) and regional geoportals in Europe (D. Dukaczewski, A. Ciołkosz-Styk, M. Sochacki 2012). The methodology of the above-mentioned analyses is very similar to that used for the assessment of voivodeship spatial information systems (D. Dukaczewski 2007).

Another study assessed the usability of the beta version of a Swedish national geoportal which was part of the GeoTest project developed by the Swedish organisation Future Position X and governmental institutions. The used method was based on the ISO 9241-11 standard, and mainly criteria such as effectiveness, efficiency and user satisfaction were assessed (X. He, H. Persson, A. Östman 2012).

3. Map services analysis

3.1. The official map services of Capital City of Warsaw

The official map service of Warsaw is part of the group of official websites of the capital city of Warsaw (http://www.um.warszawa.pl/, access 10.01.2019). The home page is available at http://www.mapa.um.warszawa.pl/ (access 10.01.2019 − fig. 1), while the interface which allows to view particular map services is http://mapa.um.warszawa.pl/mapaApp1/mapa (access 10.01.2019).

The current version of the map service, available at the above-mentioned URLs, was launched on April 26, 2013. Initially, only the city map and aerial photographs of Warsaw were available. Over the following years, map services

Fig. 1. The hyperlinks to the 14 map services on the homepage of the official map services of the Capital City of Warsaw (http://www.mapa.um.warszawa.pl/, access 10.01.2019)

and functions were systematically supplemented. As of 2018, the map service of Warsaw consists of 14 data sets[1].

The *Plan of Warsaw* is the main map service, and its extended version is *Warsaw Today*. The next group is historical map services – *Historical Map* and *Heritage list*. Thanks to the first of these, one can access historical data, including old cartographic images. The *Heritage list* map service presents Warsaw's heritage assets and protected structures as well as data from the heritage list. Further map services are related to real estate and land development. These include *Property Map*, *Local Plans*, *Municipal Property*, and the *Real Estate Price and Value Register* (Rejestr Cen i Wartości Nieruchomości – RCWN). They contain interactive maps of municipal property and real estate, as well as data from local development plans. *Renewable Energy Sources* and *ADAPTCITY* are relatively new map services. The *Renewable Energy Sources* service contains data which facilitates the efficient installation of e.g. solar panels (thanks to the map presenting solar irradiance). The *ADAPTCITY* map service contains a number of maps and data related to the climate in Warsaw. The map service also includes the following data sets: *Cemeteries, Cycling*, *Geodesy* and *Noise Map*.

3.2. Analysis of compliance of the themes in Warsaw map services with guidelines of the INSPIRE directive

As part of the assessment, the degree of compliance of the theme of data contained in all map services of Warsaw was examined with the guidelines in Annexes I, II and III of the INSPIRE Directive. In total, these are 32 out of 34 thematic ranges, because the evaluation excluded those which do not apply to Warsaw (oceanographic and geographical conditions, maritime regions).

Based on this assessment, a 72% compliance result was obtained (the data contained in the data sets is compliant with 23 out of 32 thematic ranges from the INSPIRE directive). The map services of Warsaw did not contain data related to: protected areas, topography, geological structure, soils, agricultural and aquaculture facilities, habitats and areas which are uniform in terms of nature, and the distribution of plant species and mineral resources.

In comparision to other map service studies (D. Dukaczewski 2007; D. Dukaczewski, E. Bie-

[1] Based on the descriptions available at http://www.mapa.um.warszawa.pl/index.html, access: 10.01.2019

Tab. 1. The number of themes listed in the Annexes I, II, III of the INSPIRE Directive included in geoportals of different levels analyzed by various authors (own elaboration).

Authors and the year of a study	Analysed map services	Number of applied themes listed in the Annexes of INSPIRE
D. Dukaczewski 2007	voivodship map services (total)	26
D. Dukaczewski, E. Bielecka 2009	national map services of the selected European countries	from 0 to 25
D. Dukaczewski, A. Ciołkosz-Styk, M. Sochacki 2012	regional map services in the selected European countries	from 5 to 31
J. Jabłonowski, I. Gołębiowska 2018	official map services of Capital City of Warsaw	23

lecka 2009; D. Dukaczewski, A. Ciołkosz-Styk, M. Sochacki 2012), this can be considered a satisfactory result (tab. 1).

Moreover, the Warsaw map services include thematic content which among the analysed regional portals (D. Dukaczewski, A. Ciołkosz-Styk, M. Sochacki 2012) was presented rarely, e.g. population distribution – demography (only 12% of the analysed regional map services contained such data) and atmospheric conditions (8%).

4. Assessment of individual map services of Warsaw

14 map services were evaluated, which consist of 924 thematic layers, some of them are repeated in various map services. Each layer can be viewed separately. The analysis determined the number of cartographic presentation methods used in individual layers, the number of available tools enabling the analysis of the presented data, and availability measured by webpage loading time.

