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Detection, Modelling and Visualisation of Georeferenced Emotions from User-Generated Content

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"Human behaviour flows from three main sources:
desire, emotion, and knowledge."

Plato

ERKLÄRUNG DES PROMOVENDEN

Die Übereinstimmung dieses Exemplars mit dem Original der Dissertation zum Thema:

"Detection, Modelling and Visualisation of Georeferenced Emotions from User-Generated Content"

wird hiermit bestätigt.

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ABSTRACT

In recent years emotion-related applications like smartphone apps that document and analyse the emotions of the user, have become very popular. But research also can deal with human emotions in a very technology-driven approach. Thus space-related emotions are of interest as well which can be visualised cartographically and can be captured in different ways.

The research project of this dissertation 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. Motivation is the integration of an emotional component into location-based services for tourism since only factual information is considered thus far although places have an emotional impact.

The metadata of those user-generated photos contain descriptions of the place that is depicted within the respective picture. The words used have affective connotations which are determined with the help of emotional word lists. The emotion that is associated with the particular word in the word list is described on the basis of the two dimensions 'valence' and 'arousal'. Together with the coordinates of the respective photo, the extracted emotion forms a georeferenced emotion. The algorithm that was developed for the extraction of these emotions applies different approaches from the field of computer linguistics and considers grammatical special cases like the amplification or negation of words.

The algorithm was applied to a dataset of Flickr and Panoramio photos of Dresden (Germany). The results are an emotional characterisation of space which makes it possible to assess and investigate specific features of georeferenced emotions. These features are especially related to the temporal dependence and the temporal reference of emotions on one hand; on the other hand collectively and individually perceived emotions have to be distinguished. As a consequence, a place does not necessarily have to be connected with merely one emotion but possibly also with several. The analysis was carried out with the help of different cartographic visualisations. The temporal occurrence of georeferenced emotions was examined detailed.

Hence the dissertation focuses on fundamental research into the extraction of space-related emotions from georeferenced user-generated content as well as their visualisation.

However as an outlook, further research questions and core themes are identified which arose during the investigations. This shows that this subject is far from being exhausted.

ZUSAMMENFASSUNG

In den letzten Jahren sind emotionsbezogene Anwendungen, wie Apps, die die Emotionen des Nutzers dokumentieren und analysieren, sehr populär geworden. Ebenfalls in der Forschung sind Emotionen in einem sehr technologiegetriebenen Ansatz ein Thema. So auch ortsbezogene Emotionen, die sich somit kartographisch darstellen lassen und auf verschiedene Art und Weisen gewonnen werden können.

Das Forschungsvorhaben der Dissertation befasst sich mit der Extraktion von georeferenzierten Emotionen aus geschriebener Sprache unter Verwendung von Metadaten verorteter Flickr- und Panoramio-Fotos, d.h. aus nutzergenerierten Inhalten, sowie deren Modellierung und Visualisierung. Motivation hierfür ist die Einbindung einer emotionalen Komponente in ortsbasierte touristische Dienste, da diese bisher nur faktische Informationen berücksichtigen, obwohl Orte durchaus eine emotionale Wirkung haben.

Die Metadaten dieser nutzergenerierten Inhalte stellen Beschreibungen des auf dem Foto festgehaltenen Ortes dar. Die dafür verwendeten Wörter besitzen affektive Konnotationen, welche mit Hilfe emotionaler Wortlisten ermittelt werden. Die Emotion, die mit dem jeweiligen Wort in der Wortliste assoziiert wird, wird anhand der zwei Dimensionen Valenz und Erregung beschrieben. Die extrahierten Emotionen bilden zusammen mit der geographischen Koordinate des jeweiligen Fotos eine georeferenzierte Emotion. Der zur Extraktion dieser Emotionen entwickelte Algorithmus bringt verschiedene Ansätze aus dem Bereich der Computerlinguistik zum Einsatz und berücksichtigt ebenso grammatikalische Sonderfälle, wie Intensivierung oder Negation von Wörtern.

Der Algorithmus wurde auf einen Datensatz von Flickr- und Panoramio-Fotos von Dresden angewendet. Die Ergebnisse stellen eine emotionale Raumcharakterisierung dar und ermöglichen es, spezifische Eigenschaften verorteter Emotionen festzustellen und zu untersuchen. Diese Eigenschaften beziehen sich sowohl auf die zeitliche Abhängigkeit und den zeitlichen Bezug von Emotionen, als auch darauf, dass zwischen kollektiv und individuell wahrgenommenen Emotionen unterschieden werden muss. Das bedeutet, dass ein Ort nicht nur mit einer Emotion verbunden sein muss, sondern möglicherweise auch mit mehreren. Die Auswertung erfolgte mithilfe verschiedener kartographischer Visualisierungen. Eingehender wurde das zeitliche Auftreten der ortsbezogenen Emotionen untersucht.

Der Fokus der Dissertation liegt somit auf der Grundlagenforschung zur Extraktion verorteter Emotionen aus georeferenzierten nutzergenerierten Inhalten sowie deren Visualisierung. Im Ausblick werden jedoch weitere Fragestellungen und Schwerpunkte genannt, die sich im Laufe der Untersuchungen ergeben haben, womit gezeigt wird, dass dieses Forschungsgebiet bei Weitem noch nicht ausgeschöpft ist.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

3D	Three-Dimensional
AGI	Ambient Geographic Information
ANEW	Affective Norms for English Words
API	Application Programming Interface
BAWL-R	Berlin Affective Word List Reloaded
CC BY	Creative Commons Attribution
CC BY-ND	Creative Commons Attribution-NoDerivs
CC BY-NC	Creative Commons Attribution-NonCommercial
CC BY-NC-ND	Creative Commons Attribution-NonCommercial-NoDerivs
CC BY-NC-SA	Creative Commons Attribution-NonCommercial-ShareAlike
CC BY-SA	Creative Commons Attribution-ShareAlike
D-IKE	Deutschsprachiges Inventar kaufbegleitender Emotionen
DAW	Dresdner Angstwörterbuch
DES	Differential Emotions Scale
ECDESUP	Evaluation, Choice and Decision in the use of Urban and Peri-Urban Spaces
EDA	Electrodermal Activity
EmBaGIS	Emotional Barrier GIS
EXIF	Exchangeable Image File Format
GIS	Geographic Information System
GPS	Global Positioning System
GSC	Grammatical Special Case
ID	Identifier
IDW	Inverse Distance Weight
iOS	iPhone Operating System
JWNL	Java WordNet Library
LEW	List of Emotional Words
MEMOSE	Media Emotion Search
NLP	Natural Language Processing
POS	Part of Speech
RSS	Rich Site Summary
REST	Representational State Transfer
tt4j	Tree Tagger for Java

UGC	User-Generated Content
UNESCO	United Nations Educational, Scientific and Cultural Organization
URL	Uniform Resource Locator
VGI	Volunteered Geographic Information
WHO	World Health Organization

1 INTRODUCTION

1.1 Motivation

It appears that in recent years, human emotions have become more and more present in the media in a very technology-driven way: Facebook[1] makes it possible to post emotions (Constine, 2013), the search engine MEMOSE[2] retrieves emotional-laden pictures, videos and music (Knautz et al., 2010), the website and app Stereomood[3] creates music playlists for a certain mood and the app Emotion Sense[4] analyses how the mood of a smartphone user is related to the data that the smartphone captures (Lathia et al., 2013), a Samsung software even identifies the emotions of the smartphone user, for instance by tap rate or the strength of device movement (Graham-Rowe, 2012). These are only a few of many examples of how the seemingly contrary subjects of emotions and technology are currently connected. But this connection does not only include emotions and technology, it also requires and thus includes the user. MEMOSE, Stereomood and Emotion Sense are based on user ratings and user input and they are not the only projects that build upon the wisdom of the crowd (Surowiecki, 2004). But the user is not always aware of his contribution - in some projects the user is requested to contribute; other projects draw on already existing contributions. These existing contributions are usually user-generated content.

Due to the web, an increasing amount of user-generated content is available that contains not merely objective but subjective information as well, for instance in terms of product reviews, restaurant ratings and the like. This subjectivity can be utilised for different purposes, like, for instance, identifying emotions. Twitter[5] is a popular source for analysing user-generated content regarding emotions. For example the web application Hedonometer[6] determines an average happiness value for each day from Twitter data and relates this value with current events like the bombing at the Boston Marathon (Dodds et al., 2011). The number of publications in the field of Twitter data as a source for emotional data is large: Bliss et al. (2012), Bollen et al. (2011), Ohmura et al. (2014), Pak & Paroubek (2010), Quercia et al. (2012), Saif et al. (2012), Thelwall et al. (2011) etc.

[1] http://www.facebook.com/
[2] Media Emotion Search (http://memose.me/)
[3] http://www.stereomood.com/
[4] http://emotionsense.org/
[5] https://twitter.com/
[6] http://www.hedonometer.org/

Tweets can be provided with geographical coordinates. This turns Twitter into a source of georeferenced user-generated content which can be used not only for detecting emotions but also for detecting emotions that are related to a place, i.e. the perception and sense of environments. Investigations in this field are for instance Frank et al. (2013), Mitchell et al. (2013) and Schwartz et al. (2013).

Emotions and space are fundamentally connected: locations have an atmosphere which can evoke strong and diverse emotions in people (Mody et al., 2009). Places can provide feelings of privacy, control and security or can attract by the opportunity for social events. Places can be sensed as boring, attractive, calming, scary or dangerous and the loss of a place can be an emotional experience (Korpela, 2002). Interesting places that evoke certain emotions are important for tourism, but yet looking at travel guides - whether as a book or as a mobile application - reveals that they contain merely factual information, like the address of a sight, the opening hours, entrance fees etc. If the travel guide comes in the form of a mobile application, possibly it adapts to the spatial-temporal situation of the user. This work aims at adding an emotional component and at establishing a basis for the integration of those emotional aspects for location-based services.

For gathering the required spatial emotional data for this research, georeferenced user-generated content shall serve as base data as well, although further possibilities for capturing emotions exist (see 2.1.4). The advantages are that user-generated content already exists and does not have to be gathered, that it has a spatial density that could only hardly be reached by empirical surveys or biometric measurements and that numerous people contributed even though user-generated content might not represent people of all ages since, for instance, social media are mainly used by young adults (Duggan & Brenner, 2013).

These last mentioned issues show that user-generated content can also be unfavourable regarding some matters. The data can be very unstructured in terms of noisiness as well as multilingual, incomplete and thus heterogeneous content. If the content is georeferenced, the accuracy of geographic information can be very poor (see 2.2.4). Privacy issues have to be regarded as well especially for individual analyses since anonymisation techniques cannot be assumed as reliable (Huang et al., 2013). Keeping this in mind, user-generated content can be used as convenient and rich base data for the detection of space-related emotions since the advantages outweigh the disadvantages.

For this work, the emotional data are extracted from the written language in the metadata of georeferenced Flickr and Panoramio photos considering grammatical special cases within this written language, for instance, negations. The photos have a title and tags, Flickr photos also have a description, and they are tagged with longitude as well as latitude. The extracted emotion combined with the coordinates of a photo results in a georeferenced emotion.

Although Twitter is a popular source for the detection of emotions, Flickr and Panoramio data are chosen since - with a few exceptions - the georeferenced photos show places and thus the additional information like title and description refer to these places. Tweets refer not necessarily to the place where they were written (Hahmann, 2014).

1.2 Research Questions

Basically the research questions have to be regarded in two sections. The first section consists of two fundamental research questions concerning the retrieval of emotional data. The research questions in the second section arise from the first section and refer to data features, analysis and visualisation. They can be pursued depending on the findings of the first segment.

(1) Is it possible to extract georeferenced emotions from the written language in the metadata of Flickr and Panoramio photos?

(2) How far can grammatical special cases like negations be considered within this extraction?

The research questions of the second section require a positive outcome of the first two thesis objectives.

(3) What are features of the extracted emotional data?

(4) Do the extracted emotional data reflect the sense of a place?

(5) How can the spatial emotional data be visualised for analysis purposes?

(6) Can events with a certain temporal occurrence be detected in the emotional data?

(7) Are georeferenced emotions time-dependent? Are they influenced by temporal periods (e.g. the seasons)?

1.3 Thesis Structure

The dissertation starts with an introductory chapter which presents the motivation, research questions and structure as well as the underlying publications of this work. The state of the art of subjects relevant for this work is treated in chapter 2. The subjects are emotions from the field of psychology as well as user-generated content. In the end of this chapter, a conflation of these two subjects is accomplished by introducing research projects that combine the previously named fields. Subsequently, after providing a basis, the work of the author of this dissertation is presented in chapter 3, 4 and 5. Chapter 3 declares the basic idea of this research as well as the practical implementation. The following chapters 4 and 5 present outcomes resulting from applying the research approach to real data. The resulting data are analysed with the help of multiple visualisation methods and additionally they are examined focusing particularly on temporal aspects. Thus chapter 4 and 5 answer the research questions listed in 1.2. Hereafter chapter 6 presents an evaluation of the approach and discusses problems and weaknesses that emerged before. The dissertation ends with chapter 7. In this last chapter, the work is summarised, conclusions are drawn and an outlook is presented by initiating further research questions.

1.4 Underlying Publications

Many sections of this dissertation are based on contributions that were published either as a paper or as a talk at a conference. The basic idea of this research as well as first visualisations and interpretations of the emotional data are presented in Hauthal & Burghardt (2013b). A more detailed treatment of the algorithm, the emotional data and the consideration of grammatical special cases was given as a talk on the 26th International Cartographic Conference in Dresden in August 2013. The content of this talk is very briefly summarised in an abstract (Hauthal & Burghardt, 2013a) and described in detail in a journal paper (Hauthal & Burghardt, 2014). Furthermore, an extended abstract focusing on the temporal analysis of spatial emotional data was accepted (Burghardt et al., 2014) for GIScience 2014. This extended abstract as well as chapter 5.1 until 5.3 are based on a master thesis (Körner, 2014) which was initiated, guided and supervised by the author of this dissertation.

The following list includes all the previously named publications:

HAUTHAL E. AND BURGHARDT D. (2014): *Mapping Space-Related Emotions out of User-Generated Photo Metadata Considering Grammatical Issues.* The Cartographic Journal.

BURGHARDT D., KÖRNER A. AND HAUTHAL E. (2014): *Temporal Analysis of Georeferenced Emotions Extracted From Photo Metadata.* In: *Proceedings of GIScience 2014: Eighth International Conference on Geographic Information Science, September 23-26, 2014, Vienna*.

HAUTHAL E. AND BURGHARDT D. (2013a): *Detection, Analysis and Visualisation of Georeferenced Emotions*. In: Buchroithner M.F. (Ed.), *Proceedings of the 26th International Cartographic Conference: August 25 - 30, 2013, Dresden*.

HAUTHAL E. AND BURGHARDT D. (2013b): *Extraction of Location-Based Emotions from Photo Platforms*. In: Krisp J.M. (Ed.), *Progress in Location-Based Services: Lecture Notes in Geoinformation and Cartography*, pp. 3-28, Springer, Heidelberg, New York.

KÖRNER A. (2014): *Analyse und Visualisierung der Zeitabhängigkeit verorteter Emotionen*. Master Thesis. Technische Universität Dresden, Dresden.

2 STATE OF THE ART

This chapter about the state of the art gives an introduction to the two huge fields forming the base of this work. First, emotions as a subject of psychology are treated; second user-generated content is covered. In a third step, these two fields are joined by presenting research projects combining both subjects.

2.1 Emotions

2.1.1 Definitions and Terms

The oft-cited statement of Fehr & Russell (1984: 464) "Everyone knows what an emotion is, until asked to give a definition" appropriately represents the comprehensive result of literature research for finding such a definition. The enormous number of definitions might be an indication for the fact that the occurrence of emotions is not completely resolved although scientific emotion research has been conducted for more than 100 years.

The majority of definitions admits the complex occurrence of emotions. An explanation is complicated since emotional experiencing can be reported by humans only with difficulties and also the measurement of brainwaves or of the nervous, respiratory[7], circulatory[8] and adenoid[9] system does not describe emotions completely (Izard, 1977). According to Izard (1977) a complete definition of emotions needs to cover the following three aspects equally:

- the experiencing or conscious sensing of a feeling
- the processes happening in the brain and in the nervous system
- the observable expression (gestures and facial expressions)

Scherer (1990) understands emotions as an interface between the environment and an organism and considers the synergy of different subsystems with sophisticated functions for a limited period as a particular characteristic.

In summary, most definitions have in common that emotions are a subjective occurrence, i.e. an inner excitement that is more or less consciously experienced as pleasant or

[7] relating to respiration/breathing
[8] of or pertaining to the circulatory system
[9] of or relating to lymphatic glands or lymphoid tissue

unpleasant and occurs with neurophysiologic processes (Kroeber-Riel et al., 2009). Another important aspect of emotions is a high ego-involvement of the individual (Jahr, 2000). Furthermore a consensus is reached that there are basic emotions which refer to inherent emotions like surprise, anger or joy which can be broken down into convergence and rejection, as well as emotion schemas which describe emotions that differ across cultures and individuals and appear only in interaction with other individuals like, for instance, shame, guilt feelings or pride (Izard, 2009), i.e. emotions that are differentiated and reshaped in the course of a lifetime by socioenvironment and culture.

Related terms of emotion are 'sentiment', 'affect' and 'feeling' which are often used as synonyms but rather should be distinguished. Sentiments are enduring, less intense and diffuse emotions (Jahr, 2000) that are not related to certain issues and can influence cognitive processes like perception, information processing and memory. The term feeling means the experience-related aspect of an emotion, that is to say the interpretation of the conscious and subjective perceiving of an emotion (Kroeber-Riel et al., 2009). Affect in Anglo-American language is a hypernym for mental processes, emotions, sentiments and also for attitudes. Less often affect means merely the valence of experiences in the sense of pleasure and displeasure or positive and negative (Mau, 2009). Whereas in German, affects are essential, transient and intense feelings of convergence or rejection, i.e. an emotion that is cognitively barely controlled and hardly differentiated regarding content (Mau, 2009; Trimmel, 2003).

Due to the possibility that all these terms impact closely on each other, a clear demarcation is not feasible in every case. The occurrence of a certain feeling can be accompanied by sentiments and sensations (Jahr, 2000).

2.1.2 Emotion Theories

Emotions are extraordinarily complex processes and their emergence is still discussed controversially. The different approaches for explaining the occurrence of emotions can be reduced to one fundamental question which is also called the Zajonc-Lazarus debate: Are cognitive processes part of emotions or not? Thus two kinds of theories can be distinguished: the biologically or physiologically oriented ones on one side and the cognitive ones on the other side (Gelbrich, 2007). The former are grounded in the theory of James (1884) and assume that stimuli are evoking a physical reaction called feeling.

Cognitive approaches originate from the attribution theory. According to it, individuals are searching for reasons for an inner excitement with the result that different emotions arise depending on the situation or the interpretation of this situation. Thereby, in contrast to the attribution theorists, appraisal theorists do not restrict themselves to the appraisal of the causes of a situation but assess them more comprehensively (Gelbrich, 2007). Figure 1 shows the origins and characteristics of both kinds of emotion theories as well as important exponents.

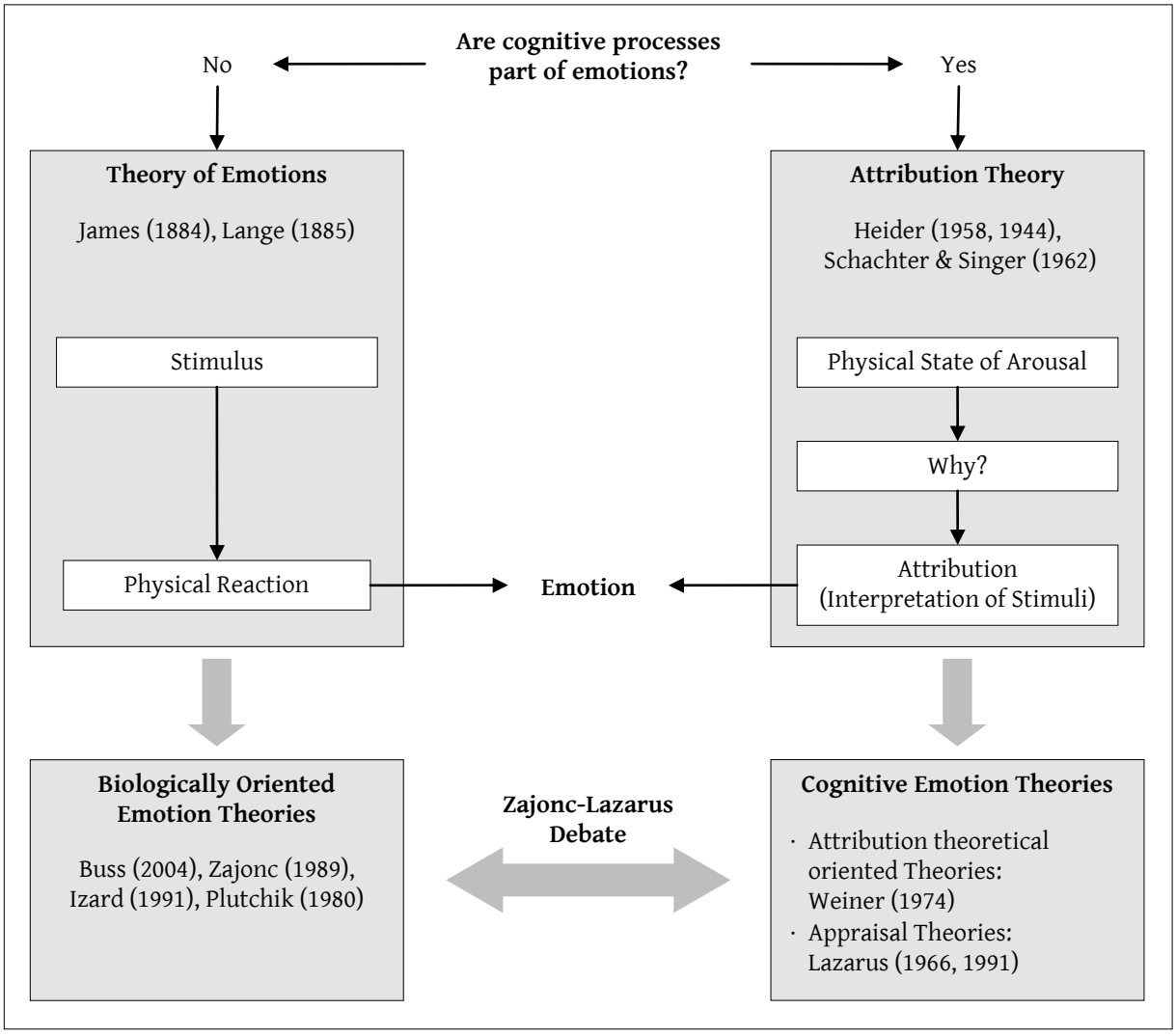


Figure 1 The two kinds of emotion theories (Gelbrich, 2007)

In the following the two most influential emotion theories at present will be shortly introduced.

2.1.2.1 James-Lange Theory

At the same time and independently of one another, James (1884) and Lange (1885) developed very similar emotion theories, therefore literature often refers to the James-Lange theory. In terms of an example, this theory implies that we are not crying because we are sad but we are sad because we are crying. That means after a stimulus (e.g. a wild bear) is simply recognised it leads immediately to a visceral change (e.g. accelerated heart beat) and motoric reactions (e.g. running away) that are emotionally perceived in a next step (e.g. fear).

The James-Lange theory remains controversial: the same visceral changes can appear for different emotions (we can cry because of joy) and the simulation of visceral changes (such as adrenalin injections) does not cause real emotions (Kroeber-Riel et al., 2009).

2.1.2.2 Two-Factor Theory

According to the two-factor theory of Schachter & Singer (1962) for an emotion, a physiological arousal has to exist on one hand, and on the other hand it has to be interpreted subjectively. Schachter & Singer (1962: 398) write "Precisely the same state of physiological arousal could be labelled joy or fury or jealously or any of a great diversity of emotional labels depending on the cognitive aspects of the situation". If one of the two factors is missing, the emotion is incomplete or is not even perceived. Thus an individual correlates inner arousal states of physiological origin with plausible causes - the inner excitement is interpreted as happiness in one situation, as anger in another one.

With their theory Schachter & Singer (1962) draw attention to the interaction of subjective mental processes and physiological processes which is significant for human behaviour (Kroeber-Riel et al., 2009).

2.1.3 Structuring Emotions

The definition of emotions allows a distinction between emotional and non-emotional states as well as structuring those emotional states. Approaches for structuring emotions can be distinguished into 'dimensional' and 'differential' whereas the differential approaches again can be divided into basic emotions and empirical similarity categories.

2.1.3.1 Dimensional Approaches

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. Latest research manifests two approaches that show up as two- or three-dimensional models. In almost every case, one dimension describes the valence of emotions. However there is disagreement on the nature of arousal which is regarded as one- or two-dimensional. While Russell (1980) considers one dimension of arousal in combination with the valence dimension as sufficient for the description of emotions, other researchers feel confirmed in their assumption of two arousal-dimensions in addition to one valence-dimension by empirical results (Mau, 2009). The subsequently developed three-dimensional models postulate one valence and two arousal dimensions which terms differ between the models. Nevertheless the respective explanations reveal that these models are similar constructs despite diverging denotations (see Table 1).

Osgood et al. (1957)	Mehrabian & Russell (1974)	Sjöberg et al. (1979)	Matthews et al. (1990)	Steyer et al. (1997)	Schimmack (1999)
evaluation	pleasure	pleasantness	hedonic tone	bad - good	pleasure - unpleasure
potency	dominance	activation	energetic arousal	vigilance - fatigue	vigilance - fatigue
activity	arousal	tension	tense arousal	calm - disturbance	arousal - calm

Table 1 Overview of important three-dimensional models of emotions (Mau, 2009)

The two dimensions valence and arousal proposed by Russell (1980), which will be of importance in the following, can be described as ranging from negative/displeasing to positive/pleasing and from unarousing/numbing to arousing/intense (see Figure 2).

Dimensional approaches claim to describe completely the space of possible emotional qualities (Russell & Mehrabian, 1977) but there are results indicating that emotions which are experienced as qualitatively very different have similar values in the dimensions of valence and arousal (Mau, 2009), which give rise to doubts.

Dimensional emotional models have the following advantages (Mau, 2009):

- The reduction of emotional experiences to a few dimensions simplifies the measurement and quantification of emotions. Not every possible emotional quality

needs to be captured but merely the estimation of experience in two or three dimensions.

- In most cases the emotional states gathered this way are described by two or three metrically scaled variables. This simplifies the analysis.
- Due to the reference of emotional states to a few dimensions, the interpretation of results is simplified.

With the help of these two dimensions it is not difficult 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.

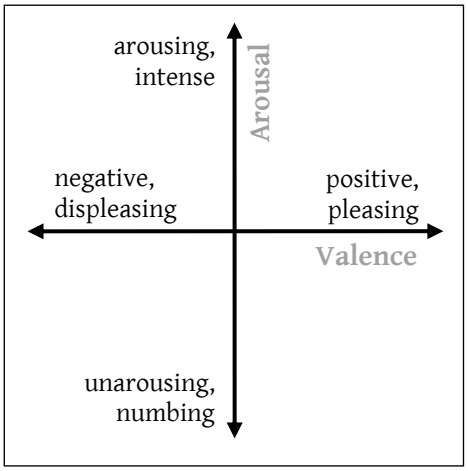


Figure 2 Two-dimensional structure of emotions by Russell (1980)

In contrast to dimensional approaches which try to ascribe emotions to a few global dimensions, differential approaches emphasize the distinguishable subjectively experienced qualities of emotions (Izard, 1977). In these approaches, emotions are structured according to complex similarities. This similarity can be defined by the spectrum of emotional qualities in basic emotions or by statistical methods based on subjective appraisal (Mau, 2009).

2.1.3.2 Basic Emotions

The exponents of this approach assume that from certain emotions with a special status (basic or primary emotions) all other emotions (secondary emotions) can be derived. The identification of these basic emotions follows theoretical assumptions. Variations within this approach are caused by different reasons for the choice of basic emotions: universal

facial expressions, the direct relation to behavioural tendencies or inherent physical and phenomenological reactions are named as identification features. Furthermore, attributions theoretical, neuroanatomic and evolutions theoretical criteria are used as criteria for the basis of distinction (Mau, 2009). Table 2 compares nine established approaches and conveys the strong heterogeneity: quantity as well as kind and quality of the postulated primary emotions vary.

Emotion	Ekman et al. (1982)	Gray & McNaughton (1982)	Izard (1977)	James (1884)	Oatley & Johnson (1987)	Plutchik (1980)	Tomkins (1963)	Watson (1930)	Weiner & Graham (1984)
acceptance						✓			
anger	✓	✓	✓	✓		✓		✓	
anticipation						✓			
contempt			✓				✓		
disgust	✓		✓		✓	✓	✓		
distress			✓				✓		
fear, anxiety	✓					✓			
grief				✓					
guilt			✓						
happiness	✓				✓				✓
interest			✓				✓		
joy		✓	✓			✓	✓		
love				✓				✓	
rage		✓	✓					✓	
sadness	✓				✓	✓			
shame			✓				✓		
surprise	✓		✓			✓	✓		

Table 2 Overview over important differential models and their postulated primary emotions (Mau, 2009)

2.1.3.3 Empirical Similarity Categories

The approaches of the empirical similarity category try to structure emotions according to the experienced subjective similarity or according to common linguistic usage. Therefore empirical similarities of the estimation or of the usage of particular terms for emotions are used as a basis for category creation (instead of theoretical considerations). For the definition of those similarities, paired comparisons of two words denoting emotions are used, for example, as well as semantic differentials of estimated subjectively experienced quality of particular emotions or the common occurrence of emotions in everyday life. Based on the distances determined that way, preferably homogenous groups of emotions

can be summarised with the help of factor analysis, multidimensional scaling or similar methods (Mau, 2009). Table 3 lists four approaches of empirical similarity categories.

Emotion	**Schmidt-Atzert (2000)**	**DES-studies**[10]	**Richins (1997)**	**D-IKE**[11]
anger	✓	✓	✓	✓
awkwardness				✓
contentment			✓	✓
disappointment				✓
discontent			✓	
disgust	✓			
doubt				✓
eager			✓	
elation				✓
enjoyment				✓
envy			✓	
excitement			✓	
fear, anxiety	✓	✓	✓	✓
guilt		✓	✓	
happiness				✓
interest		✓		
joy	✓	✓		
loneliness			✓	
love				
optimism	✓		✓	
peacefulness			✓	
proud			✓	
relief			✓	✓
sadness	✓	✓	✓	
safety				✓
shame		✓	✓	
stress				✓
surprise	✓	✓		✓
worry			✓	

Table 3 Overview of important differential models based on subjective appraisal and their postulated emotions (Mau, 2009)

[10] Differential Emotions Scale (Schmidt-Atzert, 2000)
[11] Deutschsprachiges Inventar kaufbegleitender Emotionen (Mau, 2009)

2.1.4 Acquisition of Emotions

The overall emotional reaction of humans has the following components (Battacchi et al., 1996):

- physiological reactions (cardiovascular[12], respiratory, electrodermal[13])
- tonic posture reactions (tension and relaxation of body)
- instrumental motoric reactions
- expressive motoric reactions (gestures, countenance, paralinguistic events)
- expressive linguistic reactions (syntactic and lexical selection, stylistic varieties)
- subjective experience components (emotions as such, referring to the feeling that everybody experiences while having emotions)

These reactions can be exploited for gathering emotions with verbal or non-verbal procedures.

2.1.4.1 Verbal Procedures

Requesting emotions is a verbal procedure but has the disadvantage that verbal statements on emotions are often difficult to access, not detailed enough, are not made perception-simultaneously with the reception (Egner & Agüeras-Netz, 2008) and might be manipulated or filtered by the proband (Kroeber-Riel et al., 2009).

2.1.4.2 Non-Verbal Procedures

Non-verbal procedures can be distinguished into physiological measurements, explicit emotion measurements (Egner & Agüeras-Netz, 2008) and behavioural observations like the analysis of facial expression (Westerink et al., 2008). For explicit emotion measurements, emotional states are classified on a scale with the help of a slider but this procedure requires a certain amount of training by the proband. Physiological measurements interconnect a scalar value of emotion to a measureable physiological value, e.g. to the electrodermal activity (EDA) of the skin (Egner & Agüeras-Netz, 2008). EDA is an intensely sensitive and valid indicator for measuring changes of emotional and cognitive involvement

[12] relating to the circulatory system, i.e. the heart and blood vessels
[13] pertaining to the electrical properties of skin

(Kroeber-Riel et al., 2009). In practice this fact is exploited in the form of biofeedback trainings or polygraphs (lie detectors). The advantage of physiological measurements is that the user does not have to recognize and interpret his emotions. However interpreting a meaning from those data is ordinarily difficult, though the complex meaning extraction of behavioural observations and physiological measurements is counterbalanced by the real-time pureness of emotions (Westerink et al., 2008).

2.1.5 Relation between Emotions and Places

In a certain way, emotional states and places can be seen as external and internal versions of one another (Gallagher, 2007). The principle is simple: a good/bad environment evokes a good/bad mood triggered by good/bad memories leading to good/bad behaviour. Usually those environmental stimuli are not even sensed consciously. Especially the just mentioned memories play an important role. A dramatic example is drug addiction. The body is longing for the drug particularly in the environment where it is used to getting the drug or in an environment with cues of the used surrounding, which can be referred to as an environmental addiction. Thus a successful drug withdrawal should involve a systematic exposure to drug-related environmental cues. Another phenomenon is that occasionally addicts take the usual fix in a strange environment and die as if they had an overdose (Siegel et al., 1982). In an experiment, photos of jungle warfare or war movies like 'Platoon' were shown to combat veterans of Vietnam War. By looking at those pictures, their memory recalled the high arousal they experienced in this exotic milieu and stimulates the nervous systems to produce surges of opiates which are meant to soothe temporal stress (van der Kolk et al., 1996).

Csikszentmihalyi (1990) gathered about 25,000 experience reports in 25 years by prompting persons eight times a day by beeper to write down where they are, what they are doing and how they are feeling (Csikszentmihalyi, 1990, quoted by Gallagher, 2007). This way Csikszentmihalyi (1990) found out that most of his subjects felt happiest in parks, cafés and other sociable and carefree places as well as for some reason they liked to be in a car. Furthermore he detected that the two genders favour different places at home: men prefer the basement whereas women consider the bathroom to be the best but both of them like the bedroom as well. A similar study was carried out by MacKerron & Mourato (2013) for

the United Kingdom. With the help of a smartphone app named Mappiness[14] they asked their participants several times a day how happy they are, whom they are with, where they are and what they are doing. The app determined the precise location of the participants via GPS (Global Positioning System) at the moment of answering these questions. Furthermore weather data have been used for analysing the results. MacKerron & Mourato (2013) found out that their participants are less happy at work than at home and outdoors they are most happy while doing activities typical for natural environments like gardening or running. Coastal locations are the ones rated with most happiness. Participants were particularly happy outdoors with good weather, i.e. with sunshine, without rain and fog, with high temperature and low wind (MacKerron & Mourato, 2013).

It is commonly known that nature restores humans. Kaplan & Kaplan (1989) analysed this statement by monitoring the responses of people in an 'outdoor challenging program' and found that nature indeed eases so called mental fatigue, a condition of inner weariness. The most notable reasons for this recovery is detected by the Kaplans as a sense of self-discovery in nature, desire to make nature a part of future life and enthusiasm for the experience (Gallagher, 2007).

Less natural is the process of urbanisation which will be the most important environmental influence in the 21st century according to social scientists. Urban places send many stimuli changing quickly and continuously that are often very intense while in nature the majority of stimuli change gradually and periodically as well since there are not many people (Gallagher, 2007). A mostly permanent stimulus of urban space is noise. Noise facilitates the outburst of aggression and if the noise comes from an uncontrollable source, physiological arousal as well as aggression increases (Bronzaft, 2002; Veitch & Arkkelin, 1995). Another characteristic of urban areas is a high population density and crowding. Studies have indicated that urbanites are less willing to help strangers than people in rural regions - which does not mean that they are less helpful or friendly because paying less attention to other people might be a strategy for coping with excessive stimulation. Furthermore conditions of high social density reduce interpersonal attraction (i.e. liking another person) and increase social withdrawal. For instance students are less sociable, talkative and group oriented when they are housed in a socially dense dormitory (Veitch & Arkkelin, 1995).

[14] http://www.mappiness.org.uk/

Extreme environments evoke extreme emotions. High mountain ranges are an extreme environment as well as polar or very hot regions or even artificial environments of space flight, flying or diving. The easiest und probably most useful method for reducing aversive arousal and stress caused by such extreme environments is humour. In the transcription of astronaut communication and in some Arctic groups, a lot of humour and wit occurred. Another method is the so-called paratelic dominance which means to regard an aroused state not as fear but as excitement which leads to a more certain coping behaviour (Suedfeld, 1991). Positive affective states in extreme and unusual environments are courage, self-sacrifice and altruism with well-known examples: people giving scarce food to others or health professionals giving up rest or the chance to escape for helping patients (Gallagher, 2007). The most salient negative affective state in extreme environments is fear. Others are aggression (direct or indirect) often occurring within isolated groups, and boredom after an adaptation to the extremeness leading to hypersensitiveness concerning the characteristics of coworkers and in turn to hostility (Suedfeld, 1991).

Behaviour or culture may not be predefined by climate but can be affected by certain limitations set up by it (Gallagher, 2007). Research shows that aggression (thus violence as well) increases by temperature but in turn decreases in blazing heat (Bell & Fusco, 1986; Veitch & Arkkelin, 1995). Domestic violence is significantly higher during heat waves (Bell & Fusco, 1986), suicide peaks in May and June (Gallagher, 2007) and in 1967 temperature rose one to three days before the onset of urban riots in the USA and outdoor temperature was at least 27°C (Bell & Fusco, 1986; Bell & Greene, 1984). Of course negative behaviour is not solely a function of ambient temperature but also of other variables such as situational factors and individual differences in heat-tolerance (Bell & Fusco, 1986) as well as clothing, acclimatisation, humidity or air speed (Bell & Greene, 1984). For instance judges in the Near East judge impulsive crimes less strictly that were committed when the dry and hot Khamsin is blowing. Strong wind gives exposed people a feeling of loss of control and causes an increasing degree of arousal (Veitch & Arkkelin, 1995).

2.1.6 Emotions in Language

Besides physical reactions such as facial expressions, emotions are reflected in language. Non-verbal cues like the former ones can indicate which general emotion a person is experiencing but this way typically no precise information about the specific form of an

emotion is imparted. However language makes it possible to express the richness of emotions (Valitutti et al., 2004).

For the expression of emotions in language it is useful to distinguish between the 'production' of expression and the 'occurring' expression (involuntary expression). Usually an emotional expression - as far as it occurs - is based on a communicative purpose. An emotion modifies behaviour and is expressed without remarkable purpose at all or without communicative purpose (Fiehler, 1990).

There are two ways of emotional expression: primary and secondary, i.e. different kinds or levels of socially normalised expression. Primary and secondary expression differ from each other regarding the situations they occur in, their frequency of usage and regarding their level of conventionalisation. Primary kinds of expression are common, frequently used and form the normal repertoire for expressing an emotion. If in a certain situation with social rules a primary expression is inappropriate, a secondary expression can replace it. Secondary expressions occur especially in all forms of institutional communications. For this kind of communication, the dictate of emotional neutrality is valid which hampers the primary expression of emotions or makes it impossible. A secondary expression evolves into a primary one if the primary expression is permanently inappropriate in certain situations because of social rules (e.g. politeness) (Fiehler, 1990). For instance instead of uttering disappointment 'He failed completely' the secondary expression 'He made reasonable efforts' might be used. Nevertheless according to Dittmann (1972: 98, quoted by Fiehler, 1990) "most emotional messages are probably sent without controls, or without very little effort to control".

In the linguistic field of language-and-emotion-research, two spheres can be distinguished: pragmatic-communicative approaches that empirically examine emotions as speech attending and influencing phenomena as well as semantic-lexical approaches that examine and describe the potential of expressive media in one or several languages. The latter investigate the emotional vocabulary of a language that is available to a linguistic community in a mental lexicon for naming emotional categories (Schwarz-Friesel, 2007). Hence each culture has its own vocabulary, syntactic forms, semantics and range of pragmatic effects. Although emotions are regarded as transcultural, their characteristics and the manner they occur are too different, so that culture and language has an influence on the categorisation of emotions (Jahr, 2000).

Emotional aspects of linguistic meanings of utterance coded by formal-grammatical factors are not related to discrete emotions termed by lexemes like hate, envy, anger, disgust, fear, mirth, affection, appreciation, joy, love, curiosity etc., but especially to the affective appraisal of objects or issues (Fries, 1996).

Table 4 summarizes formal-grammatical means of expression for emotional meanings.

Formal-Grammatical Means of Expression	**Example**
word choice: emotion-induced choice between alternatives	*racketeer* instead of *renting agent*
interjections, mostly for non-intentional states like pain, cold- or warmth-sensation	*oh*, *yuck*, *ouch*
exclamations	*Oh my god!, What a stupid man he is!*
idiomatic appraisals	*Are you crazy?*
insults	*moron*
praises and acknowledgements	*You're a dear.*
curses, reproaches, threats, warnings, disciplining, plaints	*You will get a punch on your nose.*
expressive verbs	*wish*, *hope*, *crave*, *yearn*
modal particles	*even*, *but*
affective adjectives	*marvellous, awkward*
optative sentences	*I wish I could...*
combination of emotion-expressing and emotion-denoting verbs	*slimy*, *creepy, hate*
dimension adjectives/particles or combination of modal particles and emotive adjectives	*great anger*, *extremely afraid*, *It was a very wild party.*
morphemes/prefix formations as intensification of emotional expressions	*shit work*, *super awesome*
intensifying genitive constructions	*the book of books*
idioms	*Nuts to you.*
diminutive and augmentive formations	*bitsy*, *teensy-weensy*
repetition	*a long long time ago*, *over and over again*

Table 4 Formal-grammatical means of expressions for emotions (Fiehler, 1990; Fries, 1996; Schwarz-Friesel, 2007)

In terms of user-generated content, users of photo platforms usually do not write in the description of their pictures whether they like or do not like a place. Detecting emotions in

the written language of those metadata works more in an indirect way, because single words can have an emotional content. Hayakawa (1952) and Salomon (1966) call this phenomenon affective connotation. Hayakawa (1952: 83) defines affective connotation as "the aura of feelings, pleasant or unpleasant, that surrounds practically all words". Similarly Salomon (1966), who defines affective connotation as the emotional reaction that is triggered in a person by using a given word. However Nida (1964, 1975) uses the term emotive meaning for the emotional reaction of the participants of the communication. These affective connotations of words are based on personal memories and experiences. That's why a person has different emotions while hearing or reading the word 'garden' in comparison to the word 'factory'. Of course, those affective connotations do also influence the word choice - therefore words such as 'amazing', 'great' or 'awesome' are used for describing something very good instead of merely 'nice' or 'fine'.

2.1.7 Affect Analysis and Sentiment Analysis

Research areas studying the relationship between language and emotional information and dealing with their computational processing are sentiment analysis and affect analysis. Those approaches focus on text which is an important medium for extracting emotions because the majority of computer user interfaces are based on text (Valitutti et al., 2004).

Sentiment analysis originates from text mining and computer linguistics and deals less with the content analysis of a document but rather with the overall polarity of opinions and sentiments in it, usually in the sense of positive, negative and neutral sentiments (Zafarani et al., 2010). Sentiment analysis is also called opinion mining, sentiment extraction or sentiment detection. However affect analysis considers a significantly larger number of potential emotions, such as joy, sadness, hate, excitement, fear etc. (Abbasi et al., 2008).

Sentiment and affect analysis require linguistic resources containing emotional knowledge (Valitutti et al., 2004). Possible resources are ANEW (Affective Norms for English Words; Bradley & Lang, 2010), BAWL-R (Berlin Affective Word List Reloaded; Võ et al., 2009), LEW (List of Emotional Words; Francisco & Gervás, 2006) or SentiWordNet (Esuli et al., 2010). ANEW is a list containing 2,476 English words with values for the three dimensions valence, arousal and dominance. Each dimension ranges from 1 to 9 (Bradley & Lang, 2010). BAWL-R with 2,901 German words covers the dimensions valence (-3 ... +3), arousal (1 ... 5), and imageability (1 ... 7) and furthermore contains a set of psycholinguistic factors known to

influence word perception. LEW contains emotional dimensions of 1,736 English words and categories of 1,448 English words. Emotional dimensions include evaluation, activation and power. For emotional categories, LEW stores for each word the probability of this word for indicating one of the 84 emotional categories (e.g. boredom, depression, pleasure, satisfaction, worry) (Francisco & Gervás, 2006). SentiWordNet assigns to each synonym set of WordNet three sentiment scores: positivity, negativity and objectivity. These scores range from 0 to 1 and their sum is 1 for each synonym set (Esuli et al., 2010).

