Temporal occurrence and time-dependency of georeferenced emotions extracted from user-generated content

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Abstract

Space-related emotions can make a valuable contribution to several fields like urban planning, tourism and social sciences. Therefore research on affect analysis was carried out by capturing and analysing georeferenced emotions from user-generated content (UGC). An approach was developed for extracting location-based emotions from the written language in the metadata of georeferenced Flickr and Panoramio photos. These data describe places and thus contain the sense of users as places and emotions are connected fundamentally. The approach was applied to the study area of Dresden, Germany.

Keywords: emotional cartography, user-generated content, geoinformation retrieval, affect analysis, natural language processing

1   Introduction

The presented research deals with the extraction of georeferenced emotions from the written language in the metadata of Flickr and Panoramio photos, thus from user-generated content, as well as with their modelling and visualisation. The metadata of those user-generated photos contain descriptions of the place that is depicted within the respective picture and thus the user perception of a place.

The detection of space-related emotions is interesting for different potential fields of application: event detection, opinion mining, urban planning, social sciences and geography but also tourism could benefit from the integration of emotional aspects.

The approach was applied to a dataset of Flickr and Panoramio photos of Dresden (Germany). The analysis was carried out with the help of different cartographic visualisations. The temporal occurrence and time-dependency of georeferenced emotions was examined detailed.

2   Related Work

The related work reflects the different methods of acquiring emotions. One option are physiological measurements of biometric parameters like the electrodermal activity of the skin ([2], [10], [20]). Empirical surveys are another way to gather a person's sense of a place ([4], [14], [25]), e.g. by the use of a smartphone app ([12], [17], [19]). But also georeferenced user-generated content can be a source for space-related emotions by applying natural language processing ([1], [15], [16], [18], [21]).
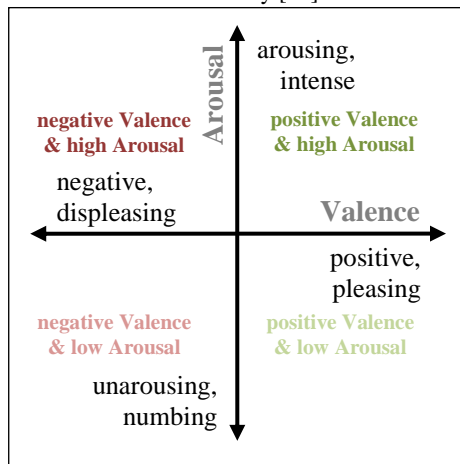
Besides [15] all the last-named projects are using Twitter as a source, [15] uses the comments of Flickr photos. Except for [21], all research projects conduct sentiment analysis, which means emotions are ranged on a positive-negative-scale.

However this work also considers the emotional arousal beside the sentiment and thus conducts affect analysis which opens up a wider range of emotions since, for instance, the sole indication of a positive emotion leaves open whether it is relaxation, joy, happiness, excitement or the like. [21] applies affect analysis as well by regarding the basic feelings according to [6] but only six feelings are considered. Furthermore none of these five research projects considers grammatical issues like negations or amplifications. [15] alone regards negated words, all the other projects disregard these issues (or at least they do not mention it explicitly if not doing so) although negations especially have a huge impact on the results, i.e. on the kind of extracted emotions.

3   Data Extraction

For gathering emotional information, emotions need to be structured. In psychology different approaches for structuring emotions exist and can be distinguished into dimensional and differential approaches [23]. Differential approaches emphasize the distinguishable subjectively experienced qualities of emotions [13]. Dimensional approaches try to reduce affective states to a few dimensions. Thus each emotion can be described as a combination of different severities of those dimensions. We are working with the model proposed by [22] involving the two dimensions valence and arousal which can be described as ranging from positive/pleasing to negative/displeasing and from arousing/intense to unarousing/numbing (see Figure 1). With the help of these two dimensions it is possible to locate emotions within valence-arousal-space. For instance joy is a very positive emotion with high arousal whereas anger also has a high arousal but a negative valence. In the following, emotions are roughly assigned to four quadrants of valence-arousal-space which are combinations of positive/negative valence and high/low arousal (see Figure 1).

Figure 1: Two-dimensional structure of emotions by [22]

Source: J.A. Russell. A circumplex model of affect. *Journal of Personality and Social Psychology* (39): 1161–1178, 1980.

