# WEB MAPPING ERRORS AND THEIR TYPOLOGY.

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## Abstract

The Internet revolutionised the dissemination of information. The volume of information available on the World Wide Web has grown exponentially since 1992, when the first web browser was realised. Maps, as a preeminent means of recording and communicating information about the location and spatial characteristics of the natural world and of society and culture, represent a major component of the Internet traffic. Millions of maps are produced and used annually throughout the world by scientists, scholars, governments, and businesses to meet environmental, economic, political, and social needs. Maps allow us to convey information and findings that are difficult to express verbally, they could be used to convince and persuade, or even propagandize. But correct comprehension and interpretation of geographic information by a user requires the respect of the cartographic and semiotic rules during a map designing process. Unfortunately a lot of web maps are made by IT specialists or computer graphic specialists, who does not know the cartographic rules, what results in very low quality of web maps.

This paper examines errors that appear in maps published on web services held by public authorities at national or regional level (105 geoportal and about 1 000 maps). The research leads us to the conclusion that even maps available on the official governmental web map services are not free of errors. These errors occurred at all stages of web mapping, but majority of them is related to the processes of map editing and technical issues used for data visualisation.

## Introduction

The rise of the Internet, and especially the WWW during the 1990s, revolutionised the dissemination of information. The volume of information available on the World Wide Web has grown exponentially since 1992, when the first web browser was realised (Green and Bossomaier 2002). Information published online is accessible anywhere and by anyone, what means access to the relevant information is simpler and faster than in the past. Map, defined in ISO 19 198 Geographic Information – Web Map Server Interface (2005), as a portrayal of geographic information in a form of a digital image

file suitable for display on a computer screen, represents a major component of Internet traffic. People look to the Internet to find all manner of maps and the Internet has clearly become the new medium for cartography. The questionnaire survey conducted in 2008, in Poland shows that Google Maps came in first with nearly 22% of users (comparatively in US Google Maps has the second position and 42% of users) followed by the Polish web map location service zumi.pl. The fifth position took the Polish version of Map24 (Map24.interia.pl) just more than 3.5% (table 1).

Table 1. Web map sites users in Poland

| No | Web map site | Real users | Maps per day | % |
|---|---|---|---|---|
| 1 | Google Maps | 3 229 020 | 11 273 417 | 21.25 |
| 2 | Zumi.pl | 2 852 345 | 28 584 144 | 18.77 |
| 3 | Szukacz.pl | 1 198 416 | 4 097 939 | 7.89 |
| 4 | Targeo.pl | 588 917 | 2 990 913 | 3.88 |
| 5 | Map24.interia.pl | 543 686 | 25 414 035 | 3.58 |

¸*source: Megapanel PBI/Genius, July 2008 http://www.internetstandard.pl/news/print.asp?id=168052*

Maps are becoming a pervasive part of the Web. They are being used to provide information, for marketing, for reference in ways that were difficult to imagine only a few years ago. The number of web map services increases from one year to the next. It is inextricably linked with such advantages of web maps as: easy deliver up to date information in graphic form, free available and easy to operate software for the Internet map browsing and using, possibility of personalisation, collaborative mapping and support hyperlinking to other information on the Web. While map use has expanded rapidly with the new medium, the quality of Internet maps have not evolved appreciably over the last decade. Moreover Peterson (2008) finds „**all** is not well in the world of maps and the Internet".

This paper examines errors that appear in masp published in WMS technology on web services (so called geoservices or geoportals) held by public authorities (any government or other public administration) at national or regional level.

## Objectives and methodology

Governmental or other public administration web pages are perceived as a reliable source of information, also geographic information. Therefore available data should be complete and updated and the way that data is published on the Internet (e.g. maps, graphs, tables) should be suited both for data and for users.

At present, almost all governmental and public administration web pages have incorporated web map services and offer a set of thematic layers, composed a map, to users. The main objective of the study is an analysis of conformity of maps presented on

governmental or other public administration web map services with cartographic play of arts. Analysis was done on the three fields:

(1) the element of map layout (body of the map, legend, marginal information, hypertext),
(2) the type of errors,
(3) the stages of map production (map concept, data collecting, data transformation, map editing, visualisation).