The Gottschalk-Gleser Content analysis is an important language content analytical method for measuring current emotional states of fear. This method is very difficult and analyses spoken language including stuttering, pauses etc. Based on the Gottschalk-Gleser Content analysis, Berth (2004) developed the so-called Dresdner Angstwörterbuch (DAW), the Dresden dictionary of fear.

Visualising the valence and arousal values of all words of ANEW and BAWL-R in diagrams reveals a boomerang-shaped distribution (see Figure 3) which has been reported for many languages. The reason for missing positive words with high arousal in BAWL-R is that taboo words have not been included (Võ et al., 2009).

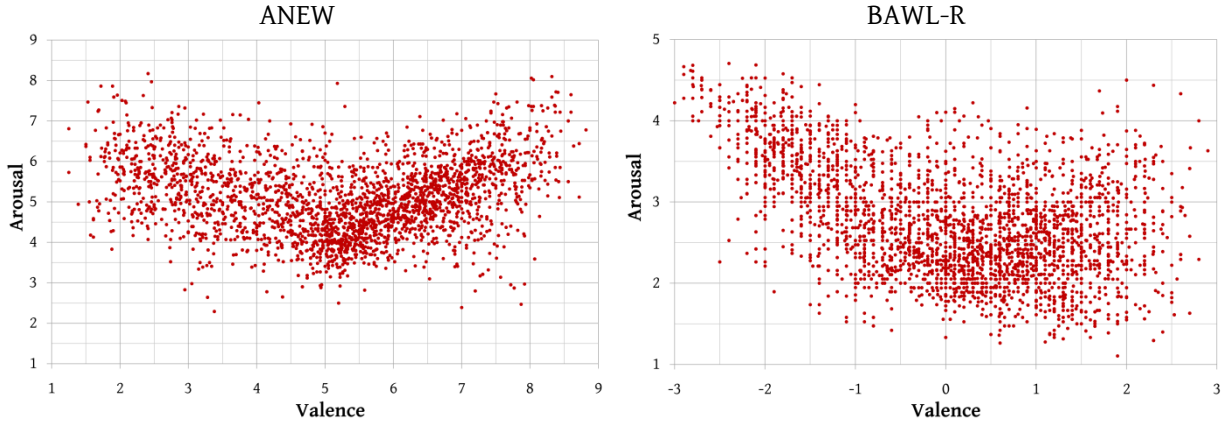


Figure 3 Distribution of ANEW and BAWL-R words in valence-arousal-space

Some of the influences of emotions on language summarised in Table 4 can be found in the previously mentioned word lists (examples: see Table 5). Expressive verbs are rated with much more arousal in ANEW than inexpressive and more formal verbs. Insults and nick names are rated as similarly arousing but differ clearly in valence. Affective adjectives have more distinct values than condition or shape adjectives. Not all linguistic phenomena of Table 4 are demonstrable in ANEW or BAWL-R because those lists contain only nouns, verbs and adjectives as base forms.

Expressive verbs			vs.	Inexpressive/Formal Verbs	
Example	**Valence**	**Arousal**	**Example**	**Valence**	**Arousal**
wish	1.57	3.08	*sleep*	1.65	1.9
hope	1.54	3.22	*impart*	-0.02	2.43
crave	-0.09	3.57	*behave*	0.375	2.465
love	2.79	3.72	*dwell*	-0.09	2.5
Insults			**vs.**	**Nick Names**	
Example	**Valence**	**Arousal**	**Example**	**Valence**	**Arousal**
moron	-0.92	3.35	*sweetheart*	2.57	3.25
Affective Adjectives			**vs.**	**Condition or Shape Adjectives**	
Example	**Valence**	**Arousal**	**Example**	**Valence**	**Arousal**
awful	-1.76	3.36	*simple*	1.13	2.37
terrific	2.37	3.61	*plain*	-0.46	2.26

Table 5 Valence and arousal values for selected words of ANEW

2.2 User-Generated Content

2.2.1 Definition and Characterisation

Based on mobility and interactivity, the today's map user captures data independently and therewith undergoes a transition from a pure data user to a producer and user united in one person, i.e. to a ProdUser (Budhathoki et al., 2008). This trend is accompanied by the widespread success of social networks, online communities and rating platforms where users can exchange personal opinions and appraisals. In general these contents are called user-generated content (UGC). The phenomena that thousands of people are willing to invest time for sharing geographically referenced content in the web without any prospect of financial reward, is called volunteered geography or volunteered geographic information (VGI) by Goodchild (2007b). The showcase example for VGI is OpenStreetMap[15], a completely user-generated world map based on the approach of CrowdSourcing.

Contributions in social media often have a geographic reference. The difference from VGI is that the user does not have the explicit purpose to provide spatial information, for instance for storing them in a data base for further processing like in OpenStreetMap (Crooks et al., 2013). The contained geographic footprint is a side effect. This kind of UGC is called ambient geospatial information (AGI) (Stefanidis et al., 2013) and examples are Tweets or Flickr

[15] www.openstreetmap.org

photos when they have a geospatial reference. Nevertheless, contents from social media cannot be considered as AGI by default. As soon as somebody shares space-related data with the intention that they can be used by others, then it is a case of VGI (Crooks et al., 2013). Since the distinction between VGI and AGI is not obvious for all kinds affected of data, the term georeferenced user-generated content will be used in this work.

The motivation of users to provide self-gathered geographic information can be of different kinds (Coleman et al., 2009; Stöckl et al., 2006): altruism, professional or personal interest, intellectual stimulation, social recognition, acknowledgement of expert status for a certain subject, creative and independent self-fulfilment or self-presentation, easy publishing of one's own productions etc. Additionally also negative but not less important motivations exist which should not be disregarded. Not all producers of UGC are interested in a provision of objective and reliable data. After Coleman et al. (2009) they want to do damage, spread wrong information or have malicious or criminal intentions. According to Budhathoki (2010) local knowledge is the most significant determinant for such contributions. If users become aware of their possession of knowledge in consideration of faulty and incomplete mapping of a region that is interesting for them, they are encouraged to map because obviously they are able to do a job more attentive to detail and more up to date than nonlocal agencies or mapping organisations.

Reasons to use geographic UGC are especially that websites like OpenstreetMap are inexpensive data sources, and in some cases the only ones, especially in areas where access to geographic information is a matter of national security (Goodchild, 2007a).

The data provided by those agencies and organisations are formalised, accurate and allow the description geospace in a consistent manner. If a subjective view is requested or the way a place is sensed, these data are unsuitable. Georeferenced UGC provides an opportunity to access notions of locations because the content of georeferenced UGC contains bias of users as individuals (Purves et al., 2011). According to Rorissa (2010) Flickr tags are much richer in semantic content than index terms assigned by professionals.

2.2.2 Advantages and Disadvantages

A clear advantage of georeferenced UGC are the low costs. Another benefit which seems to be the deciding reason for many end users is the high up-to-dateness. Since various users are observing reality simultaneously, changes are noted and recorded quickly. A negative

aspect is the disadvantage that users are said to register in a map only objects they are interested in. Quality assurance by the operator in the form of controlling the data is not always possible. Often users are controlling each other. In this matter the largeness of the respective community is of importance. The more users are viewing and using the content, the faster and more probable it is that mistakes are recognised and eliminated, and thus a better and more reliable quality assurance is given as well as growing information density and increasingly improving information content. This is called CrowdSourcing (Zipf, 2009).

The biggest fear regarding UGC is vandalism. Users are afraid that their data will be manipulated, falsified or even deleted. UGC receives most of the criticism because of the assumed bad quality. Missing editing, anonymous publishing and doubtful reliability of the authors are reasons for this. The just mentioned doubtful reliability of the authors is taken into account in the form of a particular mechanism: users are rating other users which is visible to everybody like, for instance, on eBay[16]. On Wikipedia[17] the procedure is similar since contents can be marked as questionable or on facebook where users can announce inappropriate behaviour of other users. However a comparable mechanism does not exist for georeferenced UGCs (Gartner & Schmidt, 2010).

Professionals fear a loss of clients and a fall in prices which is probably necessary for counteracting the first issue (Hornig, 2007). Yet it is relevant if professional contents can be compared with UGC. Since the data are gathered and published voluntarily, these projects do not have a professional aspiration but want to provide noncommercial authenticity and quantity. Several publications deal with quality and completeness investigations of OpenStreetMap in comparison with proprietary data: Haklay (2010), Mooney et al. (2010), Neis et al. (2010) and Zielstra & Zipf (2010).

More disadvantages in the form of inaccuracies are discussed in 2.2.4.

2.2.3 Tagging

Tagging is a term for assigning keywords to content in the web with the purpose of linking, categorising and describing that content. The relation of tags to each other is not structured hierarchically but serves for grouping elements. Tags are filed as metadata and are helpful for making searched elements detectable for the user (Sjurts, 2011).

[16] www.ebay.com
[17] http://www.wikipedia.org/

Sen et al. (2006) define three general classes of tags based on the seven detailed classes of Golder & Huberman (2006). The general classes reflect the intent of use of the particular tags. These classes are summarised in Table 6. However Sigurbjörnsson & van Zwol (2008) assign tags to six categories: location, artefacts or objects, people or groups, actions or events, time and others.

General Tag classes (Sen et al., 2006)	Detailed Tag Classes (Golder & Huberman, 2006)	Short Description (Sen et al., 2006)
Factual Tags	Item Topics Kinds of Item Category Refinement	· identify 'facts' about an item · help to describe an item and to find related ones
Subjective Tags	Item Qualities	· express user opinions related to an item
Personal Tags	Item Ownership Self-Reference Task Organisation	· have an intended audience of the tag applier themselves · most often used to organize a user's collection

Table 6 Tag classes

Viana et al. (2008) developed an ontology especially for photo annotation. In this ontology they define five dimensions of possible photo tags (see Table 7).

Photo Tag Dimension	Respective Elements
Temporal	· day, month, year · time of day · day of week
Spatial	· latitude, longitude, elevation · city and country name · nearby fixed objects · spatial relations
Computational	· camera properties · nearby Bluetooth devices
Spatiotemporal	· season · weather conditions · light status · nearby moving objects
Social	· around people · known people

Table 7 Photo tag dimensions (Viana et al., 2008)

More specific is a categorisation of tags by Beaudoin (2007) particularly for Flickr-images. Beaudoin (2007) distinguishes 18 categories of tags (see Table 8). The five most used categories are place name (28.21%), compound (14.05%), thing (11.37%), person (8.81%) and event (5.69%).

Category	Definition	Examples
Adjectives	all adjectives	*cold*, *wet*, *bright*
Compound	terms with two or more words combined	*Newyorkcity*, *Mydog*
Emotion	identification of emotional state	*happy*, *depressed*
Event	pertaining to holidays, happenings or news occurrences	*wedding*, *Easter*, *assassination*
Humour	terms used for humorous reasons	*Ithinkbobbyisgreat*
Language	terms in any language beyond English	*eau*, *gefühle*, *madrina*
Living thing	living, non-human creatures and plants	*bird*, *rose*, *tree*, *dog*
Number	terms composed of numbers	*64325*, *1+111*, *2000*
Person	named (common and proper) individuals and groups	*baby*, *Elvis Costello*, *Girl Scouts*, *woman*
Photographic	terms relating to imaging/photographic devices and/or processes	*Canon*, *SLR*, *I100*
Place - general	places identified with their common names	*beach*, *field*, *bedroom*
Place - name	places identified with their proper names	*Amsterdam*, *Seoul*
Poetic	terms that are poetic in nature	*heavenly mirage*, *daydream*
Rating	terms which evaluate images	*topten*, *tag1*, *taggedout*
Thing	non-living objects	*house, car, rock, water*
Time	terms with chronological meaning	*June, 2006, night*
Unknown	unidentifiable terms	*Sha78, Pp73*
Verb	all verbs	*running, look, crying*

Table 8 Category model for image tags found in Flickr (Beaudoin, 2007)

With the rise of photo sharing platforms such as just mentioned Flickr, the major motivation of users for tagging changed. Tags make photos not only searchable but also enable discovering other users' photos as well and replace the former use for annotation, organisation and retrieval (Ames & Naaman, 2007). The motivations for tagging photos can be summarised as a taxonomy with two dimensions (see Table 9).

		Function	
		Organisation	**Communication**
Sociality	**Self**	· retrieval, directory · search (1)	· context for self · memory (2)
	Social	· contribution, attention (3) · ad hoc photo pooling	· content descriptors (4) · social signalling

Table 9 Taxonomy of photo tagging motivations (Ames & Naaman, 2007)

The dimension sociality depends on whether the intended use of the tag is by the photographer/uploader or by others. This dimension is not part of the already mentioned traditional motivation. The dimension function indicates whether tags were applied to facilitate organisation and later retrieval or to communicate additional information to the viewers. Field (1) of Table 9 represents traditional tagging motivations, i.e. annotation for later retrieval and personal organisation purposes. Field (2) aims at adding a context to a picture for recalling the situation on the photo in future, whereas the motivation of field (4) is to communicate contextual information to others. In field (3) the motivation can be found to make pictures detectable by others (Ames & Naaman, 2007). In turn this is inspired by the aim to attract attention, for self presentation or opinion expression (Marlow et al., 2006).

While most of the tags are subject related, some tags (such as 'cool' or 'fun') indicate a user's emotional reaction to an object represented by the particular document, i.e. these are affective tags and consist of words describing an emotional state. The use of those affective tags shows that users may regard tagging and classification as a holistic process (Kipp, 2007).

Taggers often do not distinguish between the different semantic levels 'of' and 'about' (Schmidt & Stock, 2009). The semantic level 'of' is related to the object represented in a document. The level 'about' belongs to the interpretation mediated by a document which depends strongly on the interpreter (Shatford, 1986). Some practical experience and everyday familiarity is required for recognising, for instance, sadness in a certain gesture or countenance, or appropriate knowledge is needed for discerning a three-person family as the Holy Family. These semantic levels can be explained quite well with the help of the

photo 'Migrant mother' by the documentary photographer Dorothea Lange: it is a picture of a mother with her children and it is about poverty and homelessness.

A particular kind of tag is geotags, i.e. geospatial metadata that belong to the dimension of spatial tags as named in Table 7. Geotags add geographical identification data to media and usually contain latitude and longitude coordinates though altitude, accuracy data and place names may be included as well. With the help of geotags, users can find location-based news, websites or images taken close to a certain location. Another less common term for geotagging is geocoding which more often refers to non-coordinate based geospatial identifiers like street addresses (Miller et al., 2009). Geotagged media such as travelogues or photos can be used for extracting tourism related knowledge, e.g. for analysing travel patterns (Girardin et al., 2008), for detecting cultural differences of certain local regions (Zheng et al., 2011) or for the automatic generation of travel routes (Choudhury et al., 2010).

2.2.4 Inaccuracies

Since user-generated georeferenced data of photo platforms like Flickr or Panoramio are increasingly used for spatial analyses, it is required to examine their quality in spatial and semantic respects.

Flickr as well as Panoramio offer different possibilities for georeferencing a photo. Recent cameras with an integrated GPS receiver store the position where a photo was taken in the EXIF format which can be uploaded in both portals together with the photo. Likewise position information can be added manually, for instance when they were acquired with an external GPS device. Moreover both platforms allow the user to drag and drop a photo at the respective location on a map. Each of these methods can cause errors for different reasons. While GPS receivers provide an accuracy of a few meters when they have a visibility of enough satellites, treetops or street canyons decrease this accuracy. The manual placing of a photo in a map requires a certain familiarity of the photographer with the area which might not be the case for touristic visitors. Furthermore similar places like bridges or parks can cause confusion and thus misplacement in the map. Another often occurring error is placing the photo at the location of the photographed object instead of at the position of photographer at the time of capturing (Hochmair & Zielstra, 2011). An indirect georeferencing of photos can be done also by using toponyms as tags.

Each georeferenced Flickr photo is assigned automatically to an accuracy level between 1 (world level) and 16 (street level) depending on the accuracy of the GPS measurement or on the zoom level used while locating the picture in the map. The majority of photos is assigned to the accuracy levels 12 to 16 with decreasing frequency for lower levels (Hollenstein & Purves, 2010). Hochmair & Zielstra (2011) found that the georeferencing of Flickr photos (mean error distance: 58.8 m) is less accurate than the one of Panoramio photos (mean error distance: 0 m), probably because Panoramio allows a correction of the positioning afterwards and Panoramio users are requested to georeference their photos which are subsequently displayed in Google Earth and integrated into a monthly contest. That means it can be assumed that Panoramio is a community which is more spatially aware and more interested in mapping than the community of Flickr (Hochmair & Zielstra, 2011).

Since users can tag the objects of georeferenced UGC freely, it is difficult to determine the semantic accuracy. Even the restriction of the users freedom would not change the lowness of the semantic accuracy because it depends on the training and on the knowledge of the user (Aragó et al., 2011). That means tags of georeferenced UGC have a low formal semantic which is usually neither predefined nor unambiguous. Consequently this applies as well to the tags of documents from photo platforms like Flickr. An automated analysis is complicated by different problems like misspelling, typing errors, polysemy and synonymity or the use of different inflection forms. Therefore tags are often reduced to a certain degree, for example by removing special or punctuation characters, by decomposition or lemmatisation. However in most cases defensive normalisation strategies are applied, since in individual tagging styles special characters or particular spellings can have a specific meaning (Lohmann & Ziegler, 2007). For normalising tags Flickr merely strips special characters and concatenates all terms in compound tags (Serdyukov et al., 2009).

2.2.5 Flickr and Panoramio

Flickr and Panoramio are of high relevance for this work, thus they will be shortly introduced in the following. Since both are photo platforms for georeferenced pictures, their data belong to georeferenced UGC.

2.2.5.1 Flickr

Flickr is a commercial web service portal with community elements that gives users the possibility to upload digital and digitised photos as well as short movies with comments and notes and thus to share with other users. Besides conventional uploading via the website, pictures can also be transferred by email or with the help of a smartphone and can be linked from other websites later.

Flickr was developed and released in February 2004 by Ludicorp Research & Development Ltd., a company founded 2002 in Canada and based in Vancouver. Originally uploading photos was an aspect of the online game 'Game Neverending' but this component was the most popular for the users so that the development of the game was discontinued and Flickr emerged in its present form. In March 2005 Flickr and Ludicorp was bought by Yahoo.

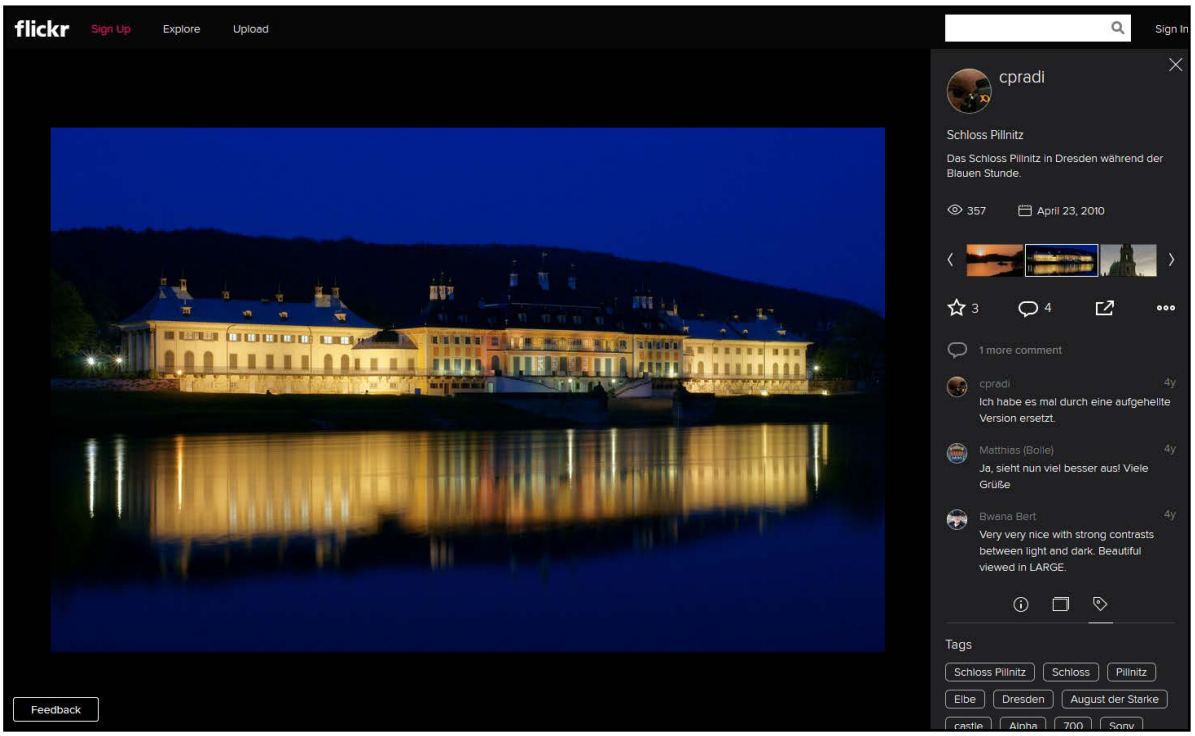


Figure 4 Website with Flickr photo (ID 4546631608) and its title, description, comments and tags[18]

Flickr provides the opportunity to tag, entitle and describe photos freely, to include them in so-called pools, to search for keywords, to look at so-called photostreams of other users (user profiles in the form of photo blogs) and to comment on pictures. Furthermore a variety of RSS feeds is available which are supposed to simplify the presentation of photos on other websites and the search for new pictures about a certain topic. Flickr provides a

[18] http://www.flickr.com/photos/cpradi/4546631608/ (accessed 30 July 2014)

particular search function for finding photos in the public domain with Creative Commons licenses granting a further processing.

Users can choose to upload their photos as publicly available or only for their own access. The permission to view photos can be also limited to a group of other Flickr users. In 2005 82% of the users made their pictures available for everybody. The photos can be assigned with 6 Creative Commons licenses[19].

2.2.5.2 Panoramio

Panoramio is a photo sharing website that can be used for publishing georeferenced photographs and was released by two Spanish developers in October 2005. Panoramio is owned by the US-American company Google. Beside the publication on the actual website, photos with geotags are integrated into the program Google Earth and further internet services at irregular intervals.

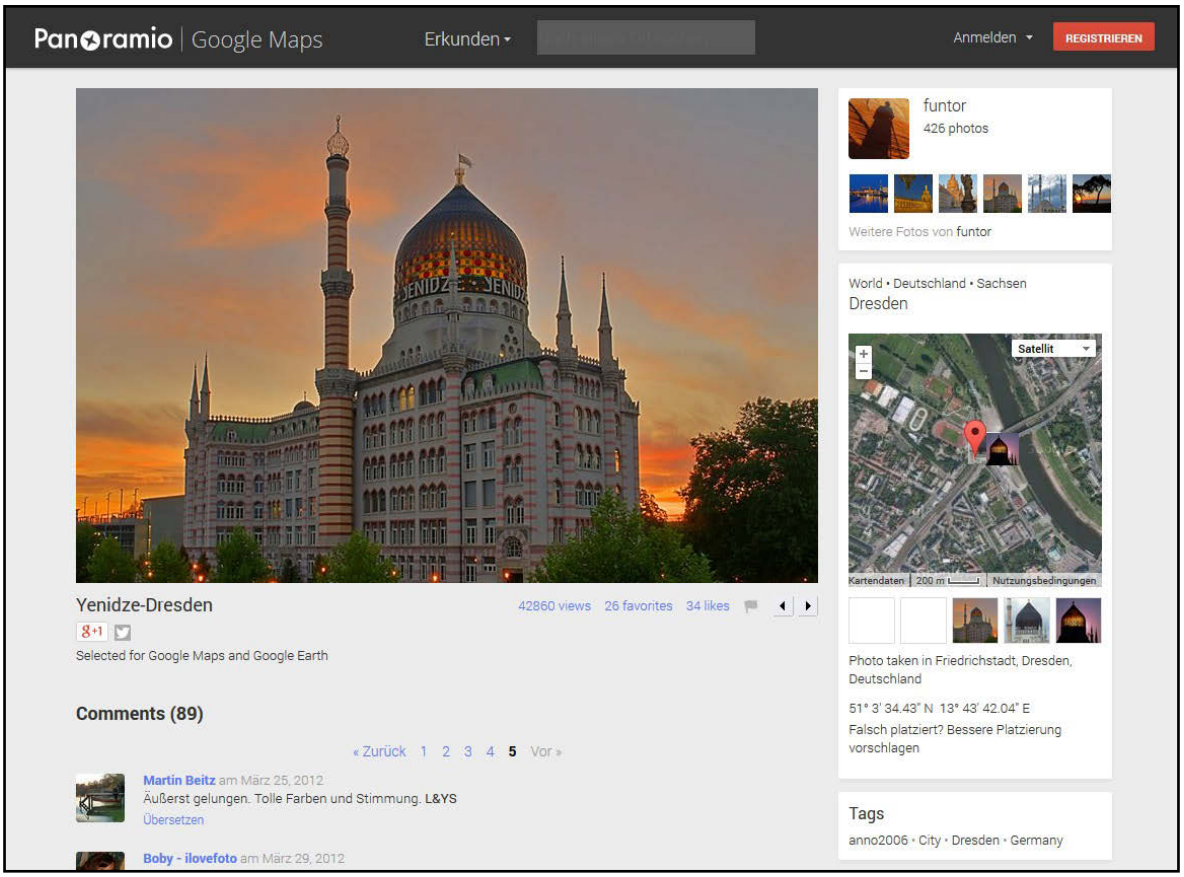


Figure 5 Website with Panoramio photo (ID 9663147) and its title, tags and comments[20]

[19] http://de.wikipedia.org/wiki/Flickr (accessed 01 August 2014)
[20] http://www.panoramio.com/photo/9663147 (accessed 30 July 2014)

Panoramio accepts photos for uploading which can be assigned to groups. Uploaded pictures can be provided with a title and tags. As is the case for Flickr, photos can be commented on by users in Panoramio also.

Panoramio states for users to review uploaded photos and to use only pictures of places, landscapes etc. for Google Earth. Photos showing persons, cars, interior views and the like are not used for Google's geoinformation systems but they remain on the personal page of the user[21].

2.3 Related Work on Georeferenced Emotions

There are several projects dealing with georeferenced emotions. The main difference between them is the method of acquiring the spatial emotional data. This can be distinguished into biometric measurements, empiric surveys and extraction from UGC (see Table 10).

Biometric Measurements	Empiric Surveys	Extraction from UGC
Ein emotionales Kiezportrait Höffken et al. (2008)	*Map of World Happiness* White (2006)	*Twittermood* Ahn et al. (2009) Mislove et al. (2010)
BioMapping Nold (2009)	*WiMo* Mody et al. (2009)	*Beautiful picture of an ugly place* Kisilevich et al. (2010)
EmBaGIS Bergner et al. (2011)	*Emotional study of Yeongsan River Basin* Jang (2012)	*Emography* Palmér et al. (2011)
	Mappiness MacKerron & Mourato (2013)	*Tweetbeat* Long (2012)
	EmoMap Klettner et al. (2013a)	
	ECDESUP Couillet (2013)	

Table 10 Related work on georeferenced emotions grouped by method of data acquisition

[21] http://de.wikipedia.org/wiki/Panoramio (accessed 01 August 2014)

2.3.1 Emotional Data Resulting from Biometric Measurements

2.3.1.1 Bio Mapping

The first time emotions were gathered related to space was in 2004 in the context of the project Bio Mapping (Nold, 2009) with the help of a device using GPS as well as a biometric sensor for measuring EDA. The project cooperated with artists, psycho-geographers, designers, cultural scientists, futurologists and neuroscientists for investigating political, social and cultural implications of the visualisation of body data and emotions.

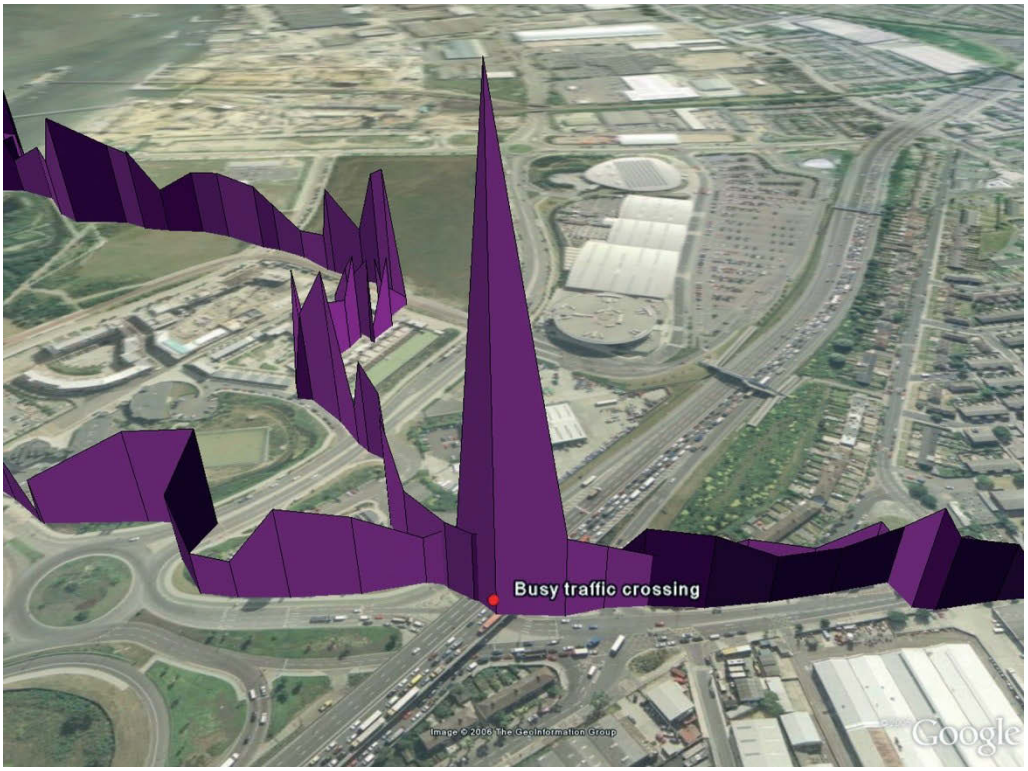


Figure 6 Visualisation of Bio Mapping data shown in Google Earth (Nold, 2007)

Thousands of participants from 16 countries were involved. Results were on the one hand visualisations of individual tracks of measured EDA response (Figure 6) and on the other hand emotional city maps, for instance the Stockport Emotion Map including sketches and notes of the probands showing and describing their hometown Stockport as well as the results of biometric measurements representing the emotional arousal while walking around in town freely (Figure 7).

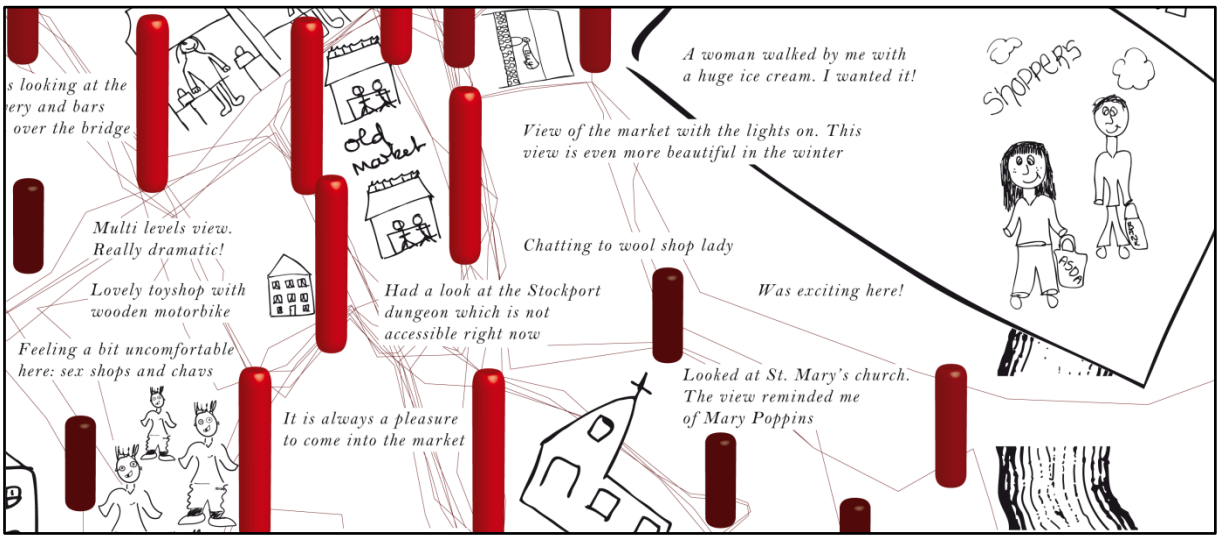


Figure 7 Excerpt of Stockport Emotion Map (Nold, 2007)

2.3.1.2 EmBaGIS

The project EmBaGIS (Emotional Barrier GIS) develops an innovative urban planning tool for identifying and removing spatial barriers for handicapped people (Bergner et al., 2011). Significant barriers are identified working with the 'Empirical Three-Level-Analysis'. On the first level, velocity is measured based on the hypothesis that increasing kinetic energy indicates the impact of a spatial barrier. The second level represents EDA indicating attention and on the third level, changes of skin temperature are used as an indicator for stress. Probands were blind as well as visually and bodily handicapped people. Punctual barriers (advertisement boards, lamp post, trash cans) and areal barriers (uneven ground cover, cobblestone patches, ramps, staircases) were identified since they were stress triggering (Figure 8).

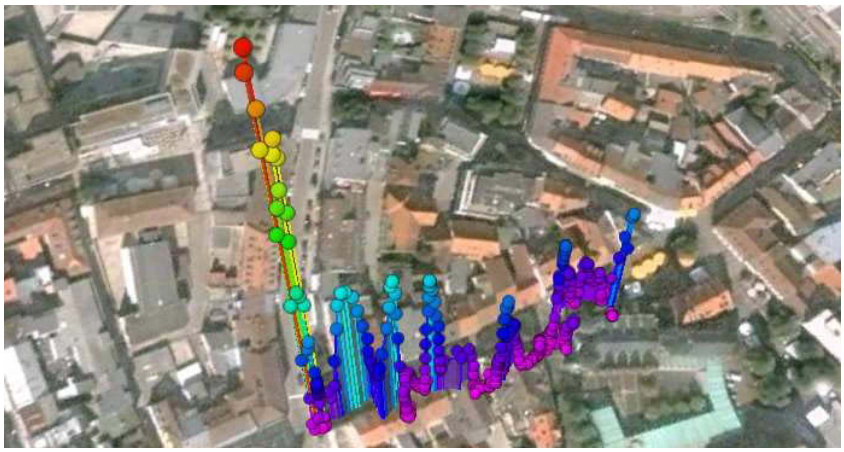


Figure 8 3D visualisation of a blind person's mental stress points illustrated in Google Earth (Bergner et al., 2011)

2.3.1.3 Ein emotionales Kiezportrait

The project 'Ein emotionales Kiezportrait' (engl. An emotional city neighbourhood portrait) tries in an explorative way to measure, record and visualise the emotions of residents whereby another form of cityscape and structural analysis emerges. The aim is to figure out how people concretely perceive and experience urban space in real-time and how to integrate them into formal and informal city planning processes (Höffken et al., 2008).

10 inhabitants were equipped with a GPS logger and a so-called Smart-Band which measured and stored psychophysiologic body functions like EDA and also acceleration (Figure 9). These persons had to walk around in a certain area freely for one hour and had to mark highlights. With this an exhibition was designed showing how the participants beheld the neighbourhood.

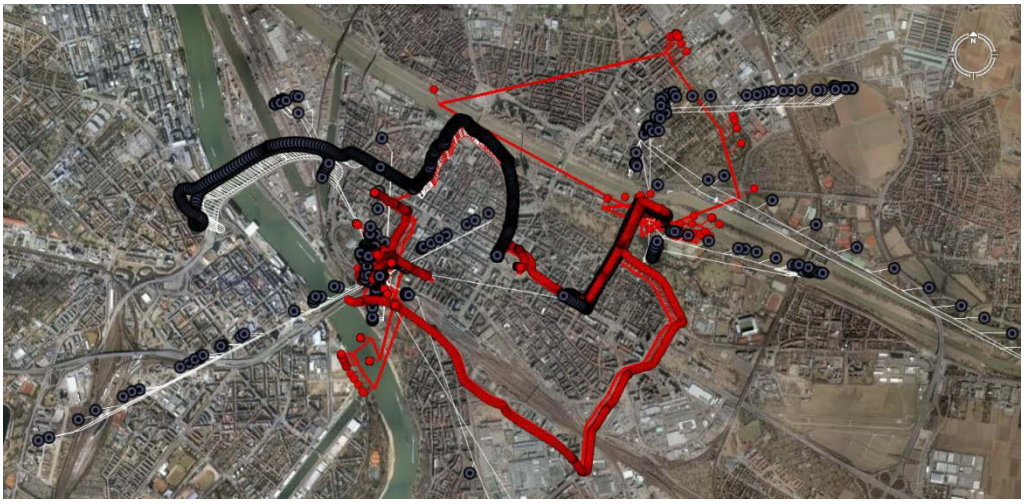


Figure 9 Tracks of two probands in Google Earth (Höffken et al., 2008)

2.3.2 Emotional Data Resulting from Empirical Surveys

2.3.2.1 EmoMap

The project EmoMap is based on the assumption that every person perceives urban space in a different way. Some places are perceived as beautiful, other places as unsafe. This perception is subjective and influenced by emotions of the particular person. The idea of EmoMap is to collect emotional spatial data in a CrowdSourcing approach and to make these data publicly available in the form of an online database (Gartner & Ortag, 2011). The resulting data can be used for different purposes such as urban development and planning. However EmoMap focuses on the visualisation of emotional data and their utility for

improving pedestrian navigation systems, i.e. EmoMap aims at adding a subjective layer for providing more satisfying navigation services (Klettner et al., 2012).

The data were collected in-situ in the study area of Vienna with the help of a mobile application asking people for their feelings regarding comfort, safety, diversity, attractiveness and relaxation related to their current place. The study area was divided into green area, area with light traffic and area with heavy traffic. Green areas received the most positive ratings whereas areas with heavy traffic got low or negative ratings (Figure 10) (Klettner et al., 2013a).

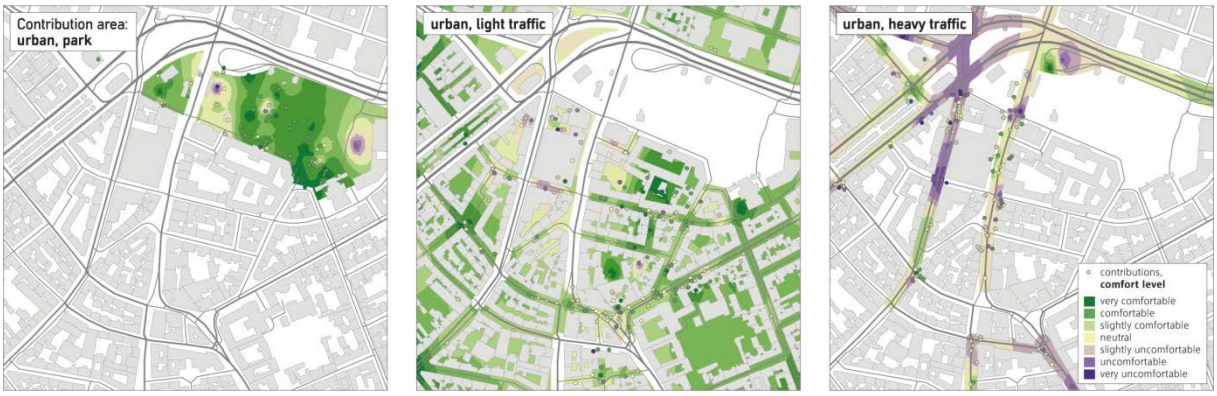


Figure 10 Level of comfort according to three urban scenes (Klettner et al., 2013b)

A route was calculated based on this subjective geodata for navigating pedestrians along the most comfortable way. A video of this route was shot and shown to participants of an online survey in comparison to a video of the shortest route. 69% of the participants preferred the 'Emo-Route' over the shortest route (Klettner et al., 2013a).

2.3.2.2 WiMo

Another project working with a mobile application as well is WiMo (Mody et al., 2009) which aims at integrating social networks practices in terms of emotion mapping and location tagging. WiMo is based on a prototypical two-dimensional emotion matrix for location-based emotion tagging. One dimension contains values from 'comfortable' to 'uncomfortable', the other one ranges from 'Like it' to 'Don't like it'. The matrix is built upon the finding that those two variables are used commonly and intuitively but are not necessarily correlating. The user can define the emotional quality of a place in the matrix and leave a short message linked to this place (Figure 11). Furthermore the geo-emotional tags shared by other users can be viewed.

Figure 11 Prototype showing the process of creating a geo-emotional tag (Mody et al., 2009)

2.3.2.3 ECDESUP

The project 'Evaluation, Choice and Decision in the use of Urban and Peri-Urban Spaces' (ECDESUP) gathered spatial emotional data for the town Besançon in the east of France (Couillet, 2013). 250 residents participated in the survey and documented all trips done within 7 days including information about the trip destination, duration and purpose as well as the transportation mode. Furthermore an emotion had to be assigned to each trip. An analysis of the survey data reveals that most of the trips are associated with positive emotions and that positive emotions occur mainly in the east of the city whereas negative emotions can be found primarily in the west (Figure 12).

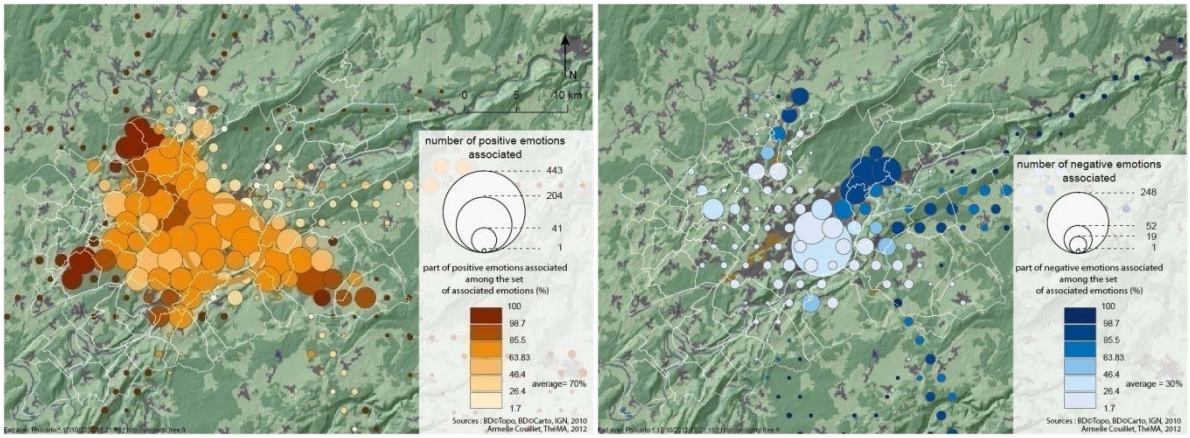


Figure 12 Location of the positive emotions (left) and negative emotions (right) associated to movements during a week (Couillet, 2013)

This spatial structure can be explained by a growth of the eastern part of town and a decline or at least stagnation of the western part in terms of economic development and demographic change. From a temporal point of view, trips associated with positive emotions occur from 9 am until the end of the day except for the period of 7 am - 9 am, especially in the centre of Besançon. The most frequently appearing trip purpose during this period is 'work' which might the reason for the negative emotions.

2.3.2.4 Map of World Happiness

The analytic social psychologist Adrian White used data published by UNESCO, WHO and other organisations for creating a world map of happiness. For the underlying data 80,000 people worldwide were interviewed regarding happiness and life satisfaction. This global projection of subjective well-being (Figure 13) reveals Denmark, Switzerland and Austria as the happiest countries whereas the three least happy countries in the world are the Democratic Republic of Congo, Zimbabwe and Burundi (White, 2006).