Our approach applies several methods of natural language processing to words that are contained in the title, description and tags of georeferenced Flickr and Panoramio photos [7]. All words are matched with two emotional word lists: ANEW (Affective Norms for English Words [3]) and BAWL-R (Berlin Affective Word List Reloaded [24]) comprise words that are weighted with a valence and an arousal value and reflect affective connotations [9] and thus represent emotions. ANEW covers 2476 English words, while BAWL-R contains 2901 German words. Each word is stored together with its emotional values from ANEW or BAWL-R and with the coordinates of the respective photo. Within this extraction approach, various grammatical issues were considered, like negations of words or amplifications. Procedures were developed for modifying the emotional values of the affected

word, for example for inverting or intensifying them [8].

We applied the algorithm for extracting georeferenced emotions from photo metadata to a dataset of 52,954 Flickr and Panoramio photos of Dresden (Germany) from 4,344 users covering a period starting at the launch date of Flickr (February 2004) and Panoramio (October 2005) until 2013-07-05. The data were requested with the respective REST API. The photo metadata used altogether contained 792,089 words. 116,780 of those words or respective synonyms/hypernyms of them were found in the emotional word lists ANEW and BAWL-R.

The following amounts of emotions were detected for the previously described four quadrants of valence-arousal-space:

- positive valence & high arousal: 23%
- positive valence & low arousal: 61 %
- negative valence & high arousal: 6%
- negative valence & low arousal: 10%

More than 80% of all detected emotions are positive ones and more than the half of those are of low arousal. So obviously users usually take pictures of positively appealing places. Emotions of negative valence are mainly of low arousal although it could be assumed that boring places are less often photographed than negatively arousing places but the latter ones might not exist quite as often. Another reason for the high amount of positive emotions with low arousal is the fact that also in ANEW and BAWL-R emotions of this quadrant are the prevailing ones.
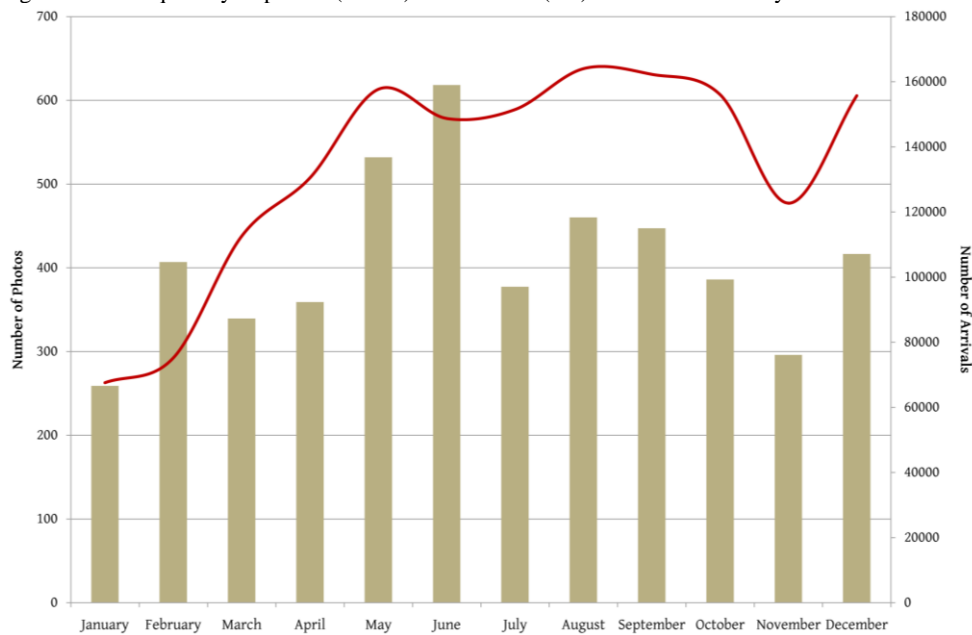
4 Temporal occurrence and time-dependency

The results of extracting georeferenced emotions from user-generated photo metadata of Dresden allow an emotional characterisation of space which makes it possible to assess and investigate specific features of georeferenced emotions. On the one hand these features are especially related to the

Figure 2: Temporal distribution of photo and emotion frequency over the course of the years 2009 until 2012

Figure 3: Mean quantity of photos (brown) and arrivals (red) in Dresden for the years 2004 until 2013

Source: arrival data by Statisches Landesamt Sachsen

temporal dependence and the temporal reference of emotions: e.g. some years or even decades ago a place might have evoked different emotions than it does currently but these former emotions can still be detected with the help of Flickr and Panoramio photos. On the other hand collectively and individually perceived emotions have to be distinguished based on the consideration of personal preferences, experiences or memories. As a consequence, a place does not necessarily have to be connected with merely one emotion but possibly also with several.

