Title

A comparative study of existing multi-scale maps: what content at which scale?

Journal

International Conference on GIScience Short Paper Proceedings, 1(1)

Authors

Dumont, Marion
Touya, Guillaume
Duchene, Cecile

Publication Date

2016

DOI

10.21433/B3112993d46

Peer reviewed

A comparative study of existing multi-scale maps: what content at which scale?

Marion Dumont[1], Guillaume Touya[1], Cécile Duchêne[1]

[1]Laboratoire COGIT, IGN, 73 avenue de Paris, 94165 Saint-Mandé Cedex, France
Email: {marion.dumont; guillaume.touya; cecile.duchene}@ign.fr

Abstract

This paper presents a comparative study of existing topographic multi-scale maps, regarding relations between display scale and level of abstraction (LoA) of the map content. The general trends in zoom levels distribution across scale and the original patterns in transitions between LoAs are especially highlighted.

1. Objectives

Multi-scale maps are displayed in mapping applications, i.e. websites where a multi-scale navigation in topographic maps is available. Each producer chooses the display scale and the map content for each zoom level. When users zoom in or out, they actually change the displayed zoom level in the multi-scale map.

In some multi-scale maps, the difference of content between two consecutive zoom levels can be strong, partly due to the change of scale. Mackaness (2007) explains that map scale also relates to a level of abstraction (LoA) of the map. It represents the amount of complexity of the map content: which geographic phenomena are represented, and with how much detail? Due to these changes, we believe that general users may have difficulties to recognize the depicted location or the different representations of a same object across zoom levels.

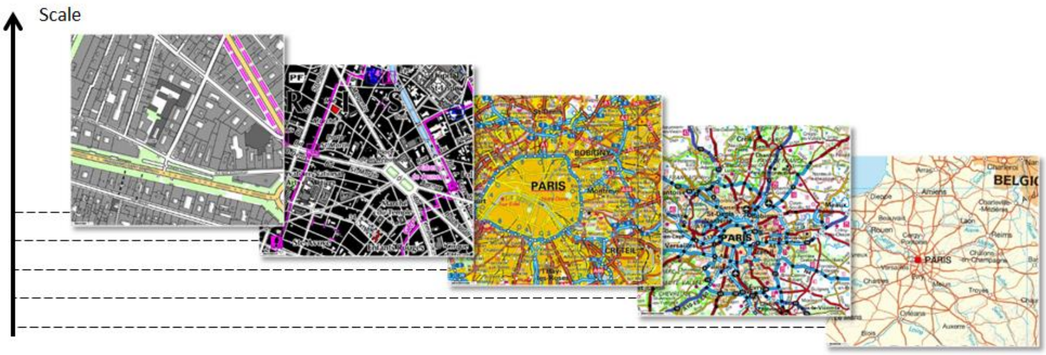

Figure 1. Zoom levels of this multi-scale map (IGN France) present large differences

To build knowledge from multi-scale maps specifications, we study sixteen existing multi-scale maps, provided by national mapping agencies, private companies or collaborative communities. In this paper, we study the correlation between zoom levels, display scale and level of abstraction of the map content, in general (section 2), then focusing on a particular geographic theme: the settlement areas (section 3).

2. How Zoom Levels, Display Scale and Map Content Are Related?

To compare the distribution of zoom levels across scale between multi-scale maps, we first need to define and measure the scale of each zoom level. Besides, most national mapping agencies build their multi-scale map from their topographic paper map series, where each map is designed for a specific printing scale. This map can then be displayed at one or more zoom levels in the mapping application. We call "definition scale" the initial map scale and "display scale(s)" the scale(s) at which the map is displayed.

2.1 Display Scale

Some cartographic producers explicitly give the display scale in the mapping applications, or show a graphic scale bar. In this case, the display scales have been obtained by measuring the bar length. As this length varies according to the size and resolution of the display screen, we measured it on various screens to check the consistency of the obtained display scales. Although we found some variations, we considered it negligible according to the level of detail of the following analysis.

Comparing the display scales between multi-scale maps, we found that producers generally apply the Web Map Tile Service standard (WMTS). This standard defines a scale set, composed of twenty-one zoom levels, numbered from 0 for the 1: 100 scale to 20 for the 1: 500M scale. For each zoom level, we can thus compare the map content of different multi-scale maps, as their display scales are close (given the map projection approximations).

2.2 Definition Scale

When the definition scale was not mentioned in the mapping application, we obtained it by comparison with the map series of their producer. However, some multi-scale maps have not been built from map series (e.g. OpenStreetMap) and will not be considered in the following graph. Figure 2 represents the relation between definition and display scale of each zoom level (represented as a point) in considered multi-scale maps (differentiated by colour).