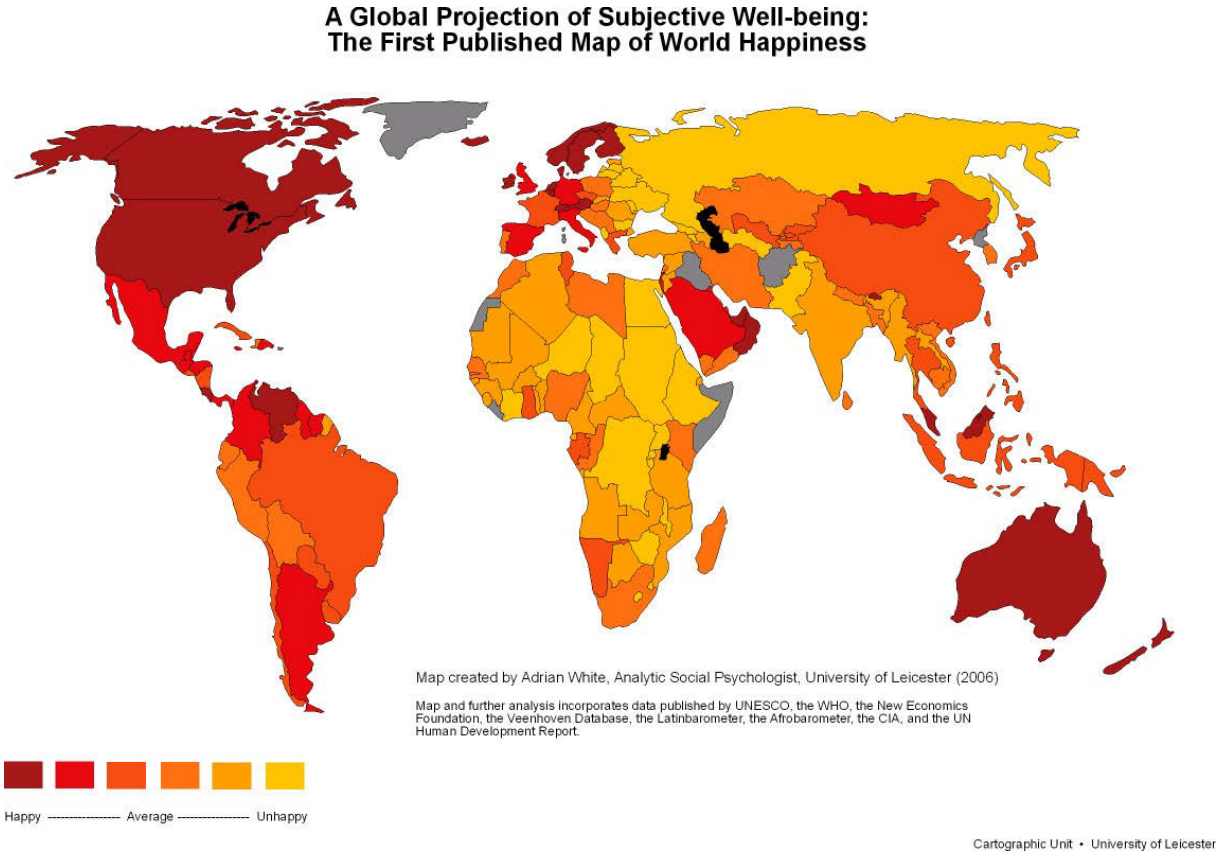


Figure 13 Map of world happiness [22]

[22] http://www.zonu.com/images/0X0/2010-09-07-12097/World-happiness-2006.jpg (accessed 22 May 2014)

2.3.2.5 Emotional Study of Yeongsan River Basin

Jang (2012) believes that a country's or region's distinctive emotions are reflected in historical remains and relicts and thus a close relation between the emotions of people and the regional culture exists. Choosing the Yeongsan River Basin as a study area, the basic data include more than 4,000 historical relics of this region as well as interviews with locals. The 100 relics with the most abundant emotional factors revealed loyalty, justice, courtesy, resentment and anger as the major emotional elements. This study used the Inverse Distance Weight (IDW) method for visualising the emotional data in the form of distribution and 3D maps (Figure 14). The emotional maps reflect the history of Yeongsan River Basin which experienced various invasions. For instance areas where people withstood military tyranny, anger, resentment and justice were expressed.

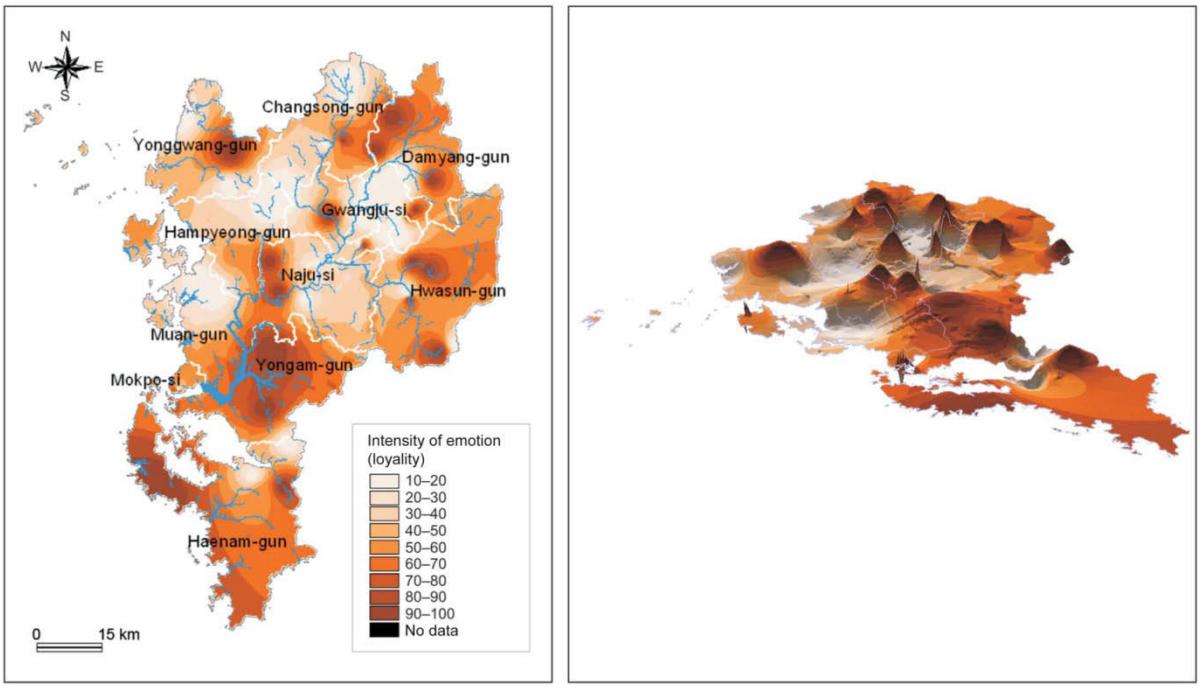


Figure 14 Distribution and 3D visualisation of 'loyalty' (Jang, 2012)

2.3.3 Emotional Data Resulting from User-Generated Content

2.3.3.1 Emography

Emography analyses georeferenced Tweets for 13 cities and focuses on the six basic feelings (happiness, sadness, fear, anger, disgust and surprise) according to Ekman et al. (1982) using Java API Synesketch. The detected emotions are displayed the in the form of donut charts on a world map (Figure 15). The Emography application is designed for large multi-touch screens which enable the users to move the charts to the cities where they want to know the current emotions (Palmér et al., 2011).

Figure 15 Donut chart visualising emotions in Cairo (Palmér et al., 2011)

2.3.3.2 Twittermood

The web application Twittermood (Ahn et al., 2009) extracts emotional information from georeferenced Twitter messages of the last 24 hours for the USA and visualizes them in coarse resolution (Figure 16). Twittermood distinguishes over- and below-average moods based on the emotional word list ANEW. Mood over the average is represented by the colour yellow; blue stands for moods below the average. The size of the circles shows the number of tweets (Abdalla & Weiser, 2011).

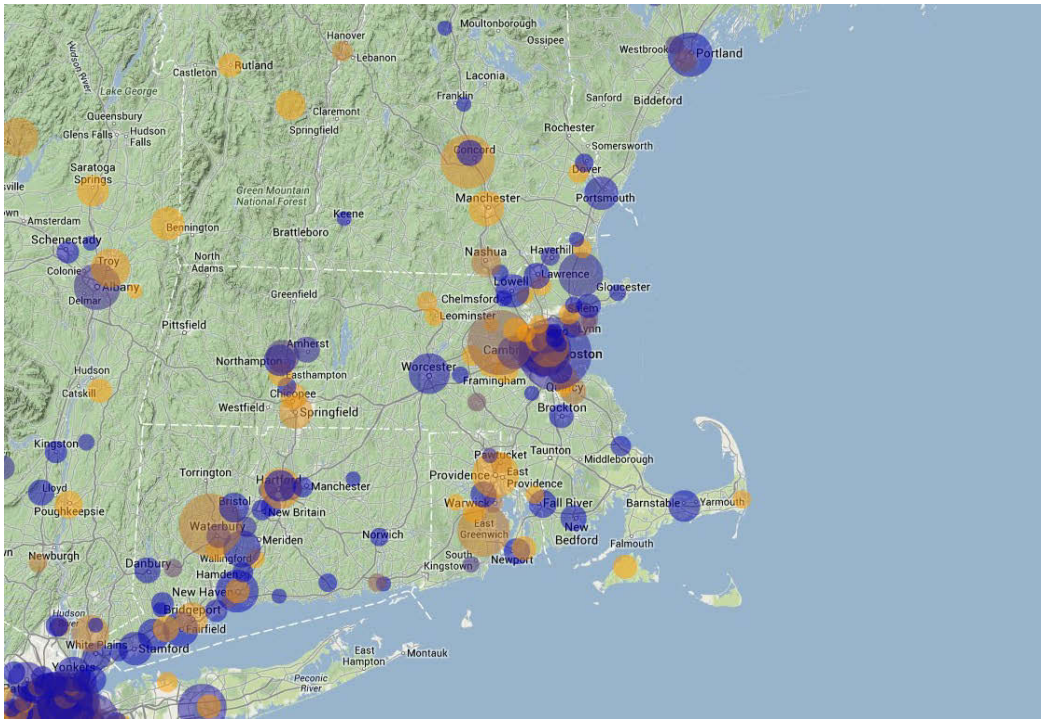


Figure 16 Visualisation of emotions extracted from Twitter data near Boston (Ahn et al., 2009)

In another approach, Twittermood uses georeferenced Twitter data of the previous 3 years and analyses the mood changes of US citizens over the course of the day and the week (Mislove et al., 2010). Findings include the fact that people are happier in the morning and on the weekend (Figure 17).

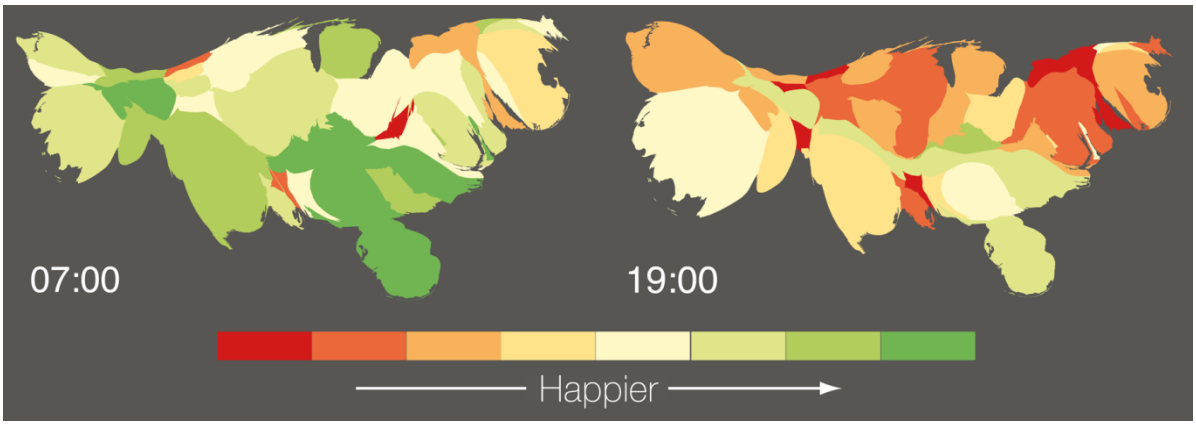


Figure 17 Cartograms about happiness in the USA (adapted from Mislove et al., 2010)

2.3.3.3 Tweetbeat

The Global Twitter Heartbeat Project - Tweetbeat for short - processes georeferenced tweets in real-time regarding sentiment (Long, 2012). Figure 18 shows a map visualising the mood in the USA during hurricane Sandy and reveals that most of the negative tweets (red) come from regions that were most affected.

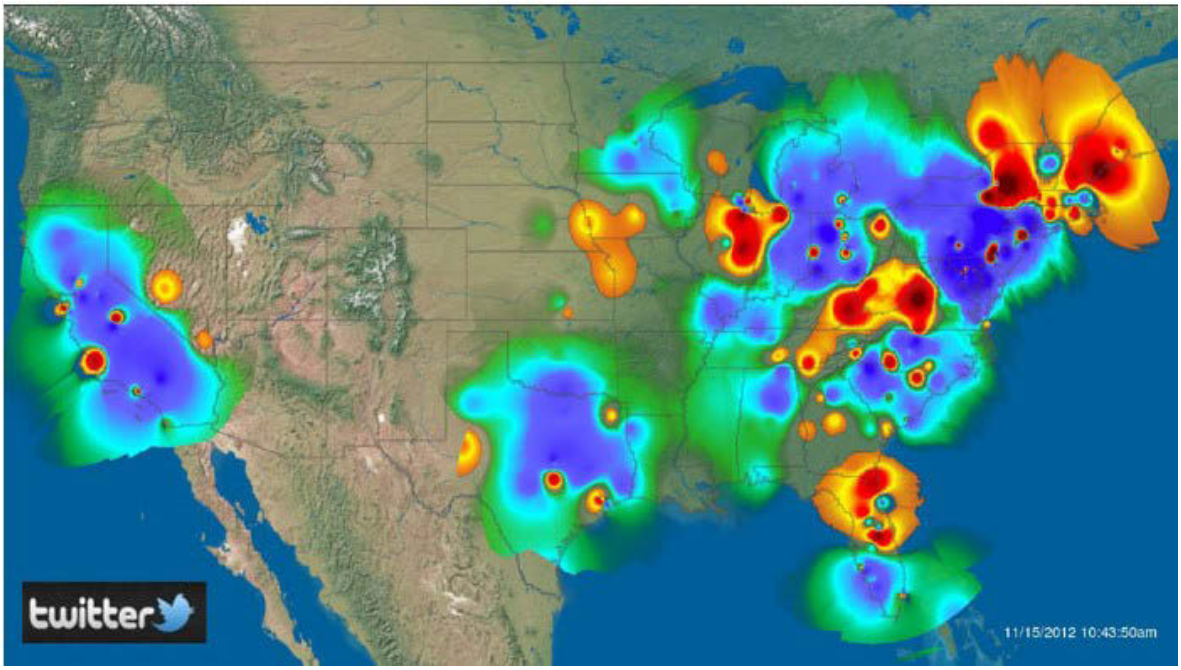


Figure 18 Mood in the USA during hurricane Sandy (Long, 2012)

2.3.3.4 Beautiful picture of an ugly place

'Beautiful picture of an ugly place' is a project applying sentiment analysis to Flickr photo comments for extracting emotions related to the photo quality and emotions related to the place where the photo was taken. Both are graded on a positive-negative-scale (Kisilevich et al., 2010). Four places in Poland (Krakow, Warsaw, Wisla and Auschwitz) and one in Germany (Dachau) were chosen for testing purposes. Using linguistic features, a lexicon of adjectives with opinion strength has been built. The two concentration camp memorials, Auschwitz and Dachau, have generally a more negative sentiment in contrast to the popular touristic cities of Warsaw and Krakow which have high positive sentiments. The neutral place Wisla lies between these extremes.

Although the determined sentiments are related to a certain location, no cartographic visualisations are presented.

2.3.4 Visualisation in the Related Work

Not all projects of Table 10 present visualisations of their spatial emotional data. The ones that do are classified by method of cartographic representation (Koch, 2001) in Table 11.

Point-Related	
Point Diagram	*BioMapping,* *ECDESUP,* *Emography,* *Twittermood*
Sketches	*BioMapping*
Line-Related	
Linear Signature	*BioMapping,* *EmBaGIS,* *Ein emotionales Kiezportrait*
Area-Related	
Isoline Method	*BioMapping,* *EmoMap,* *Tweetbeat,* *Emotional study of Yeongsan River Basin*
Choropleth Mapping	*EmBaGIS,* *Map of World Happiness,* *Twittermood*
Cartogram	*Twittermood*
3D map	*Emotional study of Yeongsan River Basin*

Table 11 Visualisations of related work classified by method of cartographic representation

Since all projects recording biometric measurements in combination with the GPS position of the probands are capturing route-related values, the tracks are visualised in Google Earth in the form of linear signatures. In some cases the line signature has a third dimension for representing the level of the measured emotional arousal. Multiple projects make use of point diagrams, primarily in the form of pie charts varying in size and/or colour, however Emography utilizes donut charts. The isoline method is applied when point-related values have been interpolated for visualising georeferenced emotions as a continuum. Choropleth

mapping is used for indicating a certain level of happiness or emotional arousal for a certain region, for instance countries or states. As several emotional city maps were published within the project BioMapping, various methods of cartographic representation are applied. Several of those maps include sketches and comments of the probands. Besides choropleth mapping, Twittermood also makes use of cartograms.

In the case of choropleth mapping for states or countries, it is questionable if emotions can be summarised for such small scales since other projects show that emotions occur and vary within larger scales. Nevertheless the visualisation of point or route related emotions does not reveal the reason for the occurrence of the respective emotions, except for the city maps of the project BioMapping. These contain comments of probands explaining the surrounding and thus the emotions sensed there which make these maps particularly interesting.

Mappers of georeferenced emotions are almost exclusively researchers from various sciences: social scientists, urban planners and developers, cartographers, geomedia technologists, media designers, geoinformation scientists, computer scientists, mathematicians and statisticians, and also psychologists. Tweetbeat was developed by a company for high performance computing and BioMapping is a project of an artist and designer cooperating with psycho-geographers, cultural scientists, futurologists and neuroscientists.

3 METHODS

3.1 Approach for Extracting Georeferenced Emotions from the Metadata of Flickr and Panoramio Photos

In the approach for gathering location-based emotional data that serve as base data, affect analysis is applied to metadata of user generated pictures of the photo platforms Flickr and Panoramio. Based on the assumption, that users tag, describe and entitle their photos differently when they liked a place than when they felt uncomfortable there, certain metadata of pictures are analysed regarding their emotional content. Certainly users do not concretely name their emotions felt at the place represented by a photo, but affective connotations are contained in the description of a place. That means for example, that the description of a scenic park, which provoked positive emotions in a person or of a decayed ruin being sensed as scary, is likely to contain words with respective affective connotations although an emotional state of the user is not specifically addressed in this description. The detected emotion in combination with the geographical coordinate of the respective photo forms a georeferenced emotion.

Consequently this approach builds upon the two-factor-theory of Schachter & Singer (1962) and regards a place as the required emotion triggering situation.

The emotional content of the words used in those metadata is determined with the help of ANEW and BAWL-R. The approach works with a valence-arousal-space ranging from 1 to 5 for arousal and from -3 to +3 for valence. Those ranges are the same as the ones of BAWL-R and were chosen for the reasons that valence represents a kind of positive-negative-feeling which can be expressed best with a bipolar scale and that arousal has a certain intensity which cannot be negative (Võ et al., 2009).

3.2 Implemented Algorithm

For realising the previously described idea, an algorithm processing the photo metadata has been developed using Java. In the following, the algorithm is presented in a simplified form (Figure 19).

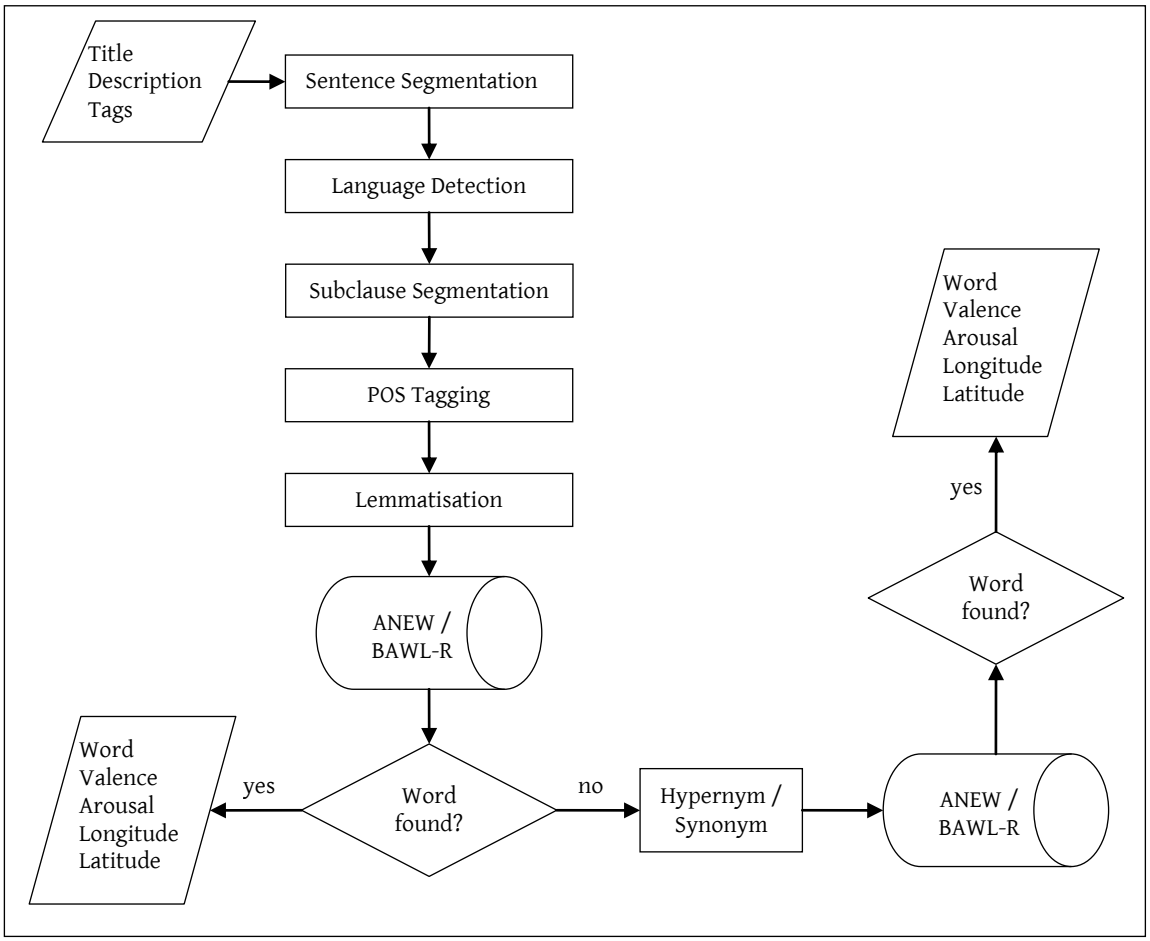


Figure 19 Simplified flowchart of algorithm for extracting emotions from the metadata of Flickr and Panoramio photos

As an initial step, all emoticons as well as hyperlinks are removed from title, description and tags of each photo. Then, sentence segmentation is applied to each component of the photo metadata and language detection considering German and English is applied to each sentence. Then all sentences are again subdivided into subclauses. The next step is a part of speech (POS) tagging for each word, i.e. it is determined if a word is an adjective, a noun, a verb etc. Subsequently all the words are reduced to their base form, a process called lemmatisation. For example nouns are reduced from plural to singular or verbs are reduced to infinitive. Then each lemmatised word is looked up in ANEW or BAWL-R, depending on the detected language. If the word was found, it is stored in a database together with the valence and arousal values from the emotional word list and with the longitude and latitude of the photo associated with the word. If the word was not found, a synonym (for adjectives and adverbs) or respectively a hypernym (for nouns) is determined to increase the matches in the emotional word lists. After that the synonym/hypernym is looked up again in ANEW

or BAWL-R. If it is not found, it is skipped; otherwise the word is also stored in a database with the emotional values and the coordinates.

The following Java libraries were used within the algorithm:

- Language Detection Library [23]
  for detecting German and English language
- JWNL [24]
  for English lemmatisation and determination of English hypernyms and synonyms
- tt4j [25]
  for German POS tagging and German lemmatisation
- GermaNet Java API [26]
  for determination of German hypernyms
- Stanford JavaNLP API [27]
  for subclause segmentation and English POS tagging

Furthermore the REST API of Xerox Linguistic Tools[28] is used to identify comparatives and superlatives of German adjectives.

3.3 Grammatical Special Cases

The algorithm described previously also considers several grammatical special cases within the written language of photo metadata. For instance in a sentence containing the word 'happy' it is not enough to consider only this one word but rather the entire sentence because possibly the full statement could be 'not happy' which expresses the opposite. This would be a case of negation. Negations can be also amplified, for example by a word combination like 'not happy at all', which means 'unhappier than unhappy'. Furthermore words can be amplified, e.g. 'very happy'. Realising that there is a comparative ('happier') as well as a superlative ('happiest'), reveals that there are two levels of amplification.

[23] http://code.google.com/p/language-detection/
[24] http://sourceforge.net/apps/mediawiki/jwordnet/index.php?title=Main_Page
[25] http://code.google.com/p/tt4j
[26] http://www.sfs.uni-tuebingen.de/lsd/tools.shtml
[27] http://nlp.stanford.edu/software/
[28] http://open.xerox.com/Services/fst-nlp-tools

Accordingly, in our approach there are also two levels of attenuation. For a summary see Table 12.

	Maximum	Amplification	Attenuation	Minimum	Negation	Amplified Negation
Example	*absolutely happy*	*very happy*	*a bit happy*	*hardly happy*	*not happy*	*not happy at all*
Indicators	superlatives, degree words	comparatives, degree words	degree words	degree words	prefixes, degree words	degree words

Table 12 Grammatical special cases considered within the algorithm for extracting emotions from photo metadata

3.3.1 Degree Words

Beside the classes maximum and amplification, which are also indicated by superlatives or respectively comparatives, as well as negations signified by prefixes, indicators for all grammatical special cases are degree words. In English as well as in German language, linguists use different terms for items modifying the intensity of other words (Table 14 and Table 13). In this work the term degree words will be used as an umbrella term for all those items.

	Helbig (1994)	Hoffmann (2009)	Kunkel-Razum et al. (2009)
Abtönungspartikeln	✓	✓	✓
Antwortpartikeln	✓		
Ausdruckspartikeln (Interjektionen)			✓
Fokuspartikeln			✓
Gesprächspartikeln			✓
Gradpartikeln	✓	✓	✓
Infinitivpartikeln	✓		
Intensitätspartikeln		✓	
Konnektivpartikeln		✓	
lautmalende Partikeln (Onomatopoetika)			✓
Modalpartikeln		✓	
Steigerungspartikeln	✓		

Table 13 Terms for items modifying the intensity of other words in German language

Source	Modifier of Adjectivals	Modifier of Verbs
Halliday (1985)	Submodifier	Mood Adjunct
Quirk et al. (1985)	Modifier	Subjunct
Allerton (1987)	Intensifier	Adverb of Degree

Table 14 Terms for items modifying the intensity of other words in English language (Paradis, 1997)

Several models for structuring degree words exist for English and German and are compactly summarised in Table 15.

English	German
models for structuring degree words	
Allerton (1987)	**Biedermann (1969)**
· scalar modifiers	· absolut
· telic modifiers	· hoch
· absolutive modifiers	· gemäßigt
· differential modifiers	· schwach
	· minimal
Bolinger (1972)	· negativ
· boosters	
· compromisers	**Heringer (1989)**
· diminishers	· übertrieben
· minimizers	· absolut
	· hoch
Quirk et al. (1985)	· gemäßigt
· amplifiers	· schwach
· maximizers	· niedrig
· boosters	
· downtoners	**van Os (1989)**
· approximators	· absolut
· compromisers	· approximativ
· diminishers	· extreme hoch
· minimizers	· hoch
	· gemäßigt
Stoffel (1901)	· abschwächend
· intensives	· minimal
· down-toners	· negativ

Table 15 English and German models for structuring degree words

In all models of Table 15 a rough division into amplifying and attenuating classes can be identified. Only do some of the models also consider the negation. For this work two classes

of amplification are surmised to be sufficient since comparative and superlative are obvious indicators. Accordingly, two classes of attenuation were chosen. The assignment of specific degree words to the four grammatical cases maximum, amplification, attenuation and minimum (Table 12) is based on some of the existing classifications listed in Table 15:

- Maximum:
  - corresponds to the class 'maximizers' by Quirk et al. (1985) (for English language)
  - corresponds to the class 'absolute Stufe' by van Os (1989) and to the class 'absolute Stufe' by Biedermann (1969) and merges the classes 'übertriebene Stufe' and 'absolute Stufe' by Heringer (1989) (for German language)
- Amplification:
  - corresponds to the class 'boosters' by Quirk et al. (1985) (for English language)
  - merges the classes 'extrem hohe Stufe' and 'hohe Stufe' by van Os (1989) and corresponds to the class 'hohe Stufe' by Biedermann (1969) and to the class 'hohe Stufe' by Heringer (1989) (for German language)
- Attenuation:
  - merges the classes 'approximators', 'compromisers' and 'diminishers' by Quirk et al. (1985) (for English language)
  - merges the classes 'approximative Stufe', 'gemäßigte Stufe' and 'abschwächende Stufe' by van Os (1989) and the classes 'gemäßigte Stufe' and 'abschwächende Stufe' by Biedermann (1969) and the classes 'gemäßigte Stufe' and 'schwache Stufe' by Heringer (1989) (for German language)
- Minimum:
  - corresponds to the class 'minimizers' by Quirk et al. (1985) (for English language)
  - corresponds to the class 'minimale Stufe' by van Os (1989) and to the class 'minimale Stufe' by Biedermann (1969) and to the class 'niedrige Stufe' by Heringer (1989) (for German language)

The references considered for this new classification developed by the author of this dissertation contain comprehensive lists of degree words with assignment to the respective class. These degree words were reclassified into the new groups maximum, amplification, attenuation and minimum and are listed in Appendix 1 and Appendix 2 including their

original classes. All the listed degree words are considered within the algorithm for extracting georeferenced emotions from Flickr and Panoramio photo metadata. The class attenuation in Appendix 1 as well as in Appendix 2 is quite extensive since it contains combinations of the negation particle 'not' and a degree word of the class amplification or maximum which results in an alleviation of the respective degree word. All those combinations were not part of the original references the new classification is based on.

Appendix 1 contains degree words that are not assigned to a class by Quirk et al. (1985). These degree words were added from Huddleston & Pullum (2002) for extending the list since Quirk et al. (1985) does not itemize very many degree words. The assignment to the new classes is based on synonymy.

Degree words do not modify an entire sentence but only adjectives, adverbs or verbs (Peters, 1993). When modifying an adjective or an adverb in English language, the degree words stand prior to the adjective/adverb (words printed in italics are the degree word, underlined words are the words affected by the degree word):

> It was *really* good.
> They loved their dog *very* dearly.

When modifying a verb, degree words can stand in front of the verb or in the end of a phrase:

> He *strongly* denied it.
> He denied it *strongly*.

Furthermore auxiliary verbs can stand between the degree word and the modified verb (Quirk et al., 1985):

> She will *virtually* have finished by the time they arrive.

These rules are implemented in the algorithm for the extraction of georeferenced emotions from photo metadata in the following way: the first adjective, adverb or full verb[29] after the degree word or - if not existing - the first full verb of the phrase is assumed as being affected by the degree word.

[29] full verbs exclude modal verbs (*can*, *could*, *may*, *might*, *must*, *shall*, *should*, *would*) and auxiliary verbs (*be*, *do*, *have*, *will*).

Also in German language degree words do not apply to the entire sentence but in most cases to adjectives or adjective-adverbs:

Der Schüler ist *ziemlich* fleißig.
Der Läufer ist *sehr* schnell.

In some cases a reference to a verb is also possible (Helbig, 1994):

Das Bein schmerzte *sehr*.
Wir haben *sehr* gelacht.

Furthermore degree words can modify nouns (Breindl, 2009):

ein *ziemlicher* Aufwand
ein *regelrechter* Abenteurer

Thus degree words are always positioned in front of the reference word which intensity they modify (Helbig, 1994). If the reference word is a verb, the degree word can be positioned behind the verb as well.

Similarly as for the English language, the implemented algorithm looks for the first adjective, full verb or noun after the German degree word or respectively the first full verb of the phrase.

Adjectives in comparative and superlative form are simply identified by the Part of Speech Tagging for both English and German and hence are assigned to the classes 'amplification' or 'maximum' respectively.

3.3.2 Negation

In English and German, three patterns of negation can be distinguished (Givón, 1993; Kunkel-Razum et al., 2009):

- syntactic negation
  She is not happy.
- morphological negation
  She is unhappy.
- inherent negation
  She is sad.

Morphological negation adds a negating prefix to words whereas inherent negation arises from the oppositeness of pairs of words. Syntactic negation uses different kinds of words that are summarised as 'degree words' in Table 12. Table 16 lists all those words in German and English language according to their part of speech that are important for syntactic negation. All the listed words can also be found in Appendix 1 and Appendix 2.

English	**German**
words for syntactic negation	
· Negation Particles *never* *no* *not* · Indefinite Pronouns *neither ... nor* *no one* *nobody* *nothing* *none* *nowhere* · Prepositions *instead of* *rather than* *without* · Idioms *anything but* *everything but*	· Negationspartikeln *nicht* · Indefinitpronomen und Artikelwörter *kein* *keinerlei* *nichts* *niemand* *nix* · Präpositionen *anstatt* *anstelle* *außer* *ohne* *statt* · Adverbien *keinesfalls* *keineswegs* *mitnichten* (deprecated) · Indefinite Pro-Adverbien *nie* *niemals* *nimmer* *nirgends* *nirgendwo* *nirgendwoher* *nirgendwohin* · Konjunktionaladverbien *weder ... noch* · Subjunktionen *anstatt dass* *ohne dass* · Idiome *alles andere als*

Table 16 English and German words for syntactic negation

Syntactic and morphological negation are of peculiar interest for this work since they follow clearly defined rules and thus can be detected by language processing. These rules refer to the scope of negation, i.e. the part of the sentence the negation applies to

semantically (Huddleston & Pullum, 2005), especially in the case of syntactic negation. For each part of speech indicating a syntactic negation, rules summarised by the author of this dissertation have to be applied in English as well as in German.

Also morphological negation was considered within the implemented algorithm for the extraction of georeferenced emotions from photo metadata, in particular the prefixes in Table 17.

English	**German**
negating prefixes	
(Huddleston, 1984; Payne, 2011)	(Hentschel, 1998)
a-	*a-*
*a*moral	*a*typisch
de-	*an-*
*de*frost	*an*organisch
dis-	*des-*
*dis*comfort	*des*illusioniert
il-	*dis-*
*il*legal	*dis*proportioniert
im-	*il-*
*im*possible	*il*legal
in-	*im-*
*in*tolerant	*im*materiell
ir-	*in-*
*ir*relevant	*in*kompetent
non-	*ir-*
non-smoker	*ir*relevant
un-	*miss-*
*un*happy	*Miss*erfolg
	nicht-
	*Nicht*achtung
	un-
	*un*glücklich

Table 17 Negating prefixes in English and German language

Those prefixes mainly negate adjectives. Moreover some of them can be also applied to nouns (e.g. *dis-*, *non-* (English), *Nicht-* , *Un-* (German)) and to verbs as well (e.g. *de-*, *dis-* (English), *im-*, *dis-* (German)).

The idioms in Table 16 have a negating function, but within the classification of degree words used in this work they belong to the class amplified negation. In literature this kind

of negation is called emphatic negation (Lorenz, 1999) or negative intensification (Quirk et al., 1985). Some degree words can amplify the negation (Kunkel-Razum et al., 2009). Thus aside from idioms like *not at all*, *not by any means* or *not in the slightest*, an amplified negation can be obtained by the combination of degree words of the class maximum or amplification with a word of syntactic negation (e.g. *absolutely not*, *really not*, *gar nicht*, *bestimmt nicht*).

3.3.2.1 Syntactic Negation in English Language

In the following, all rules for each part of speech from Table 16 for English negation as they were implemented in the algorithm for the extraction of georeferenced emotions from photo metadata are summarised (Downing & Locke, 2006; Huddleston, 1984; Huddleston & Pullum, 2005; Payne, 2011).

Negation Particles

- *Never* negates the following verb or adjective.

  I will *never* tell.
  In thirty years of marriage I was *never* unfaithful.

- *No* negates the following noun, verb or adjective.

  There is *no* water left.
  My mother's *no* fool.
  No easygoing people went with me on the trip.
  No smoking.

- *Not* negates the following parts of speech, if existing, in this order: adverb, adjective, full verb, noun.

  Try *not* to get too tired playing tennis.
  It will *not* be easy.
  I did*n't* log out purposely.
  I purposely did*n't* log out.
  Not realising the danger, she walked in the dark towards the edge of the cliff.
  I do*n't* want to revenge on you.
  He hoped I was *not* beginning to idle.

  In case of the sequence *verb to verb*, the second verb is negated.

Not just and *not only* are no cases of negation!

If the sentence ends with a question mark, it is a so-called negative-interrogative sentence and not a case of negation.

Did*n't* he take the car?
Is*n't* that woman the secretary?

Indefinite Pronouns

- *Neither ... nor* negates the respectively following parts of speech if existing in this order: adjective, full verb, noun.

  I could *neither* laugh *nor* cry.
  He mentioned *neither* the flooding *nor* the landslide.
  The coffee was *neither* hot *nor* tasty.
  Neither the staging *nor* the singing was above mediocre.

- *Nothing, nobody*, *no one* and *nowhere* negate the following full verb or adjective or - if not existing - the first full verb of the clause.

  He said *nothing*.
  They were eating until there was *nothing* left.
  He had *nothing* to lose by talking.
  Nobody called her that day.
  Nobody could understand why.
  He was careful to tell *nobody*.
  Homeless people have *nowhere* to sleep at night.
  I went *nowhere*.

  Nothing but and *nobody but* are not cases of negation.

  Nobody and *nothing* can also appear as a noun. This is not a case of negation.

- *None* negates the following parts of speech if existing in this order: adjective/adverb, verb, noun.

  None of my friends remembered my birthday.
  She has done *none* of the work I told her to do.

None of them were friendly.
None of the children are happy.

Prepositions

- *Instead of*, *rather than* and *without* negate the following full verb, adjective or noun.

  He likes to eat everything *without* sharing.
  He shot *without* warning anyone.
  The press ridiculed him *without* pity.
  He left *without* a word for me.
  He left *without* a nice word for me.
  I stayed in bed all day *instead of* working.
  I will have coffee *instead of* tea.
  We ought to invest in machinery *rather* than buildings.
  I decided to write *rather than* phoning.

  If the sentence contains *not* prior to *without*, it is not a case of negation. (e.g. We could *not* do it *without* the risk of being observed by the neighbours.)

Idioms

- *Anything but* and *everything but* negate the following adjective or noun.

  Our current life-style is *anything but* sustainable.
  They are interested in *everything but* safety.

3.3.2.2 Syntactic Negation in German Language

In German language, eight word classes indicate negations and imply certain rules that were implemented in the algorithm for the extraction of georeferenced emotions from UGC (Helbig, 1994; Helbig & Buscha, 2001; Kunkel-Razum et al., 2009; Strecker, 2009):

Indefinitpronomen und Artikelwörter

- *Kein* and *keinerlei* negate the following noun or adjective.

  Er hatte *keine* Macht mehr über das Land.
  Kein Apfel war in dem Obstkorb zu finden.
  Kein frischer Apfel war in dem Obstkorb zu finden.

Keiner war glücklich.

Mein Nachbar scheint *keinerlei* Interesse daran zu haben, neue Bekanntschaften zu machen.

Es gibt *keinerlei* Nachweise für ihren Tod.

- For *nichts* and *nix* the same same rules like as for *nicht* are valid.

  Warum hast du mir *nichts* gesagt?

  In der Schublade fand ich *nix*.

- *Niemand* negates the following full verb.

  Ich bin froh, dass uns *niemand* beobachtet.

  Wenn es auch *niemand* laut ausspricht, weiß jeder bescheid.

Präpositionen

- *Anstatt*, *anstelle*, *außer*, *ohne* and *statt* negate the following adjective, full verb or noun.

  Hier seid ihr *außer* Gefahr.

  Das steht *außer* Zweifel.

  Ohne zu grüßen ging er an mir vorbei.

  Er bleibt lieber zu Hause, *statt* sich uns anzuschließen.

  Statt eines Kleides reichte sie mir eine Hose.

  Statt eines grünen Kleides reichte sie mir ein rotes.

  Anstatt /Anstelle von Blumen schenkte sie eine Topfpflanze.

Adverbien

- *Keinesfalls* and *keineswegs* negate the following parts of speech, if existing, in this order: adjective, full verb.

  Ich möchte Sie *keineswegs* stören.

  Dieser Film ist *keineswegs* so gut wie du behauptetest.

  Das dürfen wir *keinesfalls* akzeptieren.

  Ihre Namen dürfen *keinesfalls* bürgerlich klingen.

Indefinite Pro-Adverbien

– *Nie*, *niemals*, *nimmer*, *nirgends*, *nirgendwo*, *nirgendwoher* and *nirgendwohin* negate following parts of speech, if existing, in this order: adjective, full verb, noun. If none of these follows, the first full verb of the clause is negated.

Ich werde *nie* mit dir ins Kino gehen.
Ich werde das *niemals* akzeptieren.
Das zeigt, dass man ihm einen Hund zur Pflege *nie* und *nimmer* anvertrauen dürfte.
Ich suche seit zwei Stunden meine Brille, aber ich kann sie *nirgends* finden.
Er wollte am liebsten *nirgends* auffallen.
Nirgendwo kann man seine Ruhe haben!
Ich habe meinen Geldbeutel überall gesucht, aber *nirgendwo* gefunden.
Die Tänzer kommen *nirgendwoher*, wollen *nirgendwohin*.
Aber ich gelangte *nirgendwohin*.

Konjunktionaladverbien

– *Weder … noch* negate the following parts of speech, if existing, in this order: adjective, full verb, noun.

An jenem Tag empfand ich *weder* Spaß *noch* Freude.
Weder will ich schlafen *noch* bin ich müde.
Weder der Schnitt *noch* die Kameraeinstellungen waren gut.

Subjunktionen

– *Ohne dass* and *anstatt dass* negate the following parts of speech, if existing, in this order: adjective, full verb, noun.

Die Tomaten werden in Butter gegart, *ohne dass* sie zerfallen.
Anstatt dass sie ihre Hausarbeiten macht, spielt sie im Garten Fußball.
Anstatt dass er den Bruch schweißte, setzte er ein neues Stück ein.

Außer dass is no case of negation.

If the previous clause contains *nicht* or *nichts*, *ohne dass* is no case of negation.

Ich kann den Film *nicht* ansehen, *ohne dass* es mich gruselt.

Idiome

– *Alles andere als* negates the following adjective or noun.

Sie war *alles andere als* freundlich.

Er ist *alles andere als* ein Romantiker.

Since the rules for the scope of the German negation particle 'nicht' are quite complex, they are depicted separately and neatly arranged in Appendix 3 in the form of a flow chart.

3.3.3 Modification of Words Affected by Grammatical Special Cases

When a grammatical special case is identified based on the rules described previously, the valence and arousal values of the affected word have to be modified within the implemented algorithm for the extraction of georeferenced emotions from photo metadata. In the case of negation the following procedure is used: the centre of the respective value range is used for flipping the value horizontally. Figure 20 shows this procedure by taking the example of 'not happy'. The calculated values of 'not happy' are V_{neg} = -2.4075 and A_{neg} = 2.255. In ANEW the word 'unhappy' exists which corresponds to 'not happy' and has the values V_{ANEW} = -2.5725 and A_{ANEW} = 2.59, so the distance between these two pairs of values is only 0.37343, which shows that this method of calculation is valid.

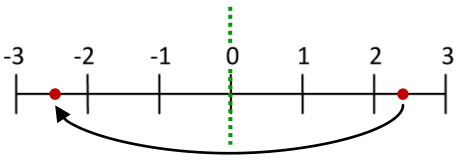
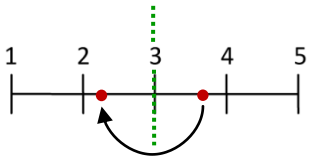
Valence	Arousal
happy	
V_0 = 2.4075	A_0 = 3.745
not happy	
	
$V_{neg} = -V_0$	**$A_{neg} = 6 - A_0$**
V_{neg} = -2.4075	A_{neg} = 2.255

Figure 20 Modification of valence and arousal values in the case of negation for the example 'not happy'

For all the other grammatical special cases, the range between the centre and the outer boundary of each value range is assumed as 100%. Based on this, the distance of an emotional value to the outer boundary is calculated in percent. Amplification cases are

increased by this calculated percentage, attenuation cases are decreased. For maximum and minimum this procedure is applied twice to the respective emotional value. Thus in the case of maximum and amplification, the emotional values are brought closer to the outer boundaries of the respective value range whereas in the case of attenuation and minimum the values are brought closer to the centre. The reason for this procedure is to stay within the defined borders of valence and arousal. For the amplified negation the values are first negated and amplified afterwards. Appendix 4 illustrates the procedures of all grammatical special cases in more detail and explains the derivation of the formula used for applying the modification of each case to the emotional values of the affected word.