4.1. The cartographic criterion

Based on a query of the cartographic presentation methods used to visualize data in the map services of Warsaw, it was found that 8 different methods were applied. These are: point and line symbols (qualitative, ordinal), the qualitative area method, a choropleth map, isolines, and labels. This result does not differ significantly from those reported by other authors in similar studies (tab. 2).

In the Warsaw data sets, the most commonly used methods to visualize data (fig. 2) were: qualitative point symbols (in 71 sets of layers,

Tab. 2. The number of cartographic presentation methods used for data visualization in geoportals analysed by various authors (own elaboration)

Authors and the year of a study	Analysed map services	Number of the cartographic methods
D. Dukaczewski 2007	voivodship map services	9
D. Dukaczewski, A. Ciołkosz-Styk, M. Sochacki 2012	regional map services in the selected European countries	13
J. Jabłonowski, I. Gołębiowska 2018	official map services of Capital City of Warsaw	8

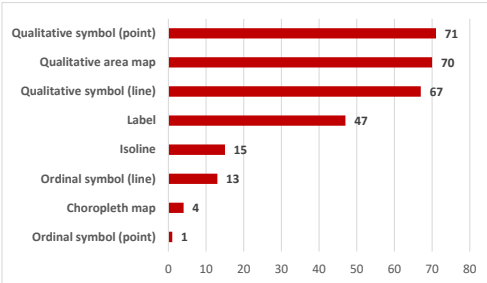

Fig. 2. The frequency of application of cartographic presentation methods in map services of Capital City of Warsaw (own elaboration)

fig. 3A), the chorochromatic method (in 70 sets of layers, fig. 3B), and qualitative line symbols (in 67 sets of layers, fig. 3C). The study of voivodeship map services (D. Dukaczewski, 2007) found that the most popular method was qualitative area symbols (in interactive and non-interactive versions – including the qualitative area method). The method of qualitative line symbols was also often applied. The most frequently used method in Warsaw map services – qualitative point symbols – was not mentioned in the surveys of voivodeship map services (D. Dukaczewski 2007).

The widespread use of the symbols method is related to the multitude of layers visualizing structures and phenomena of a point or linear nature in Warsaw data sets (J. Pasławski 2010). Point symbols are the most often used method in sets about the location, type and purpose of a given element – usually a building (e.g. sets such as *Administration*, *Healthcare*, and *Education*). Qualitative line symbols are mainly used to present transport routes (e.g. *Transport*, *Bicycles*), borders between areas or zones (*Historical City Borders*, *Parcels*).

On the other hand, the popularity of the qualitative area method in Warsaw data sets is associated with a large number of layers which show nominal differences on a given surface – they indicate whether a given area has the same features or not (J. Pasławski 2010). These include layers distinguishing the type of land cover (e.g. *Buildings*, *Water – surface water, Green Areas*), the type of area or zone and the designation of their authorities (e.g. *Administrative Division*, *Land Registration* , *Reference*, *Principal Map*) and the range of hazardous areas (*Flood risks*).

Additionally, in the Warsaw map services, one can display additional details about elements (e.g. description, district, address) by clicking on the symbol or polygon.

Labels are most often used to display address information or names (*Address*). The isoline method is usually used to present climatic or meteorological phenomena. It is no different in this case since the isoline method was used e.g. in the *Precipitation* and *Air temperature* layers. A choropleth map in which data is referenced to territorial division units (e.g. districts) is used in this way in the mentioned data sets (J. Pasławski 2010). Demographic data contain references to districts (the *Demographics* layer, the *Population density in districts* layer set).

As mentioned previously, a total of eight cartographic presentation methods were used in

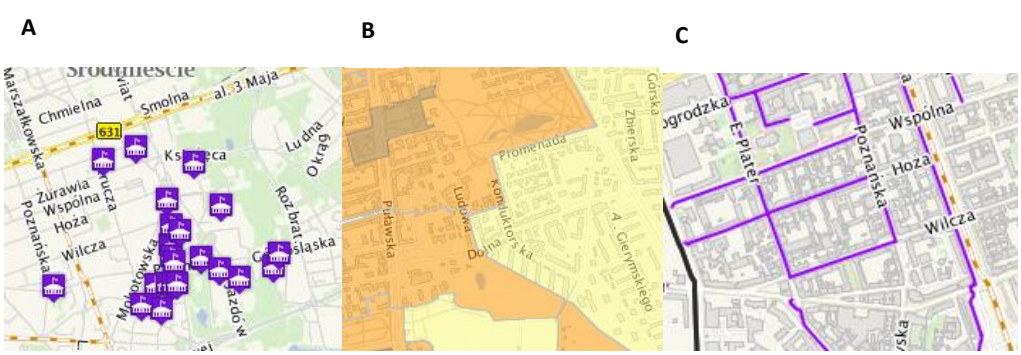

Fig. 3. The most commonly used cartographic presentation methods in the official map services of Capital City of Warsaw: A – point, qualitative symbols, B – choropleth maps C – line, qualitative symbols (http://www.mapa.um.warszawa.pl/, access 10.01.2019)

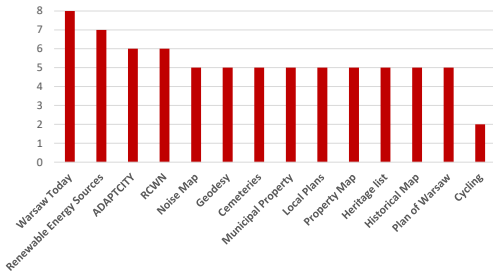

Fig. 4. The number of cartographic presentation methods used in particular map services of Capital City of Warsaw (own elaboration)

Warsaw map services. However, the number of methods in particular map services varies ranging from two to eight (fig. 4).