The survey of over 100 geoportals, authorised by the public authorities at national or regional level in the European countries, was done in March-April 2009. This study follows up previous research works on methods of portrayal spatial data on web services (Baranowski at al 2009; Dukaczewski, Bielecka 2009) Particularly there were analysed (almost 1 000 maps) published on the following official web map services:

28 European national geoportals,
40 regional geoportal and
37 thematic geoportals (e.g. geological, forest, environmental, meteorological).

All maps were carefully examined due to correctness of the cartographic methods used for portrayal qualitative and quantitative data as well as the proper design of the map. Observed errors were classified into two groups based on a type of error and a “place” where an error occur. Twelve types of errors were observed:

1. Lack of data completeness,
2. Lack of data harmonisation,
3. Planimetrically incorrect,
4. Incorrect usage of cartographic presentation method,
5. Incorrect usage of combination of cartographic presentation methods,
6. Incorrect usage of visual or/and dynamic variables,
7. Incorrect usage of combination of visual or/and dynamic variables,
8. Errors of isometry,
9. Syntactic errors,
10. Semantic errors,
11. Pragmatic errors,
12. Functional (operational) errors

According to the “place” within a map all errors were grouped into:

A - Map errors
B - Legend errors
C - Marginal information errors
D - Errors of hypertext, visual benchmarks or other supplementary utilities.

Having registered all types of web map errors the second step of the research aimed at an anticipation of the stage of web map production process where the error occur for the first time as well as the influence of each groups of the errors on users perception.

## Results and discussion

### *European national geoportals*

Geoportals in the European countries are created according to the INSPIRE Directive regulation. The geoportals provide the means to search for spatial data sets and make available relevant, harmonised and quality geographic information to support formulation, implementation, monitoring and evaluation of policies and activities, which have a direct or indirect impact on the environment (Directive 2007).

So far, the very beginning stage of the implementation of INSPIRE Directive, the thematic scope of presented geographical data is limited mainly to data listed in the Annex I and Annex II. That is, topographic data (settlement, water bodies, transport network), DTM, cadastral data, geographical names and ortoimagery. Geoportals handled generally by National Mapping Agencies mirror cartographic methods used for traditional paper maps. Maps are correctly and well design, the only problem is lack of data or lack of data harmonisation (fig.1).