4 VISUALISATION AND ANALYSIS OF EXTRACTED GEOREFERENCED EMOTIONS

The implemented algorithm has been applied to the city of Dresden (Germany). This pilot region was chosen since the author of this work lives and works here and thus know the city well. Appendix 5 contains a general map of Dresden with all of its districts.

4.1 Data Basis

The algorithm for extracting georeferenced emotions from photo metadata was applied to a dataset of 35,697 Flickr and 11,652 Panoramio photos of the city of Dresden from 3,712 users covering a period starting at the launch date of Flickr (February 2004) and Panoramio (October 2005) until the 5th of July 2013. The distribution of the altogether 47,349 photos is illustrated in Figure 21.

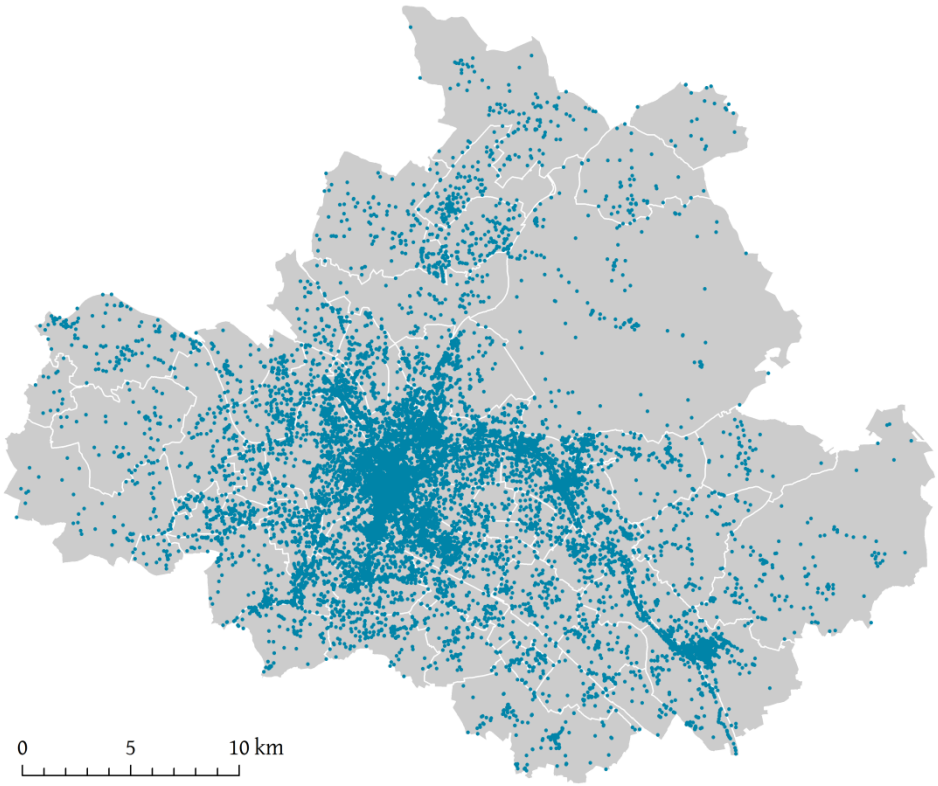


Figure 21 Distribution of Flickr and Panoramio photos within the city of Dresden

Via the respective REST API, the following metadata were requested and stored:

- photo ID
- photo URL
- title
- description (only Flickr)
- tags
- exposure date (if not available: upload date)
- longitude
- latitude
- owner ID
- owner gender (only Flickr)

The tags of a Panoramio photo as well as the exposure date cannot be requested by the REST API, so this information was acquired from the webpage of the respective Panoramio photos. The time of exposure is specified to the second. If that is not available, the upload date is stored instead.

The photo metadata used altogether contained 655,450 words. 106,364 of those words or the respective synonyms/hypernyms of them were found in the emotional word lists ANEW and BAWL-R. This does not seem to be very many, but the percentage of 16.2% found words is high considering the fact that ANEW and BAWL-R contain only adjectives, verbs and nouns and that the most frequently occurring words in the dataset (see Figure 22) are either geographical names like 'Dresden' or 'Germany', technology-related terms like 'http' or 'www' or stop words like the German article 'der'.

Figure 22 Word cloud of the 20 most frequently used words in the dataset of Dresden

This shows that not all content in the photo metadata, like technology-related terms, contains emotional information. There are also some cases in which photos are solely entitled with the name assigned by the camera to the photo file.

Figure 23 shows the distribution of those found words in valence-arousal-space which is widely spread. The average value of all valence values is 0.681 and for arousal it is 2.703. The previously mentioned boomerang-shaped distribution is recognisable again.

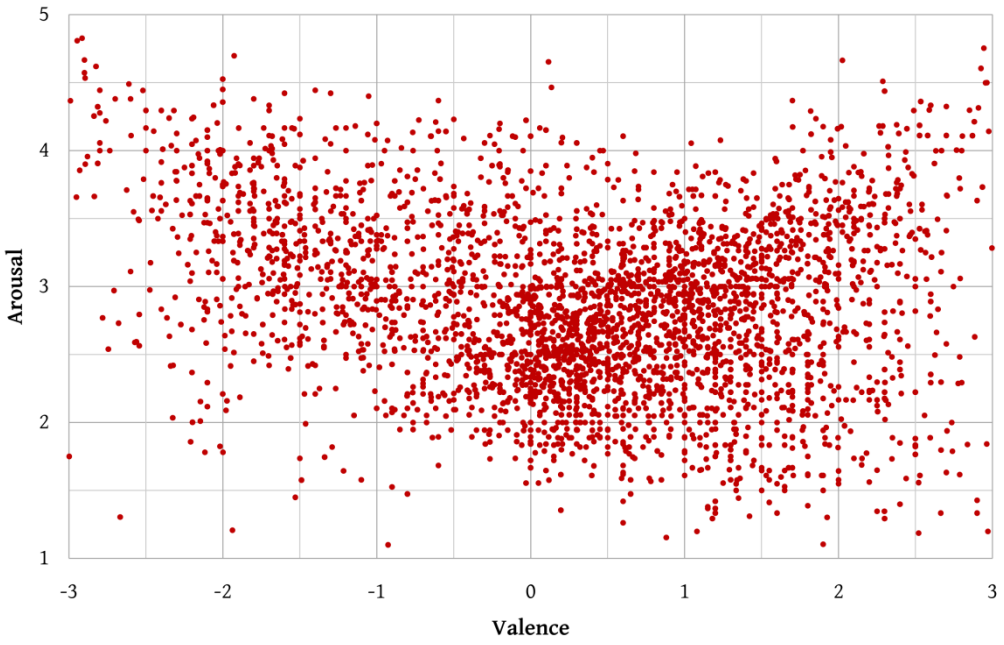


Figure 23 Distribution of all words in valence-arousal-space found within the dataset of Flickr and Panoramio photos of Dresden

While analysing the emotional data it was realised that one place is not necessarily connected with only one emotion. This can be for three reasons. The first reason could be personal preferences, experiences or memories. For example a very scenic park might be admired by most of the people but if someone remembers that their boyfriend or girlfriend broke up with them in this park, then this person probably does not like the park anymore because of this personal experience. This shows that individual and collective emotions need to be distinguished. The second reason could be temporal aspects which can be diverse. 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. Other temporal aspects can be of periodic kind, i.e. that emotions can be influenced by seasons, times of day etc. The third reason for the phenomenon that one place is not only connected with one emotion, is simply that places can evoke different

emotions at the same time in the same person and thus that places have a certain emotional spectrum.

At this point, reference should be made to Clark (2011), an American journalist focusing on location-aware technologies and their power as storytelling tools, who says that every place has a story and every story has a place. Clark (2011) understands landscape as a structure formed over time by layers of stories as if they were geological strata.

In order to analyse the data with the help of visualisations, valence-arousal-space was divided into four quadrants based on the centre of each value range, so the origin for this subdivision is the point consisting of the values $V_0 = 0$ and $A_0 = 3$. The four resulting quadrants are combinations of positive/negative valence and high/low arousal (see Figure 24). In the following, the terminology used in Figure 24 will be applied.

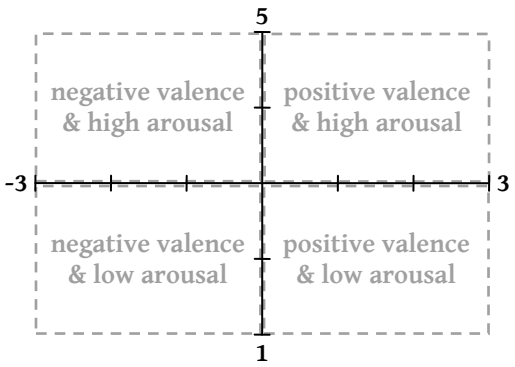


Figure 24 The four quadrants in valence-arousal space

Figure 25 shows the amount of detected emotions for each quadrant. 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.

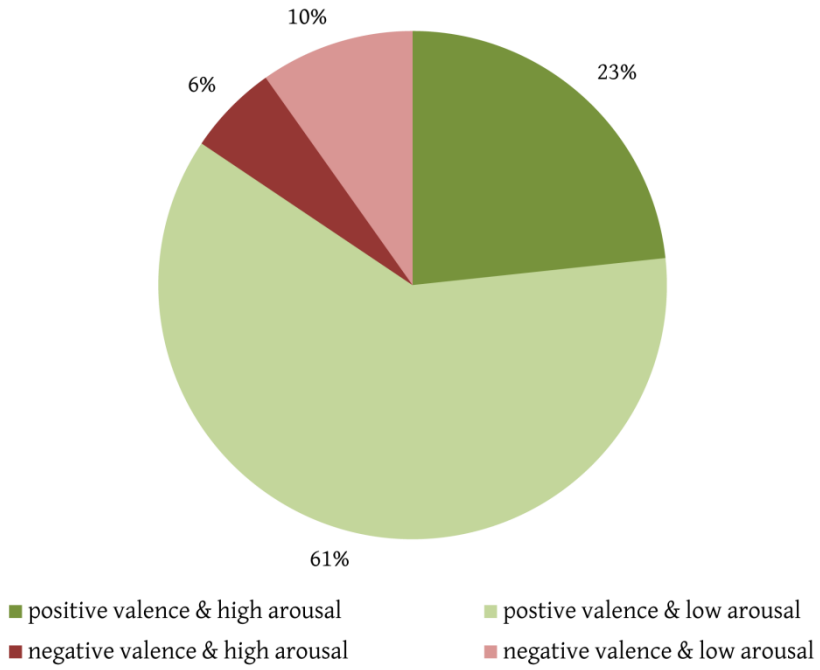


Figure 25 Number of detected emotions in each quadrant

Figure 26 shows tag clouds with the 20 most frequently found words for each quadrant. Emotional connotations are recognizable according to the respective quadrant. The word cloud of the quadrant of positive valence & high arousal reflects that many photos might be from tourists visiting Dresden, e.g. 'travel', 'trip'. The quadrant of positive valence & low arousal contains mainly words describing space-related objects like 'Kirche' (engl. church), 'Schloss' (engl. castle), 'Garten' (engl. garden) or 'building'. The most frequently found words in the quadrant of negative valence & high arousal hint at the past of Dresden concerning World War II (e.g. 'war', 'attack'). Furthermore this quadrant and the quadrant of negative valence & low arousal reveal that abandoned buildings are a popular photo subject. Indicators are words like 'ruin' or 'decay'. The words in the quadrant of negative valence & low arousal do not seem to be negatively unarousing. Most of them are only slightly negative which makes them appear in the respective quadrant.

Figure 26 Word clouds of the 20 most frequently found words of the respective quadrant

In the following, different cartographic visualisation methods are used for presenting the emotional data of Dresden. Each of them was used in related work and is mentioned in Table 11. The suitability of each method for identifying certain emotional phenomena will be pointed out.

4.2 Density Maps

Figure 27 shows maps of the inner city of Dresden which visualize the density of words of the respective quadrant located in the inner city. The maps are arranged according to the locations of the quadrants in valence-arousal-space (compare Figure 2).

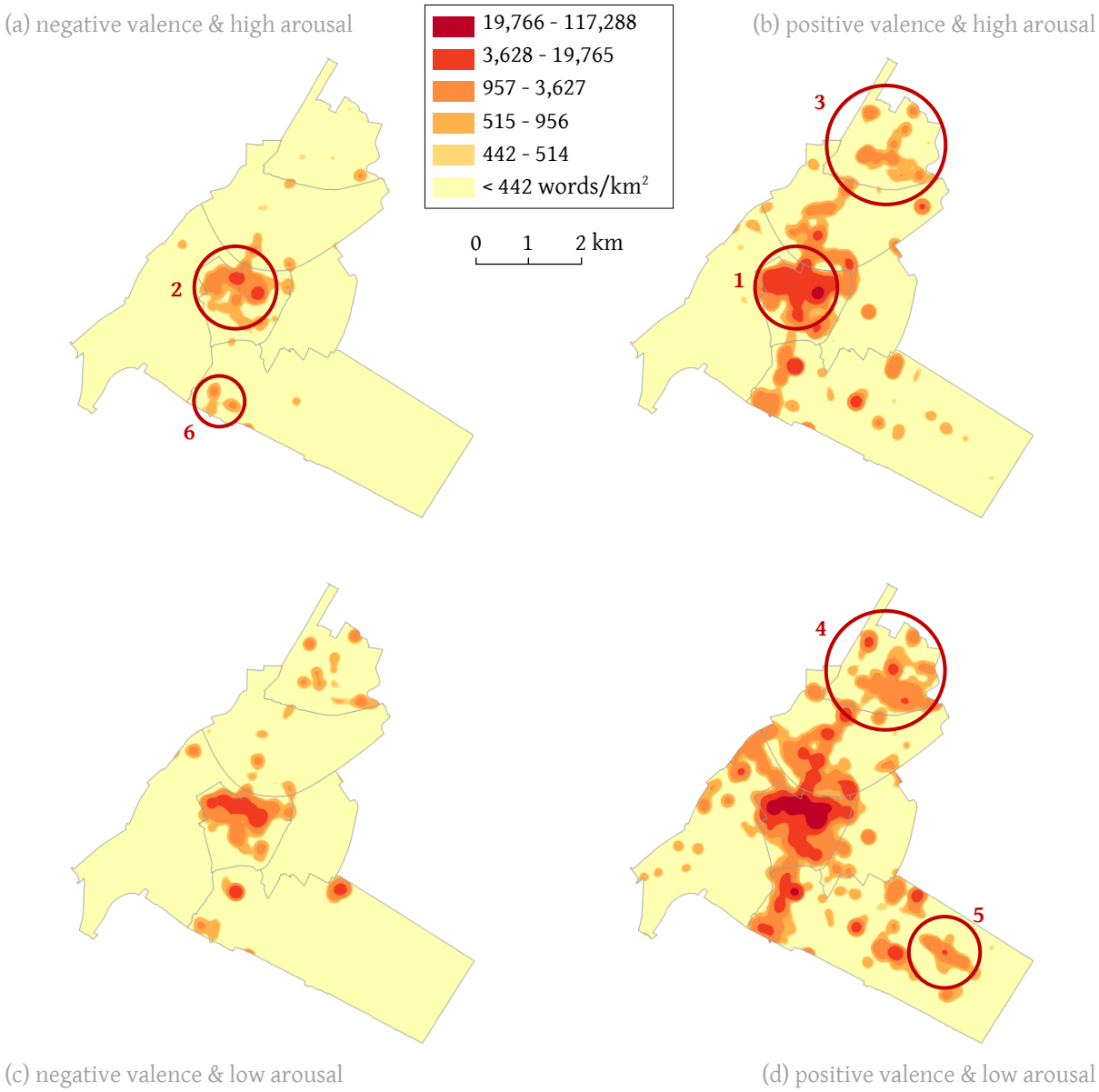


Figure 27 Maps of the inner city of Dresden showing the density of words located in the respective quadrants as well as phenomena indicated by numbers stated in the text

Circle number 1 in Figure 27(b) shows that many words that were used for describing the old town of Dresden are located in the quadrant of positive valence & high arousal, and indeed the old town of Dresden is very impressive with all the baroque, renaissance, classical and historic buildings. Yet at the same place negative emotions with high arousal can be found (number 2 in Figure 27(a)). The reason for this is because during World War II in February 1945 Dresden was bombed by allied air attack. 39 km² of the city centre were destroyed which caused tens of thousands of civilian casualties and many users mention this event in the description of their photos. Therefore they use words like 'attack', 'war' or 'damage' which are of course associated with negative emotions of high arousal. This

example illustrates well that one place is not connected with only one emotion and in this case the reasons are temporal aspects.

Number 3 in Figure 27(b) and Number 4 in Figure 27(d) indicate a district which has almost only positive emotions. It's the Äußere Neustadt, an alternative hip district with many bars, cafés and discos. The most frequently used words from the emotional word lists - 'music', 'concert', 'art' and 'party' - accurately convey a sense of this district.

A place that stands out clearly can be found in the quadrant of positive valence & low arousal (number 5 in Figure 27(d)), so this must be a very relaxing place. It is the so called Großer Garten (engl. Great Garden), a huge park in baroque style where, especially in the warm seasons, citizens of Dresden spend a lot of free time. To describe this place users used many nature-related terms like 'garden', 'flower', 'water' or 'tree' which are associated with calmness and relaxation.

Number 6 in Figure 27(a) is not an eye catching example but represents another interesting case of temporal aspects: each year a remembrance of the 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. These events are described with words like 'police', 'Nazi', 'attack' or 'damage' but they are an extraordinary occurrence - usually nothing negatively arousing can be found at this place except on those one or two days in February. Chapter 4.7 goes into details about time-dependent events like this.

Appendix 6 also contains maps visualising the density of words not only of the four quadrants but for the entire township of Dresden. Again, numbers indicate phenomena of georeferenced emotions that are described in the following. Numbers 7, 9 and 10 are located in the quadrant of negative valence & high arousal, number 8 in the quadrant of negative valence and low arousal whereas numbers 7 and 8 label the same object. All of them are ruins: the old granaries of the former army bakery in Dresden-Albertstadt (7, 8) which are demolished or renovated by now, the unused tram station in Dresden-Tolkewitz (9) and an artificial ruin in Dresden-Pillnitz (10). Those ruins are tagged with 'decay', 'ruin' and similar German terms which result in unpleasant but arousing hotspots.

Number 11 is a place of positive valence and high arousal, specifically Dresden Airport. Words used are primarily 'airport', 'airplane' and 'free' associated with the positive excitement caused by flying and thus travelling.

Another positively arousing place is number 12, a star club in the west of Dresden called Beatpol. At Beatpol mainly American and European musicians of the genres rock, metal, punk, indie, singer/songwriter, folk and pop play onstage but also established German acts and local musicians. The emotions associated with the often used words 'concert', 'band' and 'music' illustrate the character of this place.

Numbers 13 and 14 in the maps of positive valence are placed at the location of the so called Blaues Wunder (engl. Blue Wonder), a blue painted cantilever truss bridge. The extracted high arousal of this place is caused by the German word 'Wunder' (engl. wonder) which is part of the proper name Blaues Wunder and affects the kind of emotions extracted for this place. The positive emotions of low arousal are mainly caused by the words 'art' and 'Kunst' (engl. art). In the area around the Blaues Wunder many artists live and work and thus several art galleries are located there which give this area a special flair.

Numbers 15 and 16 are further examples for the not-exclusion of proper names from the algorithm. Number 15 is the so called Alter Schlachthof - a former slaughterhouse and nowadays an industrial monument with its main building serving as a venue for concerts. Number 16 is the Gläserne Manufaktur, an automobile factory of the Volkswagen Group made of glass. Both German words 'Schlachthof' and 'Manufaktur' were not found in the emotional word list BAWL-R but the hypernym 'Fabrik' was, which is associated with negative emotions of low arousal as well as 'factory' contained in the English label 'Transparent Factory' for the Gläserne Manufaktur even though both places are neither negative nor boring.

Numbers 17 and 18 again label the same place, the cemetery Johannisfriedhof in Dresden-Tolkewitz, although in very different quadrants: one is of positive valence, the other one of negative, but both are of low arousal. In 2011 the Johannisfriedhof was voted as the most beautiful cemetery in Germany and indeed it is a very special and atmospheric place with old trees, ancient tombstones and angel statues which are indicated in the quadrant by the often used word 'art'. But of course a cemetery is also a place that is related with death and thus with sadness and pain as shown by many words describing this place in the quadrant of negative valence & low arousal like 'death', 'funeral', 'lose' and 'sad'.

Place number 19 is described with the word 'art' as well but also with 'gallery' and 'modern' and thus is located in the quadrant of positive valence and low arousal. It is the OSTRALE, an annual exhibition for contemporary art, also held in buildings of a former slaughterhouse.

A very outstanding place in the map for the quadrant of positive valence & low arousal is labelled with number 20. The castle Schloss Pillnitz with its baroque pleasure garden is a place heavily frequented by tourists and the words 'Schloss' (engl. castle), 'Garten' (engl. garden), 'park' and 'palast' illustrate the impression of this area.

Another area in the same quadrant is also mainly described with the word 'Schloss' (engl. castle). This area is on the banks of the Elbe River west of the Blaues Wunder where three castles are located, the so called Elbschlösser: Schloss Albrechtsberg, Lingnerschloss and Schloss Eckberg. Especially from the other side of the river the view of these three castles is very impressive and scenic.

All the places described in this section are listed in Appendix 7 with a word cloud of the 20 most frequently found words and a Flickr photo for getting an impression of the place.

Since this kind of visualisation presents density and thus frequency, it can be used for identifying clusters of emotions, i.e. collective emotions. Individual emotions which have no high frequency disappear.

4.3 Inverse Distance Weight

The visualisations presented so far are density maps for each quadrant of valence-arousal-space that do not show concrete emotional values. In order to show those emotional values, the two dimensions valence and arousal are visualized by two colour scales. The two gradients are not smooth but classified into 12 sections of valence and 8 of arousal. Figure 28 shows two versions. Figure 28(a) uses a scale from light to dark for arousal and a scale from red over yellow to green for valence. Since the last mentioned scale is a 'traffic light' coloured scale, it is self-explanatory. Negative connotations of red are danger and devil, positive connotations of green include calm, peace and health (Feisner & Reed, 2013). Yellow is used as a neutral colour in between. Since arousal has a certain strength, low arousal is represented by white, high arousal by black as a more intensive colour than white. Figure 28(b) visualises not arousal, but valence by a scale from dark to light, i.e. from

black to white. Black is associated with darkness, depression, death and bad luck whereas white represents purity, peacefulness, cleanliness and thus something positive (Feisner & Reed, 2013), that means the exact opposite. The scale for arousal is a gradient from blue over green and yellow to red. Blue is chosen for low arousal because it is a very restful colour. Red represents high arousal as it is the most emotional colour signifying passion, anger, love and strength (Wolfrom, 2009).

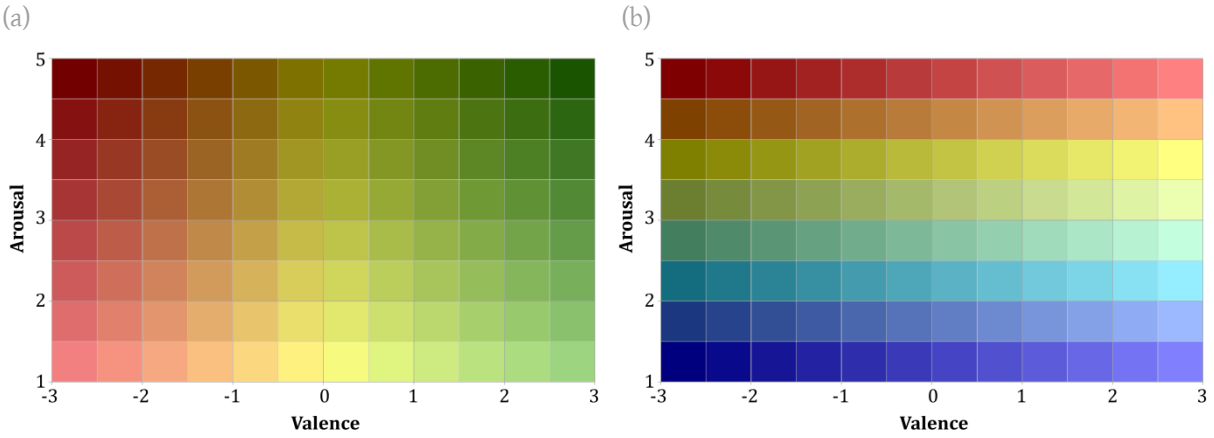


Figure 28 Two versions for visualising valence and arousal by colour

For following visualisations in this work the version Figure 28(a) will be used since the different nuances of colours are better distinguishable than in Figure 28(b). Furthermore the choice of colour scales makes more sense because valence is bipolar which requires more than a light-to-dark gradient. Likewise arousal has a certain strength and is not bipolar, thus a light-to-dark gradient is appropriate.

For visualising emotional values, a map of the inner city of Dresden was created using the method of IDW which does not divide the emotional values into four quadrants (Figure 29(a)). The IDW visualisation is extremely fine-grained in some cases, especially in the centre of the map (old town) since many photos and thus emotions are located there. Furthermore it is not clearly visible if areas are interpolated or actually populated with detected georeferenced emotions. For these reasons, the IDW visualisation will not be used for further analyses.

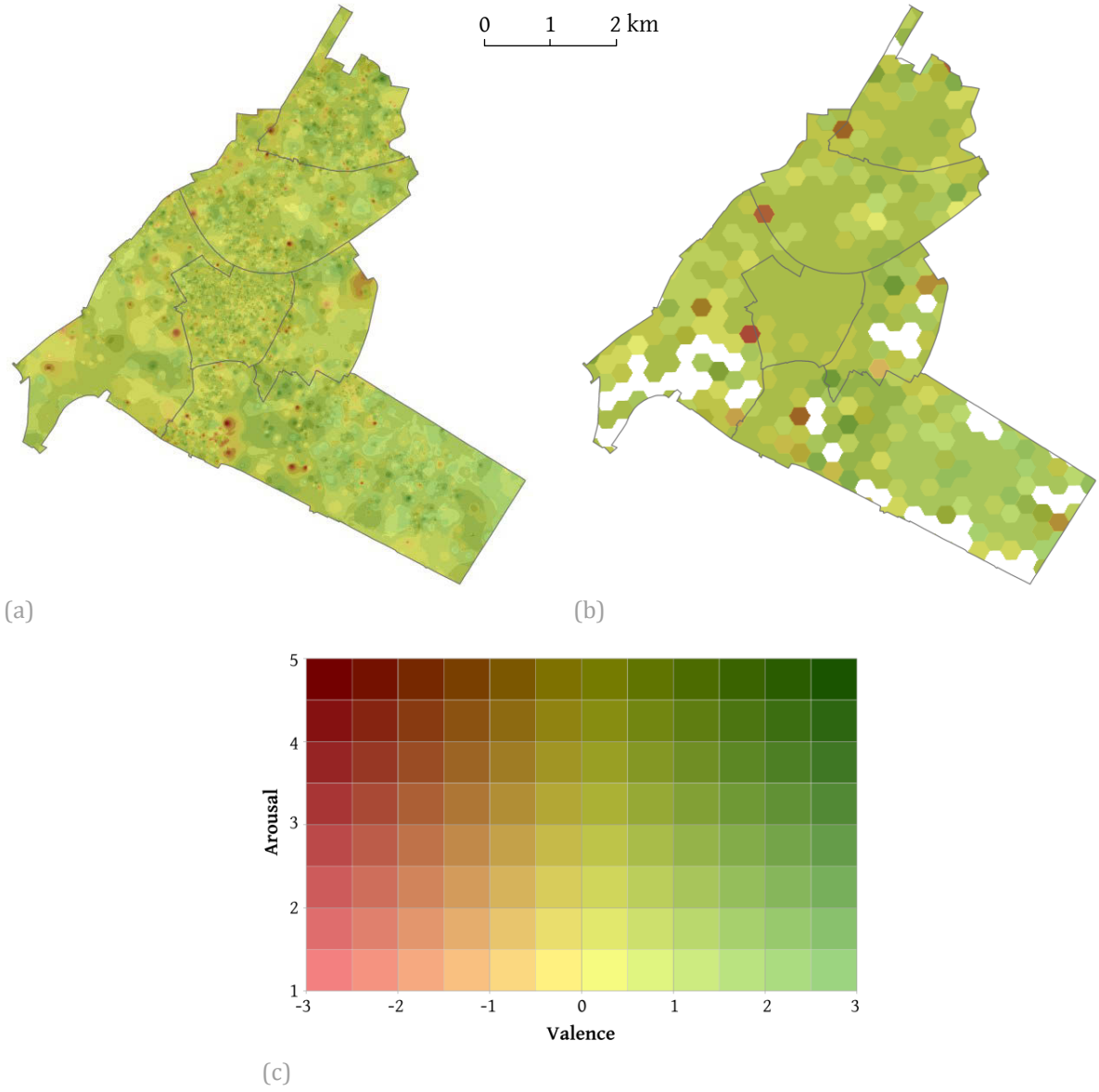


Figure 29 Georeferenced emotions in the inner city of Dresden visualised by (a) IDW and (b) choropleth mapping, (c) legend

4.4 3D Visualisation

Based on the IDW visualisation, a 3D map of the emotional landscape of Dresden was created. Valence is represented by the aforementioned IDW interpolation with the 'traffic light' coloured scale and arousal is represented by height (Figure 30). The already described disadvantages of IDW are identifiable again. Furthermore, the elevations partially cover one another. The last problem can be avoided by using this kind of visualisation not as a static but as an interactive and explorable map.

The 3D view involves a falsification of the colour scale of valence because of the shading which serves for better recognisability of elevations. Additionally the perspective distortion

complicates the use of the height scale for arousal. Thus, in general, the use of the legend might cause problems for the user. Because of these disadvantages, this 3D visualisation will not be used for an emotional analysis of Dresden.

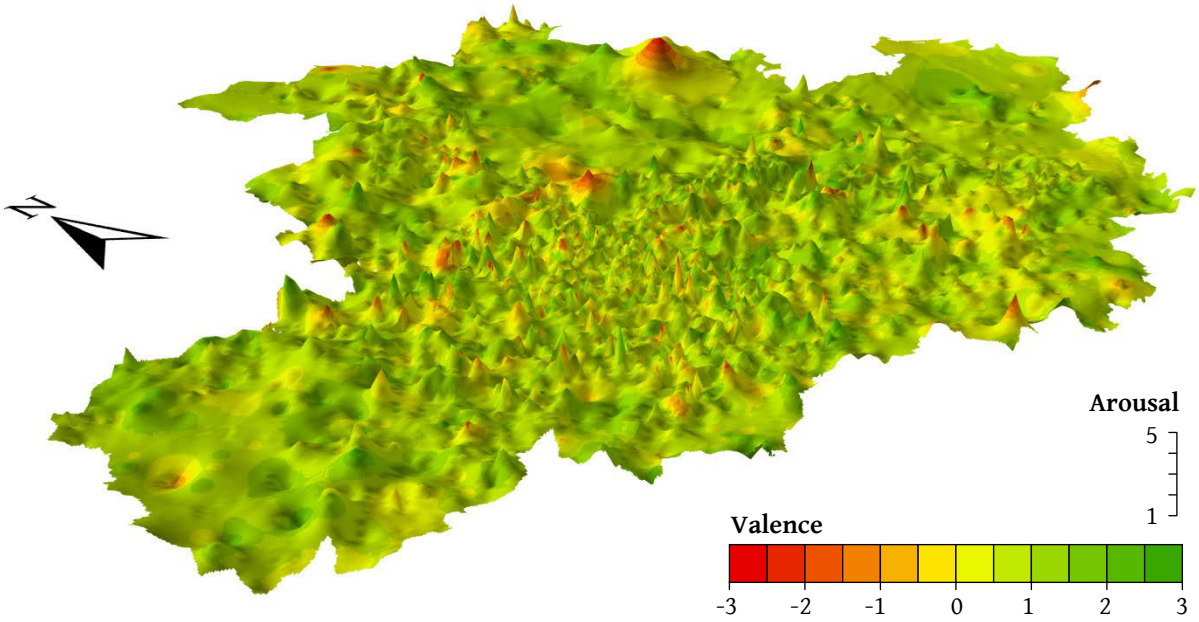


Figure 30 3D visualisation of valence and arousal in Dresden

Regarding the high granularity in the 3D visualisation, generalisation attempts were made but with unsatisfying results since emotional peaks were 'averaged away'. Still in the outlook of this work (see 7.2) a 3D visualisation is taken up again for coming up with a draft for using the extracted emotional data in tourism. Nevertheless further investigations for keeping emotional peaks by a certain parameterisation while generalising would be useful.

4.5 Choropleth Mapping

Figure 29(b) shows choropleth mapping with hexagons as reference units and uses the same colour scales as Figure 29(a) (see Figure 29(c) for legend). Since emotions are not necessarily indicated by frequency, Figure 29(a) and Figure 29(b) reveal emotional hotspots that were not visible in the density maps of Figure 27 because of low frequency. Nevertheless in this kind of visualisation, frequency is relevant insofar as all emotional values within one hexagon were averaged but yet all places associated with emotions are visible.

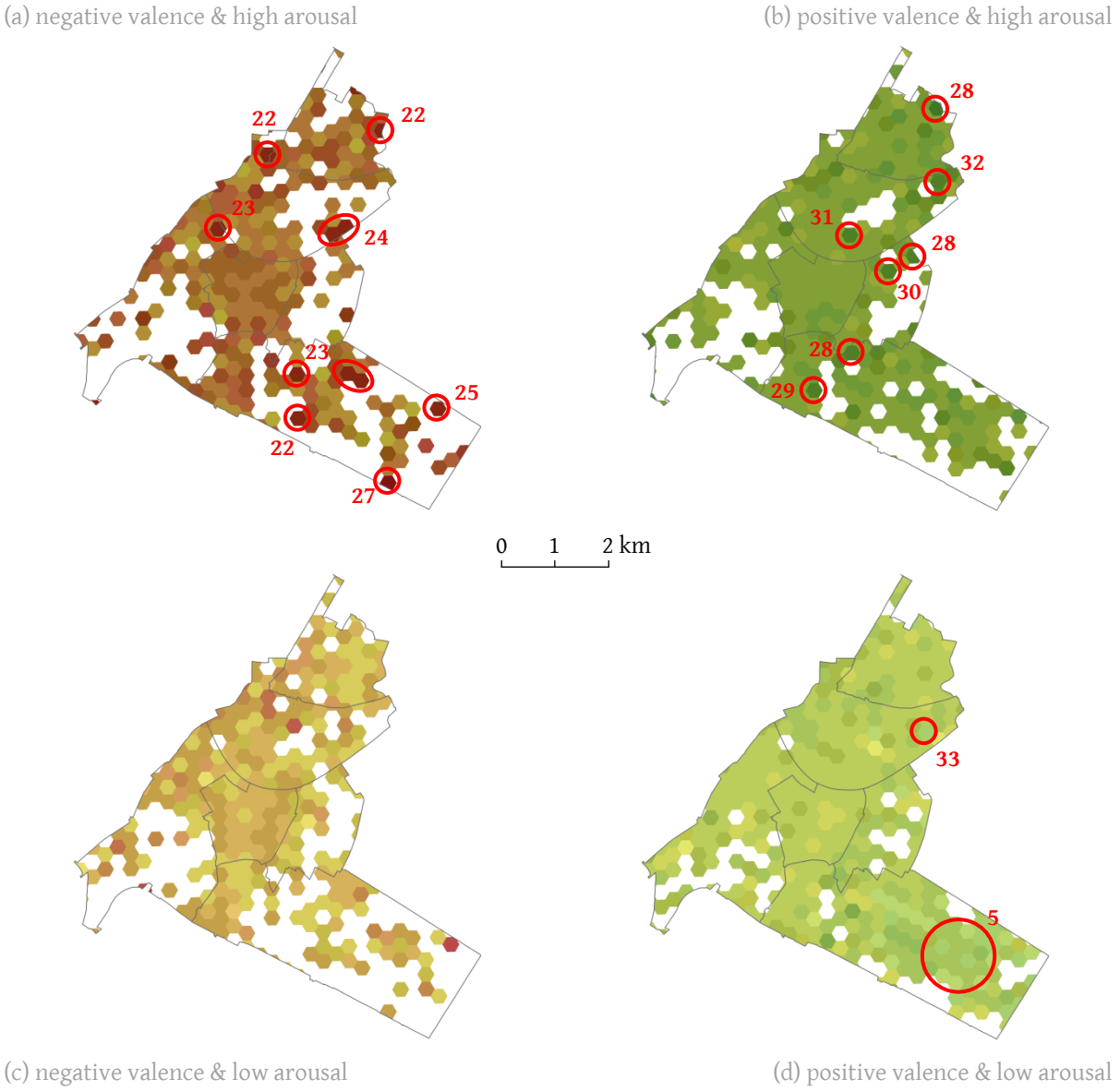


Figure 31 Choropleth mapping for the inner city of Dresden (legend see Figure 29(c))

For Figure 29(b) the emotional values were also not divided into the four quadrants. Since in general much more positive emotions were detected, negative emotions might be 'averaged away' in this map, especially in the old town where many emotions can be found as Figure 29(a) reveals. For this reason the division of data into the conventional four quadrants was done again. Figure 31 shows choropleth mapping for these four quadrants for the inner city. Since in general many photos are taken in the inner city and thus many emotions could be detected, the inner city is for all four quadrants similarly crowded with emotions, whereas the area of Großer Garten is gapless only in the quadrant of positive valence & low arousal (number 5 in Figure 31(d)). The other emotional hotspots from Figure 27 do not stand out but on the other hand, further emotional hotspots can be recognised with the help of Figure

31. Of most interest are the 'corners' of valence-arousal-space which are the four most extreme emotional states.

The very negatively arousing spots in Figure 31(a) indicated by number 22 are ruins. The three places marked with number 23 are caused by the word 'war'. Although war plays an important role in the history of Dresden, these cases have nothing to do with it. Here 'war' was detected as a hypernym for 'bw' which is a commonly used abbreviation for black-and-white pictures. Errors like this are discussed in detail in 6.2. At the location of number 24 in Figure 31(a), a relief can be found showing the tremendous burden of people hauling barges upstream the Elbe River. The respective photo metadata contain the word 'Belastung' (engl. burden) in maximum intensification. Number 25 indicates the starting point of a night geocache which is described as 'really scary' (i.e. 'scary' is intensified) by the respective photo owner. Number 27 in Figure 31(a) is caused by a photo showing an interim staircase to a platform in the twilight because of construction works. This photo is tagged with multiple words describing this eerie scene, including the tag 'Mord' (engl. murder). Certainly no murder happened there but the user seemed to be reminded by it. This is another case treated in 6.2.

The positively arousing spots in Figure 31(b) indicated with number 28 are caused by words like 'love', 'happy' and 'free' that are not related to the place, but number 29 is. The related picture shows street art in the form of a colourfully sprayed pillar in front of a dreary vacant house and is entitled with 'happiness'. At place number 30 in Figure 31(b) a car was photographed several times and only the word 'car' caused the positive excitement at this position without any intensification. The positive excitement of number 31 comes from the word 'stark' (engl. strong) as a synonym of 'hart' (engl. hard); 'hard' is related to the shadows in the picture. Many positive words like 'good', 'happy' and 'fun' are assigned to number 32 where the Flickr community of Dresden celebrated the 2nd birthday of Flickr.

Figure 31(c) contains no emotions of the 'corners' of valence-arousal-space. However Figure 31(d) shows emotions of very positive valence and the lowest arousal possible, especially around number 5 which is the Großer Garten. These emotions can be found at place number 33 as well, also caused by the word 'Garten' (engl. garden) because there the so-called Rosengarten (engl. rose garden) is located, a park planted with selected types of roses.

While Figure 31 shows choropleth mapping of emotions only for the inner city of Dresden, Appendix 8 uses the same visualisation for the entire township of Dresden and for the four

quadrants as well. These maps are analysed regarding the previously mentioned 'corners' of valence-arousal-space, but not all cases are described since some of them are caused by errors which will be discussed in 6.2.

In Appendix 8(a) the places 7, 9 and 10 that were described in 4.2 are visible too. These places are ruins that were photographed by many users and Appendix 8(a) reveals even more ruins (number 34) that were not recognisable in the density maps of Figure 27 because of low frequency. Another spot was also not previously recognizable because it is based on merely one photo showing a roadside memorial. This is a good example for an individual emotional place. It might be thought-provoking for outsiders but is not a place of collective emotions.

Emotional spots with high photo frequency named in 4.2 are identifiable in Appendix 8(b) too. Schloss Pillnitz (number 20) is identifiable in all choropleth maps but especially in the one of the quadrant of positive valence and high arousal. Number 36 describes another individual event: some friends were completely filling the bedroom of a couple that were getting married that day with balloons and hiding alarm clocks that would ring during the wedding night. The photo related to place number 37 promotes a brothel and is tagged with the word 'sex' which caused the high positive arousal of this location.

Appendix 8(c) shows a choropleth map for the quadrant of negative valence and low arousal. The emotional spots described in 4.2 are recognizable again but no extreme emotions can be found since this quadrant is the one with the least emotions in general.

The extreme emotional spots (number 38) in Appendix 8(d) come from the nature-related terms 'Blume' (engl. flower), 'Natur' (engl. nature) and 'Garten' (engl. garden). Number 39 is again an advertisement, this time for 'massage' which is of course associated with relaxation and thus located within this quadrant.

The previous explanations show that choropleth mapping is suitable for detecting clusters of emotions, i.e. collective emotions, as well as for identifying single emotional hotspots, i.e. individual emotions in certain circumstances.

As mentioned before, choropleth mapping is not as frequency-dependent as density maps but still frequency is relevant since all emotional values within one hexagon were averaged. Therefore one further visualisation is used for presenting georeferenced emotions.

4.6 Point Symbols

As a completely frequency-independent visualisation, point symbols can be used for the purpose of identifying individual emotions since each emotion is represented by one signature. For figuring out clusters, this visualisation is unsuitable as several emotions with the same coordinates appear as one point symbol.

Figure 32 shows four maps of Dresden with point symbols of the most extreme emotional values according to the classification in Figure 24, i.e. the 'outer corners' of valence-arousal-space were selected. The pale coloured point symbols in the background represent all the other emotions of the respective quadrant.

The words in the section of -3 ≥ valence < -2.5 and 4.5 ≥ arousal ≤ 5 are 'Angst' (engl. fear), 'burn', 'destroy', 'Krieg' (engl. war), 'Nazi' (engl. national socialist) and 'Weltkrieg' (engl. world war) which are related to the happenings in World War II. Most of the words 'Krieg' are located in old town of Dresden where many famous buildings were destroyed but also in other parts of the town, evidences of World War II can be found, e.g. in the form of memorials.

All 'extreme' words in the section of 2.5 ≥ valence ≤ 3 and 4.5 ≥ arousal ≤ 5 are amplified or even a maximum case. Except for one case, these words are 'fun' or 'funny' and belong, for instance, to the Flickr community of Dresden celebrating the 2nd birthday of Flickr. The maximum case says 'I just took pictures of those I liked most' and is related to a photo selection uploaded on Flickr.

The section -3 ≥ valence < -2.5 and 1 ≥ arousal < 1 is filled only by the word 'old' as the grammatical special case maximum. In ANEW 'old' is rated as a slightly negative word with relatively low arousal which is of course intensified in the case of maximum. But the use of 'old' in the present cases is not negative as history-charged objects are described with 'oldest', especially the bridge Blaues Wunder. This is another phenomenon discussed in 6.2.