With regard to this, it seems obvious to investigate the time-dependency of emotions: are there places that are more attractive in the summer or in the winter time, in the day time or in the night? Moreover for this paper we focus on three certain kinds of temporal aspects: long-term trends, periodic events and single events.

4.1 Long-term trends

Since the utilised dataset covers several years, it can be analysed regarding recurrent frequencies of photos over the course of a year, whether the photo frequency correlates with the number of emotions and if, in certain time frames, one kind of emotion is dominating. For this examination, photo data for the years 2009, 2010, 2011 and 2012 were analysed (see Figure 2).

The left part of Figure 2 shows the distribution of photo quantity for all four years while the right part shows the distribution of emotions occurring during these years differentiated by the four quadrants. The temporal distribution of photos over one year is similar for 2009, 2010 and 2011 and can be explained by tourist activities. Figure 3 shows the mean quantity of photos and arriving tourists for the years 2004 until 2013. Except for February and June, the similarity of both values in the course of a year is visible. In the warm months, i.e. from April to June, the number of tourists in Dresden is increasing but also again in December since in this time one of the oldest Christmas markets in Germany, the

Striezelmarkt, takes place in Dresden. In the other winter months and in autumn, the number of tourists decreases, probably because of low temperatures. But not only tourists take pictures of Dresden, also inhabitants who might prefer warm and dry weather for taking pictures outside as well and who are also attracted by special events like the famous Christmas market Striezelmarkt.
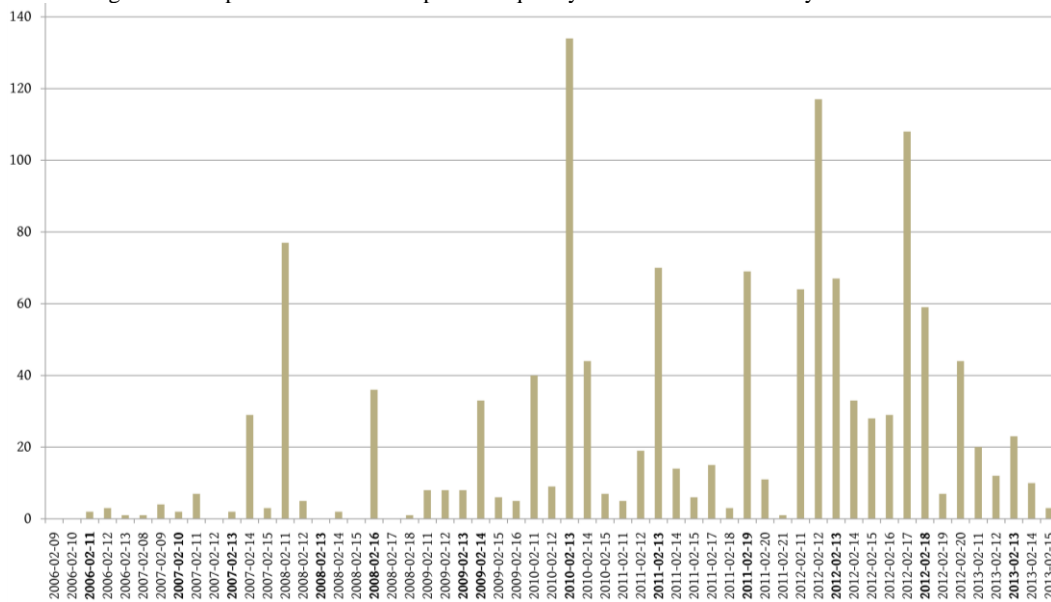
However the number of photos in 2012 is significantly lower than in the previous years. According to [11] Flickr is on a downward trend since 2005 when it was acquired by Yahoo. Since that time almost no new functions and advancements have been added. In particular, the long missing possibility to upload photos via iOS, Android and mobile Windows devices might have been a reason for many users to use other portals like Instagram.

The number of emotions (Figure 2) corresponds with the number of photos: when more pictures were taken, more emotions could be detected. In general, more positive than negative emotions were extracted, especially positive emotions of low arousal, which corresponds to the general proportions of the four quadrants (compare section 2).