The smallest number of methods – two – is applied in the *Cycling* map service (qualitative point and line symbols). In the *Warsaw Today* map service, there are collections of layers representing all eight presentation methods. It is mostly related to the number of layer sets which make up these map services. The *Cycling* service has the fewest, while *Warsaw Today* has the most. In the latter, there are many more types of data, while the *Cycling* map service is, as the name suggests, more specific.

Generally, the described methods have been used correctly in the Warsaw data sets. However, errors occurred in relation to generally accepted cartographic principles.

The most serious errors are associated with the colour scale, as well as legends to the data presented using the isoline and choropleth map methods (fig. 5). A properly constructed legend for the above-mentioned methods should consist of vertically positioned rectangles of a height proportional to the range of classes of the presented phenomenon. Values in the legend should increase upwards. In the colour scale, the higher the value, the darker the colour should be. Choropleth map rectangles should be separate and described by a range of classes, while in the legend of the isoline map they should be tangential and described only by isoline values (J. Pasławski 2010).

Another flaw is that the thematic layers in the panel on the left of the window have been ordered only alphabetically (fig. 7I), without taking into account thematic ordering, which would allow placing thematically related layers closely together.

Errors such as poor editing of the legend (all of the above), incorrect selection of the colour scale in such a way that it consists of too diverse tones (fig. 5B) or hardly distinguishable tones (fig. 5A) can be found in practically all sets of layers, which are based on choropleth map or isoline methods, and therefore they appear most often in the *Noise Map* and *ADAPTCITY*.

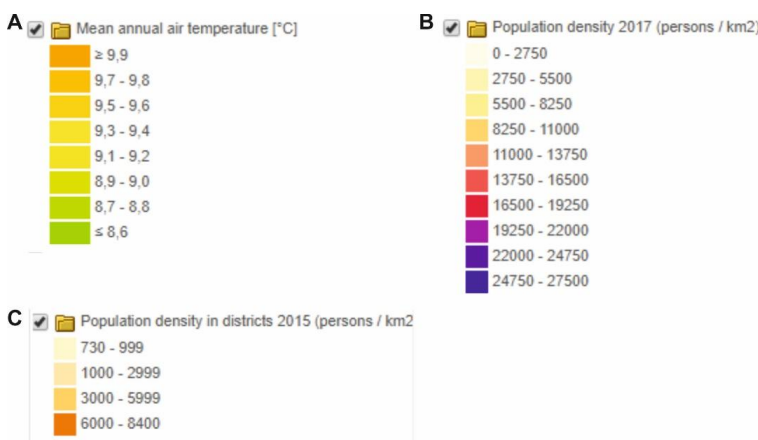

Fig. 5. The examples of the incorrect map legends in the map services of Capital City of Warsaw: A – the legend of the layer *Air temperature* – isoline method, B – the legend of the layer *Demographics* – isoline method, C – the legend of the layer *Demographics* – choropleth map (http://www.mapa.um.warszawa.pl/, access 10.01.2019)

This is a fairly serious mistake which requires correction because it makes it difficult for users to read the data sets.

Another difficulty is caused by the lack of restrictions in the display of overlapping data in layers presented using point and line symbols. In a map service with a large number of layers and their collections, turning on several of them means that when the user zooms out, the symbols overlap, which makes reading such a map extremely difficult (fig. 6). Examples of facilitations include the function of displaying information about an object, which is located in the toolbar, and the ability to edit layer visibility. Still, it is worth considering blocking the display of this type of data from a certain degree of zooming out.

4.2. The functionality criterion

4.2.1. Methodology

The assessment of the functionality criterion is derived primarily from the methodology of researching voivodeship map services (D. Dukaczewski 2007) and the regional level in selected countries (D. Dukaczewski, A. Ciołkosz-Styk, M. Sochacki 2012). It involved examining 45 basic functions. In addition, this study also evaluated additional features in particular data sets. The availability of functions was evaluated using a binary system: value 0 – no function, value 1 – function exists. For each additional function in the set, it received 1 point.

4.2.2. The functionalities of Warsaw map services

The Warsaw map services include a total of 25 to 32 functions out of 45 identified in D. Dukaczewski's study (2007) and a total of 5 additional functions used in only three sets. In each of the 14 services, at the top of the interface there are 14 buttons, thanks to which users can quickly and easily switch the view to another set or reload the current one without having to return to the main page (fig. 7A).

