# A Contribution to the Visualization of the Diversity of Places

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The availability of user-generated geographic datasets offers the possibility of exploring the phenomenon "place". In recent years researchers started some attempts to derive more information about places from the content of geo-tagged social media platforms, e. g., Twitter and Flickr. For the communicating of the analysis results, visualization is essential, but there is less knowledge available about platial visualizations. After a short review of the literature about the extraction, approaches of analysis, and visualization of places, we will present our two methods. Based on a specific use case we will utilize density based clustering and aggregation in grid cells to demonstrate quantitative information visualization of the diversity of a place on multiple scales with pie charts.

**Keywords:** place; visualization; cartography; multi-scale mapping

## 1 Places in Research

In every-day life people use places as a representation of geographic phenomena, to communicate locations in conversations, and to orientate themselves (Scheider and Janowicz, 2014; Tuan, 1977; Winter and Freksa, 2012). A place can refer to either material or immaterial entities (McKenzie and Adams, 2017) and in general describe a location together with a set of attached meanings (Cresswell, 2009). Goodchild and Li (2016) as well as Goodchild (2015) describe the possibilities of a place based analysis platform, which allows to use the potential of user-generated data. This circumstance is reinforced by the fact that there is a need for new adapted methods for the new data in a variety of fields (e. g., social life, health, transport, science) as also formulated by Tsou (2015). Another possibility is the recording of places by means of empirical studies, which can provide better results but are much more complex, as the example of Poplin (2017) shows.

Researchers have already estimated the extent of places and compared it with administrative boundaries based on multiple data sources (Hollenstein and Purves, 2010; Jaffe et al., 2006; Li and Goodchild, 2012). Sub-places and the aspects of diversity inside a place has not been in focus of research yet. It would be enlightening to uncover the things behind a place – the diversity – and allow a deeper insight. With the help of a use case and sample visualizations we would like to address this issue.

### 1.1 Reviewing Approaches to Derive and Visualize Places

Until now there has been a small number of practice-oriented publications that have dealt with places and used different visual analysis methods. The article by Hollenstein and Purves (2010) deals with data from Flickr and how to describe city cores, which are often implicit places. For the visualization of the raw data the authors use a point map and the kernel density estimation. In the end they provide a volume surface with contour lines for the place names in London as quantitative visualization.

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The visualization of places from spatial footprints by Li and Goodchild (2012) is similar and situated in Paris (France). Larger areas are delimited, but not more finely graded and a certain hierarchy in the places is considered. A weighted kernel density estimation was used by Chen and Shaw (2016) to derive the spatial extent. The figures provide only the estimated extent in combination with the boundaries of different US states. The juxtaposition of thematic regions of out different sources by McKenzie and Adams (2017) leads to examples for regions with Mexican, American, or Chinese Restaurants in Los Angles, based on social media posts from Yik Yak, Twitter, and Instagram. Moreover, temporal dynamics of spatial content were explored as well as differences between the social media platforms.

It is remarkable that all publications try to delimit places. For sure it is of interest to compare administrative borders and mental boundaries, but in the end one should not only concentrate on delimiting but rather seeing the different places in context to each other. Furthermore, it should be noted that the very thin data basis, especially with regard to the usage habits of geo-tagged social media compared to the number of people visiting these places every day, does not allow a generally valid, meaningful demarcation of places. For the visualization they often used a kernel density estimation, but provide no quantitative information in the figures and only a few or no background information.

### 1.2 Research Questions

In the reviewed publications, the visualization was not the main content, rather a means to an end. Nevertheless, for the communication of place-related behaviours and the presentation of platial data, appropriate representations are essential. That leads us to the question: How to visualize platial information and their diversity in a quantitative way? In addition, we would like to discuss whether it is worthwhile to make a visual distinction between places. It might be more relevant to look at the diversity as categorical data within a place or region instead of just concentrating on the demarcation of one place. In addition, what occurred on different scales? Nowadays, map users are used to zooming and getting more information. Using the following case study we want to present the possibilities and assess their practical effects on the visual result. Ultimately, this could be significantly influenced by the conclusions drawn by the user.