4.2 Periodic events

When an event was detected, it can be examined for repeated occurrence, or respectively repetitive emotional peaks can be analysed if a regularly occurring event might be the reason. Conversely, known periodic events can also be attempted to be identified within emotional data. For the last-named way, an annual commemoration ceremony and its side effects are regarded. On the 13th of February 1945 huge parts of Dresden were destroyed by allied air attack. Each year a remembrance of this bombing takes place on one or two days in February. For the past 15 years more and more right-wing extremists use this event for their own propaganda purposes. As a reaction to that, counterdemonstrations have been organised and in the most recent years there have been confrontations and riots on both sides.

Figure 4: Temporal distribution of photo frequency for the time of February demonstrations

For recognising this event in the emotional data of Dresden, the years 2006 to 2013 were investigated. Two days prior to and past the demonstration date of each year are also considered (see Figure 4 and Figure 5). The days of demonstrations are printed bold. It is noticeable that in 2008, 2009, 2010 and 2011 on the days of demonstrations more photos were taken und more emotions were detected than on the two days before and after. Since positive emotions usually prevail in general, it is significant that these days are influenced strongly by negative emotions. The events are described by words with negative connotations like 'police', 'Nazi' or 'attack'. They are an extraordinary, although recurrent occurrence: usually nothing negatively arousing can be found at the respective places except on those one or two days in February.

4.3 Single events

Single events are happenings which occur only once and can be analysed as already known events or can be detected by analysing emotional peaks in the data. For this work the single event of the Elbe River Flood in June 2013 was studied. The Elbe River usually has a water level of about 2 metres, but in the beginning of June 2013 it climbed to 8.76 metres within a few days.

Considering the entire month June 2013, in the 11 days of the flood (2nd of June 2013 until 12th of June 2013) 66% of all photos were taken (see Figure 6) and thus a correspondingly large number of emotions (67%) was detected for these days (see Figure 7). This reveals that single events, their temporal extent and their emotional characteristics can be detected by the number of photos. The emotional peak regarding the flood can be identified for the 4th of June, probably the day with highest uncertainty, even though the top water level was reached two days later.

Figure 5: Temporal distribution of emotion frequency for the time of February demonstrations
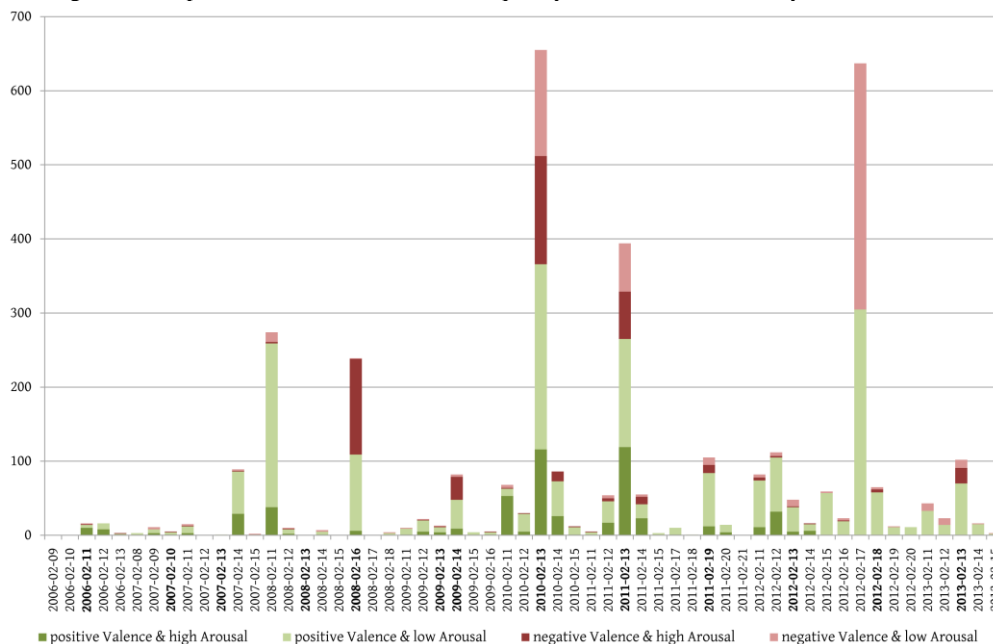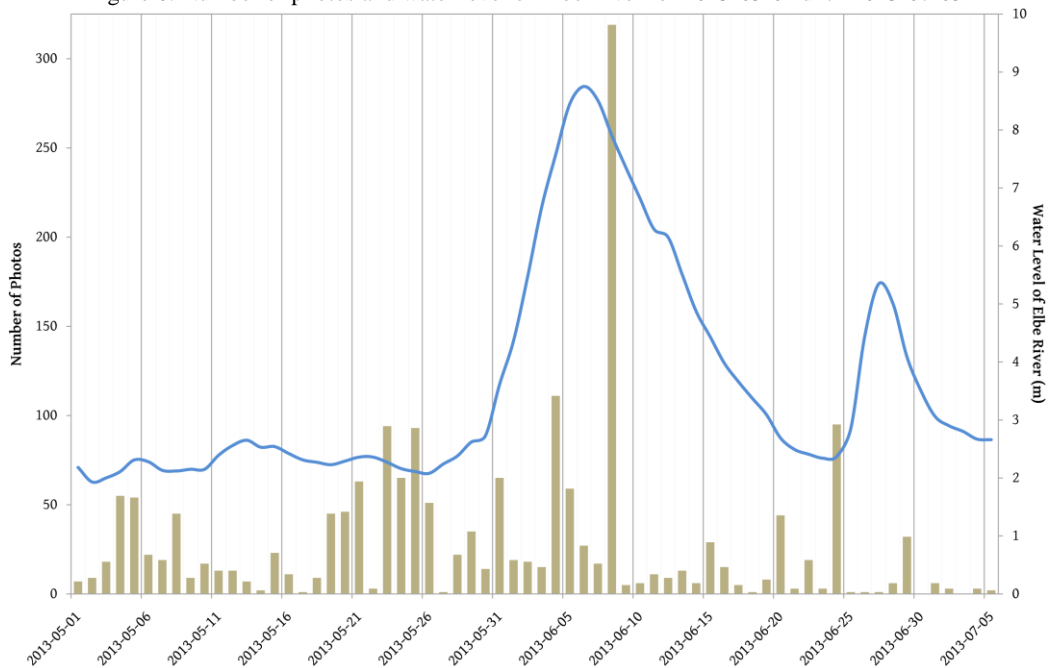
Figure 6: Number of photos and water level of Elbe River for 2013-05-01 until 2013-07-05