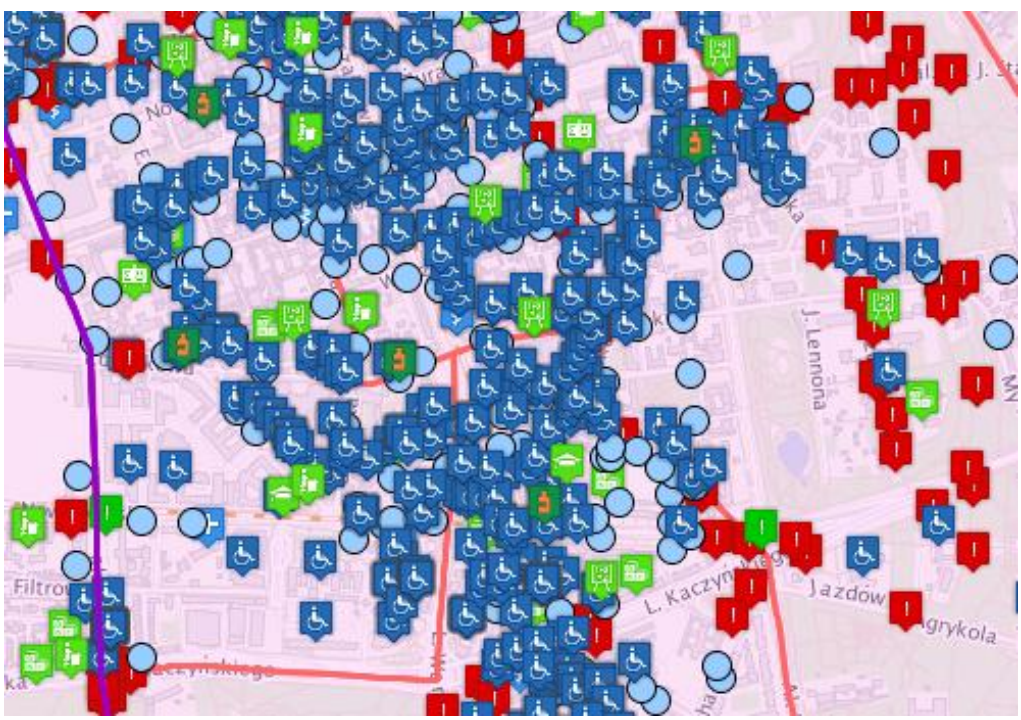

Fig. 6. A part of the map in the scale 1:16 000 in the *Warsaw Today* map service with data collections' elements : "Education", "Clean Warsaw" and "Accessible Warsaw" (http://www.mapa.um.warszawa.pl/, access 10.01.2019)

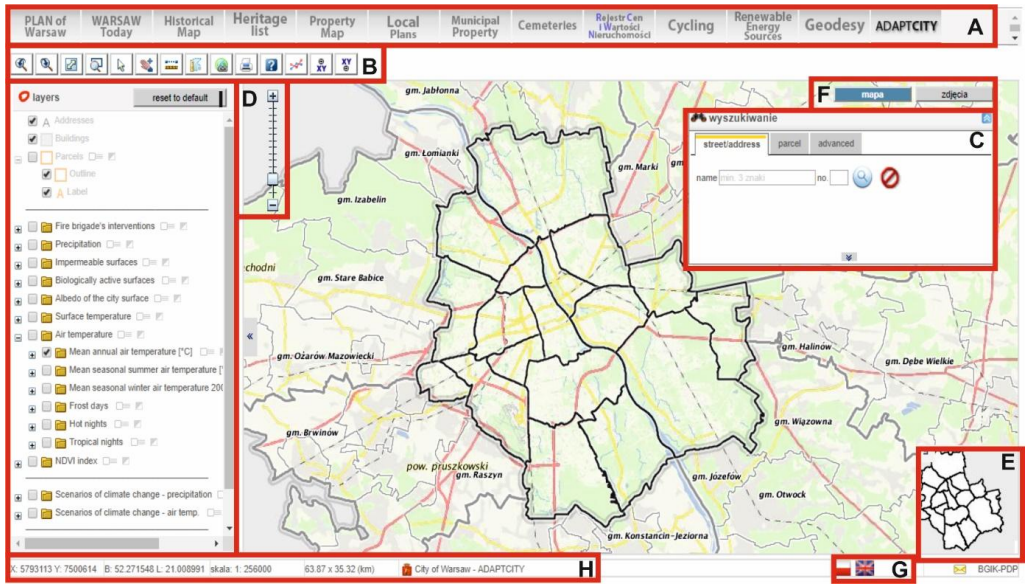

Fig. 7. Standard interface of the map services of Capital City of Warsaw (http://www.mapa.um.warszawa.pl/, access 10.01.2019)

Below, also in all map services, there is a toolbar with 14 buttons which activate the represented functions (fig. 7B and enlarged in fig. 8). There are navigation functions as well as simple analytical and selection functions: return to the previous view and proceed to the next view, return to the whole view, zoom in to the fragment selected with a rectangle, selection mode (only with point indication), pan mode, distance measuring mode (polygonal chain and straight line), perimeter and area measurement mode (polygon), creating a link to the map view, printing, help, finding the shortest route, searching for the geographical coordinates of the selected point, searching for a given point (according to the coordinates in the PUWG 2000 or WGS84 system).