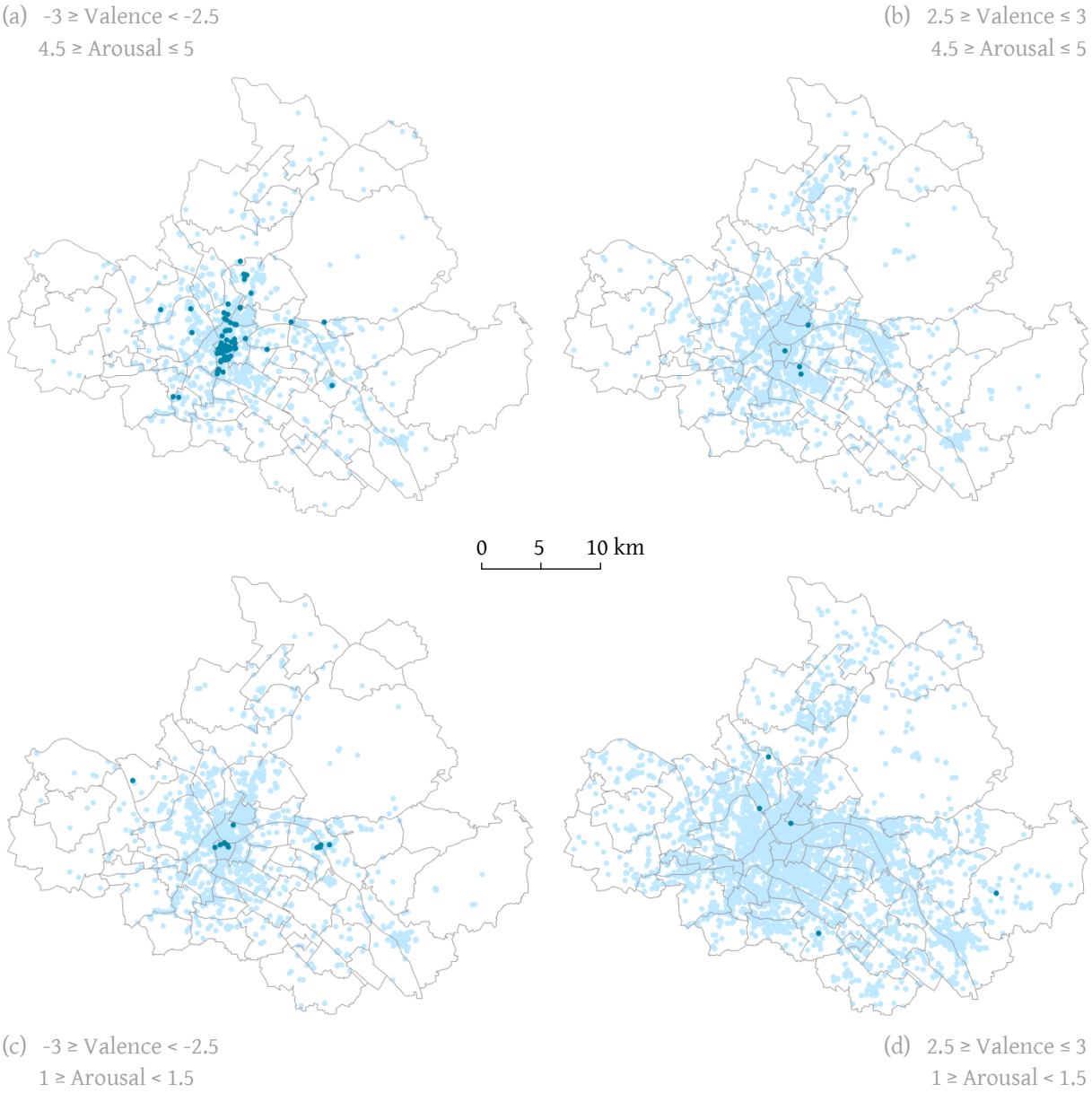


Figure 32 Point symbols of four sections in valence-arousal-space for Dresden

Beside amplified inherently positive words like 'Garten' (engl. garden), the section 2.5 ≥ valence ≤ 3 and 1 ≥ arousal < 1.5 contains the extremely negative words 'Krieg' (engl. war) and 'Nazi' (engl. national socialist) that are negated and thus become very positive and unarousing.

In the dataset of Dresden there is one photo that is a very good example for an individual emotion. Unfortunately it does not emerge in any of the created visualisations, that is why it has to be mentioned separately. The photo is located in the old town of Dresden at the bank of the Elbe River and shows a couple at night in front of light reflections in the river (see Figure 33). It is obvious that the couple did not realising they were being

photographed. Although the couple was having a romantic moment there, without knowing it they shared this moment with the photographer and thanks to him this photo tagged with the words 'love' and 'couple' at that place caused very positive emotions which cannot be considered as collective.

Figure 33 Flickr photo with the ID 5494898049 [30]

4.7 Impact of Considering Grammatical Special Cases

When applying the algorithm for extracting georeferenced emotions from the metadata of Flickr and Panoramio photos, the grammatical special cases described in 3.3 are considered. Figure 34 depicts the changes in the distribution of the found words in valence-arousal-space when considering these grammatical issues by comparing the modified emotional values of words affected by a grammatical special case with the unmodified original values of those words as they are listed in ANEW and BAWL-R. Figure 34 shows that by considering negations, amplifications etc., a more widespread distribution of emotions in valence-arousal-space, i.e. a wider range of emotions, can be obtained.

[30] http://www.flickr.com/photos/stiwwe/5494898049/ (accessed 12 August 2014), Copyright by Steven Wolf

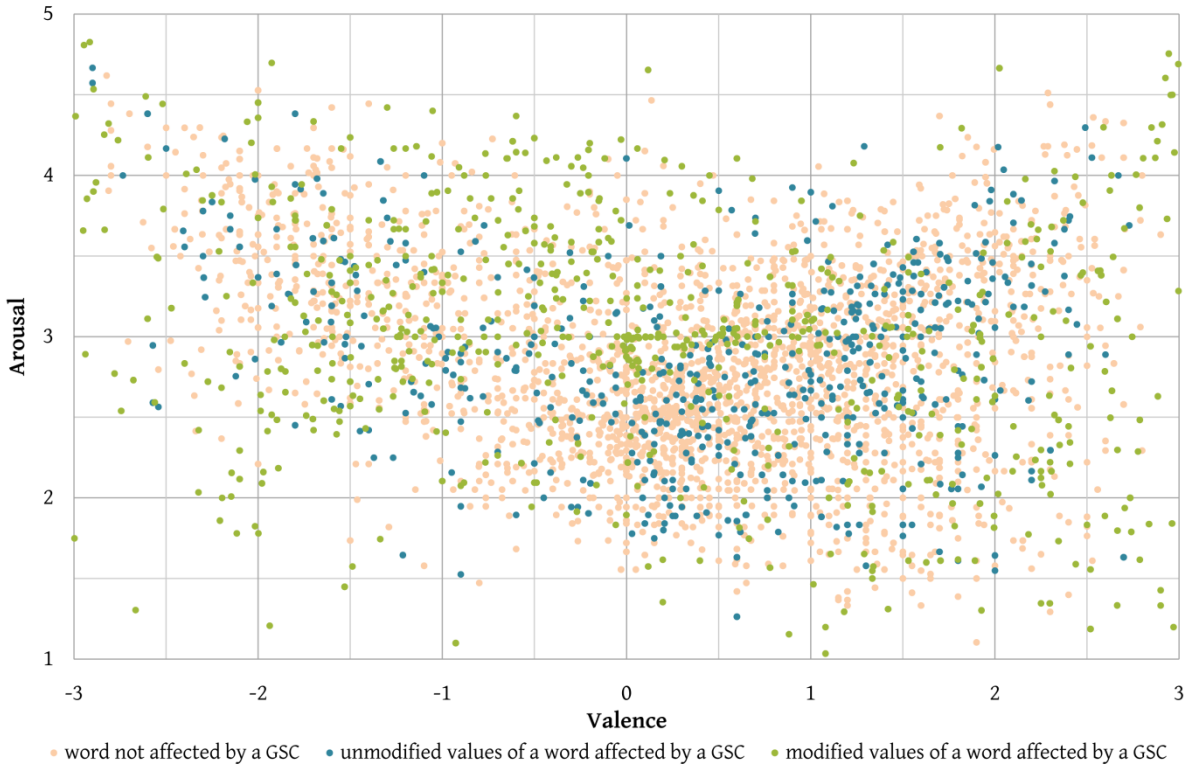


Figure 34 Changes in the distribution of the words found for Dresden in valence-arousal-space when considering grammatical special cases (GSC)

Figure 35 shows the modified values of words within the dataset of Dresden that were affected by a grammatical special case. It can be seen that attenuation and minimum cases are concentrated along the centres of both value ranges whereas amplification and especially maximum cases can be found close to the outer boundaries of valence-arousal-space. Negations are spread all over valence-arousal-space but the majority can be found in the section of negative valence. The reason for that is that positive words prevail in most languages (Kloumann et al., 2012). Thus positive words are often negated for expressing something negative and consequently appear in the area of negative valence in Figure 35. Examples of negated negative words which result in a positive valence are 'not bad' or 'not unfriendly'.

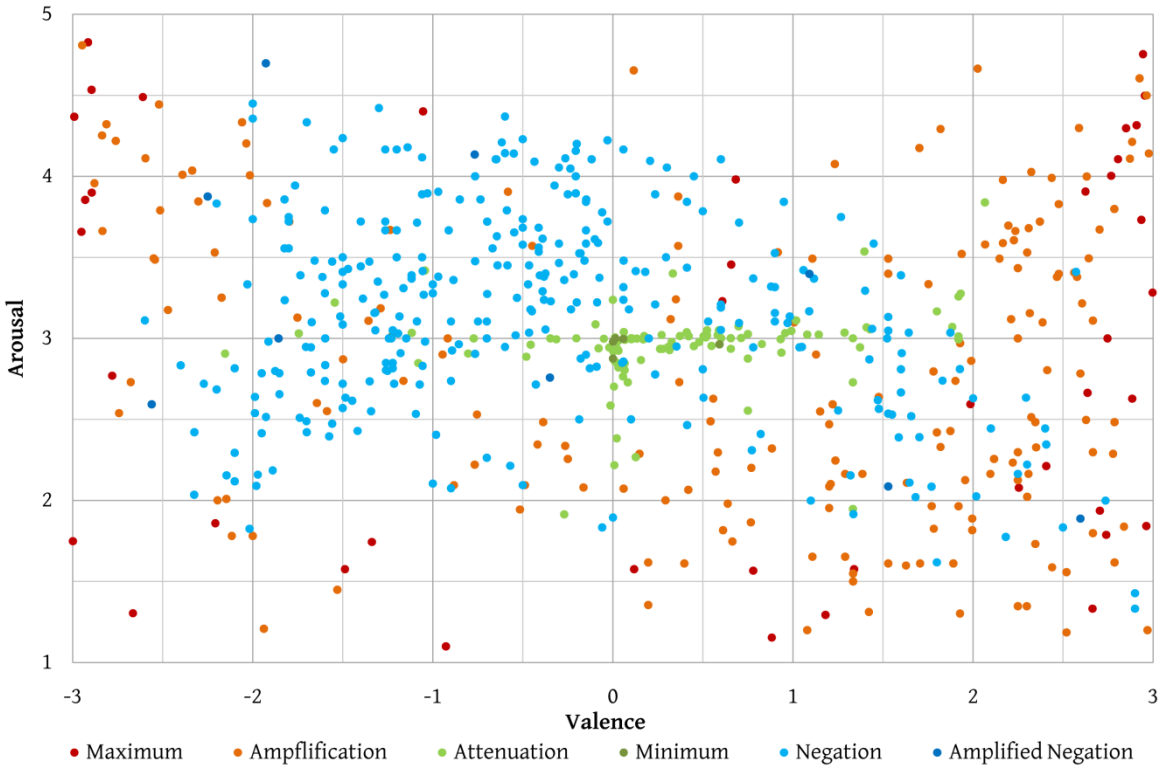


Figure 35 Distribution of words in valence-arousal-space affected by grammatical special cases

Figure 36 shows the percentage distribution of all kinds of grammatical special cases that were found within the dataset of Dresden. The most often occurring grammatical special case is the negation followed by the amplification. Minimum and amplified negation cases merely cover less than 1% each.

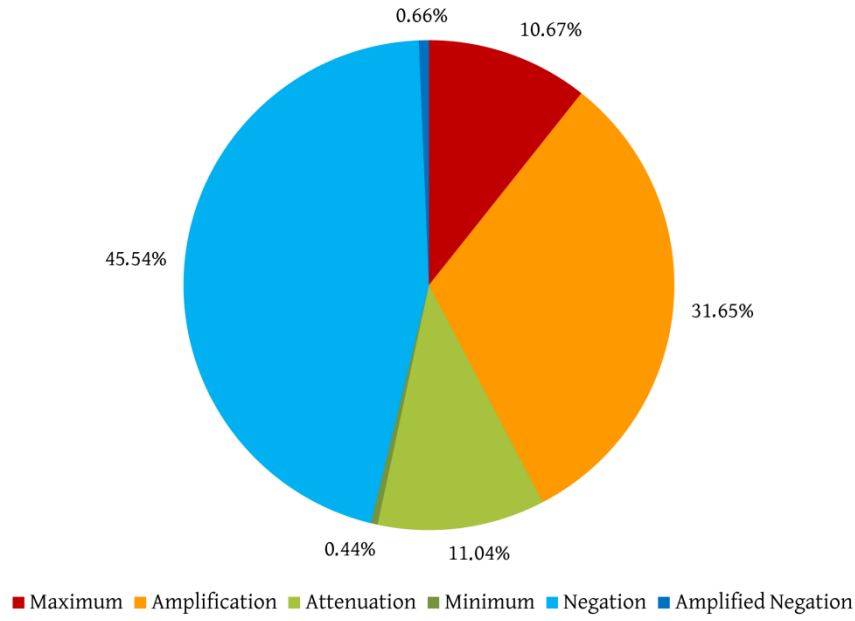
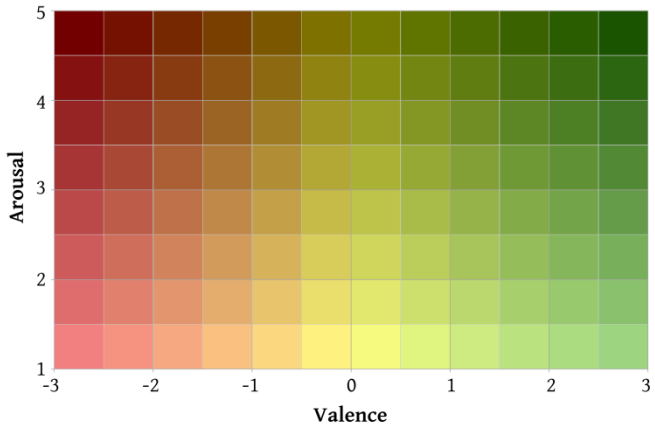


Figure 36 Percentages of kinds of grammatical special cases

Figure 37 shows a visualisation that includes only words that were affected by a grammatical special case within the inner city of Dresden. Figure 37(a) visualises the modified values of words affected by a grammatical special case whereas Figure 37(b) shows the unmodified, i.e. the original values of those words. Comparing these two maps reveals that especially in the old town of Dresden (in the centre of the maps) the emotional values change significantly. The mean values in the old town are V_{mean} = 0.1504 (standard derivation σ_V = 0.7794) and A_{mean} = 3.0115 (σ_A = 1.713) for Figure 37(a), for Figure 37(b) they are V_{mean} = 0.6621 (σ_V = 0.5323) and A_{mean} = 2.9147 (σ_A = 1.1858). So the emotional values in this area become more negative and the arousal increases from a modification due to grammatical special cases. The reason for such significant modifications in the old town of Dresden is again World War II, because in the photo metadata of this place, word combinations like 'totally destroyed', 'entirely destroyed', 'badly damaged' and 'completely destroyed' are used quite often which amplify the affected verbs 'destroy' and 'damage' and make them even more negative and more arousing. These word combinations refer especially to two objects: the Frauenkirche (Church of Our Lady) and the Hofkirche (Dresden Cathedral) - both buildings were completely destroyed in World War II. The differences in the standard derivations for Figure 37(a) and Figure 37(b) also demonstrate that by considering grammatical issues a more widespread distribution of emotions in valence-arousal-space can be obtained.

As mentioned, 106,364 words from the photo metadata of our dataset of Dresden were found in the emotional word lists. 1,368 of them were affected by a special case. This is only 1.3% but it should be noted that this number does not represent all grammatical special cases out of the photo metadata because not all contained words, and thus not all affected words, were found in the emotional word lists. So due to the fact that about 16% of all words were found, it can be assumed that also only a low percentage of all words affected by grammatical special cases were found in the emotional word lists. Furthermore the tags of a photo are simply keywords, the title of a photo is most often a word group and rarely a sentence. Complete sentences, and thus most probably also grammatical special cases, are mainly contained in the description of a photo, which is only one component of the three that were used for emotional analysis. Although a small number of grammatical special cases influenced the results of the emotional analysis of Dresden, each case and its modifications are significant, especially for negations.

(a) (b)



(c)

Figure 37 Choropleth map of the inner city of Dresden visualising (a) the modified (b) the original valence and arousal values of words affected by a grammatical special case, (c) legend for the maps in (a) and (b)

5 INVESTIGATION IN TEMPORAL ASPECTS

The previous explanations demonstrated that the derived georeferenced emotions are not independent from time: they can be related to an event and thus have a temporal reference and even if they are not related to an event, nevertheless the respective photo was taken at a certain time, on a certain weekday, in a certain season. Since the base data contain the exposure data of the photo exactly to the second, a temporal analysis of georeferenced emotions is possible.

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? Additionally, the following chapters focus on three certain kinds of temporal aspects: long-term trends, periodic events and single events.

5.1 Annually Occurrence of Emotions

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 38).

Figure 38 Temporal distribution of photo and emotion frequency over the course of the years 2009 until 2012

The left part of Figure 38 shows the distribution of photo quantity for all four years while the right part shows the distribution of emotions occurring during these years subdivided into 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 39 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 Striezelmarkt.

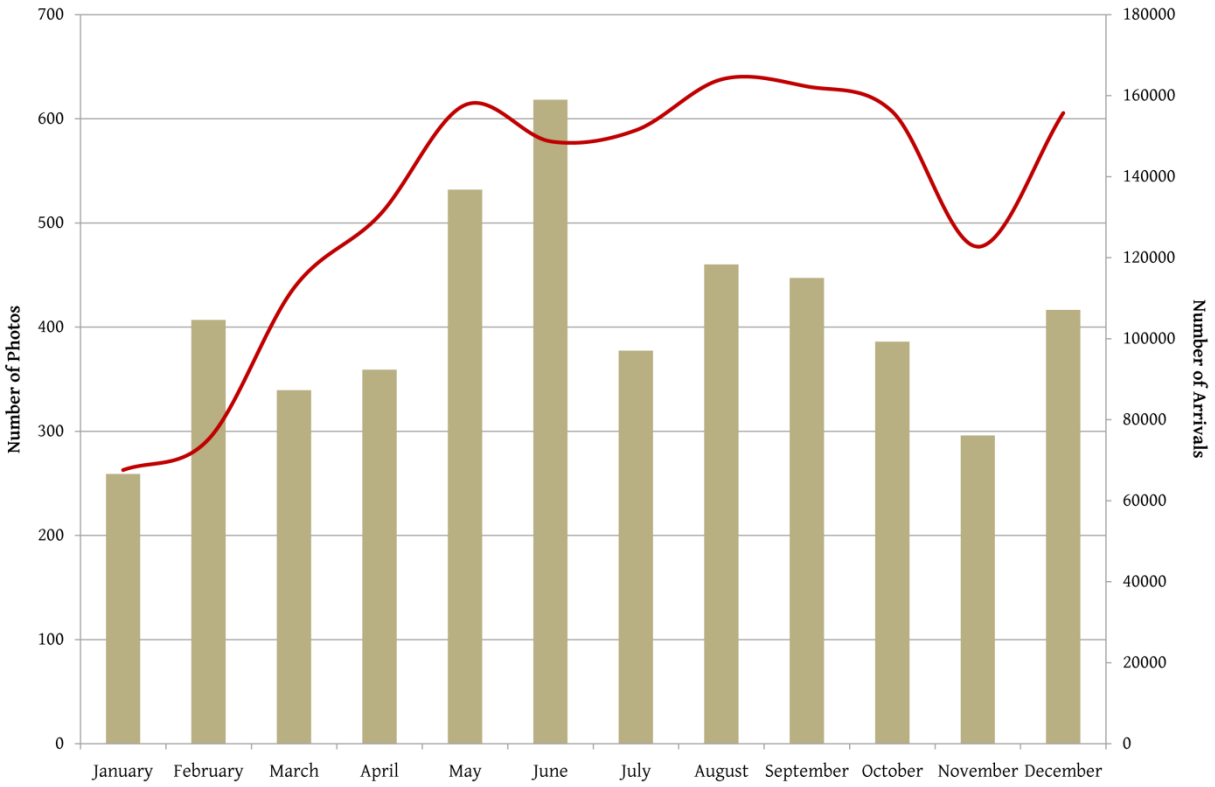


Figure 39 Mean quantity of photos (brown) and arrivals[31] (red) in Dresden for the years 2004 until 2013

However the number of photos in 2012 is significantly lower than in the previous years. According to Horchert (2012) 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 38) 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 Figure 25).

5.2 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

[31] arrival data by Statisches Landesamt Sachsen

emotional data. For the last way, several periodic events exist in Dresden: the ball SemperOpernball, the Dresden city festival, the block party Bunte Republik Neustadt or the Christmas market Striezelmarkt. In the following, the annual commemoration ceremony for the 13th of February 1945 (see 4.2) and its side effects are regarded.

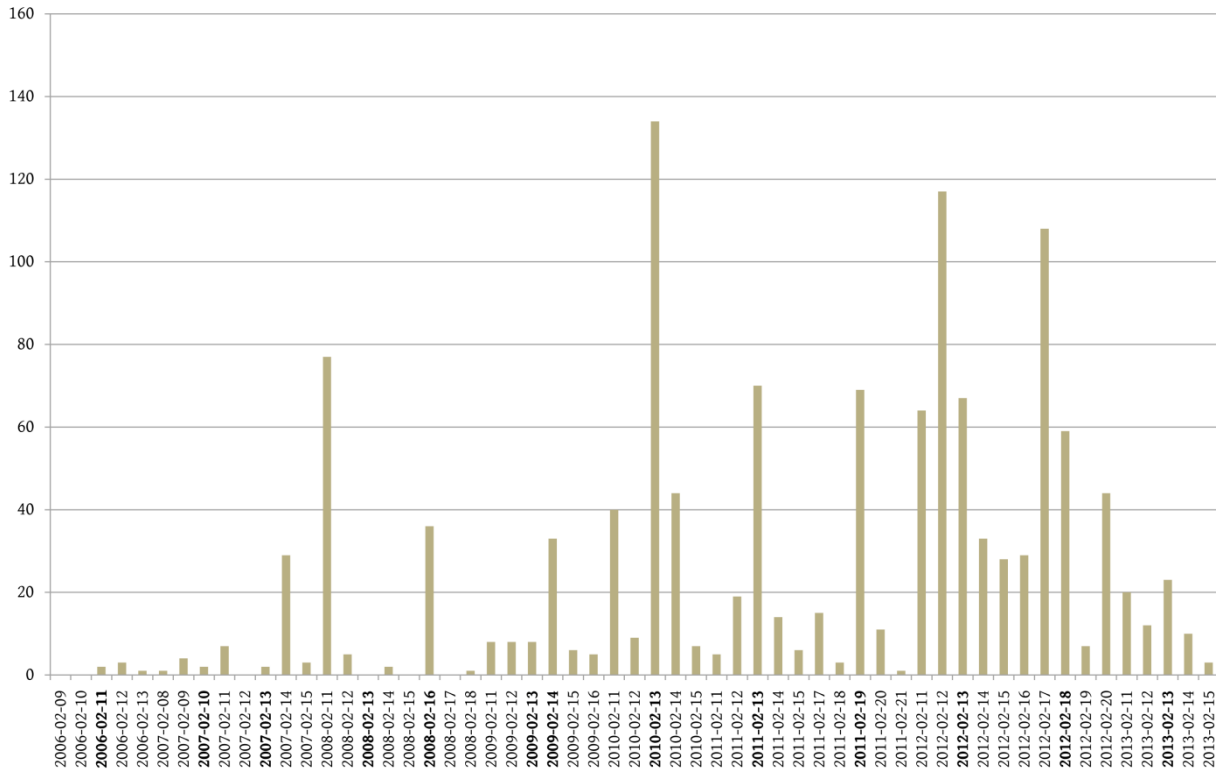


Figure 40 Temporal distribution of photo frequency for the time of February demonstrations

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 40 and Figure 41). 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 emotions were detected than on the two days before and after. Since positive emotions usually prevail in general (compare Figure 25), 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.

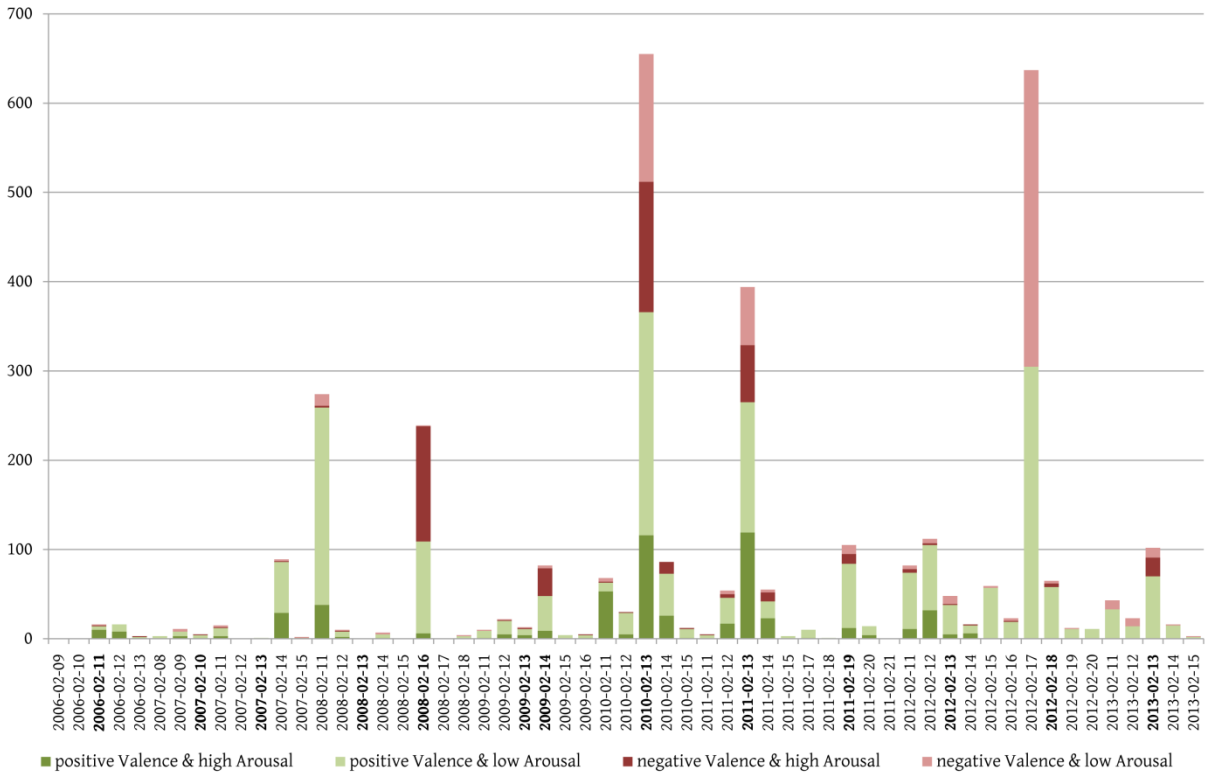


Figure 41 Temporal distribution of emotion frequency for the time of February demonstrations

In the following, the significant days 16th February 2008, 13th February 2010, 13th February 2011 and 17th February 2012 will be considered more in detail, although the last mentioned day is not a day of demonstration but regarding the number of emotions, it is a peak. Figure 42 shows the density of emotions in the inner city of these four days for each quadrant.

Figure 42(a) reveals many negatively arousing emotions for the 16th of February 2008, especially in the old town as well as west of the Großer Garten and indeed one hotspot was in the old town that day.

Beside negative emotions, many positive emotions were detected for the 13th of February 2010. The reason might be that the 'funeral march' planed by extreme right-wingers was blocked for the first time by counter-demonstrators. Thus the 'funeral march' could not leave its starting point at the train station in Dresden-Neustadt which is visible in the northern part of Figure 42(b). Negative emotions might be caused as well by the clash of police and counter-demonstrators in the old town.

Figure 42 Density maps of emotions of each quadrant for the inner city of Dresden for four days. The maps of each day are arranged according to the position of the respective quadrant in valence-arousal-space.

Also on the 13th of February 2011 positive emotions are prevailing despite the demonstrations (see Figure 42(c)), especially in the old town which could be due to the human chain around the historical old town. The human chain is an annual symbolic protection by the inhabitants of Dresden. The hotspots of this day of demonstrations are visible in the south of the maps.

The accumulation of photos and emotions on the 17th of February 2012 is obviously not related to the demonstrations. The high concentration at one location indicates a music event in Alter Schlachthof.

5.3 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.

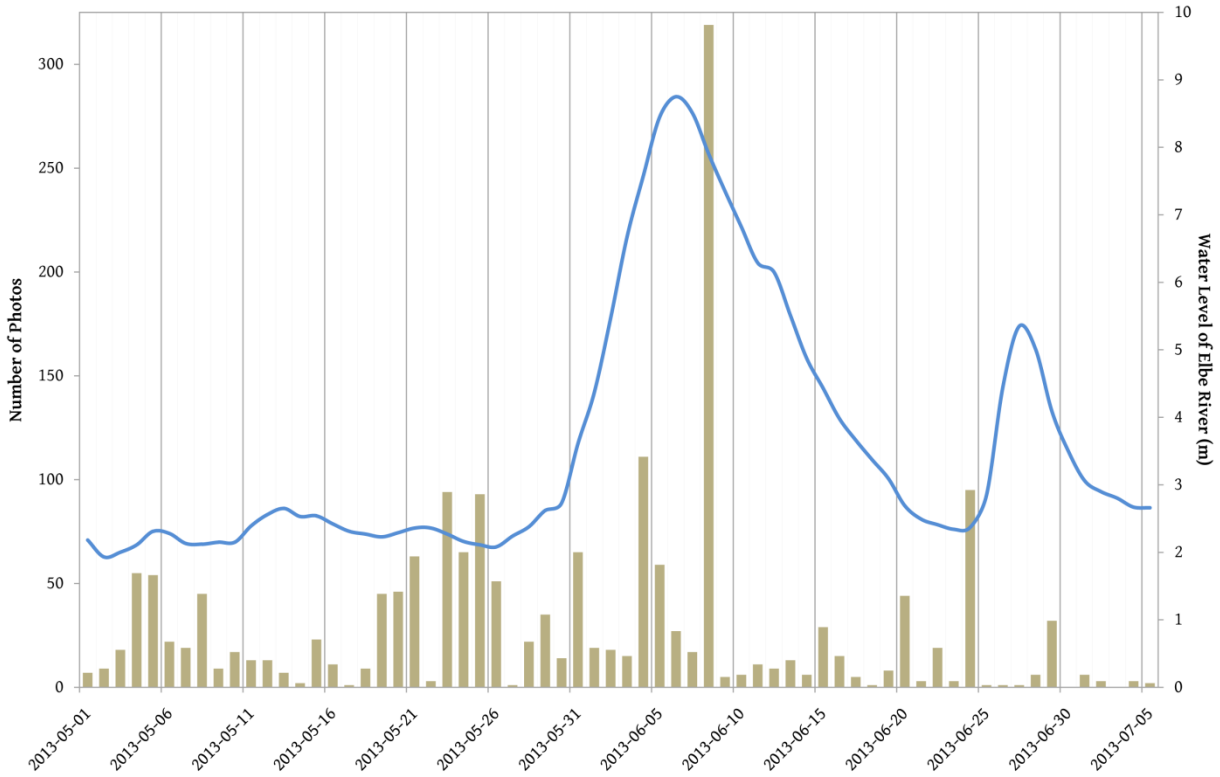


Figure 43 Number of photos and water level of Elbe River[32] for 2013-05-01 until 2013-07-05

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 and thus a correspondingly large number of emotions (67%) was detected for these days (see Figure 44). 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 (see

[32] water level data by Wasser- und Schifffahrtsverwaltung des Bundes (WSV), provided by Bundesanstalt für Gewässerkunde (BfG)

Figure 44), probably the day with highest uncertainty, even though the top water level was reached two days later.

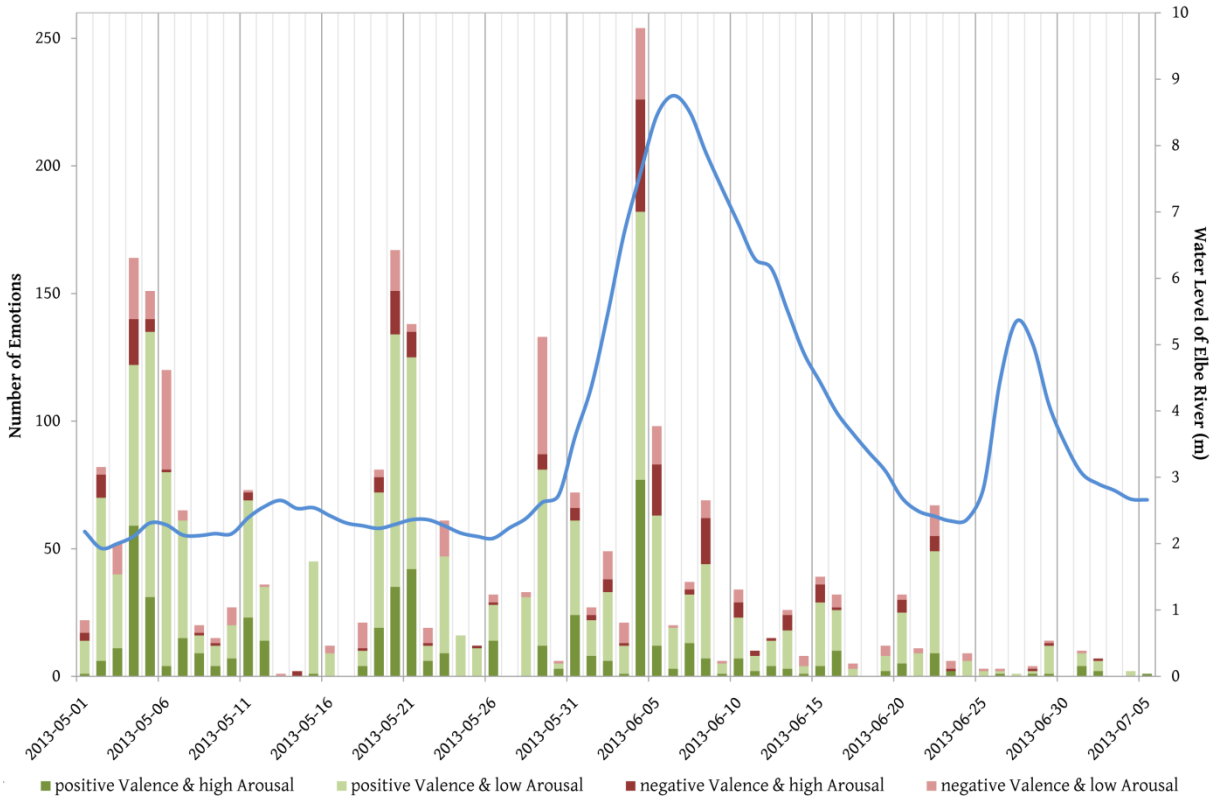


Figure 44 Temporal distribution of emotion frequency and water level of Elbe River[33] for 2013-05-01 until 2013-07-05

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 45 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.

[33] water level data by Wasser- und Schifffahrtsverwaltung des Bundes (WSV), provided by Bundesanstalt für Gewässerkunde (BfG)

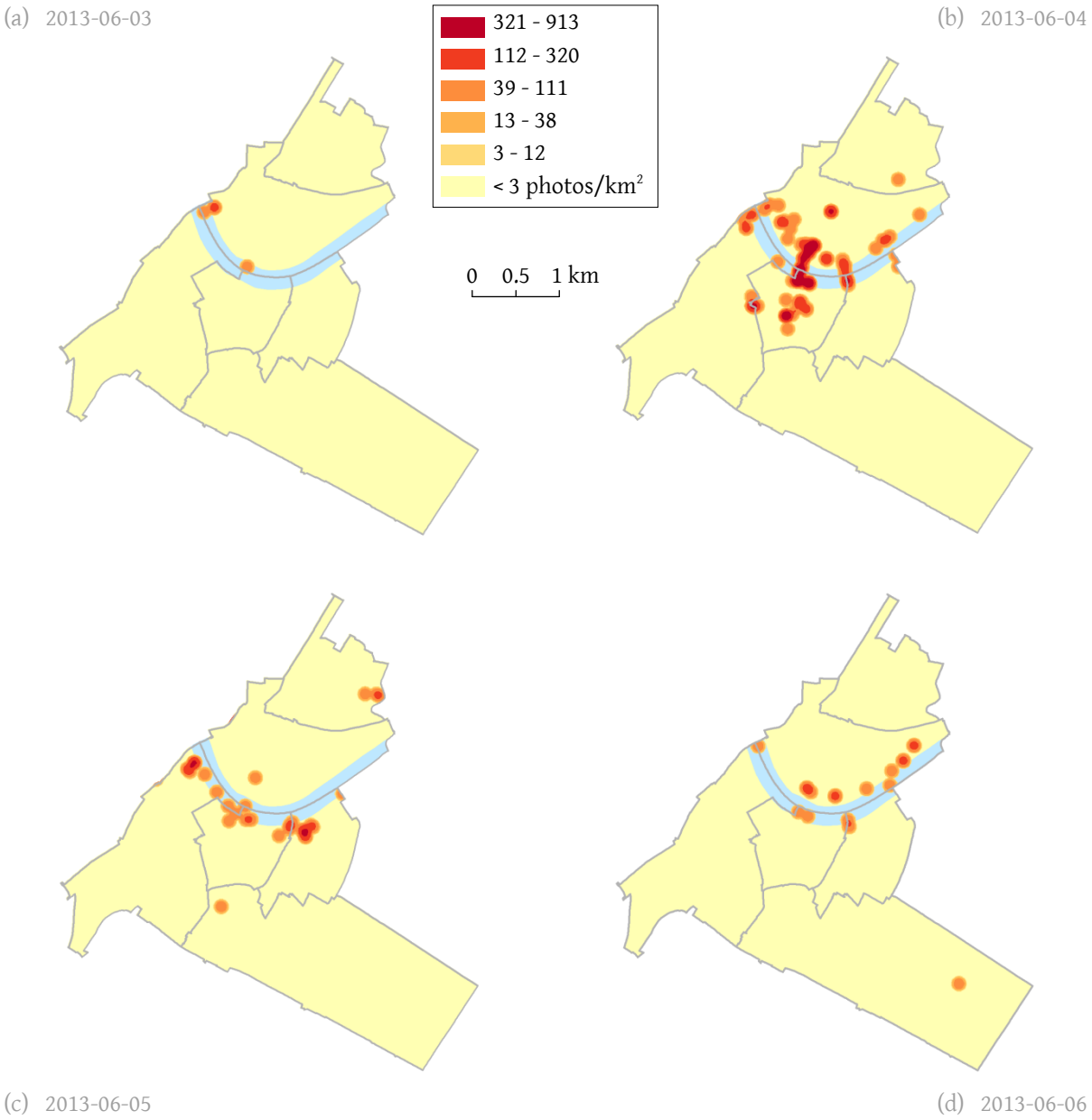


Figure 45 Spatial-temporal distribution of photos in the inner city of Dresden (with the Elbe River in blue) for the first days of the flood in June 2013

Investigations in detecting not only the Elbe river flood in georeferenced Twitter data but several large-scale flooding situations in Germany in 2013 were done by Fuchs et al. (2013).

5.4 Dependence of Georeferenced Emotions on Different Periods of Time

While the observation of the complete emotional dataset of Dresden reveals a general emotional characteristic of places, the segmentation into different temporal granularities allows the detection of single events as well as periodic events and their emotional impact.

For analysing the occurrence of emotions within different periods of time, the emotional data of Dresden have been divided into four granularities of time:

- seasons
  - spring (March, April, May)
  - summer (June, July, August)
  - autumn (September, October, November)
  - winter (December, January, February)
- months
  - January
  - February
  - March
  - April
  - May
  - June
  - July
  - August
  - September
  - October
  - November
  - December
- weekdays
  - Monday
  - Tuesday
  - Wednesday
  - Thursday
  - Friday
  - Saturday
  - Sunday
- times of day
  - morning (6 am - 9 am)

- midmorning (9 am - 12 pm)
- noon (12 pm - 2 pm)
- afternoon (2 pm - 6 pm)
- evening (6 pm - 0 am)
- night (0 am - 6 am)

Although planned, a division into week/weekend and day/night was not conducted since it is included in the granularities weekday and times of day. The subdivision of months and weekdays is clear. The classification of seasons was conducted based on the meteorological definition. For the different times of day no definition exists. Thus one day was divided into 6 times of day common in German language use.

Appendix 9 contains density maps for all the listed granularities of time for Dresden. On each page the maps for the four quadrants are arranged according to the position of the respective quadrant in valence-arousal-space (see Figure 24). In general these maps do not greatly differ from the density visualisation of all emotional data (see Figure 27 and Appendix 6) but in detail there are differences revealing emotional variations in space caused by seasons, months etc.

5.4.1 Seasons

Regarding the four seasons, most emotions were detected in spring, least in autumn. Appendix 9(1a) reveals that the Johannisfriedhof (number 1) is a place which is mainly photographed in spring and as known from 4.2 this place evokes different emotions. Thus the cemetery is clearly visible in all maps for the four quadrants caused by the use of the following words: 'Friedhof', 'Grab', 'cemetery', 'grave' and 'tomb' for the two quadrants of negative valence, in the two quadrants of positive valence the words are, for instance, 'art' but mainly they are photography related like 'film' or 'Kamera' (engl. camera). Place number 2 is conspicuous in spring for all quadrants except for the quadrant of negative valence & low arousal. This place is the Ufa Kristallpalast, a modern cinema building in the inner city of Dresden. It is not clear why this building is mainly photographed in spring but the majority of emotions for this season can be attributed to one user who used the words 'cinema', 'glass', 'metal', 'building' and 'modern'. An often photographed place in spring is the Großer Garten (Number 3). According to 4.2 and 4.5 this place evokes positive emotions, especially positive emotions of low arousal. Additionally, during spring the words 'spring',

'blossom' and 'flower' are used which shows that the respective photos were taken because of the season. But also in summer the Großer Garten seems to be a popular place (see Appendix 9(1b)). The words special for summer are 'music', 'concert' and 'theatre' since an open-air stage is in the Großer Garten which makes it a specific venue in summer.

Number 4 in Appendix 9(1c) indicates the location of OSTRALE, the annual exhibition for contemporary art mentioned in 4.2 which takes place every year from late summer until September. Used words with positive valence & low arousal are 'Kunst' (engl. art), 'modern' and 'gallery'.

Two places that were identified as emotional hotpots for the quadrant of positive valence & low arousal in 4.2 and 4.5 are the Blaues Wunder and the location the of the three Elbe River castles. In Appendix 9 these two places are recognizable in all four seasons but the highest density exists in winter (see Appendix 9(1d) number 5 and number 6). In this season the words 'Schnee' (engl. snow) and 'winter' occur additionally which shows that these two places seem to have a special atmosphere in winter and thus are increasingly photographed during this time.

5.4.2 Months

Generally the most emotions were detected in the month June, the fewest in November. The place indicated with number 7 in Appendix 9(2b) occurs several times as an emotional hotspot within one month (but not every single case will be mentioned in the following). It is the Alter Schlachthof (see 4.2). If there is an important event, photos are taken and thus emotions can be detected. This place always occurs in the quadrant of negative valence and low arousal since the German word 'Schlachthof' (engl. slaughterhouse) was ascribed to the negatively connoted hypernym 'Fabrik' (engl. factory) although it is a proper name. Depending on the event in the Alter Schlachthof, further emotions of other quadrants occur. In February it is an emotion extracted from the word 'Schiff' (engl. ship) located in the quadrant of positive valence & low arousal. Again it is a hypernym of a proper name, in this case of the band name 'Eisbrecher' (engl. icebreaker), a German rock band. Furthermore in the southern part of the inner city an increased density of positive emotions with low arousal can be identified (Appendix 9(2b) number 8). One reason is the high frequency of the word 'Feiertag' (engl. holiday). Actually a word with positive connotation, but in this case it is the hypernym of the word 'Trauermarsch' (engl. funeral

march). This is how the right-wing extremists call their annual event on the day of remembrance for the bombing of Dresden taking place every year in February (see 5.2). So the detected hypernym does not represent the original word emotionally appropriately.

In March the Alter Schlachthof is visible again (Appendix 9(2c) number 9) in the quadrant of negative valence and low arousal, but also in the quadrant of positive valence and high arousal caused by the word 'grandios' (engl. grandiose). So a concert on one day in March 2009 must have evoked great excitement in the audience.

In April a place becomes visible in the two quadrants of positive valence (Appendix 9(2d) number 10). It is the Festspielhaus Hellerau, a festival hall in the district Hellerau, the first garden city of Germany. The festival hall, begun in 1911, is used all year for multi-disciplinary contemporary art. The hotspot is caused by photos of only one day in 2009 and is tagged with the words 'Theater' (engl. theatre), 'musician' and 'concert' among others. Another place that does not stand out so much in other months except in April is Dresden Zoo (Appendix 9(2d) number 11), which is attached to the Großer Garten in the west. Words that make this place to be located in the quadrant of positive valence and low arousal are 'Park' (engl. park, as a hypernym for 'Zoo' (engl. zoo)), 'Kamel' (engl. camel) and 'Elefant' (engl. elephant). The zoo as a hotspot in April is caused by one user who uploaded a large number of photos taken in April 2007. Apart from this, Dresden Zoo is photographed all the year round.