## 2 Visualizing Platial Information

### 2.1 Methods for Visualization

**Point Map.** The nominal point symbol map shows data at their origin location. The symbols are variable in shape, orientation, and colour (Kraak and Ormeling, 2009). It allows the map user to identify the specific position of each platial information and informs about the spatial distribution. This basic method was used by Hollenstein and Purves (2010).

**Statistical Surface Derived by Kernel Density Estimation.** The kernel density estimation interpolates from some sample data (in most cases points) to an area (O'Sullivan and Unwin, 2010). The result is a density surface that can be visualized and indicates that these values are probably present in the displayed area. The result depends on the chosen kernel shape, a possible value for weighting, the radius or distance in which points are taken into account for the calculation, and the raster resolution. The result is a grid with an estimated continuous distribution of values, which then can be represented by means of colour sequences. Hollenstein and Purves (2010), Li and Goodchild (2012), Chen and Shaw (2016), and McKenzie and Adams (2017), e. g., used the kernel density estimation.

**Clustering and Diagrams.** Spatial clustering is the process of grouping objects into classes. The DBSCAN algorithm (Ester et al., 1996) generates clusters based on a defined distance and rejects points which are too far away from the cluster. It is a density-bases method, which regards clusters as regions of a high number of objects. For the presentation of the quantitative information pie charts can be used, which show the numerical proportion where as well as the size of the diagram scales with the number of items. The result is called point diagram map (Kraak and Ormeling, 2009) but in this case, it refers more to invisible areas.

**Grid-Based Aggregation and Micro Diagrams.** Micro diagrams (Gröbe and Burghardt, 2017) are a visualization method, which uses small diagrams based on aggregation to show the distribution of

Elbsandsteingebirge
Elbe Sandstone Mountains
[Labské pískovce]

| Sächsische Schweiz | Böhmische Schweiz |
|---|---|
| Saxon Switzerland | Bohemian Switzerland |
| [Saské Švýcarsko] | [České Švýcarsko] |

**Figure 1:** Structure of the sample region: The Elbsandsteingebirge consists of the Sächsische Schweiz (situated in Germany) and the Bömische Schweiz (situated in the Czech Republic). The Czech names are given in brackets.

