TOPONYMS PLACEMENT ON WEB MAPS

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ABSTRACT. The presence and use of Web maps has become a common necessity of a large number of users of various occupations and professions. Toponyms placement problem on web maps is still not well solved, and remains problem both for users and for cartographers. Specifically, toponyms placement on web maps is deviates from the set of cartographic principles, and also not in compliance with cartographic visualization and cartographic generalization. The work on practical examples shows the problem and provide solutions to web map toponyms placement. It is proposed a simple method for decision making of the display or suppress a toponym in his possible complex environment with all other cartographic elements and layers, as it is common on web maps.

Keywords: toponyms, placement, web maps, cartography

1. Introduction

Toponyms are individual names of different geographic objects. The set of all toponyms makes heritage of all mankind. Toponyms are important map content and GIS content are one of the most important elements of special database. From cartographical aspect extremely important to know the toponyms that names, but also interpret individual state (teritorionyms), regions (regionyms), relief forms (oronyms), world seas and waters (mareonyms), land water (hydronyms), inhabitat places and their parts (domicilonyms or oikonyms), roads (hodonyms), islands (nesonyms) etc. Nowadays web maps are very popular and map servers allow the user to combine many layers. Some layers have text associated. It is unfeasible to pre-compute all label arrangements, and in other words we need fast ways to generate good quality maps for web map servers. The scientists in previous works (Wolff and Strijk, 1996) mostly dealt with the problem of toponyms placement assuming that the text is horizontal and that it belongs in most cases besides point object (e.g. centroid settlements) or explains it. Map labeling is the problem of placing a set of labels, each in the vicinity of the object that it labels, while satisfying certain conditions where text labels must be placed on maps while avoiding overlaps with cartographic symbols and other labels. For example, trying to partly solve the problems of narrow specialization of individual cases of placement of toponyms on the map, as in Hirsch (1982), Yamamoto et al. (2005), Christensen et al. (1995), although the authors of this study believe that the map should always be seen as a whole and not as individual layers from which the map is made. The problem is usually simplified to several possible types of label displacement with the basic requirement of avoiding toponym overlap (Klau 2002). Different methods are more or less successfully solving label placement problem, but when we look at some examples of today's most popular web maps, then one realize that the problem remains, and that even generalization of the displayed content is not correct if one is not reconcile with the fact that the provider gives us the type of data he provides, and which is also quite different when viewed to close range map scale. Web maps must be legible, toponyms must not overlap and toponyms must be clearly associated with the features they annotate. The remaining problem for offered solutions so far is time consuming aspects for map production or visualization on web.

2. Labels should not overlap

A basic requirement in map labeling on web maps or any other kind of maps is that labels are not allowed to overlap (Figure 1). That is relatively easy to achieve, but as a consequence, it may not be possible to label all objects on a map. Another cartographic assumption is: *Every toponym represents only one object on the map* (e.g. point). Cartographers have always try to simplify names locations, e.g. in only 4 possible positions (Figure 2).

Figure 1. *Overlap – significant error for toponym placement should be avoided (i.e. each label optimum among alternatives).*

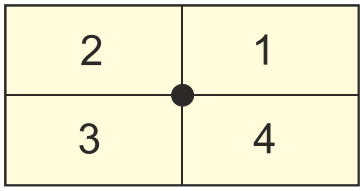

Figure 2. *Potential label positions and their cartographic preference (best = 1; worse = 4).*

If this idea expands with the combination with some other possible positions than there is usually two models, one is called *fixed-position models* and *slider models* (Van Kreveld et al. 1999), Figure 3. In fixed-position models, each label has a predetermined finite set of anchor points on its boundary (e.g., the four corners), and the label must be placed so that one of its anchor points coincides with the site of the feature to be labeled. In slider models (Figure 3), the anchor points form anchor segments on the boundary of the label (e.g., its bottom edge).