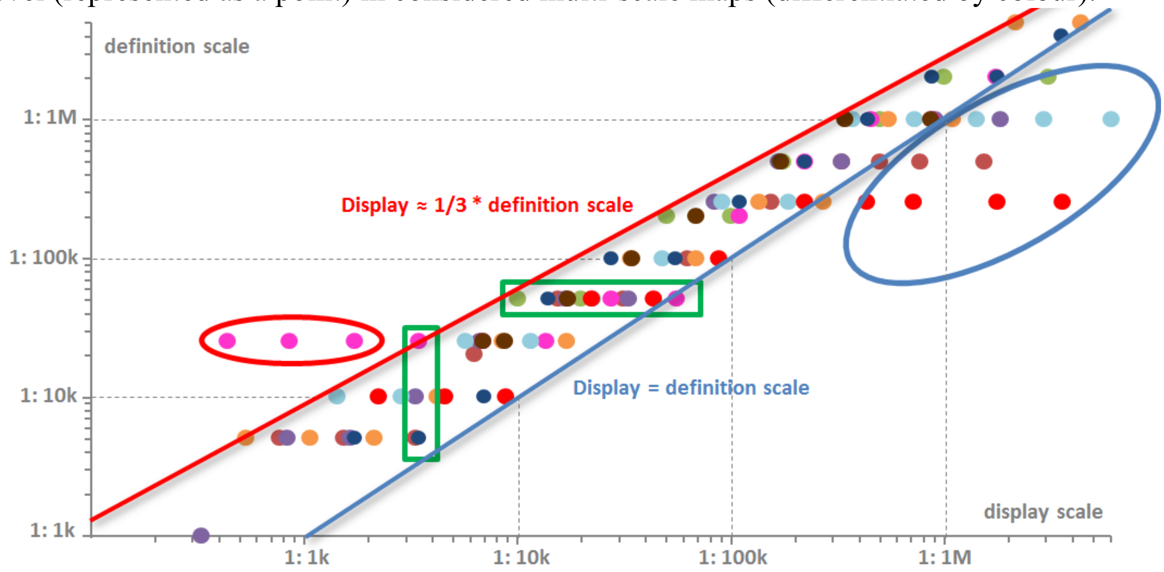

Figure 2. Relations between definition and display scales in considered multi-scale maps

Considering a given display scale (vertical green box) or a given definition scale (horizontal green box), we notice that producers use different relations between definition and display scales. This graph also confirms that many producers use a same map at several zoom levels (same coloured points on the same horizontal line). Multi-scale maps could be improved by adding new representations, specifically designed for these display scales.

We then observe that most zoom levels are concentrated between the two represented lines. According to the red line, most producers do not display a map until the display scale is equivalent to a third of its definition scale. Considering the blue line, most producers do not display a map at a display scale smaller than its definition scale. As the circled outliers present readability issues, we think that these two rules can be considered relevant.

3. Representation of Settlement Areas across Display Scales

The distribution of definition scales across zoom levels gives information about the variation of LoA across scale. However, map content at a same definition scale may differ between producers. For instance, at the 1: 50K scale, some producers represent the individual buildings, whereas others represent urban areas. To compare the representation of settlement areas between multi-scale maps, we define the following LoAs, illustrated from left to right on Figure 3: individual building, urban block, urban area and city point symbol.

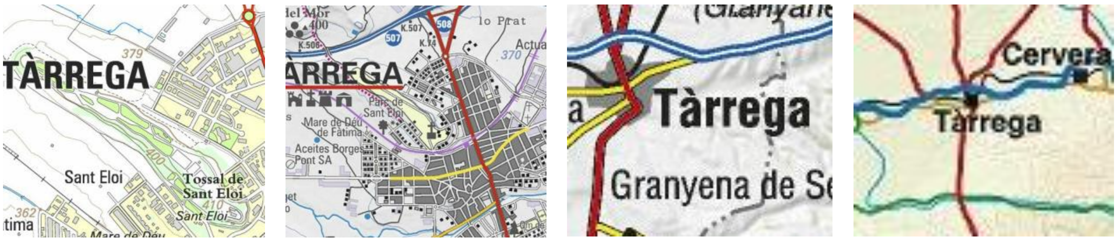

Figure 3. Illustration of the four considered LoAs for settlement areas

As generalization operators may be used to refine the LoA of settlement areas, we also observed their use in each zoom level. We noticed four of them, which specifically deal with the LoA of map content: selection, simplification, aggregation and typification. Definitions and use cases of these operators can be found in Regnauld and McMaster (2007).

When two LoAs are present in a same zoom level, we also noticed if there are coexistent, i.e. representing different objects in different areas of the map (depending on the spatial context), or superimposed, i.e. simultaneously representing a same object (Figure 4).