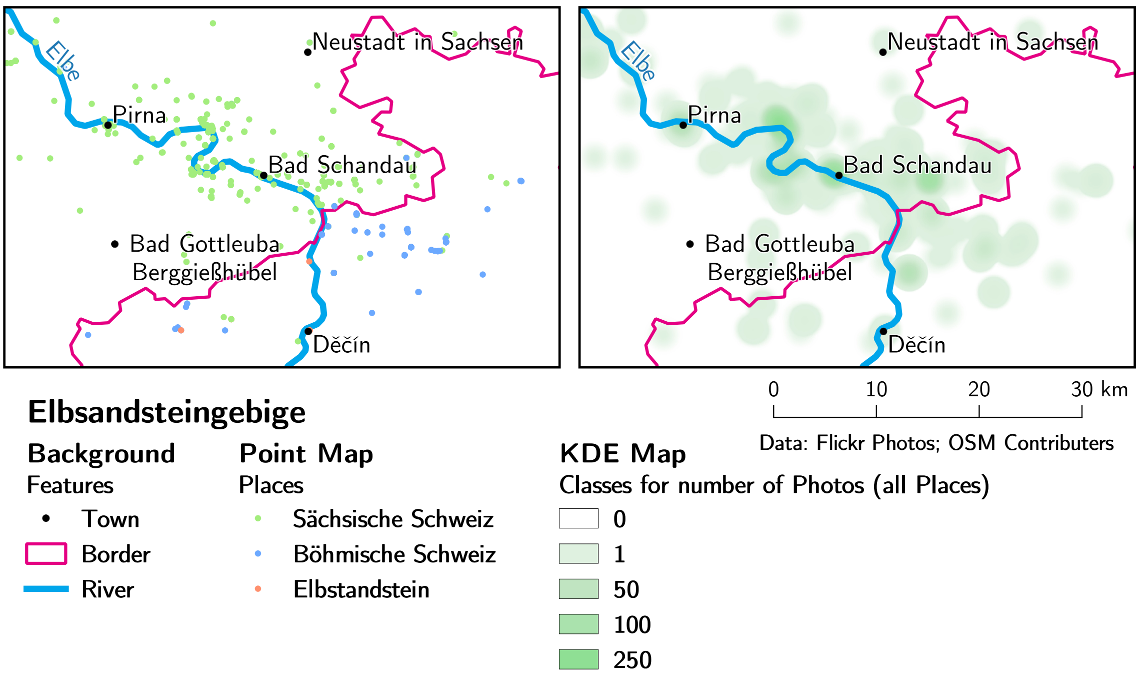


**Figure 2:** Common visualizations of place data. The left map shows the points with the different categories. The right map shows a kernel density estimation over all points. Data basis © OpenStreetMap contributors (cf. www.openstreetmap.org/copyright)

categorized dense point data. The aggregation can be performed in a grid that is suitable for the map scale. Nevertheless, the grid width is decisive for the result of the aggregation and should be chosen carefully. The pie charts visualize the number of aggregated points by their size using standardized diameters. This leads to a more detailed overview and can be seen as a kind of proportional symbol grid maps (Kraak and Ormeling, 2009).

## 2.2 Use Case

**Sample Place Region.** For the sample visualizations of a place we decided on the Elbsandsteingebirge. This is a landscape in Germany and the Czech Republic, which is further differentiated into Sächsische Schweiz (German part) and Böhmische Schweiz (Czech part) by the situation in the respective countries. In our experience, data from photo platforms have proven to be suitable for analysis, since the authors usually refer to their real situation in the descriptions of their photos and do not comment remotely on what is happening at another location. To extract the data, we searched for the landscape names in German and Czech in the image descriptions as well as the tags and merged the counterparts so that the regions are combined despite the language border. Figures 2 and 3 show the visualization of this information, while Figure 1 clarifies the hierarchy of terms in the different languages.

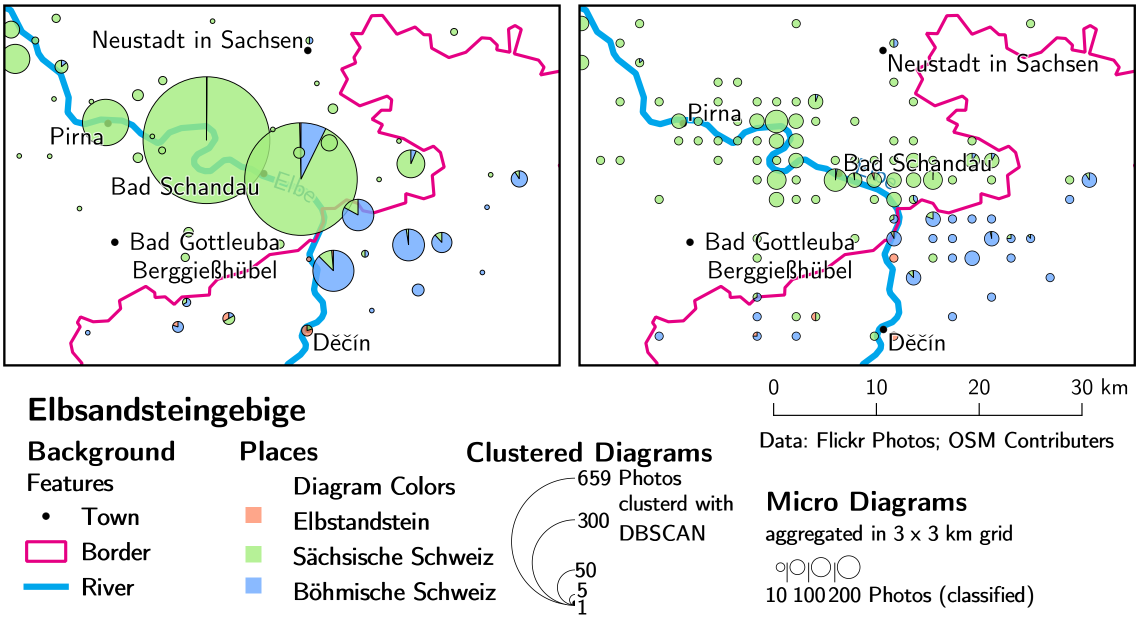


**Figure 3:** The two new approaches to describe the place Elbsandsteingebirge with a map. The left map uses area-proportional diagrams. The right map makes use of micro diagrams. Data basis © OpenStreetMap contributors (cf. www.openstreetmap.org/copyright)