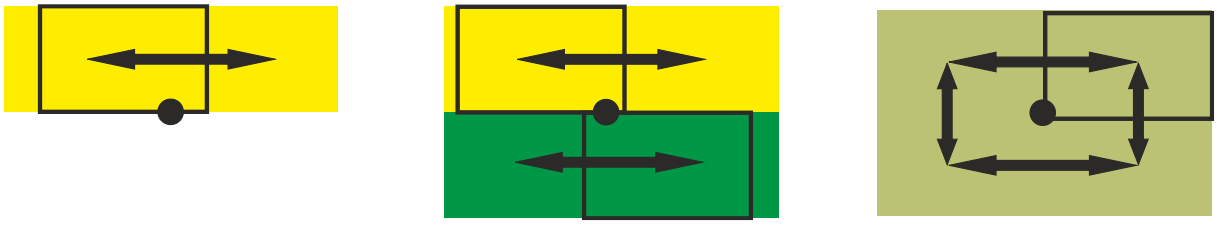

Figure 3. *Slider models and possible positions.*

Possible solutions are multiplying (Figure 4) with 2n combinations and because of that interactive speeds for web map servers are non-trivial.

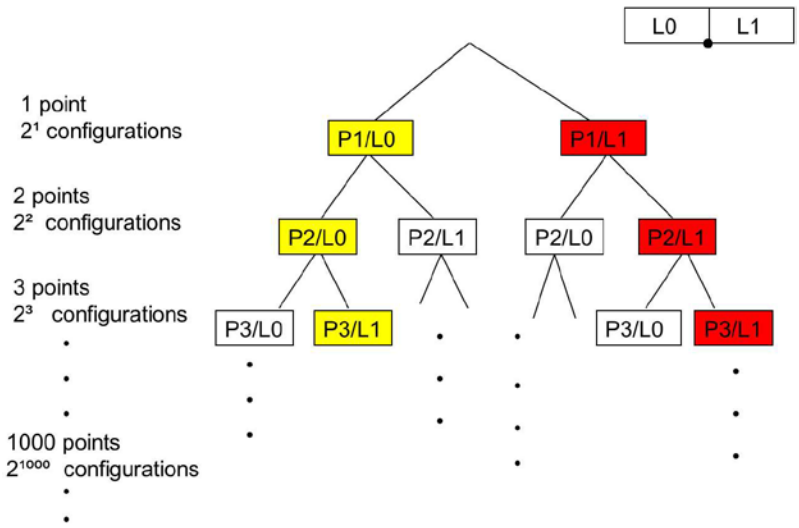

Figure 4. *The combinatorial explosion of possible solutions (Yamamoto et al. 2005)*

3. Previous research

There are various previous studies about resolving lebel placement, and other map situations with toponyms, like in Alvim and Taillard (2009) for different label placement task. First, the object to be labeled may have several different dimensions:

- Dimension 0, labeling point features (such as cities and mountain peaks),
- Dimension 1, labeling line (segment) features (such as rivers and roads) and
- Dimension 2, labeling area features (such as countries and oceans).

Been et al. (2006) focus on rules about label size invariance property where each label on screen has a fixed size that is in variant under zooming. There are three rules which are common for web maps. Labels should not vanish when zooming in, and not appear when zooming out. The distance a map feature and position of its label should vary monotonically and labels must not vanish or appear during panning except through sliding in/out of view. Display of any label is a function of state (x,y,s) so not dependent on how the view was obtained. There is also a definition of priority labels also with no conflict with other labels of the same level of priority (Poon et al. 2003).

Good dynamic labeling, regardless of the features being labeled, leads to combinatorial optimization problems that are generally NP-hard (NP-complete decision version), like in Kato and Imai (1988), Marks and Shieber (1991), Formann and Wagner (1991). Exact algorithms are able to solve problems with just a few hundred points to label (Cromley 1986, Klau 2002, Strijk et al. 2000 and Zoraster 1990 and 1991). Therefore, heuristic algorithms must be designed for dealing with larger problems or for getting approximate solutions with low computational effort. Wolff and Strijk (1996) bring complete bibliography on map label placement.

4. Common errors of toponym placement on popular web maps

On the web there are lots of local and global web maps that are using different technologies for dynamic visualization. We will focus on most popular and global web map servers like *Google Maps, Google Earth, Ask Maps, Navteq and OpenstreetMap*.