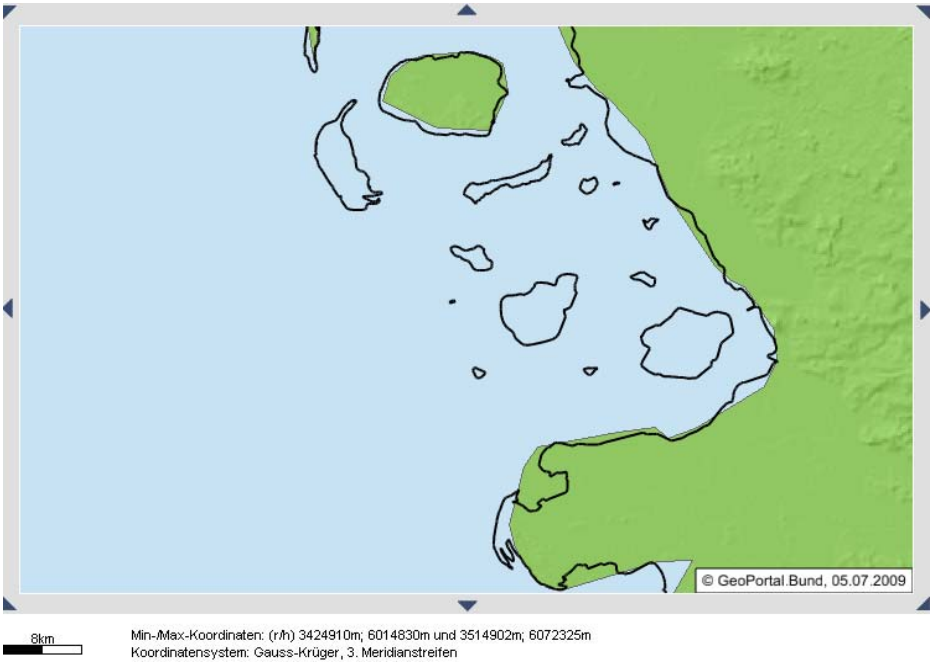


Fig. 1. Lack of data harmonisation (data stored in an administrative boundary data set differs in location from data stored in an oceans data set)

***Regional geoportals***

Web maps available on regional geoportals differ both in themes and cartographic methods of presentation. The maps present generally administrative units, transport network, water bodies, settlements, digital terrain model, spatial organisation or physical planning, tourist information, protected area, demographic data (such as: population density, unemployment), and area for investment. It is assumed that the main user of those maps is a tourist or an investor and a citizen. So, the cartographic presentation methods used for a map elaboration are rather simple. The most frequently symbol maps (327 maps out of 525) and chorochromatic maps (115) were used. The other methods were: range map (75 maps), quantitative area choropleth maps (8 maps).

Although web maps available on regional geoportals employed rather simple cartographic methods they are not free of errors. The most frequent error (see table 2) is lack of information concerning the scale of a map, lack or incomplete legend and a lot of errors connected with text editing (size, place, overlapping, direction). Some examples are shown below.

Table 2. Frequently occurring errors on maps presented on regional geoportals

| Type of error | Number of map |
|---|---|
| Size of symbols | 16 |
| Overlapping symbols | 23 |
| Errors of colors selection in chorochromatic map | 2 |
| Lack of legend | 24 |
| Incomplete legend | 29 |
| Lack of scale | 69 |
| Errors in text editing | 48 |

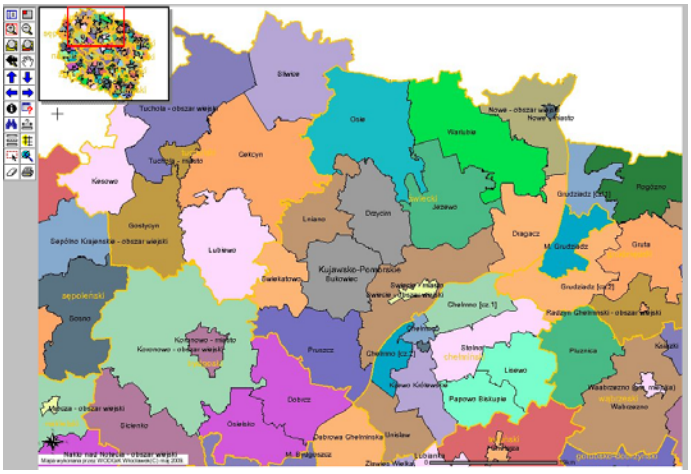

Fig. 2. An example incorrect map showing units of different level of administration

The figure 2 illustrates how a web map should not be elaborated. The number of errors in this map is remarkable:

(1) incorrectly applied choropleth method (the same color of two adjacent administrative units),
(2) error in text editing:
    a. name of lower level administration units are to small, and not scalable,
    b. name of upper level administrative units should be black and bigger,
(3) borders of upper level administrative units should be black (the same as lower level units) and wider,
(4) the map scale is hardly noticeable,
(5) lack of information about map projection and coordinate reference system.

Frequently regional public bodies consider a web map as a medium for marketing to attracts tourists or investors. Hence, map symbols are big and flickering as it is shown in the fig. 3.