Fig. 8. Toolbar located in the interfaces of all map services (http://www.mapa.um.warszawa.pl/. access 10.01.2019)

Each map service also includes a search function (fig. 7C), a zoom in/out slider (fig. 7D), a miniature view of the map (fig. 7E) and an option to change the base from a map to a photo (fig. 7F). Users can find a particular street/address, parcel, or a single layer in the layer sets using the advanced search option. These navigation functions can be considered standard for map service interfaces (D. Dukaczewski, A. Ciołkosz-Styk, M. Sochacki 2012). The first one allows to choose the appropriate zoom level in the map view. The second allows to quickly move the view to the indicated point by double-clicking. This makes it quick and easy to navigate maps in data sets.

Importantly, in all the map services a user also change the language version from Polish to English using intuitive flag buttons at the bottom of the interface (fig. 7G). The translation is complete, which means that almost every element, function and layer name is available in English. Thanks to this, the Warsaw map services can be easily used by foreigners –

tourists or city residents who do not speak Polish. In addition, at the bottom of the interface, there are windows which display in real time the coordinate values of the point indicated by the cursor (geographical and kilometre coordinates), the scale of the current map view, the name of the map service the user is currently using, and an contact email address (fig. 7H).

A panel of layers is available in 13 of 14 data sets. It also acts as a legend (fig. 7I). However, the layers panel is not available in the *Warsaw Plan of Warsaw* because it is not possible to change the visibility of any layer sets in this map service. Only the main map is available to the user.

This leads to the issue of another functionality resulting from the mentioned panel. It allows to switch the visibility of individual layer sets and layers on and off. The possibility of selecting the number of layers displayed on the map is very important. Thanks to this, each user can adapt the map to his or her preference in real time (J.-M. Kraak, F. Ormeling 1998). According to research, this feature in data sets is a highly desirable feature and significantly affects user experience (J.W. Crampton 2002). Turning on a single layer in Warsaw data sets takes place in two stages. At the beginning, one must select the option of displaying a higher level of data division in a map service (fig. 9 *Administration*). Then, by default, the visibility of all layers included in the selected set is turned on. However, there is also the possibility to reduce the number of displayed items by deselecting the selected layers. In the example in figure 9, only the layers *Embassies, Municipal offices, Office organisational units, Consulates, ZUS* (Social Security Office) *facilities, Courts, District offices, Offices of the Registrar of the Vital Statistic* and *Tax offices* will be displayed.

The number of checkboxes in individual Warsaw data sets ranges from 0 to 249. Of course, the highest number of checkboxes were in data sets with the most individual layers, e.g. *Warsaw Today* or *Historical Map*. This makes the possibility to adjust the map and limit the displayed content more important, which helps to avoid maps becoming illegible.

The *Plan of Warsaw* does not have the option to change the visibility of layers. This may be due to its intended use – mainly finding addresses, streets or objects. However, this has a negative effect on user experience, and editing layers and adding a panel could improve this.

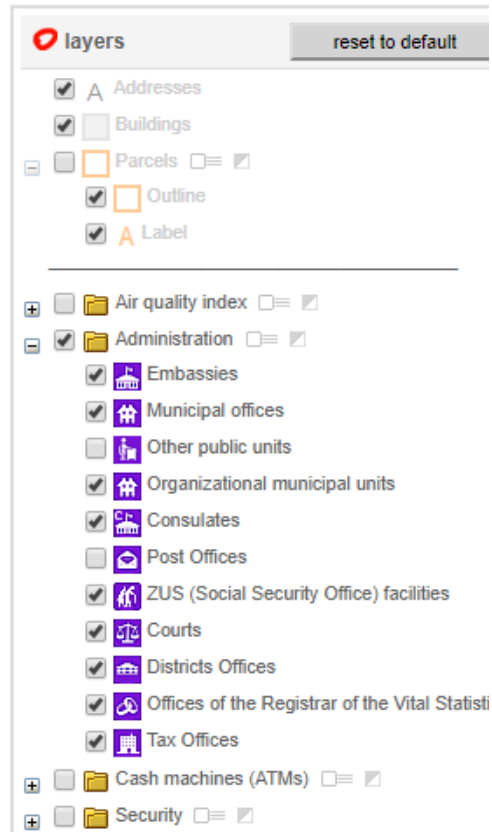

Fig. 9. A part of the layers management menu in the map services of Capital City of Warsaw (http://www.mapa.um.warszawa.pl/, access 10.01.2019)

4.2.3. Additional functionalities in Warsaw data sets

Three Warsaw map services include characteristic functions which have been included in the assessment. They are located in the following services: *Municipal Property* (one function), *Cemeteries* (two functions) and *Geodesy* (two functions).