Since June is the month with the most taken photos and most detected emotions, several events could be recognised in the two quadrants of positive valence (Appendix 9(2f)). Single events are the German Evangelical Church Assembly taking place in Dresden in 2011 (Appendix 9(2f) number 12, words: 'education', 'Herz' (engl. heart), 'Jugend' (engl. youth), 'world', 'vision'), a concert by the hard rock band AC/DC in the area of Ostragehege in 2010 (Appendix 9(2f) number 13, words: 'concert') and the four games of 2011 FIFA Women's World Cup in the football stadium Glücksgas-Stadion (Appendix 9(2f) number 14, words: 'Ball' (engl. ball), 'world', 'Frau' (engl. woman), 'Spiel' (engl. game)). Periodic events are the so called Bunte Republik Neustadt, the annual block party of the district Neustadt described in 4.2 (Appendix 9(2f) number 15, words: 'music', 'party', 'feiern' (engl. to party), 'bunt' (engl. colourful), 'Kultur' (engl. culture), 'Kunst' (engl. art)) and the Campusparty (Appendix 9(2f) number 16, words 'party', 'campus'), an event with bands and DJs on the campus of Dresden University of Technology. Although the last mentioned event takes place every

year in June, emotions could be only detected for 2008. Pillnitz Castle (number 17) seems to have a rush of visitors in June since in Appendix 9(2f) an increased density of positive emotions with low arousal can be noted, although the used words do not differ from the ones of the entire year (see 4.2).

In September (Appendix 9(2i)) another example can be found that single events can influence detected emotional characteristics although they are individual, i.e. not public and of a short duration. Number 18 is such an event: a birthday party described with 'birthday' and 'party', words associated with positive valence and high arousal. Number 19 in Appendix 9(2i) is not individual, it is the OSTRALE, mentioned in the previous chapter, again tagged with the positively low arousing words 'art', 'gallery' and 'modern'.

In October (Appendix 9(2j)) an already mentioned place makes an appearance again in the two quadrants of positive valence: the Festspielhaus Hellerau (number 20, words: 'concert', 'music', 'theatre'). The underlying photos were taken in several years and only in one year they are related to a concrete event, so it is not clear why October is a month of increased density for this place.

In December (Appendix 9(2l)) a high density of positive emotions with low arousal can be recognised in the inner city of Dresden (number 21). The first suspicion that this is due to the famous Christmas market Striezelmarkt could not be confirmed although the word 'Christmas' does exist in the emotional word list ANEW but not in the entire emotional dataset of Dresden. The reason will be discussed in 6.2.

5.4.3 Weekdays

Regarding the entire week, most emotions were detected for Saturday and least for Thursday. Within the course of a week, the outstanding places are changing (Appendix 9 (3a) - (3g)). Some of them were caused by photos taken on merely one day by one user. Although and since this is not the case for all hotspots, the density maps in Appendix 9 reflect quite well which places are frequented on which time during the week. Venues like the Alter Schlachthof (number 22) and the Beatpol (number 23) occur more or less strongly several times on weekdays. On Friday (Appendix 9(3e)) an increased density can be recognised at these places but also at other venues like the Festspielhaus Hellerau (number 24) since many events are scheduled for Friday evening. Also in the inner city (number 25) and in the Neustadt (number 26) a higher density occurs on Friday. The maps for Saturday

(Appendix 9(3f)) reveal the inner city of Dresden (number 25), the Neustadt (number 26), the Großer Garten (number 27), the Elbe River castles (number 28), the Blaues Wunder (number 29) and also Schloss Pillnitz (number 30) as highly frequented since a high density of positive emotions was detected there for this weekday. On Sunday (Appendix 9(3g)) the general density is still high but lower than on Saturday. Dresden Zoo seems to be a popular place for Sunday trippers (number 31).

5.4.4 Times of Day

It is not surprising that most emotions were detected for the afternoon and least for the night. Again the density maps in Appendix 9 (4a) - (4f) show which places are frequented at what time, in this case regarding the times of day. In the morning (Appendix 9(4a)), no places stand out, but during midmorning (Appendix 9(4b)) the old town of Dresden (number 32) as well as Dresden Zoo (number 33) are visited places. At noon (Appendix 9(4c)), i.e. during lunchtime, only Pillnitz castle (number 34) seems to be frequented but also in the afternoon (Appendix 9(4d)). At this time of day, other places also occur: the OSTRALE (number 35), the Neustadt (number 36), the football stadium Glücksgas-Stadion (number 37) and the old town (number 32) again. In the evening (Appendix 9(4e)) venues for evening events stand out, like the Beatpol (number 38), the Alter Schlachthof (number 39) and the district Dresden-Neustadt (number 36).

5.5 Potentials and Limits of Temporal Analyses

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, single events and the time-dependency of emotions regarding different granularities. Furthermore, patterns of spatial-temporal emotions can be identified as emotional hotspots. 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.

6 DISCUSSION

This second-to-last chapter contains an evaluation and thus a conclusive critical review of the algorithm, its weaknesses and resulting problems as well as a discussion of potentials and limits.

6.1 Evaluation

In order to evaluate the algorithm extracting georeferenced emotions from photo metadata, the metadata of 50 photos were randomly chosen, the only condition was that each of them has to contain at least one grammatical special case. The algorithm was applied to these 50 sample units and monitored step by step.

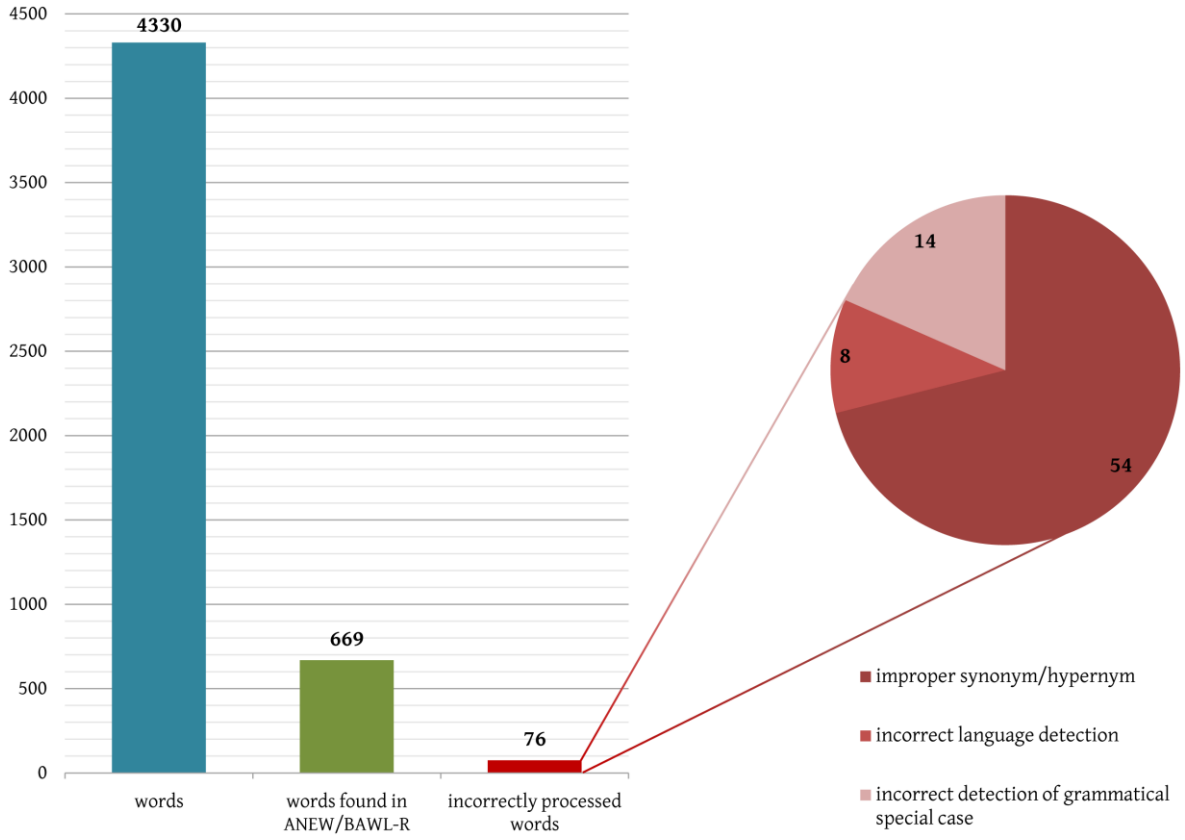


Figure 46 Interpretation and misinterpretation rate for 50 sample photos

In total the metadata of the 50 photos contained 4,330 words; 669 of the words or the respective synonym/hypernym were found in one of the emotional word lists which are 15.4%. This corresponds approximately to the general percentage of 16.2% of found words (see 4.1). 76 of the 669 words were processed incorrectly, i.e. 11.3%. Incorrect processing

means that the detected synonym/hypernym is not false but not suitable in the particular case, that the language of a word was detected incorrectly and thus the word is looked up in the wrong emotional word list or that a grammatical special case was wrongly identified. In only 11 of the 50 sample photos no misinterpretations occurred but it has to be noted that photos containing grammatical special cases in the metadata are more error-prone since the analysis is more complex. All of those numbers are illustrated in Figure 46.

Regarding the grammatical special cases, the 50 sample units contained 140 of them (see Figure 47). 134 were detected (95.7%), 8 were not (5.7%), i.e. also some non-existing grammatical special cases were identified. The reasons for not detecting a grammatical special case are similar to the reasons of incorrectly processed words like described in the previous paragraph. For the 50 sample photos, one reason was that the degree word and the affected word were separated by an underscore which is a typical tagging style but thus are not identified as two words since all special characters are not removed because commas, question marks and the like are of importance for the grammatical analysis of a sentence. Further reasons were incorrect language detection and POS tagging as well as degree words that were not considered in the algorithm ('ausdrücklich' (engl. particularly) and 'eher' (engl. rather)).

Fourteen grammatical special cases were incorrectly processed, which is a mere 10%. Here the natural language processing produced errors again, in this case it was the POS tagging and the clause segmentation. This leads to the effect that a wrong word is regarded as the affected one. Furthermore combinations of degree words occurred that are not considered within the algorithm ('fast vollständig' (engl. almost completely), 'almost total' and 'nearly completely'). The most frequent reason was that an established rule was not applicable to the particular grammatical special case. Although this comprises 50% of the reasons for a wrong detection of grammatical special cases, it must be noted that the misinterpretation rate is quite low at 10% and that it is difficult to cover every rule for degree words.

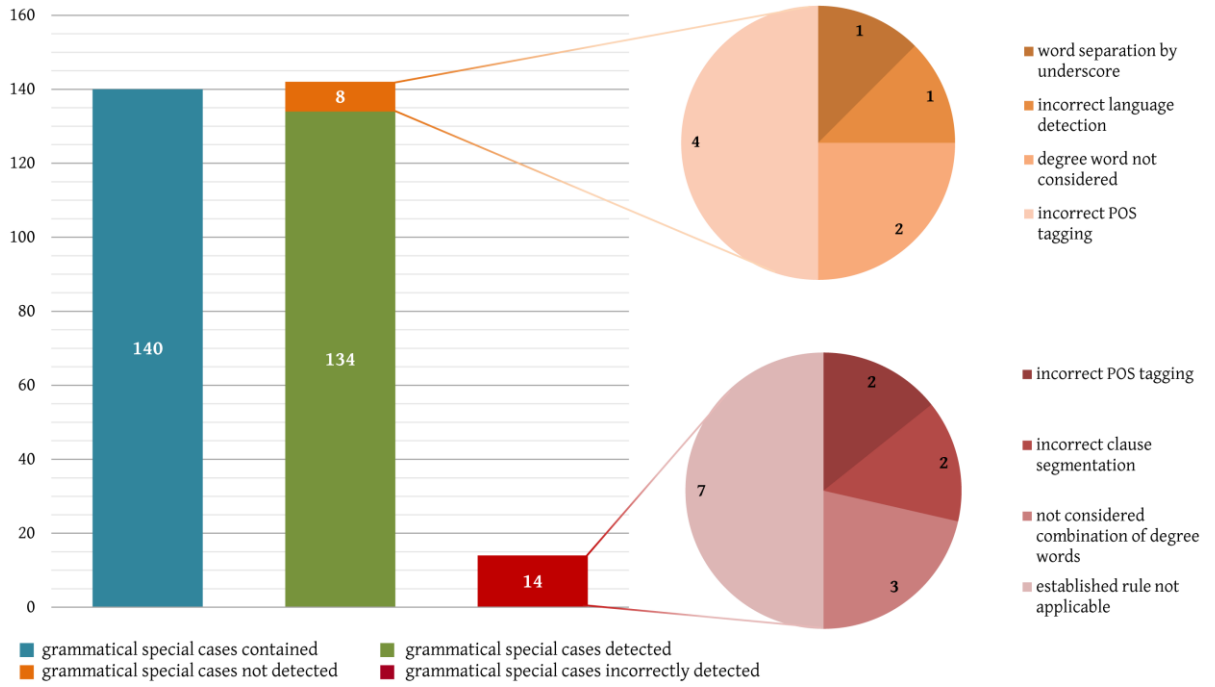


Figure 47 Interpretation and misinterpretation rate of grammatical special cases for 50 sample photos

The evaluation procedure was conducted twice. The first time was used to identify and fix elementary errors. In this way the general misinterpretation rate could be lowered from 85 to 76 and the misinterpretation rate for grammatical special cases was reduced from 26 to 14. During the first evaluation 19 grammatical special cases were not identified, during the second one merely 8.

6.2 Weaknesses and Problems

The previous chapter already reveals some of many weaknesses and problems the algorithm brings, especially related to the language processing. Although professional libraries were integrated into the Java algorithm, they can produce errors that can hardly be avoided. For instance improving language detection is difficult because many users assign tags in multiple languages to their photos and thus language detection has to be applied to single words which vastly reduces the validity.

Probably the biggest problems in the matter of language processing are the improperly determined synonyms/hypernyms. Several synonyms/hypernyms are available for one word in WordNet and GermaNet and the most commonly used one is selected but this does not necessarily mean that it is appropriate in the particular case. Therefore additional information would be required. During the analysis of the emotional data of Dresden it

turned out that it would have been useful to store not only the synonym/hypernym but also the original word in the database. Since the synonym/hypernym is not always appropriate, it would make the analysis easier when the original word is directly available.

The integrated libraries tt4j and Stanford JavaNLP API used for POS tagging make use of predefined tagsets in their results. These tagsets distinguish multiple parts of speech, also nouns and proper nouns. Many proper nouns are contained in the Flickr and Panoramio metadata, especially geographical terms like 'Dresden', 'Elbe' etc. For the two aforementioned proper nouns, the determined hypernyms would be 'city' and 'river'. Since these hypernyms are very general and would constitute the major part of the resulting emotional data, proper nouns were not considered within the developed algorithm. Nevertheless other words are also determined as proper nouns although not expected, like, for instance, the word 'Christmas' which exists in ANEW and also in the photo metadata but not in the resulting emotional data.

Another issue, also mentioned in the previous chapter, is the fact that not all combinations of degree words can be considered although already numerous combinations are taken into account, especially in the classes of attenuation and amplified negation.

The basic idea of this work assumes that all the words contained in the metadata of a photo are describing the place that is shown on the picture. But this is not always the case. Sometimes photos have merely a filename as the title which contains no emotional information. Likewise, users often describe the photo quality or add technical details. For instance they write that the light is 'hard' in the picture or that they used a photographic film called 'Paradies' (engl. paradise) which assigns a very positive emotion to the location of the photo although the word is not place-related. A case described in 4.5 uses the word 'Mord' (engl. murder) for tagging a photo and thus shows that words can also be used for representing a certain atmosphere of a place. That means that the connoted emotions of a word are appropriate for the place but since for analysis purposes the words themselves are also adduced, cases like this can lead to irritation. Another issue that belongs to the addressed kind of problem is irony. Since irony cannot be recognised by the algorithm, it happens that emotions are detected that are contrary to the actually sensed ones.

Also the investigation of the Elbe River flood as a single event shows that the occurring kind of emotions is not necessarily appropriate since places as well as words can be associated with different emotions, like the word 'water'. This word is basically positive but can be also

negative in a certain context but ANEW and BAWL-R as underlying data do not consider this phenomenon which can appear also for other words. Similar to the problem of improper synonyms/hypernyms, this is a matter of unconsidered context information. Thus a general restrictive weak point of the algorithm for extracting emotions from photo metadata is pointed out.

The dataset of Flickr and Panoramio photo metadata of Dresden also contains photos with an exposure date before the launch of the two photo platforms which are mostly scanned historic pictures with edited metadata, but also photos with an exposure date in the future exist which might be due to incorrect camera settings. Since the old photos are only a small percentage and the camera settings can never be verified, it is assumed that the exposure date is the correct timestamp registered automatically by the camera.

The major weakness of this work is that emotions cannot be validated. The estimation whether an extracted emotion is appropriate for a place is based on subjectivity.

7 CONCLUSIONS AND OUTLOOK

This chapter concludes the dissertation by answering the research questions posed in the beginning, thus summarizes the work and gives an outlook for possible future work.

7.1 Answers to the Research Questions

(1) Is it possible to extract georeferenced emotions from the written language in the metadata of Flickr and Panoramio photos?

As existing research implies, this general research question can be answered with 'yes'. Though not all content of user-generated photo metadata contains emotional information, for instance when the filename of a picture assigned by the camera is used as the photo title in Flickr, it is possible to extract emotions from written language in the form of sentences, word groups and even tags. The question of whether the extracted emotions reflect the sense of a place is answered in research question 4.

(2) How far can grammatical special cases like negations be considered within this extraction?

In the implemented algorithm for extracting emotions from the written language in the metadata of Flickr and Panoramio photos, six grammatical special cases are taken into account for English and German language. This requires the consideration of several, partially complex rules for determining which word is affected. Since the error rate is merely 10%, the procedure can be claimed as successful.

(3) What are features of the extracted emotional data?

The analysis of the extracted space-related emotions for Dresden revealed that these data have basically two characteristic features: a certain emotion associated with a place sensed by only one person is hence individual, an emotion sensed by a number of persons is collective. Moreover temporal aspects were ascertained in the emotional data (a more

detailed answer is given in research question 6). Both characteristics can be the reason for the fact that one place is not necessarily connected with only one emotion.

(4) Do the extracted emotional data reflect the sense of a place?

Actually this question cannot be answered in a scientific sense since emotions can be only validated by subjectivity. With a few exceptions which are explainable, the author's subjectivity agrees with the extracted space-related emotions for Dresden. In this work the author tries to describe every discussed place for conveying the sense of this place and thus for making understandable the emotions triggered by it. In doing so, the readers shall evolve their own subjectivity.

(5) How can the spatial emotional data be visualised for analysis purposes?

For the purpose of analysis several visualisation methods were tested in this work. An IDW map as well as a 3D visualisation was labelled as unsuitable. Density maps and choropleth mapping were used for identifying clusters of emotions, i.e. collective emotions. Also, under certain circumstances, individual emotions can be detected with the help of a choropleth mapping visualisation, meaning that in one hexagon (the reference unit of the applied choropleth mapping) merely the individual emotion and nothing else must occur, otherwise the individual emotion is 'averaged away'. In general point symbols are more suitable for identifying individual emotions.

(6) Can events with a certain temporal occurrence be detected in the emotional data?

On one hand, the derived emotional data were analysed in terms of long-term trends and a certain order in the frequency of photos and emotions that recurs for several years was identified. This pattern arises from tourist activities. On the other hand, the space-related emotions were investigated regarding periodic as well as single events with one example each. Due to these analyses the research question can be answered with 'yes'.

(7) Are georeferenced emotions time-dependent? Are they influenced by temporal periods (e.g. the seasons)?

The derived emotional data were investigated regarding four granularities of time: seasons, months, weekdays and times of day. The predetermined emotions related to a place did not change but the presence of places varies within the different granularities. Thus the research question can be answered in this sense that that the kind of emotion is not time-dependent and influenced by temporal periods, but the occurrence is.

7.2 Outlook and Future Work

After the analysis of the derived space-related emotional data for Dresden, and thus the answering of the research questions of this work, further research questions arose:

(8) How can individual and collective emotions be distinguished? How wide is the influence of individual active users?

(9) For the base data that contain information about the gender of the user: can differences in the emotional experience of a place be determined between genders?

(10) How to handle a photo with one time stamp but containing emotional information from several dates?

(11) How can the emotional data obtained be used for tourism purposes / for decision making?

(12) In the context of the previous research question: Which visualisation methods are appropriate for a spatial-temporal presentation of georeferenced emotions?

The first three additional research questions show that the analysis possibilities of the gathered emotional data for Dresden are by no means exploited yet and also raise new challenges. For instance how the distinction between individual and collective emotions could be performed. One solution could work based upon the number of users having a certain emotion at a place. Since gender information about the user - insofar as they were available - were requested and stored but have not been used yet, an analysis in order to identify differences between genders in the emotional experience of a place or in the choice of places is obvious. Furthermore there is a case that can be described best by an example: a

photo of the old town of Dresden taken in 2013 is appended with information about the bombing of Dresden in World War II. The extracted negative emotions about the war are temporally annotated with 2013 although they are related to another century. For identifying time references that are differ from the exposure data, more natural language processing would be necessary. Tenses and named dates like year dates could be used as indicators.

As for a use of the spatial emotional data that has been derived, a mobile emotional travel guide is conceivable for which methodologies first need to be developed. Therefore collective emotions are of interest. This travel guide could be adapted to the emotional state of the user, e.g. whether the user desires adventure and thrill or for a place of calm and relaxation, and, of course, to the user's spatial and temporal situation, i.e. considering how other people felt at the place the user is located or nearby and when. A kind of emotional routing could be implemented and emotional profiles of special places or sights could be offered showing all the emotions that were detected there and explain the reason for these emotions. This would be a totally new approach for discovering a city, for exploring a region and especially for conveying historical facts and background information.

Considering emotional aspects might be also interesting for adaptive information filtering on rating-platforms or for the location-based communication of emotions in social networks.

Basically, the visualisations used might yet be too abstract for tourism utilisation since they often visualise the pure emotional values as they were created for analysis purposes. Not all derived emotions should be presented to tourists but only a selection of emotional places. Visually appealing solutions could be designed in very creative ways. Figures for certain emotions and thus metaphors for emotions could be developed. Piatti et al. (2013) provide inspirations for that. Based on Chernoff faces (Chernoff, 1973), faces expressing emotions by the shape of the eyes and the mouth could be used as point symbols and would be very self-explanatory. Valence could be represented by mouth and eyes, arousal by the colour of the face. But also stick figures (Pickett & Grinstein, 1988) with different postures could stand for emotions. Apart from point symbols, a further possibility would be to display words in the map at the corresponding place that caused the extraction of a certain emotion and to style the word calligraphically depending on the emotion.

Without considering the possibilities of interaction implied by a mobile application, two versions of visualisation for tourism purposes have been designed for downtown Dresden. Appendix 10 makes use of the option to represent emotions by faces. Valence is symbolised by the mouth (positive valence: corners of the mouth upwards, negative valence: corners of the mouth downwards) and arousal by the eyes (low arousal: eyes closed, high arousal: eyes opened, additionally the position of the eyebrows is also used for the opened eyes depending on the valence for giving the faces more expression). Altogether four faces were created for the four quadrants plus a neutral face. The faces are double coded by different background colours. The face of positive valence & low arousal is green, for positive valence & high arousal it is orange, dark red is assigned to negative valence & low arousal and dark blue to negative valence & low arousal. The background colour of the neutral face is a light yellow. The colour choice is based on the emotional associations of colours (Feisner & Reed, 2013; Wolfrom, 2009) The faces are homogenously distributed over the map in a chloropleth fashion and indicate the prevailing emotions of selected places. The background of the map is formed by a pale network of the most important roads. For each selected place a box provides information and contains pictures as well as a wing chart showing the relative frequency of the four quadrants (by area). The arrangement of the quadrants in the wing chart corresponds to the structure of valence-arousal space. Furthermore a general map of Dresden indicating the location of downtown Dresden is included. The components map, text and picture give this visualisation an infographics character. This kind of visualisation could be applied to several groups of districts in Dresden.

Appendix 11 is a 3D visualisation of the same area and the same emotional places like Appendix 10. Besides a general map, boxes again provide information and pictures of the selected places. In the map the locations of the emotional places are indicated by height: the higher, the more emotions that were detected there. Hence a high rise is a 'must see'. The elevations are coloured with the four colours used in the previous version. They are arranged by relative frequency whereby the quadrant with the highest frequency is on top. The area of the underlying concentric circles/annuluses which were extruded into the third dimension corresponds to the relative frequency. The extrusion is based on an artificially created surface. The map again has a pale network of the most important roads in the background.

Comparing the two drafts, the second version appears too colourful. For the first version this is not the case. Furthermore the faces are self-explanatory which makes this version the preferable one.

With regard to content, the answered and unanswered research questions can be structured into three subjects that are illustrated in Figure 48: extraction of georeferenced emotions, analysis of georeferenced emotions and derivation of utilisation concepts.

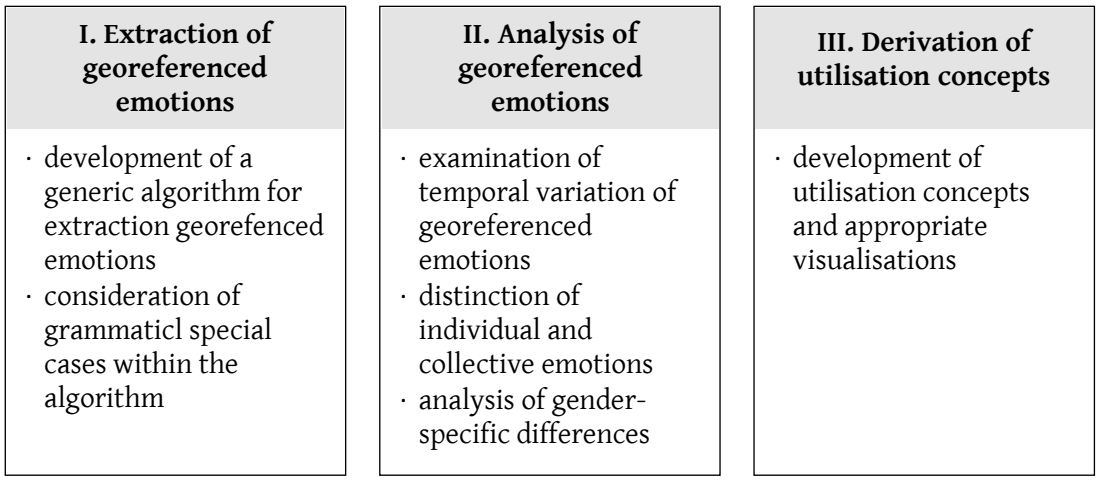


Figure 48 Structure and summary of research questions

So far the emotional analysis of places could be carried out only manually and with regional knowledge. Since a generic approach is worthwhile, an attempt should be made to assign the emotions to the respective places, meaning to the respective objects. For this purpose factual information from the base data should be linked to the space-related emotions. From a linguistic point of view, nouns and proper names are especially appropriate. Then the algorithm could also be applied to other regions. A further region should have different characteristics from the pilot region Dresden, i.e. it should not be an urban region but maybe a national park. Hence it could be investigated if the huge emotional differences that occurred in the emotional analysis of Dresden are a phenomenon of urban space.

Georeferenced tweets were intended to serve as another data source for an emotional analysis of Dresden, since a comparison of the results from the two different sources Flickr/Panoramio and Twitter would have been interesting. Though tweets are restricted to 140 characters, they consist of sentences and not merely of keywords, so they are more likely to contain grammatical special cases. The algorithm for extracting emotions from the written language in georeferenced UGC has been applied already to a dataset of 74,780

tweets located in the city of Dresden covering a time period from August 2012 to October 2013. A first glance at the derived space-related emotional data confirms the statement of Hahmann (2014) that tweets refer not necessarily to the place where they were written.

A comparison of this work with already existing research shall conclude the dissertation. Therefore the four projects using UGC, and thus written language as a source for extracting space-related emotions as well (see 2.3.3), are adduced. Emography, Twittermood and Tweetbeat build on Twitter data, only 'Beautiful picture of an ugly place' uses Flickr photo metadata. Except for Emography, all research projects conduct sentiment analysis, which means emotions are ranged on a positive-negative-scale. Although Twittermood makes use of ANEW as well, only the dimension valence is applied. However this work also considers arousal beside valence 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. Emography applies affect analysis as well by regarding the basic feelings according to Ekman et al. (1982) but only six feelings are considered. Furthermore none of the four research projects considers grammatical issues like negations or amplifications to the same extent as this dissertation. 'Beautiful Pictures of an Ugly Place' alone regards negated words (Kisilevich et al., 2010), 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. And finally, none of the existing research projects addresses temporal aspects and analyses the derived emotional data so extensively in regard to the spatial region they were extracted for as this dissertation.

So looking at this comparison and at all the findings of this dissertation, it can be said in summary that a profound methodical basis was created for extracting space-related emotions from the written language in UGC, for handling and understanding them on one hand as well as for continuing and extending this subject with further research on the other.

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APPENDICES

Appendix 1 List of English Degree Words Indicating a Grammatical Special Case

	Original Classification According to Quirk et al. (1985)					
	Maximizers	**Boosters**	**Approximators**	**Compromisers**	**Diminishers**	**Minimizers**
Maximum						
absolutely	x					
altogether	x					
completely	x					
decidedly						
downright						
entirely	x					
extremely	x					
fully	x					
in all respects	x					
most	x					
perfectly	x					
purely				x	x	
quite	x					
thoroughly	x					
too much						
totally	x					
utterly	x					
Amplification						
a lot		x				
actively		x				
amazingly						
awfully						
badly		x				
bitterly		x				
by far		x				
considerably						
deeply		x				
dreadfully						
enormously		x				
exceedingly						
excessively						
extensively						
fantastically						

	Original Classification According to Quirk et al. (1985)					
	Maximizers	**Boosters**	**Approximators**	**Compromisers**	**Diminishers**	**Minimizers**
far		x				
greatly		x				
hard		x				
heartily		x				
highly		x				
hugely						
immensely						
incredibly						
indeed						
infinitely						
intensely		x				
jolly						
largely						
lots						
lots of						
mighty						
more		x				
much		x				
noticeably						
pretty						
profoundly						
really						
reasonably						
remarkably						
severely		x				
so		x				
strikingly						
strongly		x				
supremely						
terribly		x				
too						
tremendously						
truly						
unbelievably						
very						
very much						
violently		x				

	Original Classification According to Quirk et al. (1985)					
	Maximizers	**Boosters**	**Approximators**	**Compromisers**	**Diminishers**	**Minimizers**
way						
way too						
well		x				
wonderfully						
Attenuation						
a bit					x	x
a little					x	
almost			x			
as ... as			x			
but					x	
enough				x		
fairly						
in part					x	
in some respects					x	
just					x	
kind of				x		
least						
least (of all)					x	
little bit						
merely					x	
mildly					x	
moderately						
more or less				x		
nearly			x			
not a lot						
not absolutely						
not actively						
not altogether						
not amazingly						
not awfully						
not badly						
not bitterly						
not by far						
not completely						
not considerably						
not decidedly						
not deeply						

	Original Classification According to Quirk et al. (1985)					
	Maximizers	**Boosters**	**Approximators**	**Compromisers**	**Diminishers**	**Minimizers**
not downright						
not dreadfully						
not enormously						
not entirely						
not exceedingly						
not excessively						
not extensively						
not extremely						
not fantastically						
not far						
not fully						
not greatly						
not hard						
not heartily						
not highly						
not hugely						
not immensely						
not in all respects						
not incredibly						
not indeed						
not infinitely						
not intensely						
not jolly						
not largely						
not lots						
not mighty						
not more						
not most						
not much						
not noticeably						
not perfectly						
not pretty						
not profoundly						
not purely						
not quite						
not really						
not reasonably						

	Original Classification According to Quirk et al. (1985)					
	Maximizers	**Boosters**	**Approximators**	**Compromisers**	**Diminishers**	**Minimizers**
not remarkably						
not severely						
not so						
not strikingly						
not strongly						
not supremely						
not terribly						
not thoroughly						
not too						
not totally						
not tremendously						
not truly						
not unbelievably						
not utterly						
not very						
not very much						
not violently						
no way						
only					x	
partially					x	
partly					x	
practically			x			
rather				x		
relatively						
simply					x	
slightly					x	
somewhat					x	
sort of				x		
sufficiently				x		
to some extent					x	
virtually			x			
Minimum						
at all						x
barely						x
hardly						x
in the least						x
in the slightest						x

	Original Classification According to Quirk et al. (1985)					
	Maximizers	**Boosters**	**Approximators**	**Compromisers**	**Diminishers**	**Minimizers**
less						
little						x
little less						
scarcely						x
Negation						
instead of						
neither ... nor						
never						
no						
no one						
nobody						
none						
not						
nothing						
nowhere						
rather than						
without						
Amplified Negation						
absolutely no						
absolutely nobody						
absolutely non						
absolutely not						
absolutely nothing						
absolutely nowhere						
all but			x			
anything but						
by any means						
by no means						
certainly no						
certainly nobody						
certainly non						
certainly not						
certainly nothing						
certainly nowhere						
completely no						
completely nobody						
completely non						

	Original Classification According to Quirk et al. (1985)					
	Maximizers	**Boosters**	**Approximators**	**Compromisers**	**Diminishers**	**Minimizers**
completely not						
completely nothing						
completely nowhere						
definitely no						
definitely nobody						
definitely non						
definitely not						
definitely nothing						
definitely nowhere						
everything but						
far from						
in no way						
naturally no						
naturally nobody						
naturally non						
naturally not						
naturally nothing						
naturally nowhere						
no way						
not a bit						
not at all						
not in any respect						
not in any way						
not in the least						
not in the slightest						
obviously no						
obviously nobody						
obviously non						
obviously not						
obviously nothing						
obviously nowhere						
really no						
really nobody						
really non						
really not						
really nothing						
really nowhere						

	Original Classification According to Quirk et al. (1985)					
	Maximizers	**Boosters**	**Approximators**	**Compromisers**	**Diminishers**	**Minimizers**
simply no						
simply nobody						
simply non						
simply not						
simply nothing						
simply nowhere						
so not						
surely no						
surely nobody						
surely non						
surely not						
surely nothing						
surely nowhere						

Appendix 2 List of German Degree Words Indicating a Grammatical Special Case

	Original Classification According to												
	Biedermann (1969)					van Os (1989)							
	A	B	C	D	E	F	G	H	I	J	K	L	M
Maximum													
absolut	x					x							
ganz und gar	x					x							
gänzlich	x					x							
gar	x					x		x					x
geradezu	x		x				x						
hundertprozentig	x					x							
im entferntesten	x												
im geringsten	x												x
komplett						x							
praktisch	x		x				x						
schlechthin	x					x							
schlichtweg	x					x							
total	x					x							
voll	x					x							
vollends	x					x							
völlig	x					x							
vollkommen	x					x							
vollständig	x					x							
Amplification													
allzu		x							x				
allzu sehr		x							x				
arg		x							x				
auffallend		x							x				
ausgenommen		x						x					
ausgesprochen	x		x					x					
ausnehmend		x						x					
außergewöhnlich		x						x					
außerordentlich		x						x					
äußerst		x						x					
beachtenswert		x							x				
beachtlich		x							x				
bedeutend		x							x				

	Original Classification According to												
	Biedermann (1969)					van Os (1989)							
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**
bemerkenswert		x						x					
beschissen		x						x					
besonders		x							x				
betont	x		x					x					
beträchtlich		x						x					
denkbar		x						x					
derart		x						x					
derartig		x						x					
dergestalt		x						x					
dermaßen		x						x					
direkt	x		x						x				
durchaus	x	x	x			x							
echt								x					
enorm		x						x					
entscheidend								x					
erheblich		x						x					
erschreckend		x						x					
erstaunlich		x						x					
extrem								x					
fundamental						x		x					
furchtbar		x						x					
fürchterlich		x						x					
ganz	x	x	x			x		x	x	x			
gehörig		x	x					x					
gerade		x							x				
gewaltig		x											
grundsätzlich						x		x					
hervorragend								x					
hochgradig		x						x					
höchst		x						x					
höllisch		x						x					
hübsch		x								x			
hundsmäßig								x					
im höchsten Grade		x						x					
im Höchstmaß		x						x					
in höchstem Maße		x						x					

	Original Classification According to												
	Biedermann (1969)					van Os (1989)							
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**
in hohem Grade		x						x					
in hohem Maße		x						x					
in vollem Umfang								x					
irre		x						x					
krass		x						x					
merklich		x	x						x				
ohnegleichen		x						x					
ordentlich		x	x							x			
regelrecht		x	x					x					
richtiggehend		x	x			x		x					
schrecklich		x						x					
sehr		x							x				
so		x							x				
sowas von								x					
über alle Begriffe		x						x					
über alle Maßen		x						x					
über die Maßen		x						x					
überaus		x						x					
übermäßig		x						x					
ungemein		x						x					
ungewöhnlich		x						x					
unglaublich		x						x					
unvorstellbar		x						x					
verdammt		x						x					
viel		x							x				
wahnsinnig		x						x					
weit		x							x				
weitaus		x						x					
weitestgehend		x						x					
weitgehend		x						x					
wesentlich		x							x				
wirklich	x	x				x				x			
zu		x						x					
zutiefst		x						x					
Attenuation													
annähernd							x						

	Original Classification According to												
	Biedermann (1969)					van Os (1989)							
	A	B	C	D	E	F	G	H	I	J	K	L	M
beinahe							x						
bisschen				x							x		
ein klein wenig											x		
ein kleines bisschen				x							x		
ein wenig				x							x		
einigermaßen			x							x			
etwas				x				x					
fast		x					x						
geringfügig				x							x		
halbwegs			x	x						x			
irgendwie			x	x									
mehr oder minder			x	x						x			
mehr oder weniger			x	x						x			
nicht absolut													
nicht allzu													
nicht allzu sehr													
nicht arg													
nicht auffallend													
nicht ausgenommen													
nicht ausgesprochen													
nicht ausnehmend													
nicht außergewöhnlich													
nicht außerordentlich													
nicht äußerst													
nicht beachtenswert													
nicht beachtlich													
nicht bedeutend													
nicht bemerkenswert													
nicht beschissen													
nicht besonders													
nicht betont													
nicht beträchtlich													
nicht denkbar													
nicht derart													
nicht derartig													
nicht dergestalt													

	Original Classification According to												
	Biedermann (1969)					van Os (1989)							
	A	B	C	D	E	F	G	H	I	J	K	L	M
nicht dermaßen													
nicht direkt													
nicht durchaus													
nicht echt													
nicht enorm													
nicht entscheidend													
nicht erheblich													
nicht erschreckend													
nicht erstaunlich													
nicht extrem													
nicht fundamental													
nicht furchtbar													
nicht fürchterlich													
nicht ganz													
nicht ganz und gar													
nicht gänzlich													
nicht gehörig													
nicht gerade													
nicht geradezu													
nicht gewaltig													
nicht grundsätzlich													
nicht hervorragend													
nicht hochgradig													
nicht höchst													
nicht höllisch													
nicht hübsch													
nicht hundertprozentig													
nicht hundsmäßig													
nicht im Höchstmaß													
nicht in hohem Grad													
nicht in hohem Grade													
nicht in hohem Maß													
nicht in hohem Maße													
nicht in voll umfang													
nicht irre													
nicht komplett													

	Original Classification According to												
	Biedermann (1969)					van Os (1989)							
	A	B	C	D	E	F	G	H	I	J	K	L	M
nicht krass													
nicht merklich													
nicht ohnegleichen													
nicht ordentlich													
nicht praktisch													
nicht regelrecht													
nicht richtiggehend													
nicht schlechthin													
nicht schlichtweg													
nicht schrecklich													
nicht sehr													
nicht so													
nicht sowas von													
nicht total													
nicht über alle Begriffe													
nicht über alle Maßen													
nicht über die Maßen													
nicht überaus													
nicht übermäßig													
nicht ungemein													
nicht ungewöhnlich													
nicht unglaublich													
nicht unvorstellbar													
nicht verdammt													
nicht viel													
nicht voll													
nicht vollends													
nicht völlig													
nicht vollkommen													
nicht vollständig													
nicht wahnsinnig													
nicht weit													
nicht weitaus													
nicht weitestgehend													
nicht weitgehend													
nicht wesentlich													

	Original Classification According to Biedermann (1969) van Os (1989)												
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**
nicht wirklich													
nicht zu													
nicht zutiefst													
recht			x							x			
relativ			x							x			
schier							x						
so gut wie							x						
so ziemlich							x						
vergleichsweise			x							x			
verhältnismäßig			x							x			
ziemlich			x							x			
Minimum													
kaum					x							x	
wenig					x							x	
Negation													
anstatt													
anstatt dass													
anstelle													
außer													
kein													
keinerlei													
keinesfalls													
keineswegs													
nicht													
nichts													
nie													
niemals													
niemand													
nimmer													
nirgends													
nirgendwo													
nirgendwoher													
nirgendwohin													
nix													
ohne													
ohne dass													

	Original Classification According to												
	Biedermann (1969)					van Os (1989)							
	A	B	C	D	E	F	G	H	I	J	K	L	M
statt													
weder ... noch													
Amplified Negation													
absolut kein													
absolut keinerlei													
absolut nicht													
absolut nichts													
absolut niemand													
absolut nirgends													
absolut nirgendwo													
absolut nirgendwoher													
absolut nirgendwohin													
absolut nix													
alles andere als													
am allerwenigsten													
beileibe kein													
beileibe keinerlei													
beileibe nicht													
beileibe nichts													
beileibe niemand													
beileibe nirgends													
beileibe nirgendwo													
beileibe nirgendwoher													
beileibe nirgendwohin													
beileibe nix													
bestimmt kein													
bestimmt keinerlei													
bestimmt nicht													
bestimmt nichts													
bestimmt niemand													
bestimmt nirgends													
bestimmt nirgendwo													
bestimmt nirgendwoher													
bestimmt nirgendwohin													
bestimmt nix													
deutlich kein													

	Original Classification According to												
	Biedermann (1969)				van Os (1989)								
	A	B	C	D	E	F	G	H	I	J	K	L	M
deutlich keinerlei													
deutlich nicht													
deutlich nichts													
deutlich niemand													
deutlich nirgends													
deutlich nirgendwo													
deutlich nirgendwoher													
deutlich nirgendwohin													
deutlich nix													
durchaus kein													
durchaus keinerlei													
durchaus nicht													
durchaus nichts													
durchaus niemand													
durchaus nirgends													
durchaus nirgendwo													
durchaus nirgendwoher													
durchaus nirgendwohin													
durchaus nix													
eben kein													
eben keinerlei													
eben nicht													
eben nichts													
eben niemand													
eben nirgends													
eben nirgendwo													
eben nirgendwoher													
eben nirgendwohin													
eben nix													
echt kein													
echt keinerlei													
echt nicht													
echt nichts													
echt niemand													
echt nirgends													
echt nirgendwo													

	Original Classification According to												
	Biedermann (1969)				van Os (1989)								
	A	B	C	D	E	F	G	H	I	J	K	L	M
echt nirgendwoher													
echt nirgendwohin													
echt nix													
eindeutig kein													
eindeutig keinerlei													
eindeutig nicht													
eindeutig nichts													
eindeutig niemand													
eindeutig nirgends													
eindeutig nirgendwo													
eindeutig nirgendwoher													
eindeutig nirgendwohin													
eindeutig nix													
einfach kein													
einfach keinerlei													
einfach nicht													
einfach nichts													
einfach niemand													
einfach nirgends													
einfach nirgendwo													
einfach nirgendwoher													
einfach nirgendwohin													
einfach nix													
endgültig kein													
endgültig keinerlei													
endgültig nicht													
endgültig nichts													
endgültig niemand													
endgültig nirgends													
endgültig nirgendwo													
endgültig nirgendwoher													
endgültig nirgendwohin													
endgültig nix													
fürwahr kein													
fürwahr keinerlei													
fürwahr nicht													

	Original Classification According to												
	Biedermann (1969)					van Os (1989)							
	A	B	C	D	E	F	G	H	I	J	K	L	M
fürwahr nichts													
fürwahr niemand													
fürwahr nirgends													
fürwahr nirgendwo													
fürwahr nirgendwoher													
fürwahr nirgendwohin													
fürwahr nix													
ganz und gar kein													
ganz und gar keinerlei													
ganz und gar nicht													
ganz und gar nichts													
ganz und gar nix													
gänzlich kein													
gänzlich keinerlei													
gänzlich nicht													
gänzlich nichts													
gänzlich niemand													
gänzlich nirgends													
gänzlich nirgendwo													
gänzlich nirgendwoher													
gänzlich nirgendwohin													
gänzlich nix													
gar kein													
gar keinerlei													x
gar nicht													x
gar nichts													x
gar niemand													x
gar nirgends													x
gar nirgendwo													x
gar nirgendwoher													x
gar nirgendwohin													x
gar nix													x
gerade kein													
gerade keinerlei													
gerade nicht													
gerade nichts													