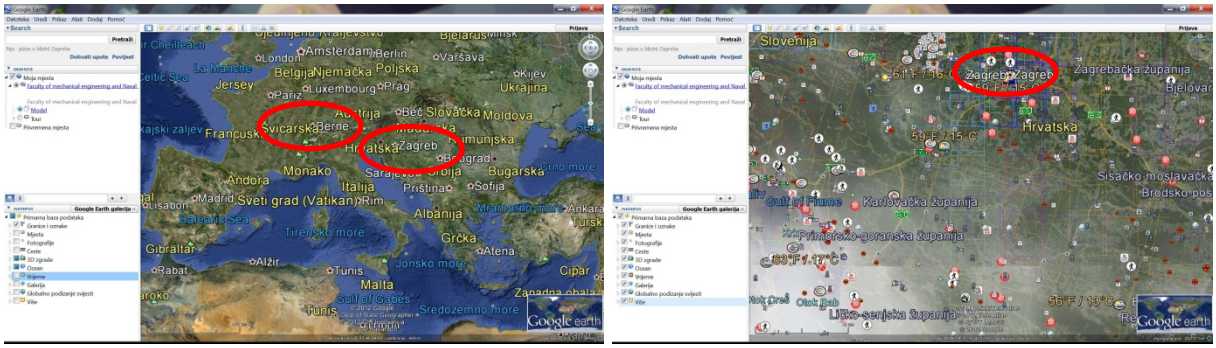

Figure 5. *Google Earth and common errors of label placement (left figure – shows overlaps and the right figures shows duplicate toponym).*

There is no answer from *Google* about model of label placement they are using, but it can be observed that label overlap is common (Figure 5-left) or that there are cases of duplicate toponyms (Figure 5-right). There are some more observations about *Google Earth*, shown on Figure 6 where legibility is very questionable because of overlaps with all layers turned on.

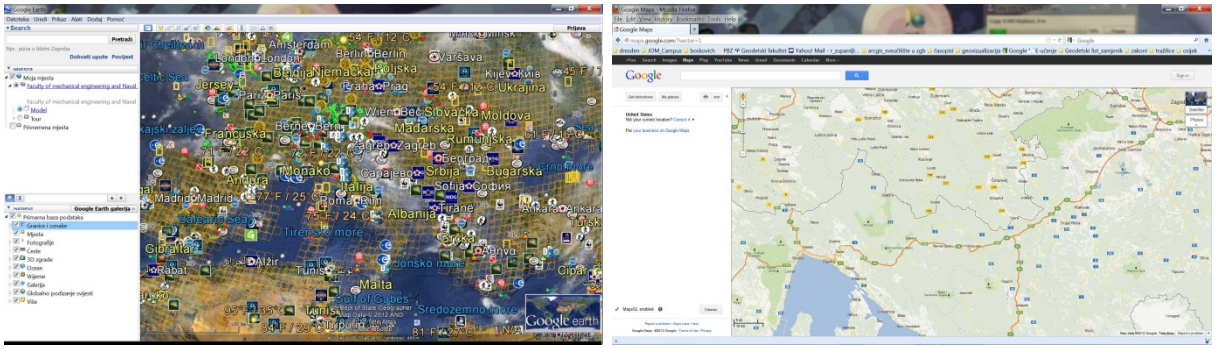

Figure 6. *Left – Google Earth with many overlaps with all layers turned on. Right – Google Maps (URL 1) with different label generalization degree between Slovenia and Croatia.*

It's important to have a purpose and focused intent of the web map. Must be carefully considered which data layers are truly needed for the map. There is a tendency to overload as many geographic layers as possible into a single web map. Only interesting and relevant geographic information should be provided and don't make it an “All-in-one Web Map”.

At *Ask Maps*, cartographic web service which use maps from Nokia and Microsoft (identically as Bing Maps) has one visible error of outstretching toponyms along relief forms (oronym) and region (regionym) that is visible on Figure 7 from Ask Maps (URL 1). “Velebit Mauntains” is not Croatian word and it would be correct to stretch oronym along the mountain. Although other toponyms are in Croatian language. Since there is no possibilitie to select any aditonal layers there seem to be plenty of space on the map that is not filled with place names, with consideration not to exaggerate the graphics density for the current map scale. In other words there is still plenty of space on the map for other toponyms. Regionym “Balcan Peninsula” is not there where it is shown on Figure 7. It is much wider area and it should be shown only in smaller scale when map shows all the area of *Balkan Peninsula* on the map. In addition there is the obvious and most frequent mistakes of toponyms, when the name is misspelled. Instead of "Ličko Leše" should be "Ličko Lešće."