In *Municipal Property*, the function is a search field used to find property for sale or rent (fig. 10). It turns on automatically after choosing this map service. The user can return to it at any time thanks to an additional button located in the upper toolbar. The search field allows to find and display information about properties for sale or rent. Users can find information about

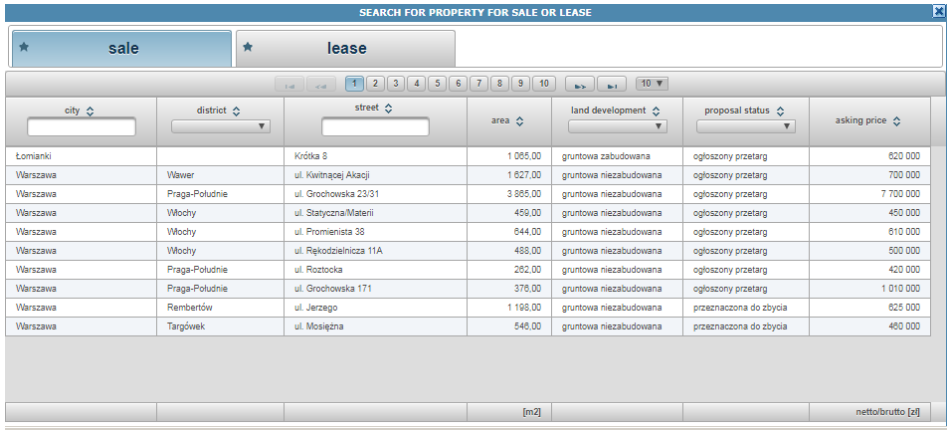

Fig. 10. An additional feature in the *Municipal Property* map service − a search field for finding properties for sale or rent (http://www.mapa.um.warszawa.pl/, access 10.01.2019)

the exact address of a property (including the district), the surface area, the development status, and the starting price. For those interested in purchasing or renting real estate in Warsaw, this seems to be a very interesting and useful tool.

The *Cemeteries* set include a list of cemeteries (fig. 11A) and a grave search field (fig. 11B). The first of these tools allows to select and zoom into a particular cemetery. This enables to quickly find a cemetery and find a route to reach it. The second tool is used to search for a grave based on the surname and first name of the buried, the identification number, or the date of death. As of the date of completing the analysis, this function applies only to four cemeteries in Warsaw. Its extension to other cemeteries would significantly improve navigation.

The *Geodesy* includes a search field for geodetic control network points (fig. 12A) and the option to display the scope of geodetic works on the map (fig. 12B). The first function uses a standard search engine included in every Warsaw map service. Thanks to the additional tab, users can search for a given point based on its number, the DER number (Work Records Logbook) or KEM (Material Records Book) number. For specialists and users interested in this information, access to detailed geodetic data is greatly facilitated by these functions.

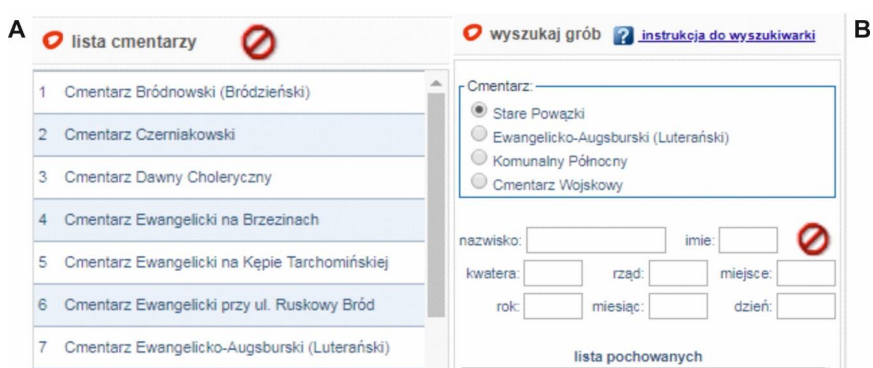

Fig. 11. Additional functions in the *Cemeteries* data map service: A – list of cemeteries, B – grave search field (http://www.mapa.um.warszawa.pl/, access 10.01.2019)

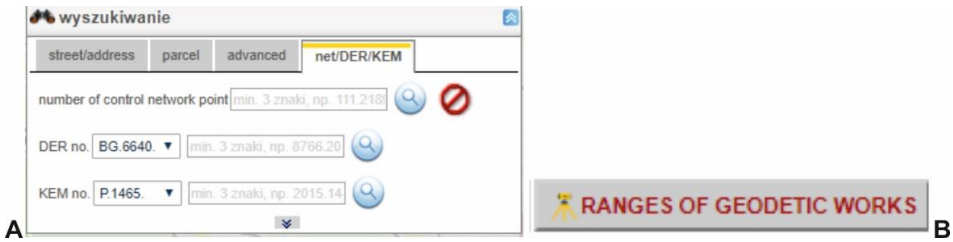

Fig. 12. Additional functionalities in the Geodesy map service: A – search field for geodetic control network points, B – button for displaying the scope of geodetic works (http://www.mapa.um.warszawa.pl/, access 10.01.2019)

4.2.4. Summary of the functionality criterion

Compared to the results of geoportal assessment in other similar studies, the position of Warsaw data sets can be considered average or good (tab. 3).