	Original Classification According to												
	Biedermann (1969)				van Os (1989)								
	A	B	C	D	E	F	G	H	I	J	K	L	M
gerade niemand													
gerade nirgends													
gerade nirgendwo													
gerade nirgendwoher													
gerade nirgendwohin													
gerade nix													
gewiss kein													
gewiss keinerlei													
gewiss nicht													
gewiss nichts													
gewiss niemand													
gewiss nirgends													
gewiss nirgendwo													
gewiss nirgendwoher													
gewiss nirgendwohin													
gewiss nix													
grundsätzlich kein													
grundsätzlich keinerlei													
grundsätzlich nicht													
grundsätzlich nichts													
grundsätzlich niemand													
grundsätzlich nirgends													
grundsätzlich nirgendwo													
grundsätzlich nirgendwoher													
grundsätzlich nirgendwohin													
grundsätzlich nix													
hundertprozentig nicht													
komplett kein													
komplett keinerlei													
komplett nicht													
komplett nichts													
komplett niemand													
komplett nirgends													
komplett nirgendwo													
komplett nirgendwoher													
komplett nirgendwohin													

	Original Classification According to												
	Biedermann (1969)					van Os (1989)							
	A	B	C	D	E	F	G	H	I	J	K	L	M
komplett nix													
lange kein													
lange keinerlei													
lange nicht													
lange nichts													
lange niemand													
lange nirgends													
lange nirgendwo													
lange nirgendwoher													
lange nirgendwohin													
lange nix													
längst kein													
längst keinerlei													
längst nicht													
längst nichts													
längst niemand													
längst nirgends													
längst nirgendwo													
längst nirgendwoher													
längst nirgendwohin													
längst nix													
nicht im Entferntesten													
nicht im Geringsten													x
partout kein													
partout keinerlei													
partout nicht													
partout nichts													
partout niemand													
partout nirgends													
partout nirgendwo													
partout nirgendwoher													
partout nirgendwohin													
partout nix													
praktisch kein													
praktisch keinerlei													
praktisch nicht													

	Original Classification According to												
	Biedermann (1969)				van Os (1989)								
	A	B	C	D	E	F	G	H	I	J	K	L	M
praktisch nichts													
praktisch niemand													
praktisch nirgends													
praktisch nirgendwo													
praktisch nirgendwoher													
praktisch nirgendwohin													
praktisch nix													
schier kein													
schier keinerlei													
schier nicht													
schier nichts													
schier niemand													
schier nirgends													
schier nirgendwo													
schier nirgendwoher													
schier nirgendwohin													
schier nix													
schlechthin kein													
schlechthin keinerlei													
schlechthin nicht													
schlechthin nichts													
schlechthin niemand													
schlechthin nirgends													
schlechthin nirgendwo													
schlechthin nirgendwoher													
schlechthin nirgendwohin													
schlechthin nix													
schlechtweg kein													
schlechtweg keinerlei													
schlechtweg nicht													
schlechtweg nichts													
schlechtweg niemand													
schlechtweg nirgends													
schlechtweg nirgendwo													
schlechtweg nirgendwoher													
schlechtweg nirgendwohin													

	Original Classification According to												
	Biedermann (1969)					van Os (1989)							
	A	B	C	D	E	F	G	H	I	J	K	L	M
schlechtweg nix													
schlichtweg kein													
schlichtweg keinerlei													
schlichtweg nicht													
schlichtweg nichts													
schlichtweg niemand													
schlichtweg nirgends													
schlichtweg nirgendwo													
schlichtweg nirgendwoher													
schlichtweg nirgendwohin													
schlichtweg nix													
sicher kein													
sicher keinerlei													
sicher nicht													
sicher nichts													
sicher niemand													
sicher nirgends													
sicher nirgendwo													
sicher nirgendwoher													
sicher nirgendwohin													
sicher nix													
sicherlich kein													
sicherlich keinerlei													
sicherlich nicht													
sicherlich nichts													
sicherlich niemand													
sicherlich nirgends													
sicherlich nirgendwo													
sicherlich nirgendwoher													
sicherlich nirgendwohin													
sicherlich nix													
sichtbar kein													
sichtbar keinerlei													
sichtbar nicht													
sichtbar nichts													
sichtbar niemand													

	Original Classification According to												
	Biedermann (1969)				van Os (1989)								
	A	B	C	D	E	F	G	H	I	J	K	L	M
sichtbar nirgends													
sichtbar nirgendwo													
sichtbar nirgendwoher													
sichtbar nirgendwohin													
sichtbar nix													
sichtlich kein													
sichtlich keinerlei													
sichtlich nicht													
sichtlich nichts													
sichtlich niemand													
sichtlich nirgends													
sichtlich nirgendwo													
sichtlich nirgendwoher													
sichtlich nirgendwohin													
sichtlich nix													
tatsächlich kein													
tatsächlich keinerlei													
tatsächlich nicht													
tatsächlich nichts													
tatsächlich niemand													
tatsächlich nirgends													
tatsächlich nirgendwo													
tatsächlich nirgendwoher													
tatsächlich nirgendwohin													
tatsächlich nix													
total nicht													
überhaupt kein													
überhaupt keinerlei													
überhaupt nicht													
überhaupt nichts													
überhaupt niemand													
überhaupt nirgends													
überhaupt nirgendwo													
überhaupt nirgendwoher													
überhaupt nirgendwohin													
überhaupt nix													

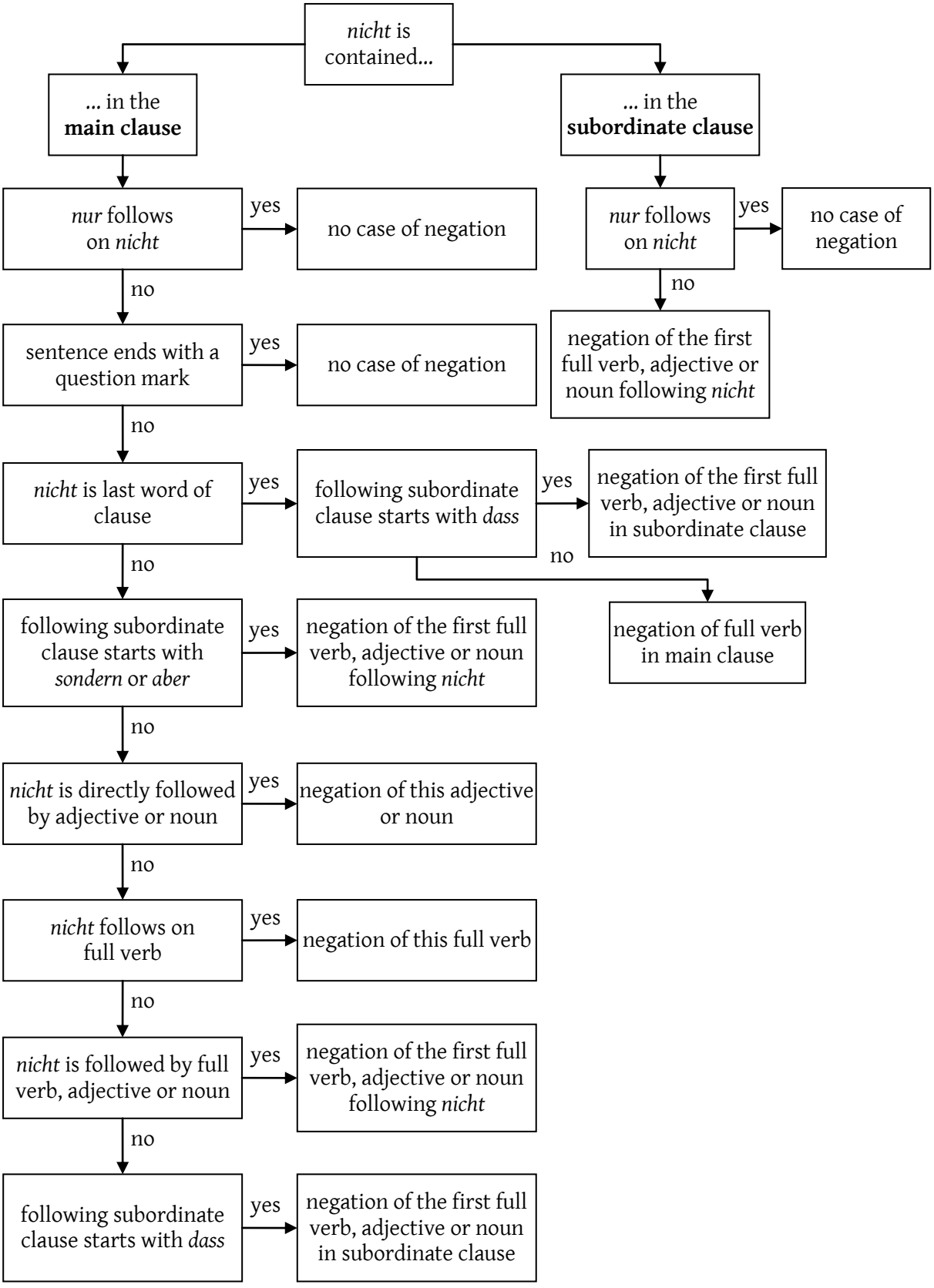
	Original Classification According to												
	Biedermann (1969)					van Os (1989)							
	A	B	C	D	E	F	G	H	I	J	K	L	M
unbedingt kein													
unbedingt keinerlei													
unbedingt nicht													
unbedingt nichts													
unbedingt niemand													
unbedingt nirgends													
unbedingt nirgendwo													
unbedingt nirgendwoher													
unbedingt nirgendwohin													
unbedingt nix													
wirklich kein													
wirklich keinerlei													
wirklich nicht													
wirklich nichts													
wirklich niemand													
wirklich nirgends													
wirklich nirgendwo													
wirklich nirgendwoher													
wirklich nirgendwohin													
wirklich nix													
zweifellos kein													
zweifellos keinerlei													
zweifellos nicht													
zweifellos nichts													
zweifellos niemand													
zweifellos nirgends													
zweifellos nirgendwo													
zweifellos nirgendwoher													
zweifellos nirgendwohin													
zweifellos nix													
zweifelsohne kein													
zweifelsohne keinerlei													
zweifelsohne nicht													
zweifelsohne nichts													
zweifelsohne niemand													
zweifelsohne nirgends													

	Original Classification According to												
	Biedermann (1969)					van Os (1989)							
	A	B	C	D	E	F	G	H	I	J	K	L	M
zweifelsohne nirgendwo													
zweifelsohne nirgendwoher													
zweifelsohne nirgendwohin													
zweifelsohne nix													

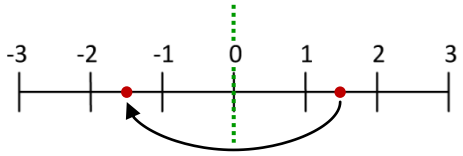
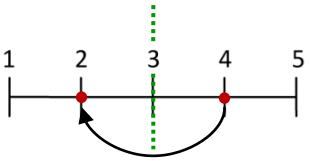
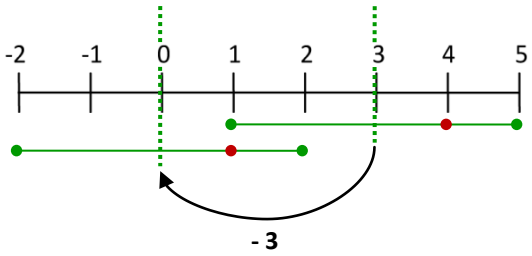
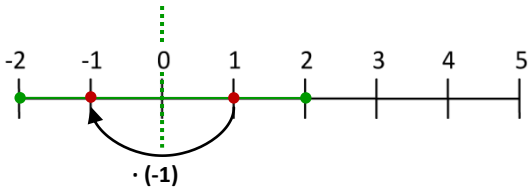
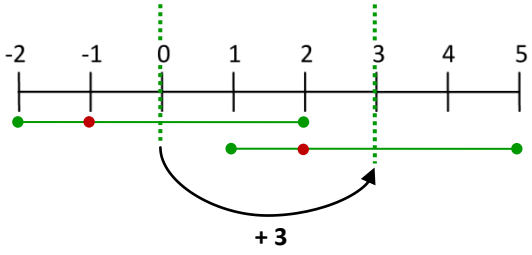
A: absolut
B: hoch
C: gemäßigt
D: schwach
E: minimal
} Biedermann (1969)

F: absolut
G: approximativ
H: extrem hoch
I: hoch
J: gemäßigt
K: abschwächend
L: minimal
M: negativ
} van Os (1989)

Appendix 3 Rules for the Scope of the German Negation Particle 'nicht'



Appendix 4 Formula Derivation for the Modification of Valence and Arousal Values for all Grammatical Special Cases

Valence $V = \{[-3 \dots 3] \mid V \in \mathbb{R}\}$	Arousal $A = \{[1 \dots 5] \mid A \in \mathbb{R}\}$
Negation	
principle: flipping the valence value horizontally at the middle of the codomain	***principle:*** flipping the valence value horizontally at the middle of the codomain
	
formula: $V_{neg} = -V_0$	***intermediate steps:*** move centre of codomain to 0 by subtracting 3 (for obtaining a bipolar scale)  multiply shifted arousal value by -1  move codomain back by adding up 3 

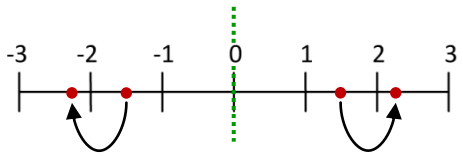
Valence	Arousal
$V = \{[-3 \dots 3] \mid V \in \mathbb{R}\}$	$A = \{[1 \dots 5] \mid A \in \mathbb{R}\}$
	formula: $A_{neg} = (A_0 - 3) \cdot (-1) + 3$ $\mathbf{A_{neg} = 6 - A_0}$

Amplification

principle:

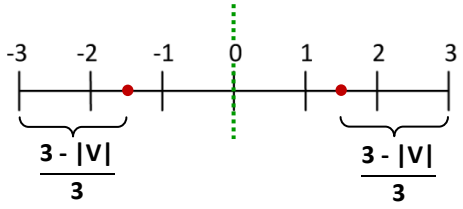
> 0: increase valence value by percentage distance to maximum value of codomain

< 0: decrease valence value by percentage distance to minimum value of codomain

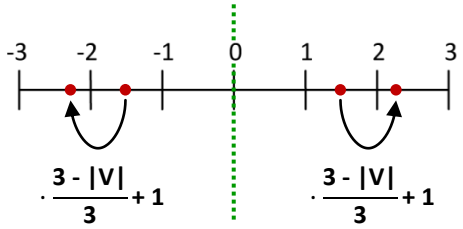


intermediate steps:

determine factor for in-/decrease by calculating distance of valence value to maximum/minimum



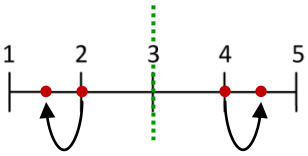
add up 1 to this percentage and multiply it with the valence value



principle:

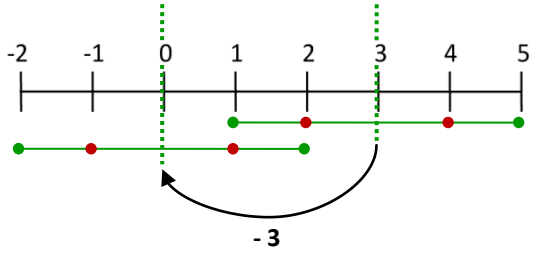
> 3: increase arousal value by percentage distance to maximum value of codomain

< 3: decrease arousal value by percentage distance to minimum value of codomain

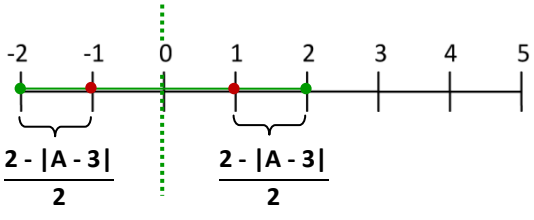


intermediate steps:

move centre of codomain to 0 by subtracting 3 (for obtaining a bipolar scale)



determine factor for in-/decrease by calculating distance of arousal value to maximum/minimum



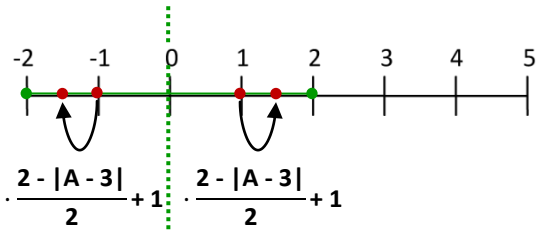
Valence	**Arousal**
$V = \{[-3 \dots 3] \mid V \in \mathbb{R}\}$	$A = \{[1 \dots 5] \mid A \in \mathbb{R}\}$

formula:

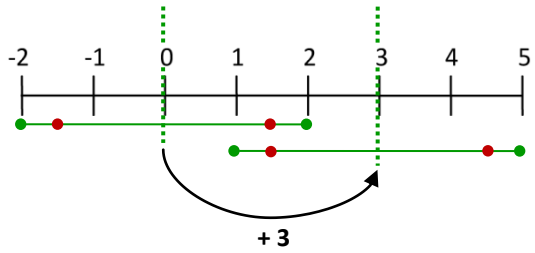
$$V_{ampl} = \left(\frac{3 - |V_O|}{3} + 1\right) \cdot V_O$$

$$\mathbf{V_{ampl} = \left(2 - \frac{|V_O|}{3}\right) \cdot V_O}$$

add up 1 to this percentage and multiply it with the arousal value



move codomain back by adding up 3



formula:

$$A_{ampl} = \left(\frac{2 - |(A_O - 3)|}{2} + 1\right) \cdot (A_O - 3) + 3$$

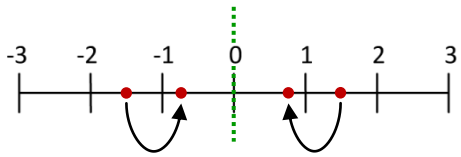
$$\mathbf{A_{ampl} = 2A_O - 3 - ½ \cdot |(A_O - 3)| \cdot (A_O - 3)}$$

Attenuation

principle:

> 0: decrease valence value by percentage distance to maximum value of codomain

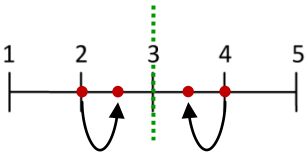
< 0: increase valence value by percentage distance to minimum value of codomain



principle:

> 3: decrease arousal value by percentage distance to maximum value of codomain

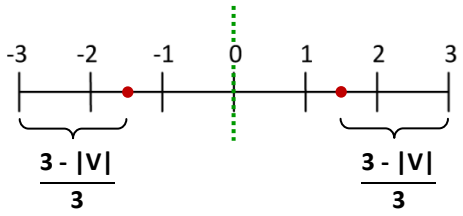
< 3: increase arousal value by percentage distance to minimum value of codomain



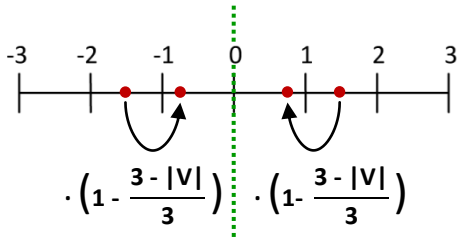
Valence	**Arousal**
$V = \{[-3 \dots 3] \mid V \in \mathbb{R}\}$	$A = \{[1 \dots 5] \mid A \in \mathbb{R}\}$

intermediate steps:

determine factor for de-/increase by calculating distance of valence value to maximum / minimum



subtract this percentage from 1 and multiply it with the valence value



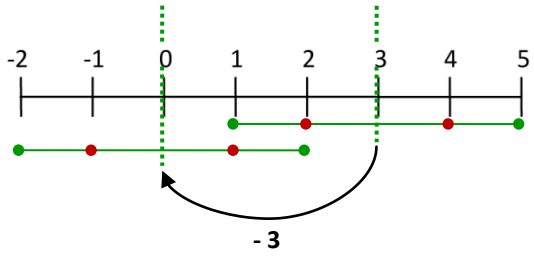
formula:

$$V_{att} = \left(1 - \frac{3 - |V_O|}{3}\right) \cdot V_O$$

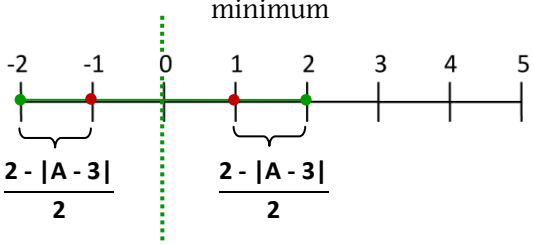
$$\mathbf{V_{att} = \frac{|V_O|}{3} \cdot V_O}$$

intermediate steps:

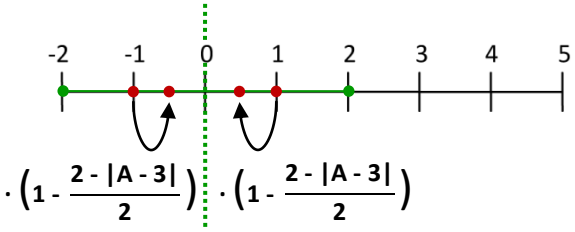
move centre of codomain to 0 by subtracting 3 (for obtaining a bipolar scale)



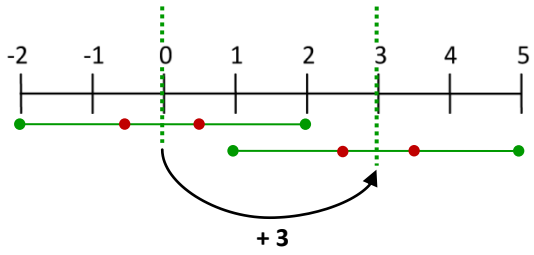
determine factor for de-/increase by calculating distance of arousal value to maximum / minimum



subtract this percentage from 1 and multiply it with the arousal value



move codomain back by adding up 3



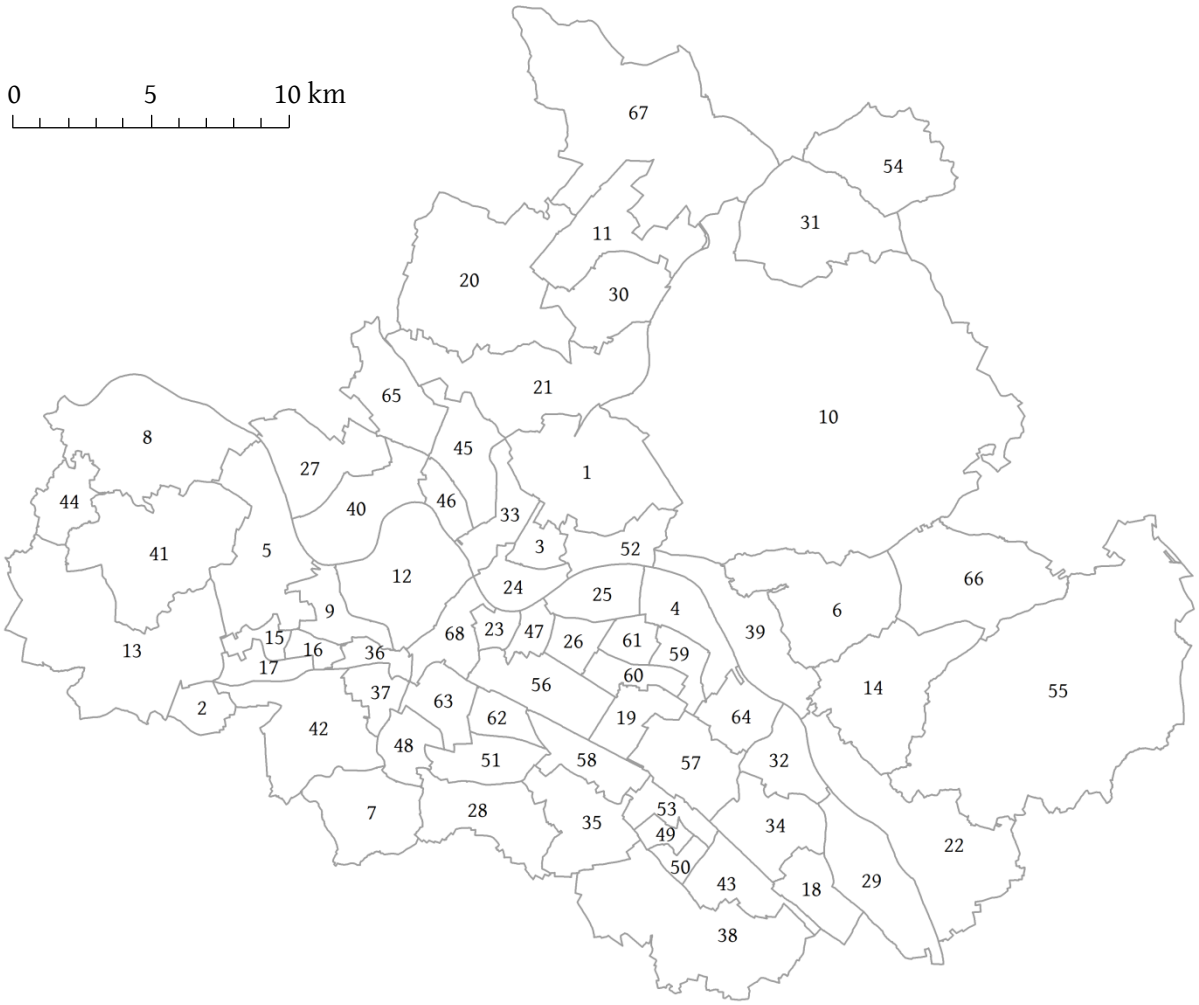
formula:

$$A_{att} = \left(1 - \frac{2 - |A_O|}{2}\right) \cdot (A_O - 3) + 3$$

$$\mathbf{A_{att} = ½ \cdot |(A_O - 3)| \cdot (A_O - 3) + 3}$$

Valence $V = \{[-3 \dots 3] \mid V \in \mathbb{R}\}$	**Arousal** $A = \{[1 \dots 5] \mid A \in \mathbb{R}\}$
Maximum	
principle: applying the formula of amplification twice to valence value	***principle:*** applying the formula of amplification twice to arousal value
formula: $V_{max} = \left(2 - \frac{\left\|\left(2 - \frac{\|V_0\|}{3}\right) \cdot V_0\right\|}{3}\right) \cdot \left(\left(2 - \frac{\|V_0\|}{3}\right) \cdot V_0\right)$	***formula:*** $A_{max} = 4A_0 - 9 - ½ \cdot \|(A_0 - 3)\| \cdot (A_0 - 3) - ½ \cdot \|(2A_0 - 6 - ½ \cdot \|(A_0 - 3)\| \cdot (A_0 - 3)\)\| \cdot (2A_0 - 6 - ½ \cdot \|(A_0 - 3)\| \cdot (A_0 - 3))$
Minimum	
principle: applying the formula of attenuation twice to valence value	***principle:*** applying the formula of attenuation twice to arousal value
formula: $V_{min} = \frac{\|V_0^3\| \cdot V_0}{27}$	***formula:*** $A_{min} = ½ \cdot \|½ \cdot \|A_0 - 3\|^3 \cdot (A_0 - 3)\| \cdot (½ \cdot \|A_0 - 3\| \cdot (A_0 - 3)) + 3$
Amplified Negation	
principle: applying first the formula of negation and second the formula of amplification to the valence value	***principle:*** applying first the formula of negation and second the formula of amplification to the arousal value
formula: $V_{neg\_ampl} = \left(2 - \frac{\|V_0\|}{3}\right) \cdot (-V_0)$	***formula:*** $A_{neg\_ampl} = 9 - 2A_0 - ½ \cdot \|(3 - A_0)\| \cdot (3 - A_0)$

Appendix 5 General Map of Dresden



(1) Albertstadt

(2) Altfranken

(3) Äußere Neustadt (Antonstadt)

(4) Blasewitz

(5) Briesnitz

(6) Bühlau/Weißer Hirsch

(7) Coschütz/Gittersee

(8) Cossebaude

(9) Cotta

(10) Dresdner Heide

(11) Flughafen / Industriegebiet Klotzsche

(12) Friedrichstadt

(13) Gompitz

(14) Gönnsdorf / Pappritz

(15) Gorbitz-Nord / Neu-Omsewitz

(16) Gorbitz-Ost

(17) Gorbitz-Süd

(18) Großzschachwitz

(19) Gruna

(20) Hellerau / Wilschdorf

(21) Hellerberge

(22) Hosterwitz / Pillnitz

(23) Innere Altstadt

(24) Innere Neustadt

(25) Johannstadt-Nord

(26) Johannstadt-Süd

(27) Kaditz

(28) Kleinpestitz / Mockritz

(29) Kleinzschachwitz

(30) Klotzsche

(31) Langebrück

(32) Laubegast

(33) Leipziger Vorstadt

(34) Leuben

(35) Leubnitz-Neuostra

(36) Löbtau-Nord

(37) Löbtau-Süd

(38) Lockwitz

(39) Loschwitz / Wachwitz

(40) Mickten

(41) Mobschatz

(42) Naußlitz

(43) Niedersedlitz

(44) Oberwartha

(45) Pieschen-Nord / Trachenberge

(46) Pieschen-Süd

(47) Pirnaische Vorstadt

(48) Plauen

(49) Prohlis-Nord

(50) Prohlis-Süd

(51) Räcknitz / Zschertnitz

(52) Radeberger Vorstadt

(53) Reick

(54) Schönborn

(55) Schönfeld / Schullwitz

(56) Seevorstadt-Ost / Großer Garten

(57) Seidnitz / Dobritz

(58) Strehlen

(59) Striesen-Ost

(60) Striesen-Süd

(61) Striesen-West

(62) Südvorstadt-Ost

(63) Südvorstadt-West

(64) Tolkewitz / Seidnitz-Nord

(65) Trachau

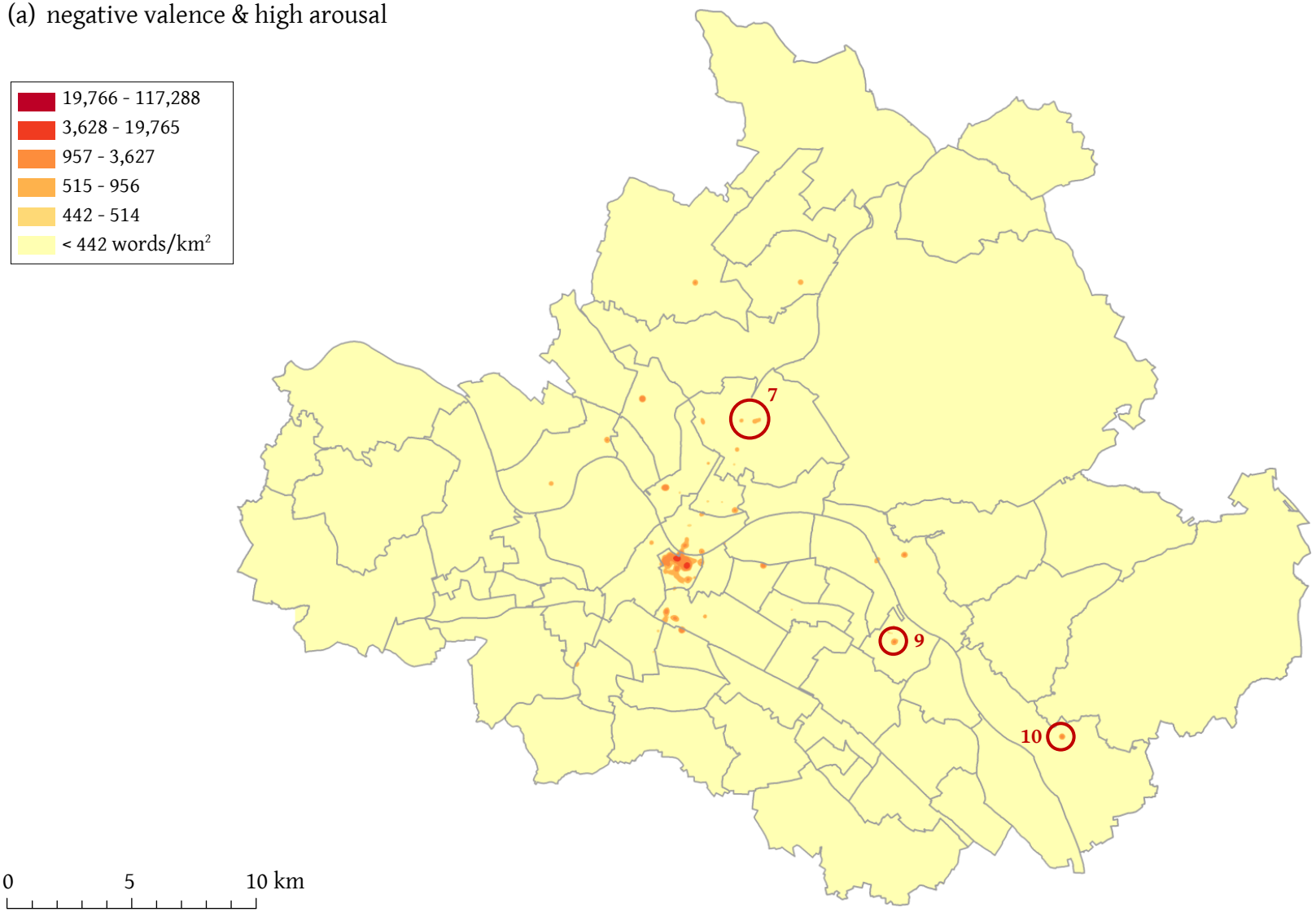
(66) Weißig

(67) Weixdorf

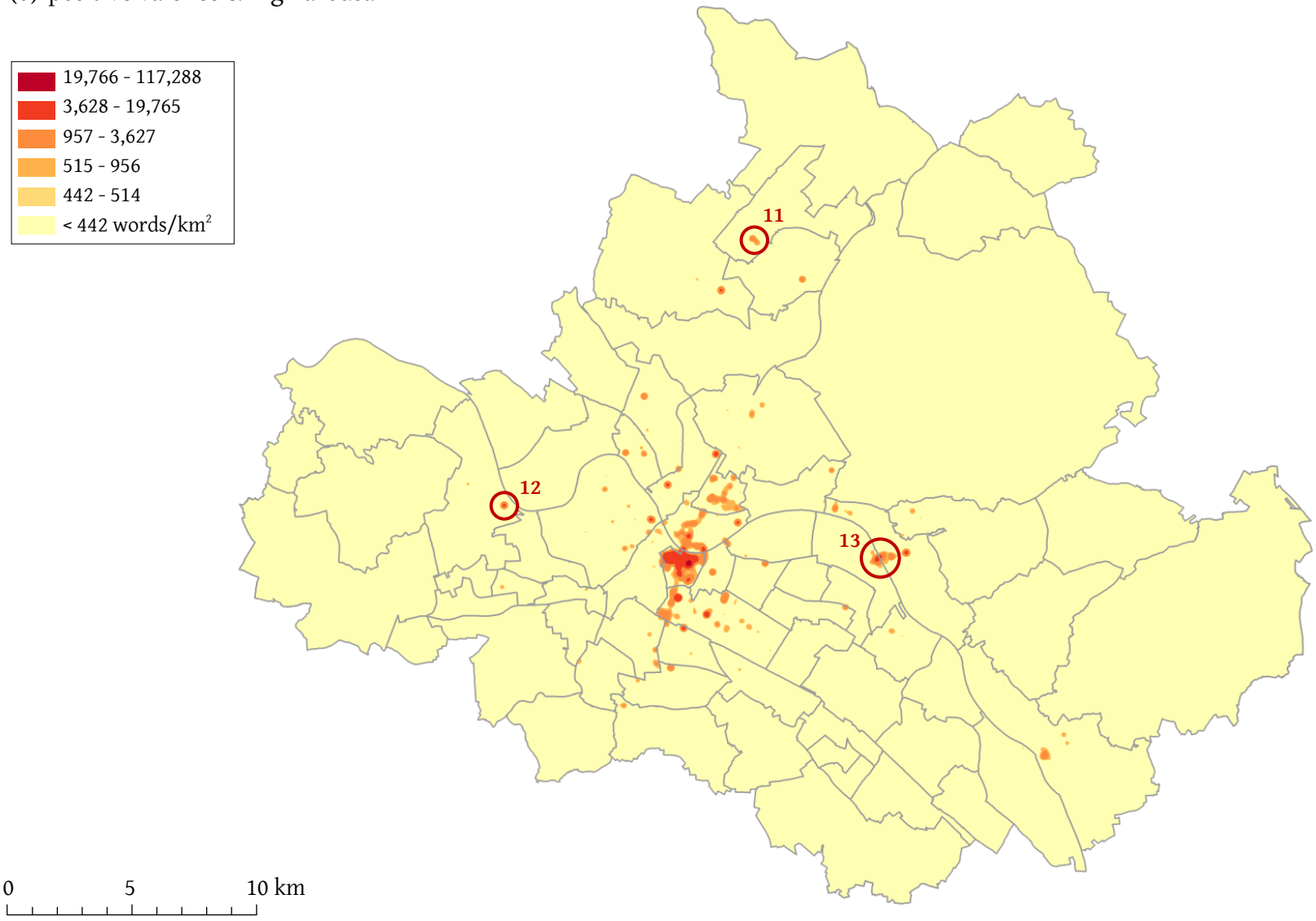
(68) Wilsdruffer Vorstadt / Seevorstadt-West

Appendix 6 Density Maps of Dresden

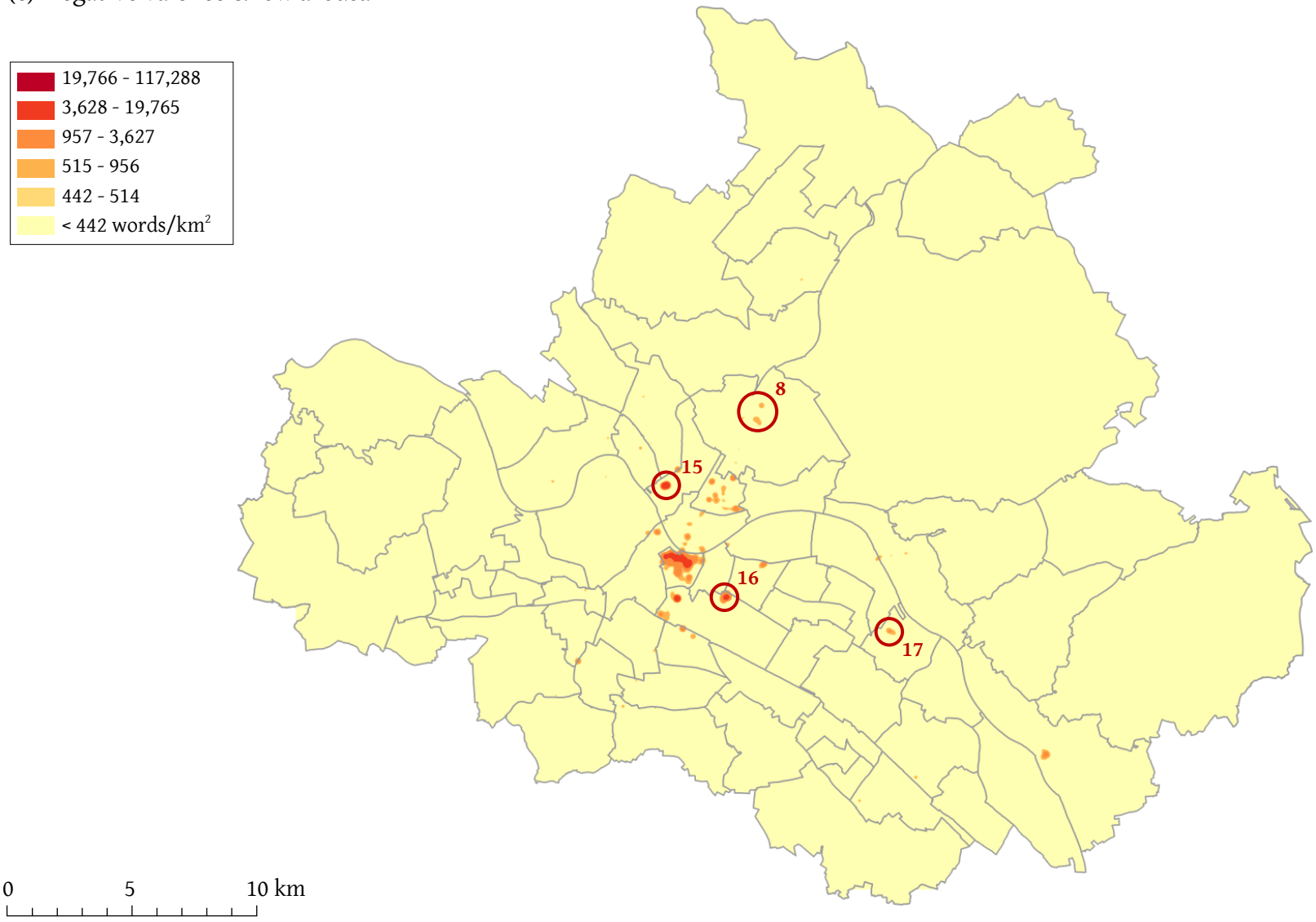
(a) negative valence & high arousal



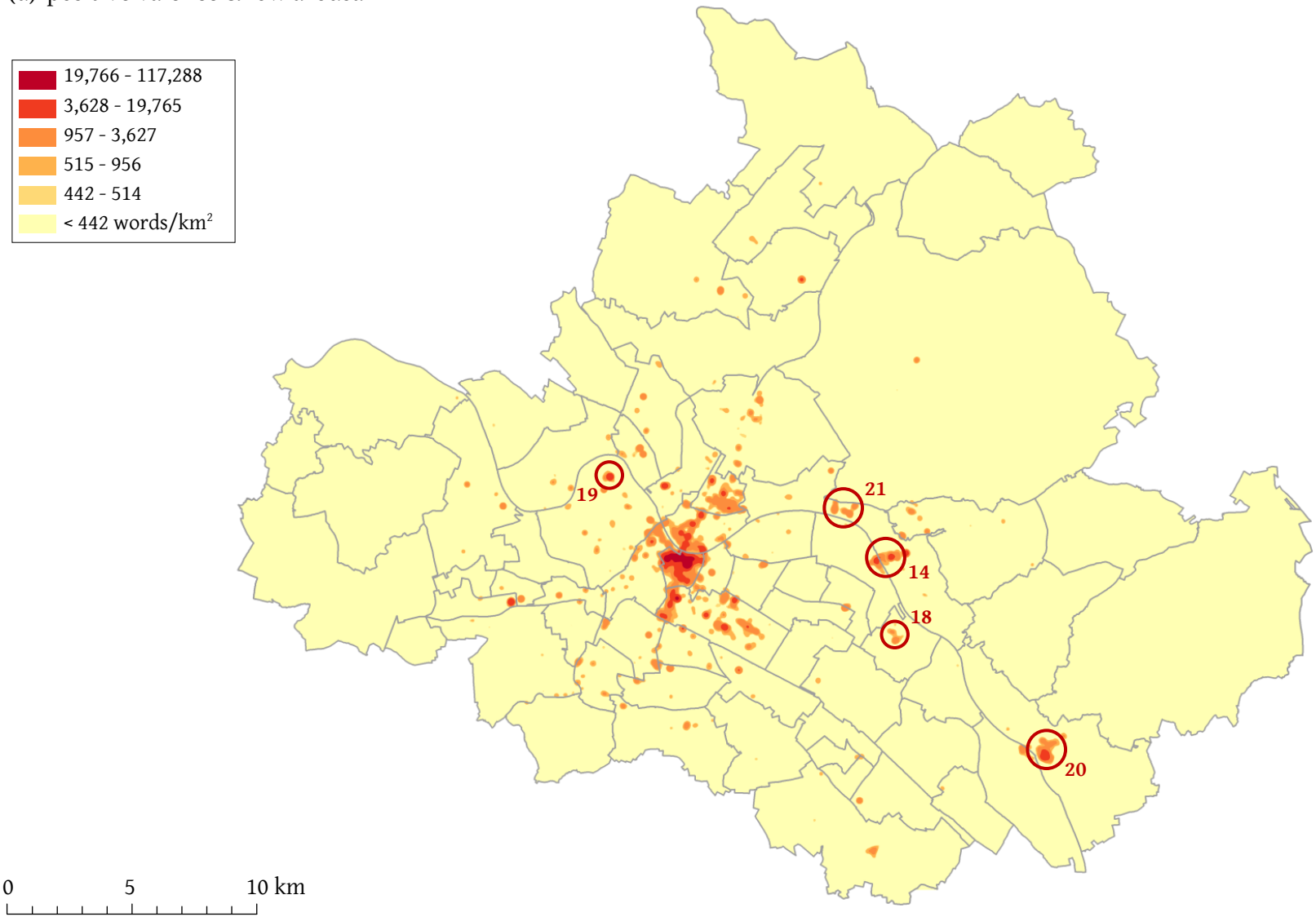
(b) positive valence & high arousal



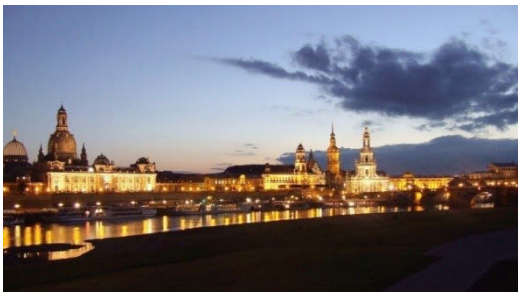
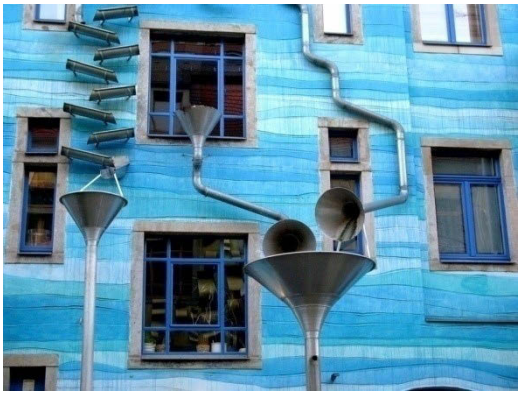
(c) negative valence & low arousal