Fig. 3. Not scalable, too big and flickering symbols

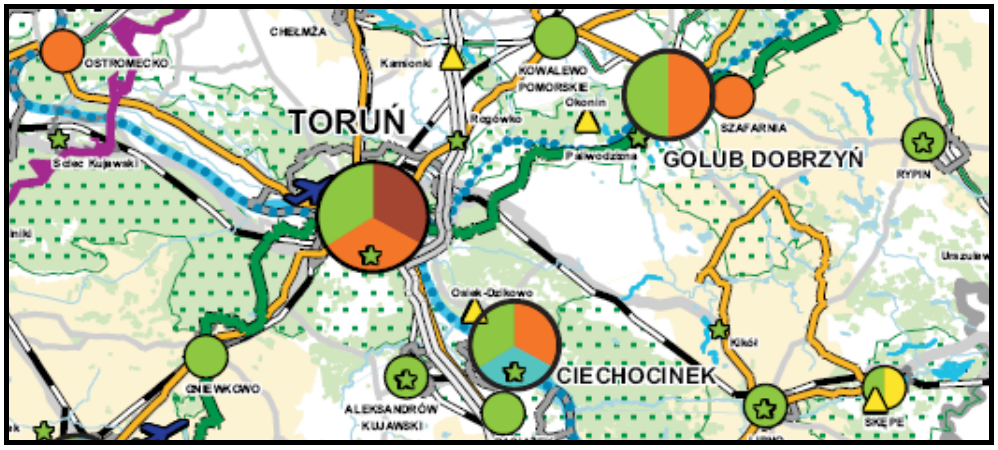


Fig. 4. Overloading of information

The next example (fig. 4) illustrates information overload and incorrect combination of cartographic methods. A topographic map creates here the background for tourist information (e.g. blue dots line means water tourist route), diagrams show structure of tourist traffic and are overlaid! with green star symbols showing location of allotments. Additionally line symbols are not intuitive (e.g. white and green symbol for non operating railway). This map is rather misinforming.

**Thematic geoportals**

Maps available on 37 thematic geoportals applied almost all cartographic methods both static and dynamic, but dominate contour line, symbols (point, line and areal), and chorochromatic maps. Generally thematic maps are well design, and there are no errors connected with proper selection of a presentation methods. The most common errors are:

- incorrect generalisation,
- incorrect graphic hierarchy,
- lack of point symbols calibration,
- errors in text size and placement,
- lack of legend or incomplete legend.


Fig. 5.Incorrect graphic hierarchy – all level crossings are presented as multilevel

**Multifactor errors typology**

The analysis of types of the error occurring in different elements of map layout of EU national, regional and thematic geoportal WMS maps, as well as the estimation of the stage of the map production process where these errors were made, allowed us to elaborate the multifactor typology of errors. The typology includes also the assessment of the influence of map errors on quality and legibility of cartographic information communication (fig 6).

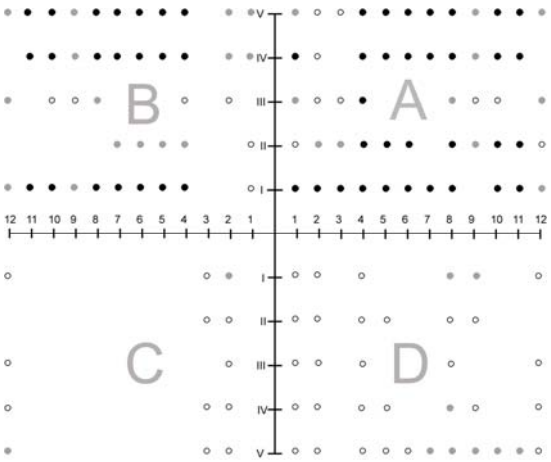


Fig. 6. Multifactor typology of web map errors

- Errors which can strongly distort the information and are very hard to detect by misleader reader
- Errors which can distort the information and generally are difficult to detect by reader
- Errors which can mislead the reader and are relatively easily detectable

I) Errors of map concept
II) Errors of data collection and data quality assessment
III) Errors of data transformation
IV) Errors of map editing
V) Errors of visualization