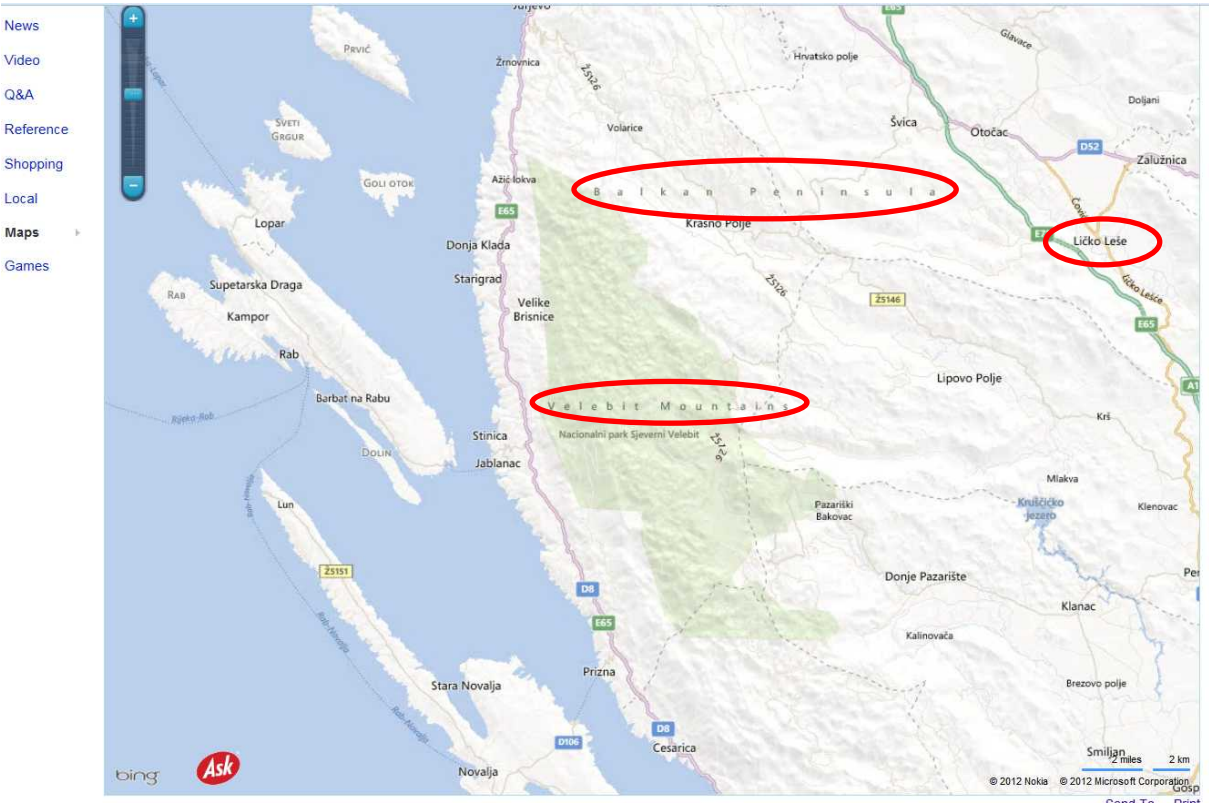

Figure 7. *Ask Maps web map servis with map from Nokia and Microsoft and their misrepresentation and toponym visualization, URL 2.*

Navteq map has two basic errors that are immediately apparent (Figure 8). One is the lack of characteristic letters of local language when displaying toponyms, and the other is showing places and their names, to which does not lead any roads. They should be displayed in the same map scale as the roads leading to them.