**Samples for the Visualization of Platial Information.** The border between Germany and the Czech Republic is shown as a background information in Figures 2 and 3. It is a 500 year old cultural border that divides the Elbsandsteingebirge into the two parts. An important landmark is the Elbe river, which has created a canyon through the mountain range. The examined landscape can roughly be defined between the cities Pirna in the west, Děčín in the east, Neustadt in the north and Bad Gottleuba-Berggießübel in the south.

The maps in Figure 2 show the basic qualitative visualization of platial information that have been used in the reviewed papers. For the three terms different colours are used in the left map, while it was not possible in the map on the right side using the Kernel Density Method to distinguish categories inside a place. In Figure 3 maps have been created using the two new methods for visualizing platial information. For the map on the left side the DBSCAN clustering was used with a distance of 2.5 kilometres and a minimal cluster size of one point. Again, the colour shows the used terms. For the creation of the micro diagrams a grid with a cell size of 3 kilometres was used. The provided information about the number of items behind the size of the diagrams was classified, which allows for an optimal usage of the available space for the visualization.

**Visualizing Platial Information on Different Scales.** The visualizations shown so far all had the same scale. In the following section, the effect of the scale on visualization should be demonstrated. Figure 4 shows an overview over the sample region on the left side and detail on the right side. The scale of the map in the middle is identical with the scale of the Figures 2 and 3. The three different scales change the map extent as well – it becomes clear that the landscape is also present in the surrounding area. While the left map provides the overview, the other two maps provide an increasing number of details. As a result, the map user would probably draw different conclusions about the region Elbsandsteingebirge from each map. For the visualization the micro diagram method was used with a grid size adapted to the scale.

## 3 Discussion

The point map in Figure 2 offers a good first qualitative overview and is simple to create. Due to the high number of points and the missing qualitative information, clustering effects are unfavourable. In addition, points overlay each other and hide possible other points of another colour, which can distort