Source: water level data by Wasser- und Schifffahrtsverwaltung des Bundes (WSV), provided by Bundesanstalt für Gewässerkunde (BfG)
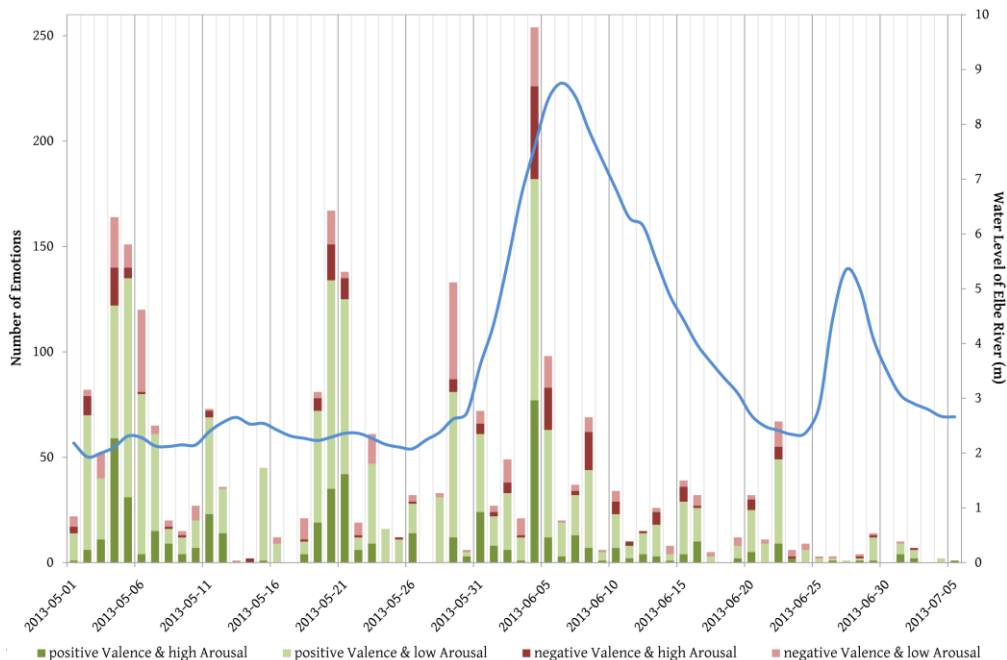
Despite this natural disaster, positive emotions are prevailing for the time of the Elbe River Flood. Although words with negative connotations are used, like 'disaster', 'flood' or 'crisis', words with actually positive connotations occur more often, for instance 'water' which is nevertheless negative in the present case.