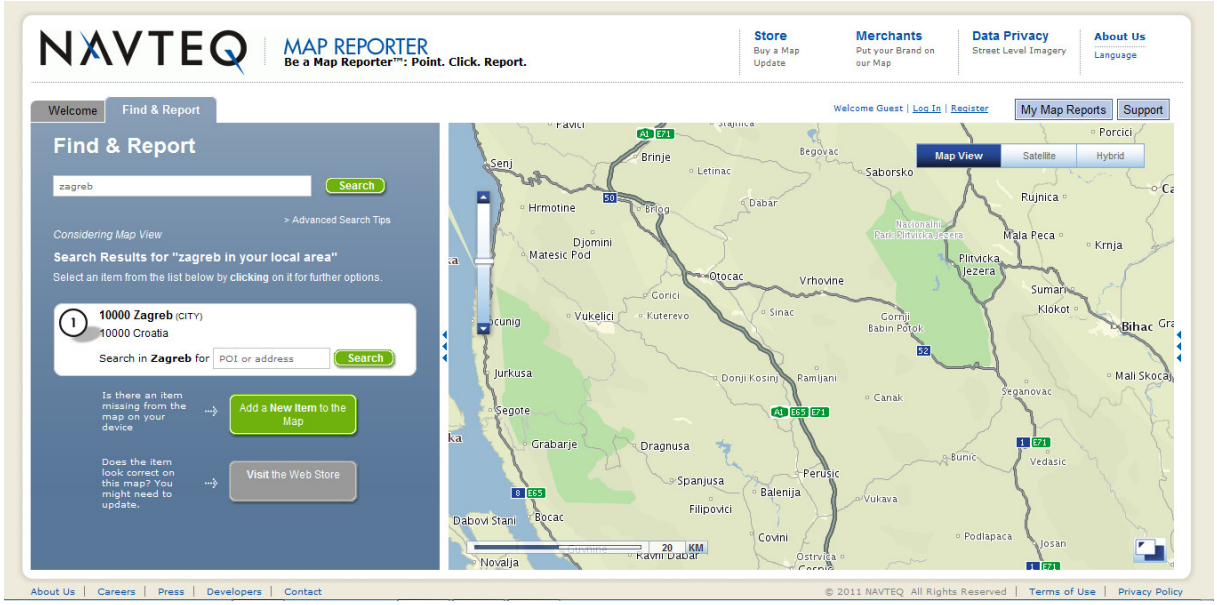

Figure 8. *Navteq map with no characteristic letters for map toponyms of individual countries (e.g. for Croatia there is no characters like š, đ, č, ć, ž), URL 3.*

There is also an interesting example for *OpenstreetMap* (URL 4) where anyone can see (Figure 9) that in small scale there is an area which have no name – in the upper right part of the map with red hatch lines and other one in the lower midle part with name “Nacionalni park Sjeverni Velebit”. There is a plenty of space for placing toponym in the first area, but when zooming the name still appears. Solution is the same as mentioned for “Balkan Peninsula”. Name also reveals that it is a military polygon (Figure 10). In web map services like *Openstreetmap* (and many more similar like this one that are on web nowadays) where anyone can set geospatial information on the map, still remains question about secrecy of military locations and their objects. Can anything anymore on Earth surface be a secret?