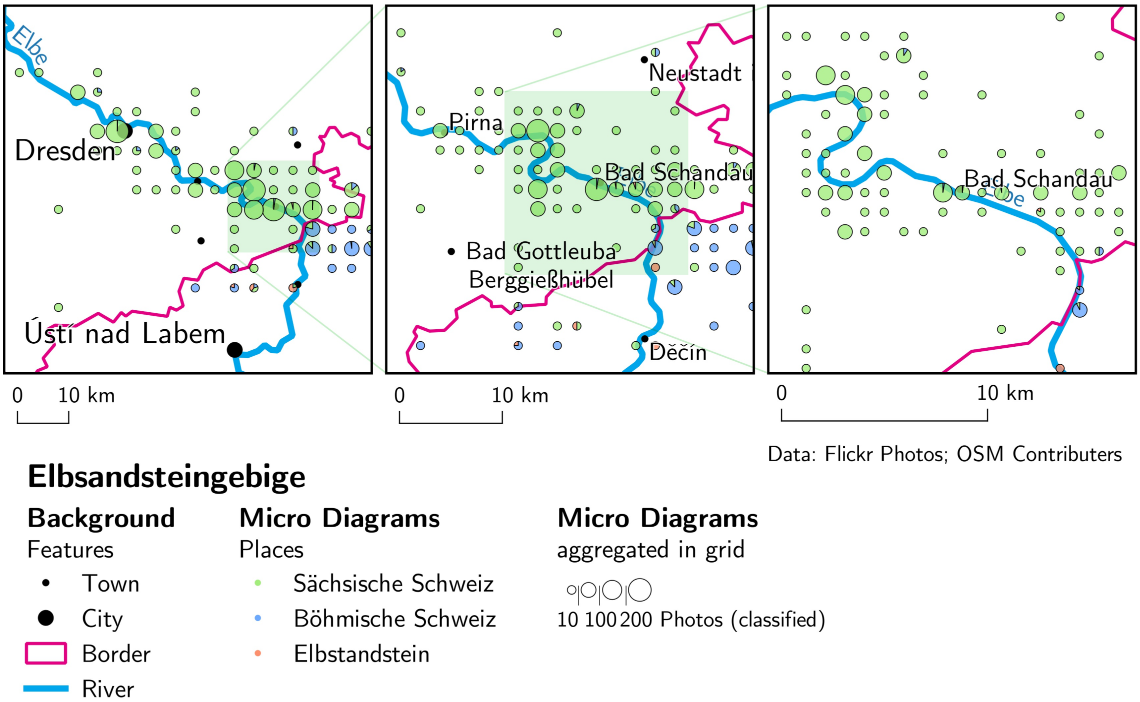


**Figure 4:** Visualization of information about the Elbsandsteingebirge at three different scales using area micro diagrams to show the diversity in the place. The extent of the right map is shown in light green in the left map. The visualization demonstrates how changes of the scale and the map extent can influence the visual analysis of a place. Data basis © OpenStreetMap contributors (cf. www.openstreetmap.org/copyright)

the distribution. This effect can be reduced by a random plot order of the points.

The kernel density estimation is a useful method for the production of statistical surfaces. In regard to the comparison of a place extent with its administrative extent it is for sure a good approach. It can describe well the unsharp nature of place, but it can only visualize more in a qualitative than a quantitative way showing the number of photos overall. Furthermore, it should be noted that the interpolated surfaces are difficult to compare and can only visualize one category. The diagrams on the left map in Figure 3 provide more overview information and may be simpler to read, but they also show the diverse categories. The micro diagrams on the right side make it possible to visualize more details while the clustering directs the view to the main content.

If we compare the maps in Figure 4, we can clearly see that by changing the scale it is possible to highlight the regions that are more important (more often tagged), but which cannot be distinguished more precisely. The left map clearly allows to distinguish between Sächsiche Schweiz and Böhmische Schweiz. Clustering can aggregate quickly across this boundary like in Figure 3 on the left side, while it is clearly visible in the micro diagrams grid on the right side. They are very useful for identifying the diverse important locations in a place.

From some points of view the shown figures are still expandable: the adjustment of the parameters for the aggregation or the kernel density estimation could lead to other results and are not optimized. Another grid width or aggregation distance can already produce another result. Quite apart from the fact that there are of course further possibilities to evaluate the used data set and further to analyse it.

The presented visualization using micro diagrams addresses mostly experts and not average users, because the maps are very detailed and have to be interpreted. Figure 4 demonstrates with the maps in different scales that a fixed delimitation of the place could be difficult. In each map you could define your own boundaries and hide the variety of landscapes of the Elbsandsteingebirge with its different subregions. At least these maps show the problem of defining a meaningful border for a place. Sure, there are some mountains of the Sächsische Schweiz visible from Dresden, but is the place really there? Choosing the extent and the scale for the analysis can be a very important decision, which can have a significant impact on the result. In addition it would be nice to have a interactive visualization to explore the place. This is more intuitive and offers a wide range of additional possibilities, e. g., changing the clustering distance or the visualization method of the micro diagrams. As a result, a map reader may conclude other results and perceives the place in another way.

## 4 Conclusions

The presented approaches for visualization of the diversity of places and the contained information have all benefits for different purposes. The micro diagram method is probably most suitable for a detailed visualization of sub-places and other facts inside places, e. g., different groups of people. A kernel density estimation is good to derive a possible area for one place and clustering to provide visualizations concentrated on a few important aspects. When visualizing a place, scale and extent should be taken into account. Furthermore, the analysis should be performed on several scales to take into account the effects of spatial aggregation effects and other scale dependent effects.

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