Figure 8 shows the density of photos in the inner city of Dresden for the days from the 3rd to 6th of June 2013. On the 4th of June 2013, the peak of photo numbers during the flood, most pictures were taken from the bridges over the Elbe since from there the flooding could be viewed best. In the following two days, pictures are taken along the Elbe River and not from the bridges anymore although the bridges in the inner city have not been closed.

Twitter as another source of user-generated content was used by [6] for detecting flood events as well.

Figure 7: Temporal distribution of emotion frequency and water level of Elbe River for 2013-05-01 until 2013-07-05
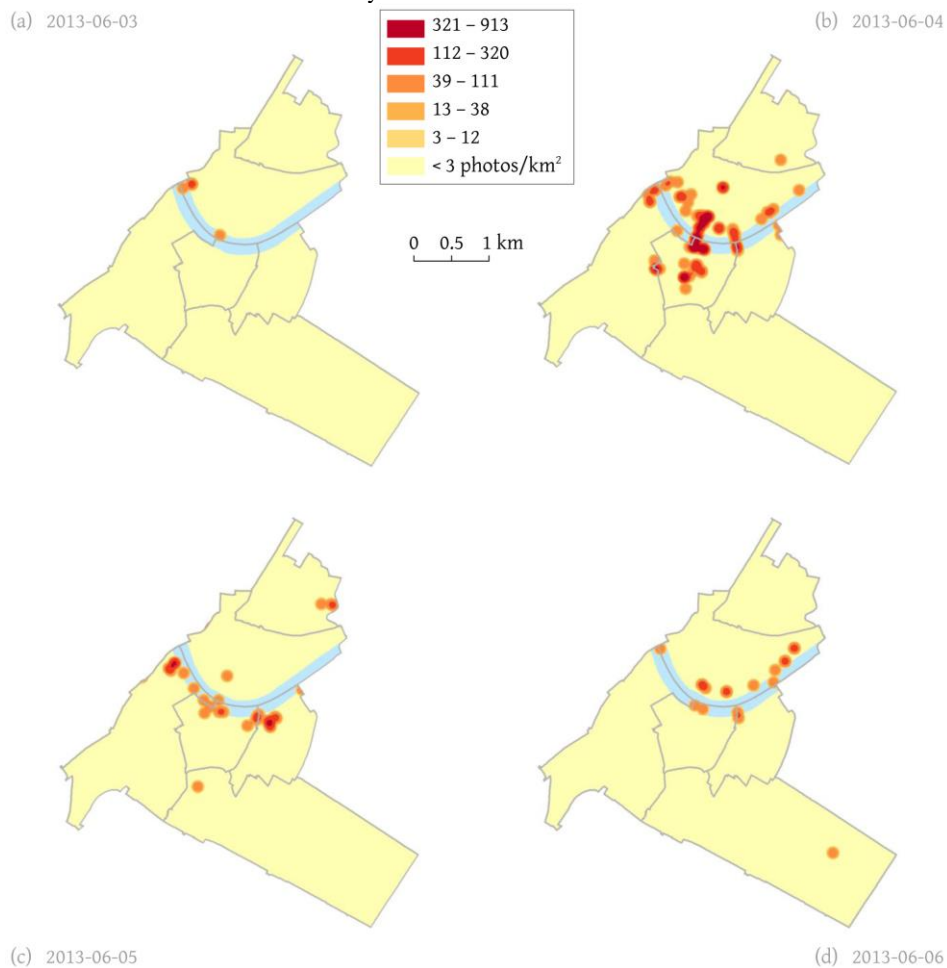

Source: water level data by Wasser- und Schifffahrtsverwaltung des Bundes (WSV), provided by Bundesanstalt für Gewässerkunde (BfG)

5   Conclusion

The emotional data extracted from the metadata of Flickr and Panoramio photos have the potential to enable temporal analyses regarding long-term trends, periodic events and single events. Limiting factors are the existence as well as the popularity of the photo platforms Flickr and Panoramio as they have existed since 2004/2005 and as their popularity is not steady. The analysis of periodic events works quite well in terms of the number of photos and emotions as an indicator for a periodic event.

Figure 8: Spatial-temporal distribution of photos in the inner city of Dresden (with the Elbe River in blue) for the first days of the flood in June 2013

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