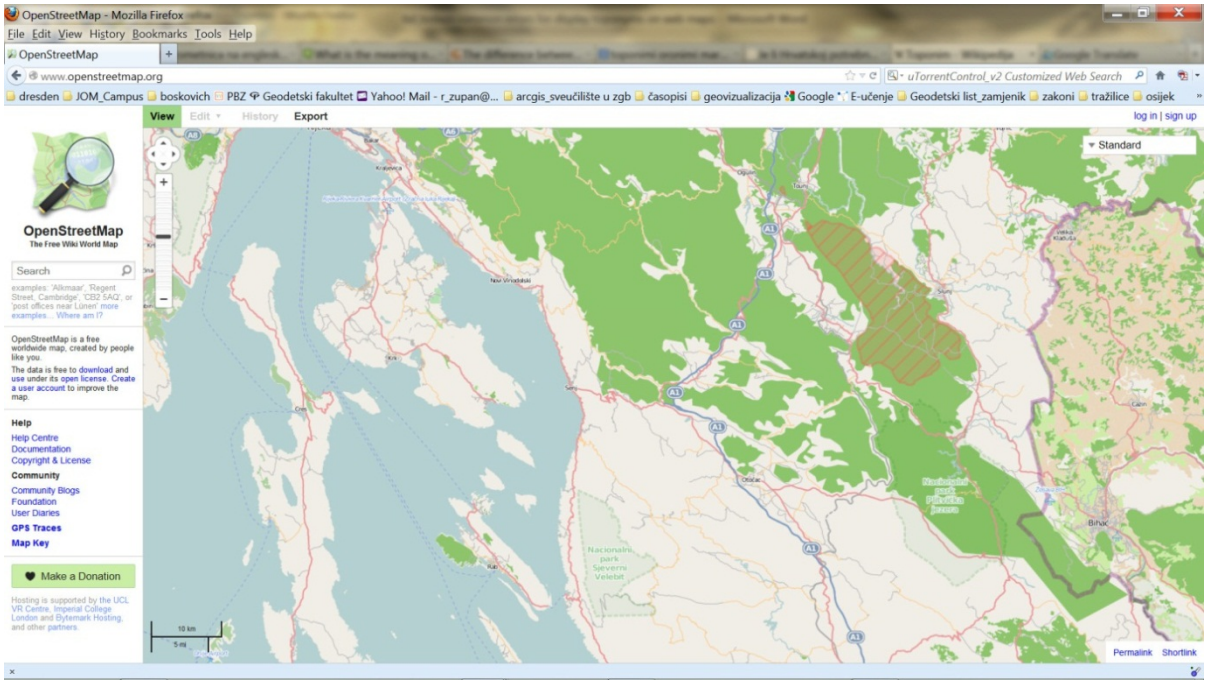

Figure 9. *Big areas in Openstreetmap and some toponyms are shown on the map but some are not until zooming in.*

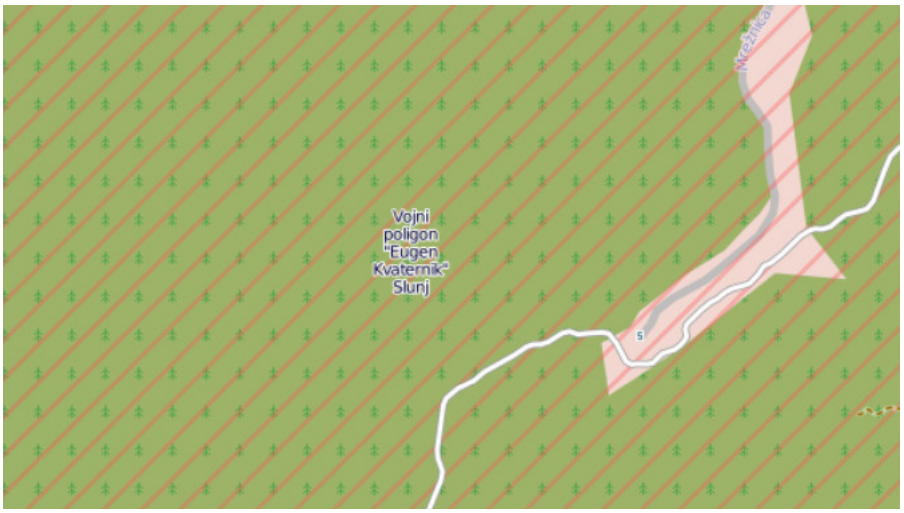

Figure 10. *Large area toponyms appear only after zooming in particular part of this area.*

Why persistently visualize toponyms on web maps with so small letters, which are barely visible, if on the map are displayed only few toponyms in a certain scale while the map has plenty of space for larger toponym to display, why is persistently displayed with so small letters that they are almost barely visible with the minimum sizes? This would mean that the computers cannot predict or calculate the amount of free space around toponyms?

5. Possible solutions

One single error occurs in all these web map service providers when displaying maps, and this is the wrong toponyms visualization on the edges of maps where they are presented to be continued beyond the map frame, so they are not complete and legible. This requires additional efforts and manual map movement and it's certainly something that needs to be corrected. This kind of fault is not visible on the paper maps. Mathematical model for the correction of such toponym presentation on web maps will be explained in the paper. It can be corrected by setting the mathematical condition that toponym are not displayed if the whole word does not fit into the map frame i.e. condition with a rectangle which include the entire toponym within the rectangle frame, Figure 11. That would mean that little rectangle around toponym is at least as high, as initial capital letter of toponym, but then another error would occurre e.g. a small letters in toponym that are not exceeded map frame and written under rotation angle are not visible. To avoid this error once again the same condition should be included in the mathematical model, but with a small rectangle (with a height as lowercase toponym letter). These two conditions do not cover cases of toponym placement when letters follow curvature, but is can be solved with the same condition with one difference and that is with a rectangle for each letter of the toponym (whether there is a rectangle inside of the map frame or not). Also need to take into account the priority of each group toponyms in relation to all other objects on the map (hierarchy).