Warsaw map services have a satisfactory number of navigational functions (e.g. map miniature, zoom in/out, return to the whole view, zooming in the marked rectangle). In terms of display functions, these map services are also satisfactory. The panel of layers/legends and measurement tools – straight line, polygonal chain – is clear. As for the search options, each data set is equipped with an easy to use search window. It allows to find a street/address, plot, or specific layers using the advanced search option.

The functions of simple analyses are sufficiently represented, including distance and area measurements, route searching, and simple point selection (displaying information, e.g. the address of the element indicated by the cursor). Unfortunately, the lack of other selection tools is a disadvantage.

Warsaw map services lack functions related to layer management. Apart from the basic editing of the visibility of a layer or a set of layers (adding, removing layers), no interaction can be performed with them. Users cannot change the order of layers, affect their content, or download them as files (D. Dukaczewski, A. Ciołkosz-Styk, M. Sochacki 2012). These deficiencies are significant in comparison to the standards in contemporary map services.

To sum up, the number of functions can be assessed as satisfactory. However, if for longer and more detailed use of the data sets, the functions seem to be quite basic in relation to 2018 standards.

4.3. The accessibility criterion

The loading time of websites is one of the most important aspects affecting the experience and satisfaction of users. A result above three seconds may result in the loss of approximately 50% of potential users (Z. Padychova, 2017). A long loading time is included as one of the

Tab. 3. The number of functions in geoportals analysed by various authors (own elaboration)

Authors and the year of a study	Analysed map services	Number of functions
D. Dukaczewski 2007	voivodship map services	from 10 to 35
D. Dukaczewski, A. Ciołkosz-Styk, M. Sochacki 2012	regional map services of the selected European countries	from 5 to 37
J. Jabłonowski, I. Gołębiowska 2018	official map services of Capital City of Warsaw	from 26 to 32

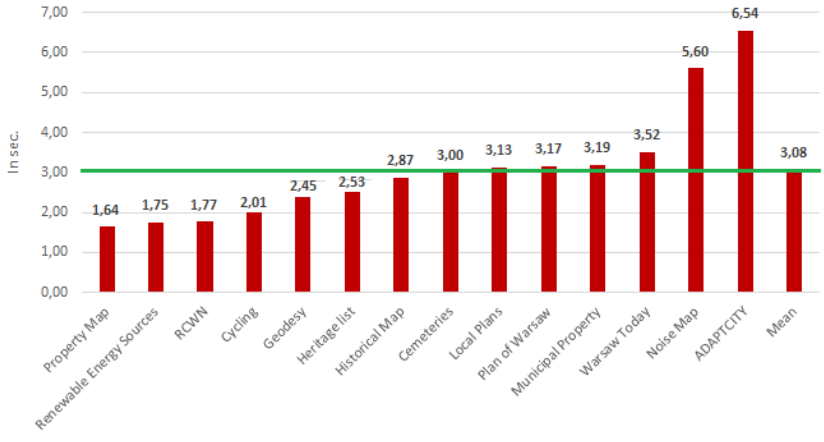

Fig. 13. The results of the average loading time measurement of particular map services performed as part of the accessibility criterion (own elaboration)

main factors affecting user satisfaction (X. He, H. Persson, A. Östman 2012).

When assessing the accessibility criterion, three measurements of the loading time of each map service were conducted from clicking on the hyperlink (on the page http://www.mapa.um.warszawa.pl/) to the point when all the interface elements were loaded. The measurements were carried out during one day, at three times: in the morning (9:38 am – 10:00 am), in the afternoon (4:30 pm – 4:40 pm) and at night (11:30 pm – 23:38 pm). Each measurement was preceded by calculating the speed of the Internet connection (download and upload speed) using SpeedTest (http://www.speedtest.pl/, access 10.01.2019). The average results of three loading time measurements of pages containing interfaces of particular data sets are shown in figure 13.

Eight data sets are below the critical value of the page loading time of 3 seconds, above which service can lose about 50% of potential users (Z. Padychova 2017). This is very positive information, and when using the Warsaw geoportal the user should not feel discomfort associated with a prolonged response time. The average loading time of all data sets only slightly exceeds the aforementioned limit and is equal to 3.08 seconds. The sets which loaded the fastest were *Property Map* (1.64 sec.), *Renewable Energy Sources* (1.75 sec.) and *RCWN* (1.77 sec.). On the other hand, the longest waiting time was noted for the *Noise Map* (5.60 sec.) and *ADAPTCITY* (6.54 sec.). These are relatively high values, and in the case of *ADAPTCITY*, it exceeded the limit of three seconds almost twofold. To some extent, these long loading times can be explained by the type of content in these two data sets. In both cases, they include quite extensive data.