A. Map errors
B. Legend errors
C. Marginal information errors
D. Errors of visual benchmarks, hypertext, etc

1. Lack of data completness
2. Lack of data harmonization
3. Planimetrically incorrect
4. Incorrect usage of cartographic presentation method
5. Incorrect usage of combination of cartographic presentation methods
6. Incorrect usage of visual or/and dynamic variables
7. Incorrect usage of combination of visual or/and dynamic variables combination
8. Errors of isometry
9. Syntactic errors
10. Semantic errors
11. Pragmatic errors
12. Functional (operational) errors

Analysis of errors has proved that the most significant errors are these of incorrect usage of cartographic presentation method (and/or its combination), visual and/or dynamic variables (and its combinations), errors of isometry, semantic and pragmatic errors. These errors can strongly distort the information and are relatively hard to detect by reader. They can be made especially during the elaboration of a map concept (AI4-8, AI10-11) and a legend concept (Bi4-8, 10,11) data collection and data quality assessment (AII4-6, AII8, All10, 11), data transformation (AIII4), as well as map & legend editing (AIV4-8, AIV10-11, BIV4-8, AIV10-11) and map & legend visualization (AV4-8, AV10-11, BV4-8, AV10-11). Significant errors can also be made during the elaboration of a map concept when lack of data completeness (AI1), lack of data harmonization (AI2), planimetric incorrectness (AI3) are observed.

The second group of errors consists the errors, which can distort the information and generally are relatively difficult to detect by many of potential readers. They are syntactic errors at the stage of elaborating of a legend & supplementary utilities concept (BI9, DI9), errors of data collection and data quality assessment (AII9), map & legend editing (AIV9, BIV9) and visualization (AV9, BV9, DV9); operational errors (AI12, BI12, AIII12, BIII12, AV12, BV12, CV12) and lack of data completeness errors (AIII1, BIV1, BV1). They can appear also when lack of data harmonization (AII2, BIV2, BV2, CI2), lack of planimetric correctness (AII3), incorrect usage of cartographic presentation method, visual or/and dynamic variables and its combinations (BII4 - 7), errors of isometry (AII8, AIV8, AV8, BIII8) are observed.

The errors of third group can mislead the reader, however they are relatively easy to detect. Big part of them are lack of data harmonization and planimetric correctness, which can make the new errors at the stage map editing and visualization as well as in many stages of elaboration of supplementary utilities.

The multifactor typology of errors is the starting point to elaborate the guideline for control procedure for designing web maps. The procedure should be based on iterative detection and rectification of three-grade assessed errors of 12 types, concerning map, legend, marginal information and supplementary utilities, and corresponds to the V stages of map production (fig 6). Each stage of the procedure should be dedicated to detection and rectification of the three-level graded errors of 12 types inside the 4 elements of web map layout, as well as to verify and harmonize the relationships between map and legend, marginal information as well as supplementary utilities. The procedure is at the test stage, abd will be published probably at the end of this year.

## Conclusions

The conducted research lead us to the conclusion that even map available on official governmental and self-governmental web map services are not free of errors. These errors occurred at all stages of the web mapping process, but majority of them is related to the processes of a map editing and technical issues used for data visualisation.

The process of a web map production and design, involves a series of activities starting for the definition of the type of web map to be created (dynamic or static) including the implementation techniques, which allows the interaction between the user and the map.

To reduce the numbers of web map errors it is necessary to elaborate detailed guideline for a web map designing including some hints and control procedures. The work demonstrates that multifactor typologies of errors can be a good starting point for elaboration of the control procedures supporting the designing of the web map.

So far, most web maps mirror the organization and features of paper maps and atlases. The most common type of map found on the public administration geoportals is the static interactive, called by Kraak (2002) as 'clickable' maps. This type of map can function as an interface to other data. Alternatively it could allow the user to define the contents of the web map by switching layers off or on.

The role of the cartographer and GIS technologist is changing from the producer of a product to someone guiding the production process. Many challenges remain to make sure that users don’t produce erroneous, misleading maps.

In the context of geospatial data handling, the cartographic visualisation process is considered to be the translation or conversion of geospatial data from a database into map-like products.

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