Figure 4. Coexistent (left) and superimposed (right) representations

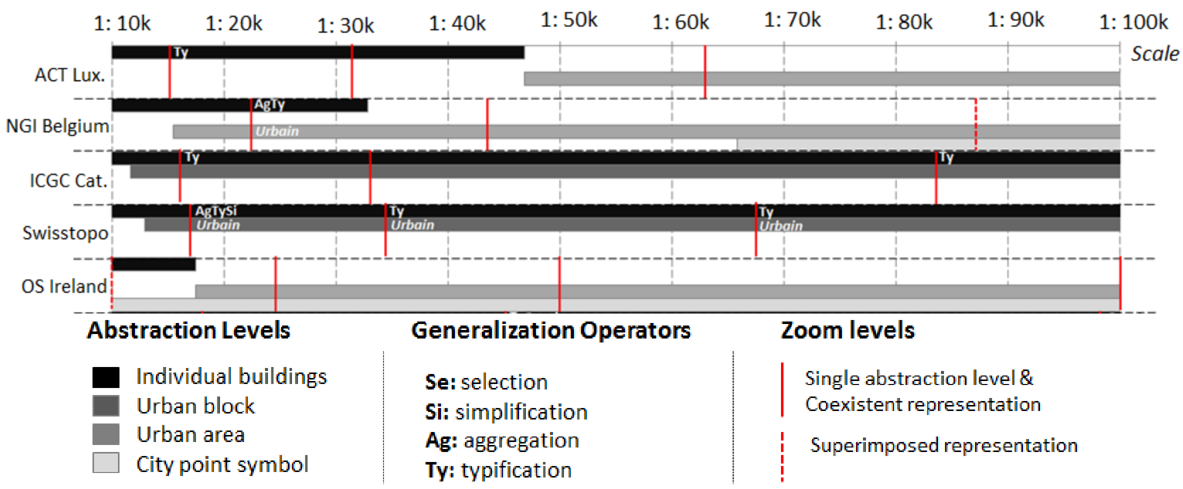

Figure 5. Extract of the representation synthesizing the surveyed information

Figure 5 is an extract of the representation synthesizing the surveyed information, inspired from the ScaleMaster tool (Brewer and Buttenfield, 2007). For each multi-scale map, the use of each LoA on a scale range is symbolized by a grey line. The different shades of grey distinguish the different LoAs. We also added on the graph if different LoAs are used in rural or urban contexts. For each zoom level (red line), coexistent or superimposed representations are identified. If generalization operators are used, their relative code is specified next to the resulting zoom level. Figure 5 shows that, each map producer applies its own variation of LoA across scale.

We analyzed the percentage of use of LoAs across scale, and found some general trends, which are represented in Figure 6. A scale range of common use (in red) could be observed for individual buildings and urban areas. This figure also confirms the use of coexistent and superimposed representations, but also the existence of different strategies used by map producers concerning the relations between LoAs and scales.

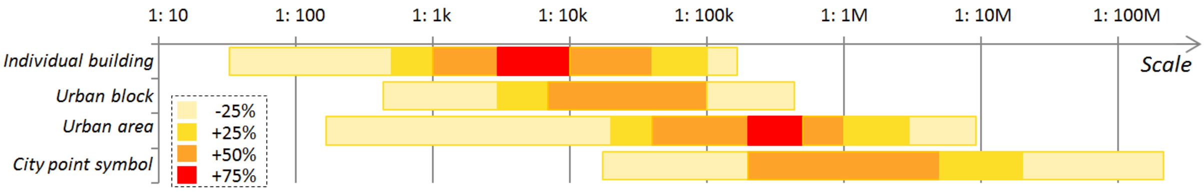

Figure 6. Use percentage of LoAs across scale in studied multi-scale maps

4. Conclusion and Perspectives

The study of zoom levels distribution across scale shows the common use of the WMTS standard. It also highlights rules about the relations between definition and display scale, ensuring the maps readability. Regarding the variation of LoA across scale, we highlight the heterogeneity of relations between LoAs and scales. We also discovered interesting patterns, as the superimposed representations, which could serve as intermediate representations between two LoAs and maybe help ease the navigation across scale.

We will thus now use the identified interesting representations and transitions between LoAs, to add intermediate representations in an existing multi-scale map. Then, we will evaluate their potential improvement for navigation across scale. Assuming that map visual complexity is a part of the problem, in an ongoing study we compare the variation of visual complexity in multi-scale maps, with visual clutter measures (Dumont *et al*. 2016).

Moreover, as reading a map is a human process, we also want to realize a user evaluation. We will measure user task performances, conducted on multi-scale maps with different intermediate representations, to identify the ones improving user navigation across scale.

Acknowledgements

This work is supported by the French National Research Agency, as part of the MapMuxing project [ANR-14-CE24-0011-01].

References

Brewer C, Buttenfield B, 2007, Framing Guidelines For Multi-Scale Map Design Using Databases At Multiple Resolutions, *Cartography and Geographic Information Science*, 34(1): 3-15

Dumont M, Touya G, Duchêne C, 2016, Assessing the Variation of Visual Complexity in Multi-Scale Maps with Clutter Measures, *Proceedings of the AGILE workshop on "Automated generalisation for on-demand mapping" and 19th ICA workshop on Generalisation and Multiple Representation*, Helsinki, Finland

Mackaness WA, 2007, Understanding Geographic Space. In: Mackaness W, Ruas A, Sarjakoski T (eds), *The Generalisation of Geographic Information: Models and Applications*. Elsevier

Regnauld N, McMaster R, 2007, A synoptic view of generalisation operators. In: Mackaness W, Ruas A, Sarjakoski T (eds), *The Generalisation of Geographic Information: Models and Applications*. Elsevier