4. Conclusions

This article presents the results of the assessment of the official map services of Capital City of Warsaw, which is a fairly extensive website with many features. The assumed goals have been achieved at a satisfactory level. The assessment was carried out at overall (one criterion) and partial (three criteria) levels and the most important related issues were described.

This is probably the first assessment of the Warsaw geoportal and can be a reference point and an introduction to the next study and evaluation of these map services in the future.

As already noted, the growing demand for spatial data and the development of available techniques and standards for the portals in which they are published requires an evaluation of these platforms. At the current rate of development, both data and functionalities need regular updates. So far (apart from the exceptions described in the article), the official map

services of Capital City of Warsaw can be rated as quite good in terms of the adopted criteria and compared to other spatial information systems.

During the analysis, the Warsaw City Office started certain activities aimed at familiarising users with data sets and encouraging them to contribute. In March 2018, a competition was announced which involved designing new functionalities for Warsaw data sets. This resulted in introducing a number of new layers in the map services. Therefore, it can be concluded that the Warsaw City Office is interested in the geoportal's development and popularization. In the following years, the significance and progress of these changes should be checked to ensure that the city achives the highest quality access to spatial data and can become a smart city.

Literature

Białousz S. (ed.), 2013, *Informacja przestrzenna dla samorządów terytorialnych.* Warszawa: Oficyna Wydawnicza Politechniki Warszawskiej.

Crampton J.W., 2002, *Interactivity types in cartography visualization.* "Cartography and Geographic Information Science" Vol. 29, no. 2, pp. 85–98.

Directive 2007/2/EC of the European Parliament and of the Council, 14 03.2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE), L 108/1PL 25.4.2007.

Dukaczewski D., 2007, *Wojewódzkie portale informacji przestrzennej.* "Roczniki Geomatyki" T. 5, z. 3, pp. 37–55.

Dukaczewski D., Bielecka E., 2009, *Analiza porównawcza krajowych geoportali w Europie.* "Roczniki Geomatyki" T. 7, z. 6, pp. 35–60.

Dukaczewski D., Ciołkosz-Styk A., Sochacki M., 2012, *Geoportale regionalne wybranych krajów Europy – studium porównawcze*. "Roczniki Geomatyki" T. 10, z. 4, pp. 77–98.

Gaździcki J., 2005, *Implikacje dyrektywy INSPIRE*. "Roczniki Geomatyki" T. 3, z. 3, pp. 19–27.

Głowacki G., Nowogrodzki L., Sosnowska K., 2005, *Koncepcja geoportalu regionalnego.* "Roczniki Geomatyki" T. 3, z. 3, pp. 169–173.

Gotlib D., Olszewski R., 2016, *Smart City. Informacja przestrzenna w zarządzaniu inteligentnym miastem*. Warszawa: Wydawnictwo Naukowe PWN.

He X., Persson H., Östman A., 2012, *Geoportal usability evaluation*. "International Journal of Spatial Data Infrastructures Research" Vol. 7, pp. 88–106.

Izdebski W., 2015, *Dobre praktyki udziału gmin i powiatów w tworzeniu infrastruktury danych przestrzennych w Polsce*. Warszawa: Geo-system Sp. z o.o.

Kraak J-M., Ormeling F., 1998, *Kartografia: wizualizacja danych przestrzennych,* Warszawa: Wydawnictwo Naukowe PWN, pp. 113–130.

Medolińska K., Gołębiowska I., Karsznia I., 2017, *Local GIS: development and assessment of the geoportal for local governments and local communities. Case study of small town in Poland.* "Miscellanea Geographica" Vol. 21, no. 4, pp. 1–8.

Padychova Z., 2017, *How page load time affects convertion rates: 12 case studies,* (https://blog.hubspot.com/marketing/page-load-time-conversion-rates, access 2.08.2018).

Pasławski J., 2010, *Kartograficzne metody prezentacji.* In: J. Pasławski (ed.), *Wprowadzenie do kartografii i topografii*, Wrocław: Nowa Era, pp. 196–234.

Salata T., Król K., Trysuła A., Koziński G., Skrzatek M., Dawid L., Deska K., Oberski K., Senetra A., Janiszek M., 2015, *Rola geoportali w rozwoju i polityce regionów.* Kraków: Wydawnictwo Uniwersytetu Rolniczego w Krakowie.

Siejka M., Ślusarski M., 2014, *Ocena geoportali internetowych powiatów na wybranych przykładach oraz według ustalonych kryteriów.* „Infrastruktura i Ekologia Terenów Wiejskich" nr 2, pp. 545–555.

Ustawa o infrastrukturze informacji przestrzennej, 2010, "Dziennik Ustaw RP" nr 76, poz. 489, pp. 1–17 (Act on Spatial Information Infrastructure).