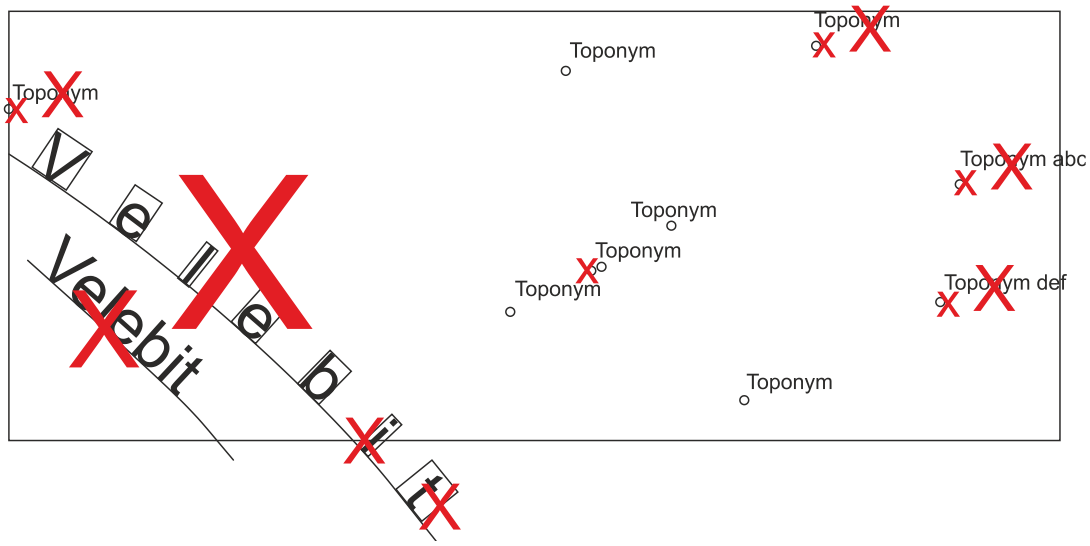

Figure 11. *Experiment and the decision to visualize or suppress toponyms.*

Finally should be mentioned that the presented solution and even the solutions in the previous studies might not be good for the visualization of the longest toponym in the world on web map. It is "Krung Thep Maha Nakhon Amon Rattanakosin Mahinthara Ayutthaya Mahadilok Phop Noppharat Ratchathani Burirom Udom Ratchaniwet Mahasathan Amon Phiman Awatan Sathit Sakkathattiya Witsanu Kamprasit" or in local version "กรุงเทพมหานคร

อมรรัตนโกสินทร์ มหินทรายุธยามหาดิลก ภพนพรัตน์ ราชธานีบุรีรมย์ อุดมราชนิเวศน์ มหาสถาน อมรพิมาน อวตารสถิต สักกะทัตติยะ วิษณุกรรมประสิทธิ์". This represent full name of Bangkok in Thailand. Map visualization of this toponym should be affected by toponym priority or should be presented in short version – *Krung Thep*.

6. Conclusion

Till now there was a lot of progress of the toponyms placement on web maps, but the problem is complicated in the moment when one need to take into account the map as an entirety with all the layers, visual variables and importance of certain objects on web maps with multi-zooming possibilities. The problem is not entirely solved by various mathematical models that have so far suggested scientists with all the improvements, so maybe cartographers should change the way of thinking and try to find solutions within the artificial intelligence and its various techniques, particularly at a time when artificial intelligence is developed to the point where a computer with artificial intelligence has the ability to learn from his own mistakes and from the previous examples. Also it should be bear in mind that this is a method for approaching ideal placements but ideal toponym placement is not a feasible and errors may appear within label placement of toponyms but also with errors of cartographic visualization.

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