(d) positive valence & low arousal



Appendix 7 List of Detected Emotional Places in Dresden

	Word Cloud	Photo
1	akademie boat car change city film free hochschule night painting people photo restaurant theater travel trip vacation winter woman world	
2	attack command court damage demand difficult fire government grab grenze krieg ruin schaden tat tod tot verkehr war weltkrieg work	
3	bar boat car change city concert event fahrrad feiern free love music night painting party people photo theater travel trip	
4	art black building bunt fest garten haus kirche konzert kultur kunst licht machen mensch musik passage rain sonne strasse unit	

5

abend aufnahme bild building color flower garden
garten herbst licht nacht
palast park sache schloss tree unit vogel
water winter

6

angriff attack bad damage die
government nazi negativ
platzen police polizei pressure
ruin tense traffic verfall verkehr
verlassen war work

7

application diskette durst fire forget ruin schlag schlagen tat
verfall verlassen work

8

atom corner dark decay deckel glass kammer kanal
larve loch menge metal punk
schatten toilet tropfen

9

ablehnen bad horror verlassen

10

robber ruin schaden

11

airplane airport bar beer beverage bewegung car face flughafen flugzeug free galaxy people photo plane red space stereo travel trip

12

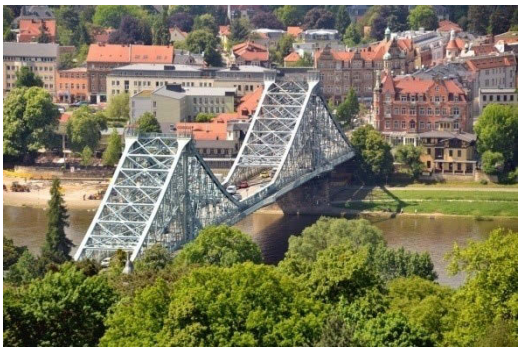
band chicken concert education event film instrument man mimik music space tattoo

13

bewegung bridge change city erotic famous film foto kamera lawyer night perfection photo restaurant think travel trip winter wonder wunder

14

abend art aufnahme blick blue building dampfer haus himmel kirche kunst month raum schwan strasse tier unit wasser winter wolke



15

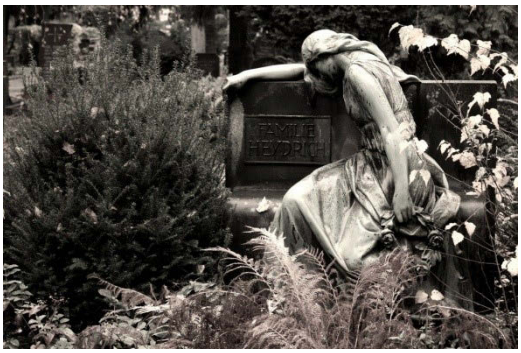
alter fabrik lose metal period schutt

16

accept change core corner end fabrik
factory folge glass label lack metal period
square stop zylinder

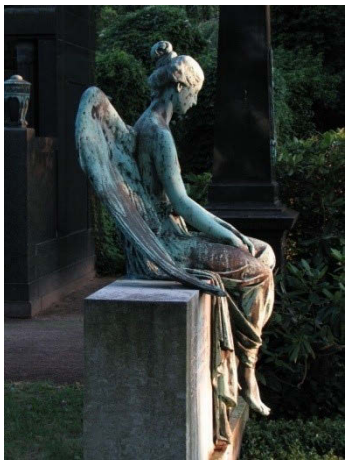
17

cemetery death desert
funeral grave lose mauer memorial
sad seat sorrow steril suchen tomb traurig



18

area art brunnen dame errichten farbe finden
frau gehen gesicht kirche kommen
kreuz linse mechanik town vehicle wife wine
yellow



19	art aufsatz beginning black building detail door fenster fest gallery gegend kunst licht linie modern paint raum sprache subject werk	
20	bild blick britisch brunnen building dampfer flower garten herbst palast park plant schiff schloss tree treppe unit wasser water werk	
21	area bauen blick brunnen building context extent flower garten herbst himmel hotel park schloss schnee tree unit villa week winter	

Image references (accessed 12 March 2014):

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(2) CC BY-NC by lyricsart
http://www.flickr.com/photos/91821458@N00/76083614/

(3) CC BY-NC-ND by Philipp Götze
http://www.flickr.com/photos/philippgoetze/4890883606

(4) CC BY-NC by _parrish_
http://www.flickr.com/photos/_parrish_/439884019/

(5) CC BY-NC-SA by 31007578
http://www.flickr.com/photos/18seconds/2949364022/

(6) CC BY-NC-SA by tonal decay
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(7) CC BY-NC-SA by tonal decay
http://www.flickr.com/photos/19363084@N07/2349853113/

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http://www.flickr.com/photos/17486526@N00/4086175994/

(11) CC BY-NC by dasjabbadas
http://www.flickr.com/photos/36666383@N00/5011727382/

(12) CC BY-NC-SA by tonal decay
http://www.flickr.com/photos/realname/3615367528/

(13) CC BY-NC-SA by pinfeng
http://www.flickr.com/photos/pinfeng/5502057776/

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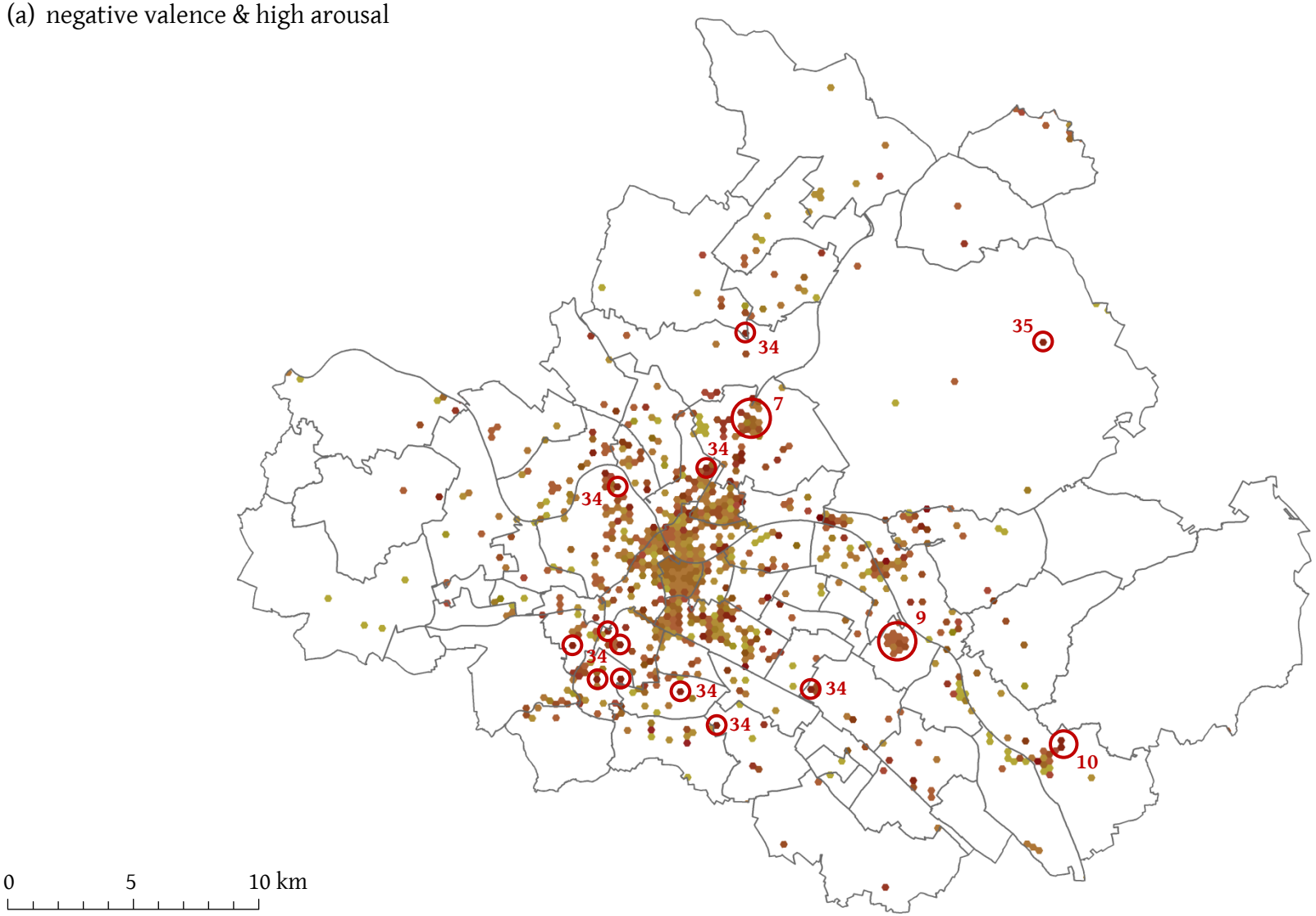
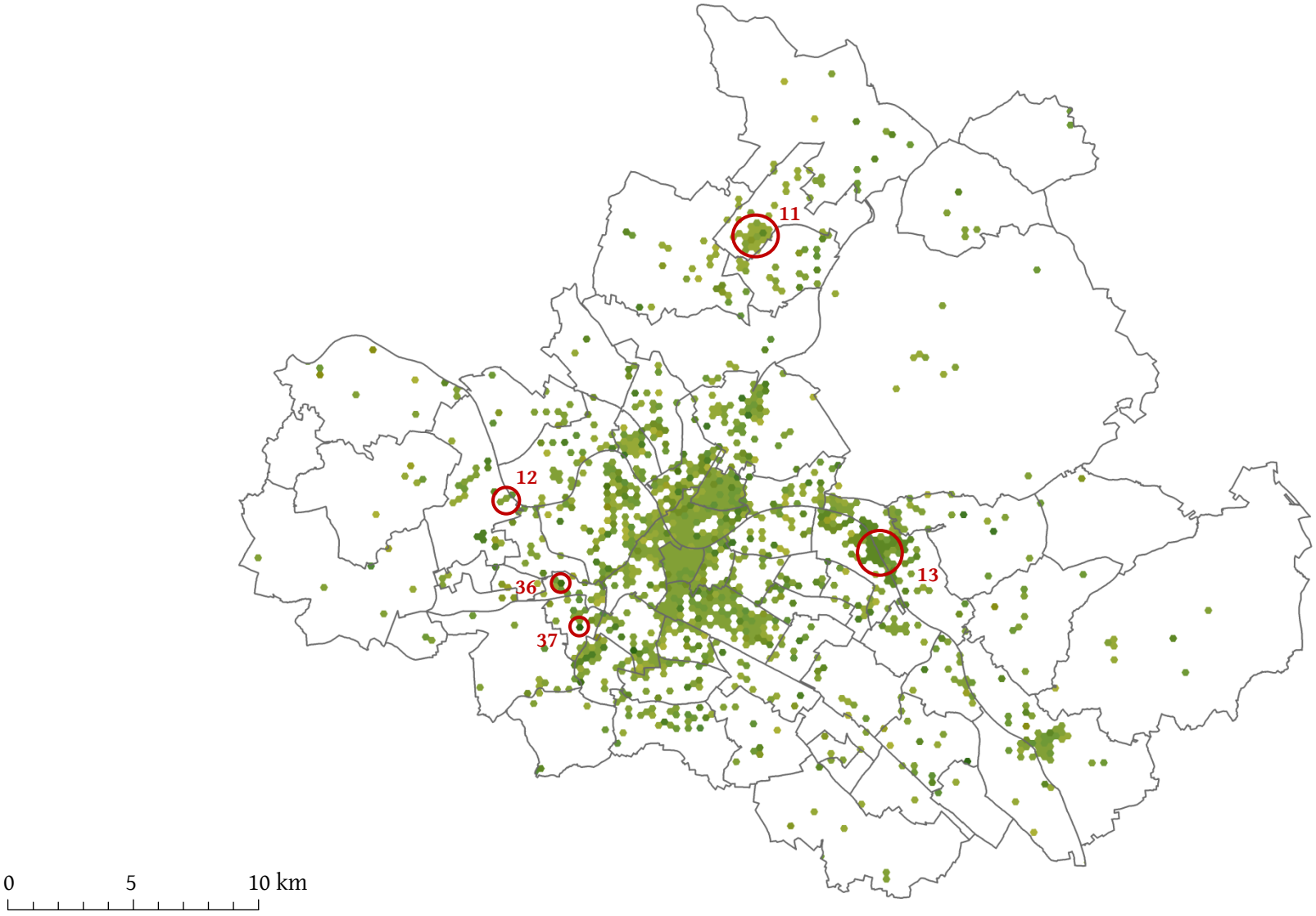
(21) CC BY-ND by Polybert49
http://www.flickr.com/photos/poly-image/10992918353/

Appendix 8 Choropleth Mapping of Dresden

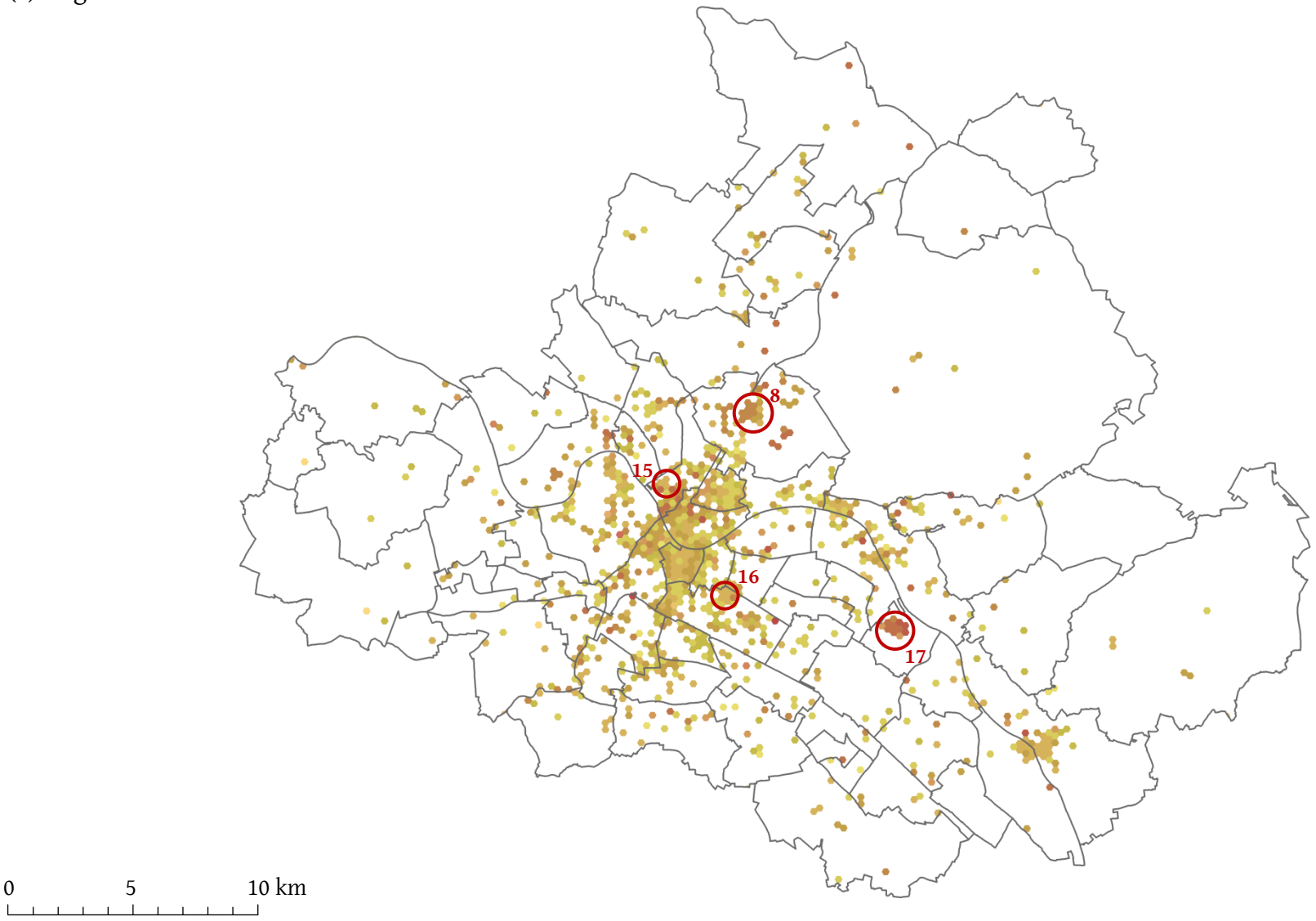
(a) negative valence & high arousal



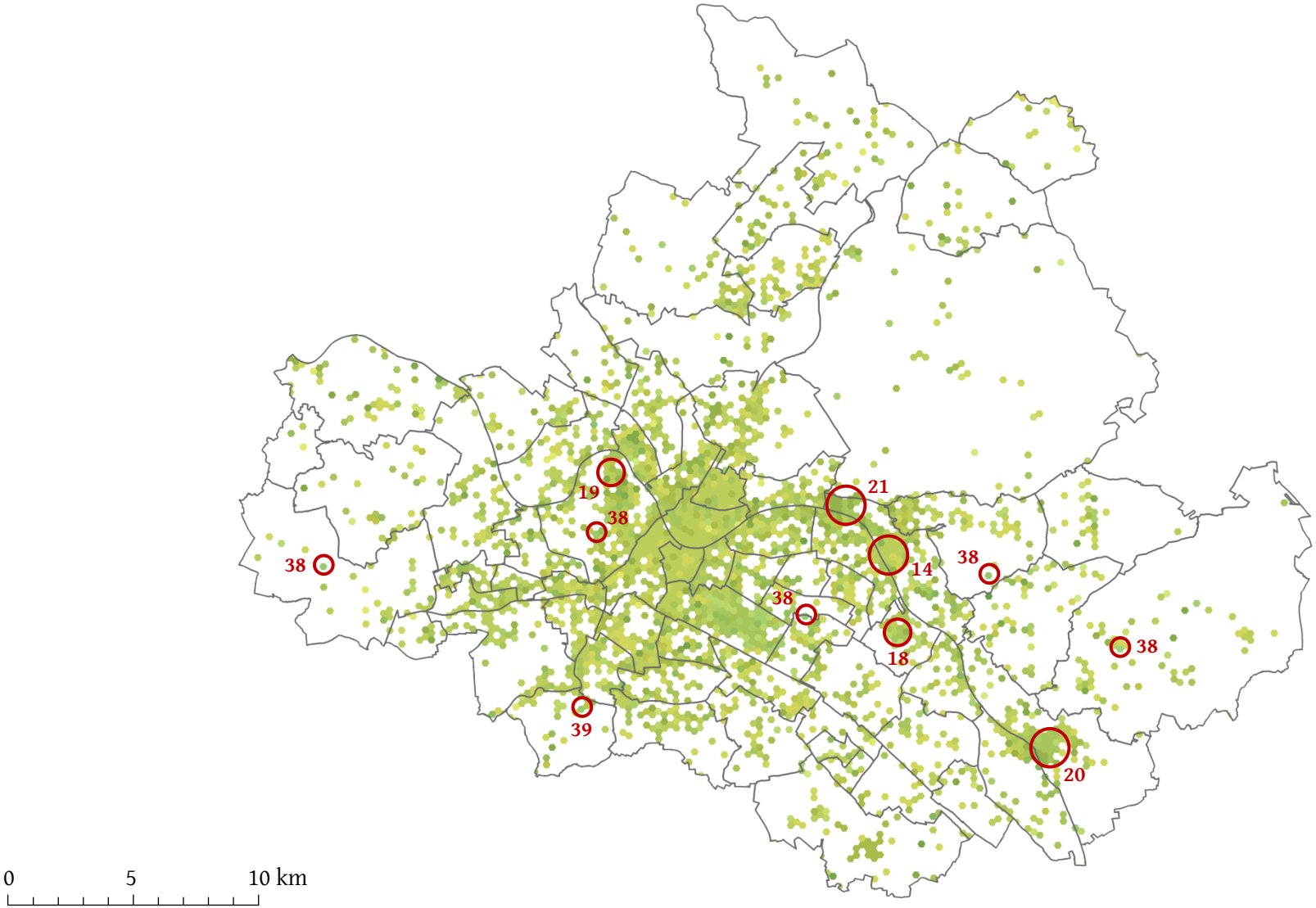
(b) positive valence & high arousal



(c) negative valence & low arousal



(d) positive valence & low arousal



Appendix 9 Density Maps of Dresden for Different Periods of Time

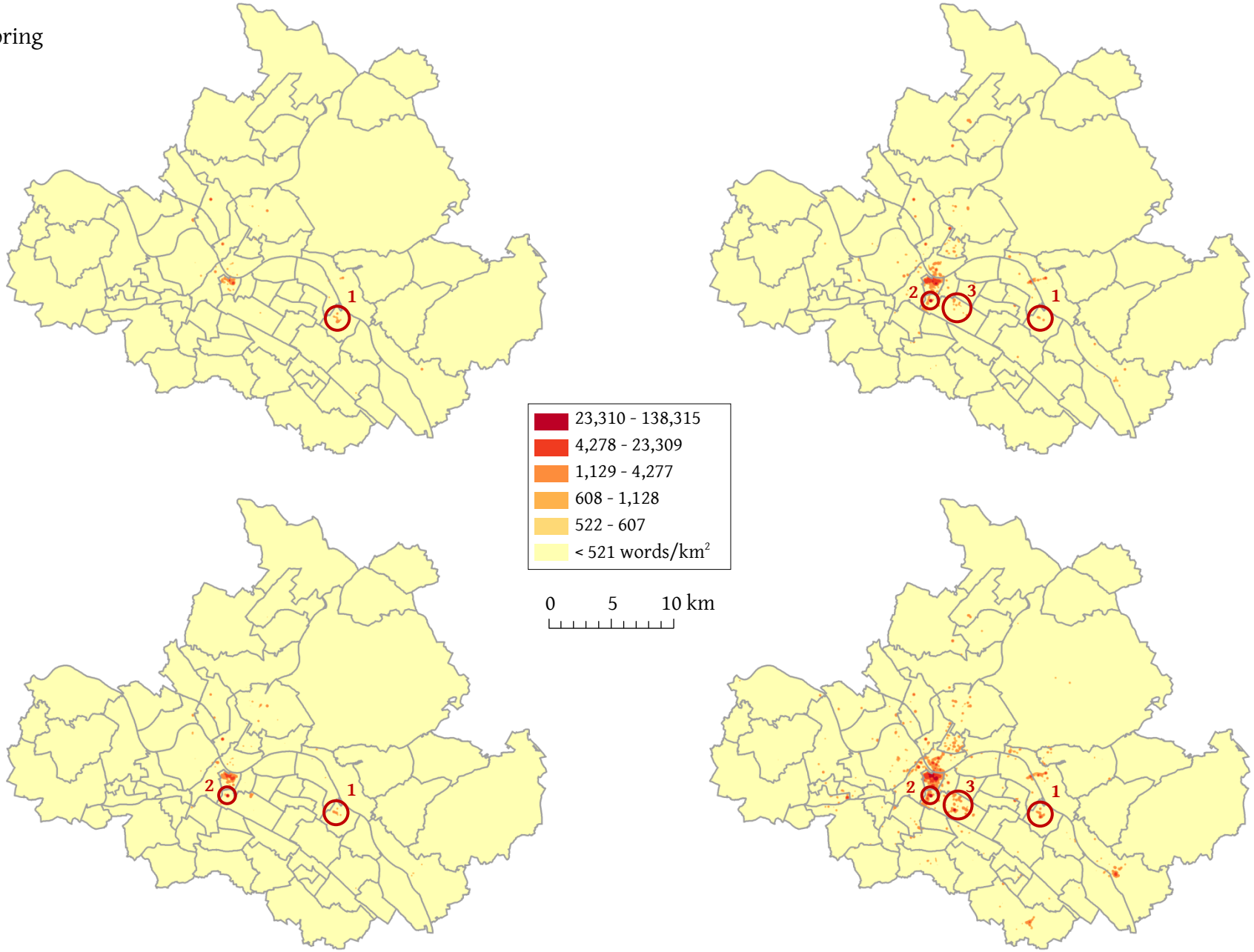
(1) Seasons

(2) Months

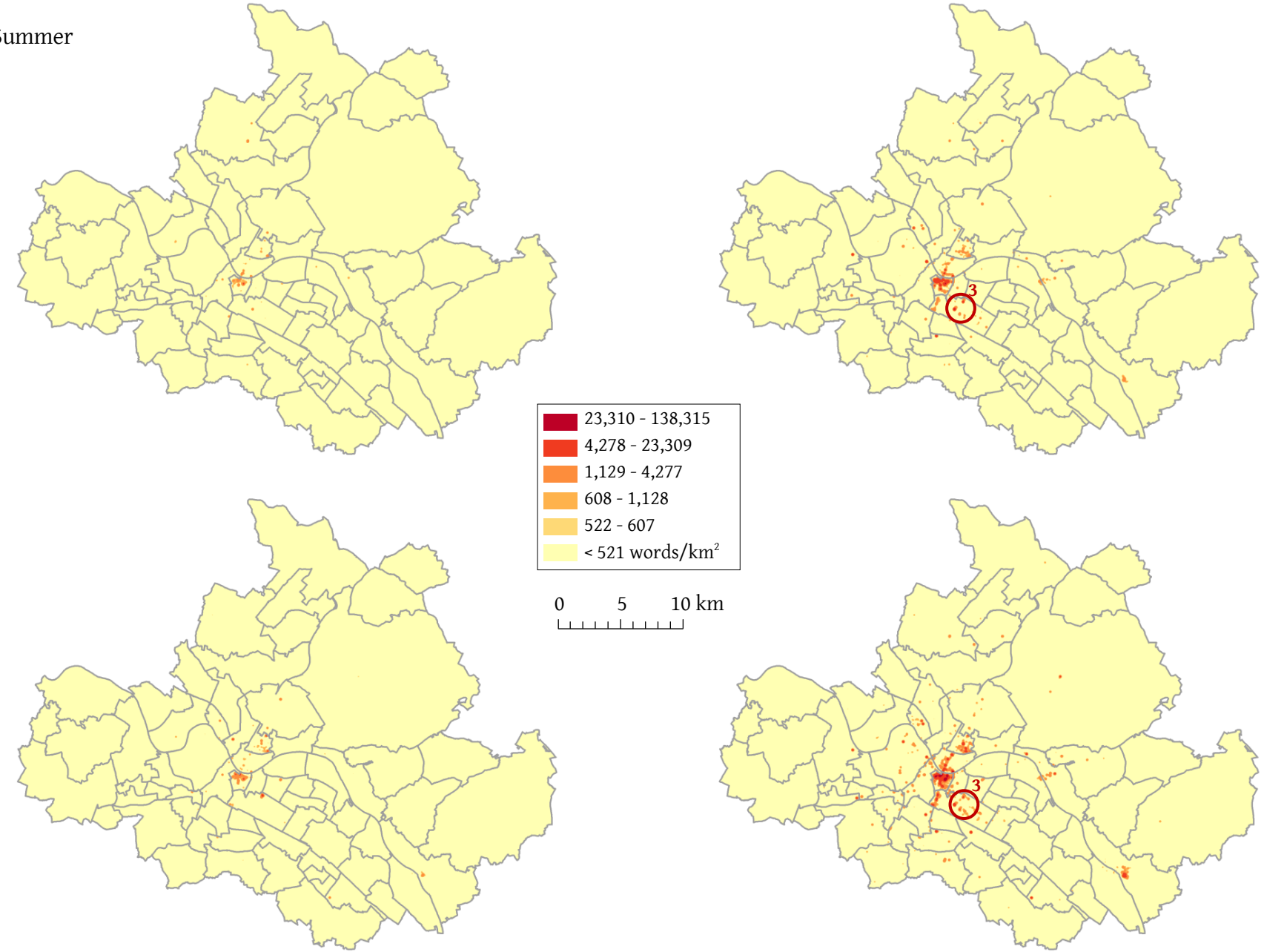
(3) Weekdays

(4) Times of Day

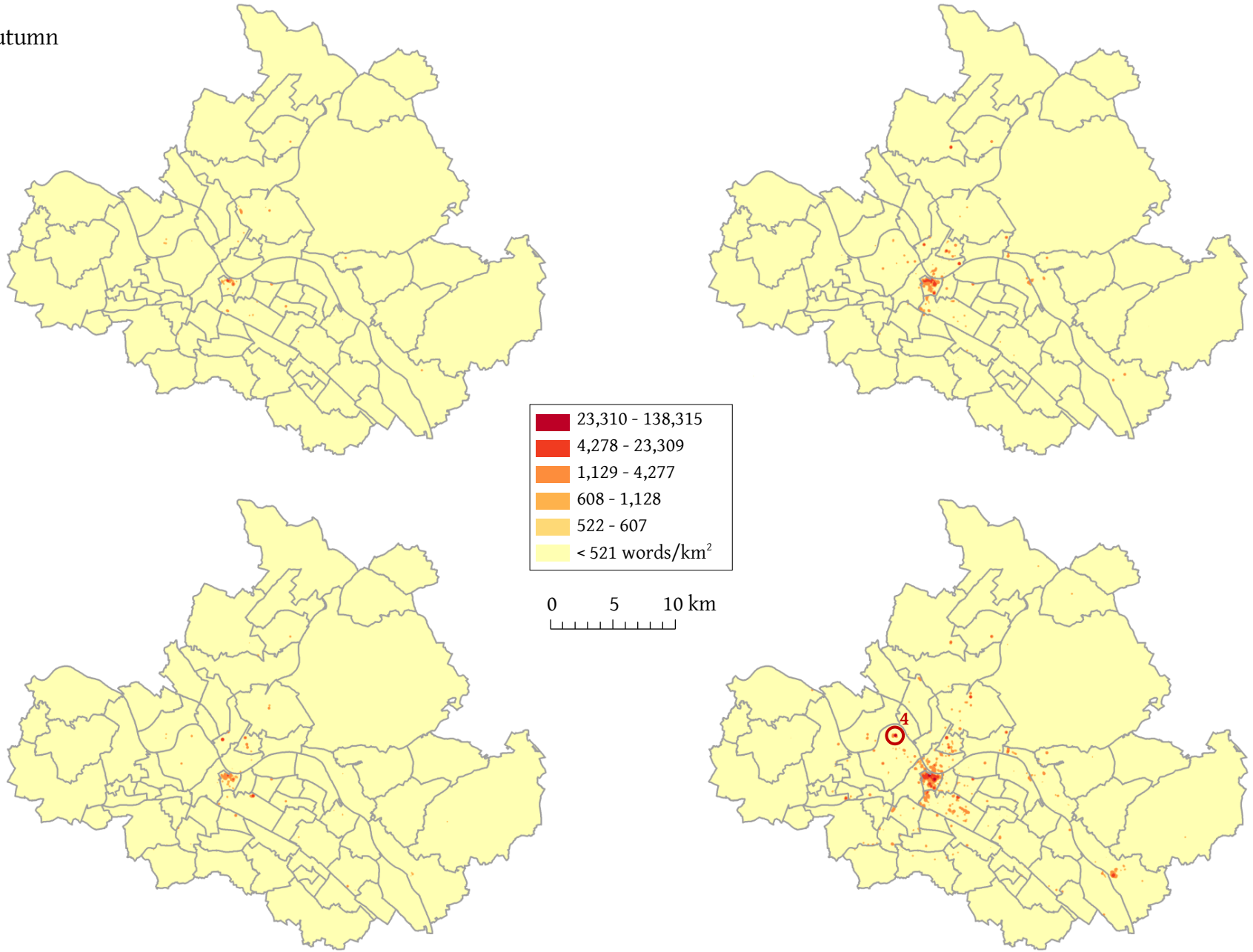
(1a) Spring


1
2
3
23,310 - 138,315
4,278 - 23,309
1,129 - 4,277
608 - 1,128
522 - 607
< 521 words/km²
0
5
10 km

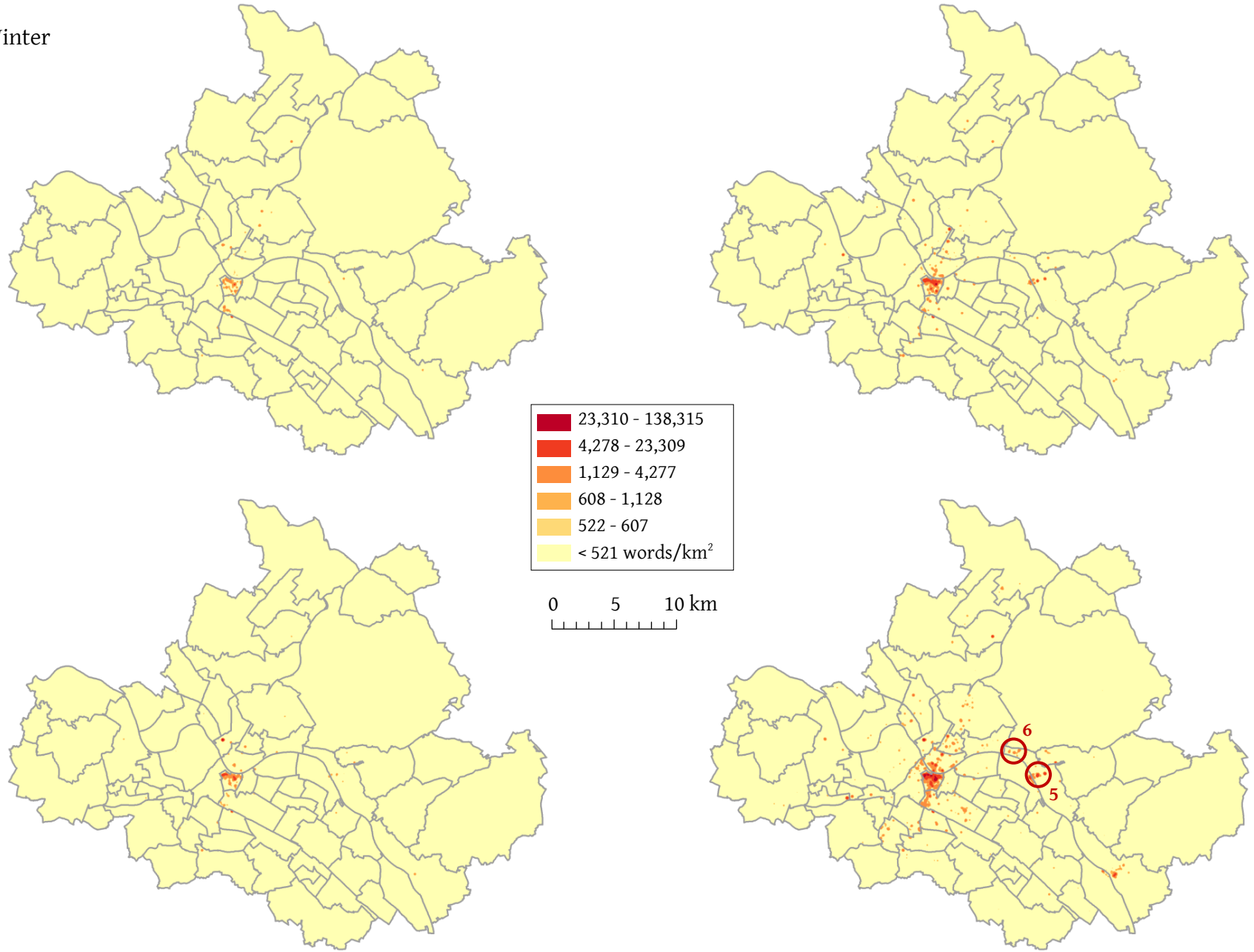
(1b) Summer


3
3
23,310 - 138,315
4,278 - 23,309
1,129 - 4,277
608 - 1,128
522 - 607
< 521 words/km²
0
5
10 km

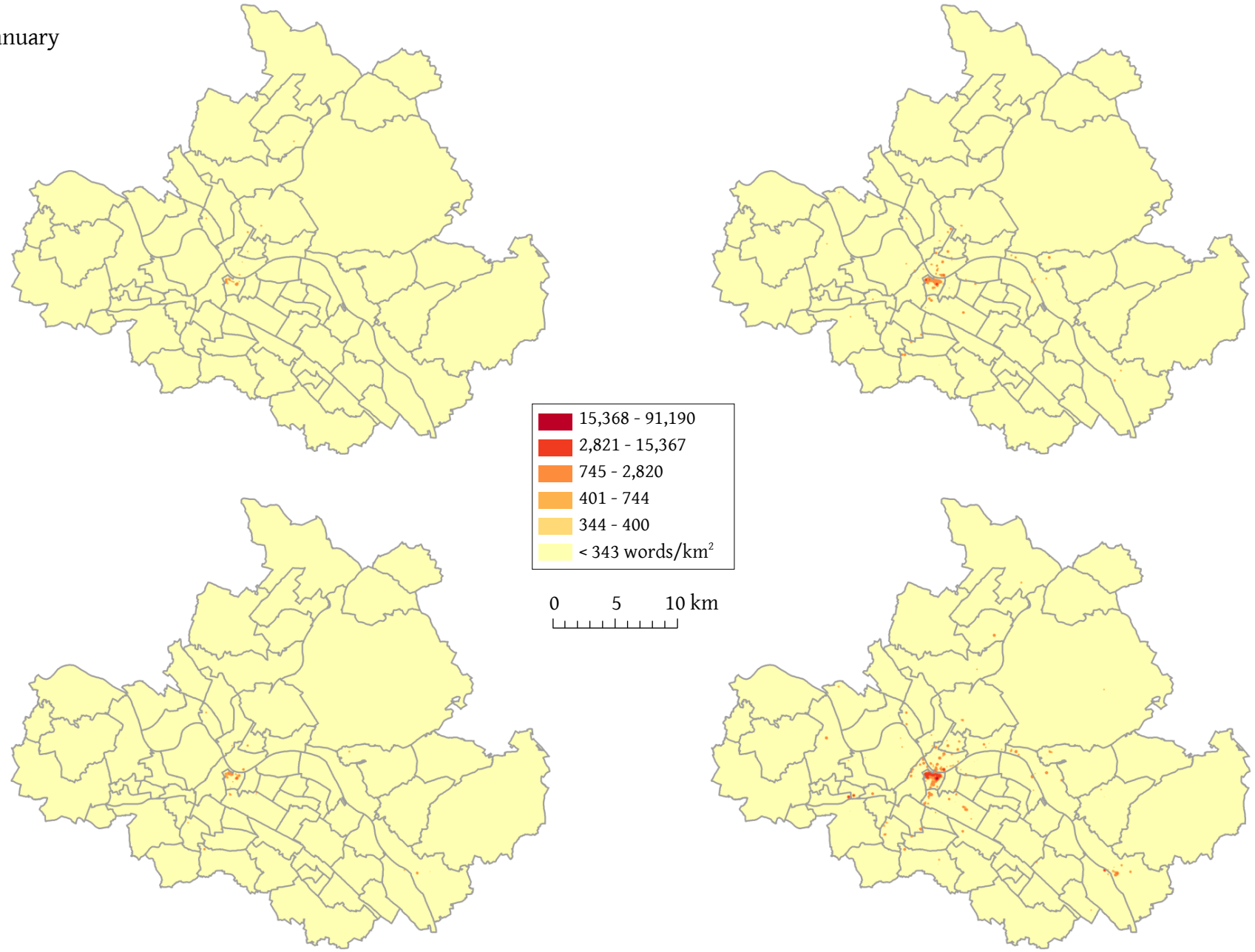
(1c) Autumn


23,310 - 138,315
4,278 - 23,309
1,129 - 4,277
608 - 1,128
522 - 607
< 521 words/km²
0
5
10 km
4

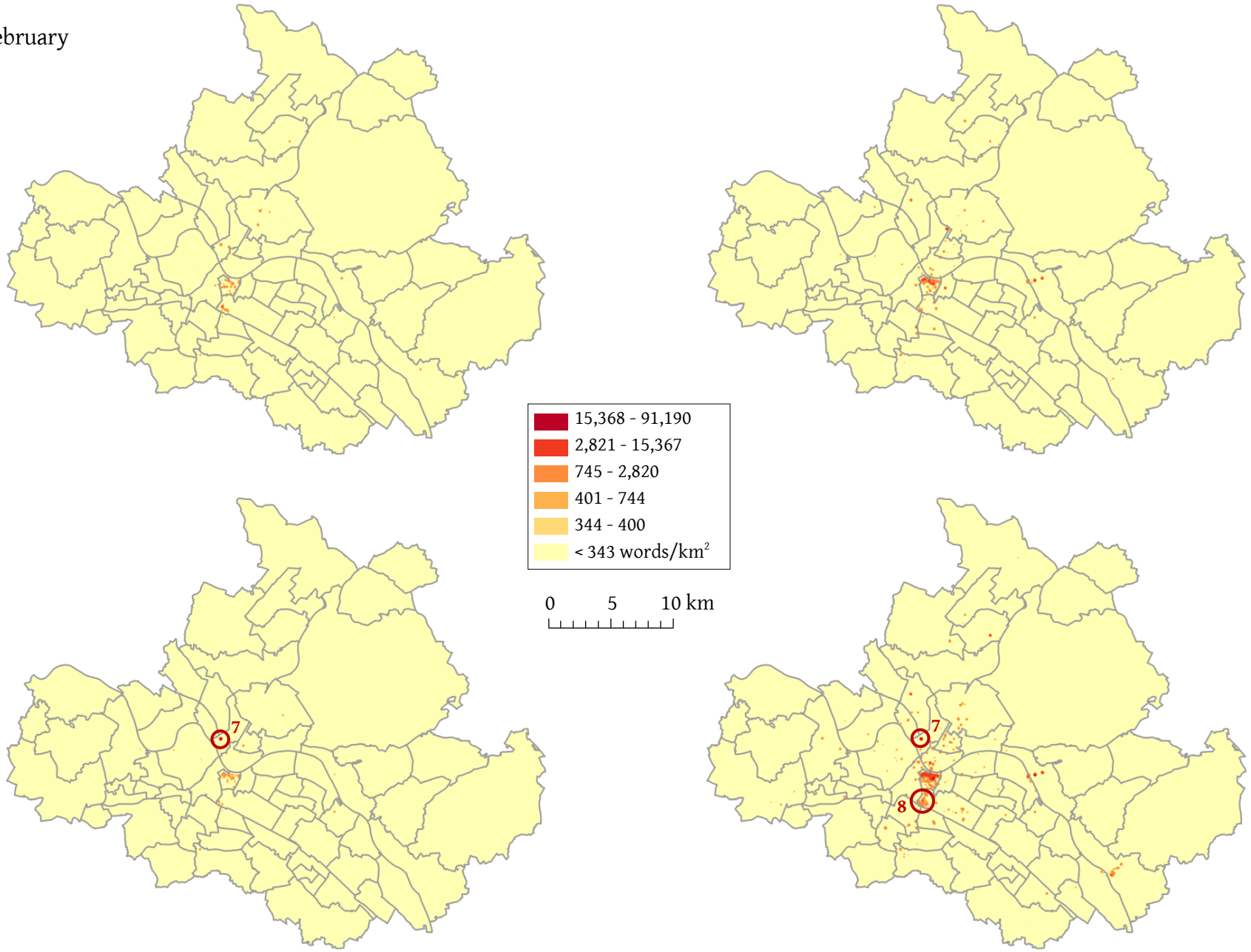
(1d) Winter


23,310 - 138,315
4,278 - 23,309
1,129 - 4,277
608 - 1,128
522 - 607
< 521 words/km²
0
5
10 km
6
5

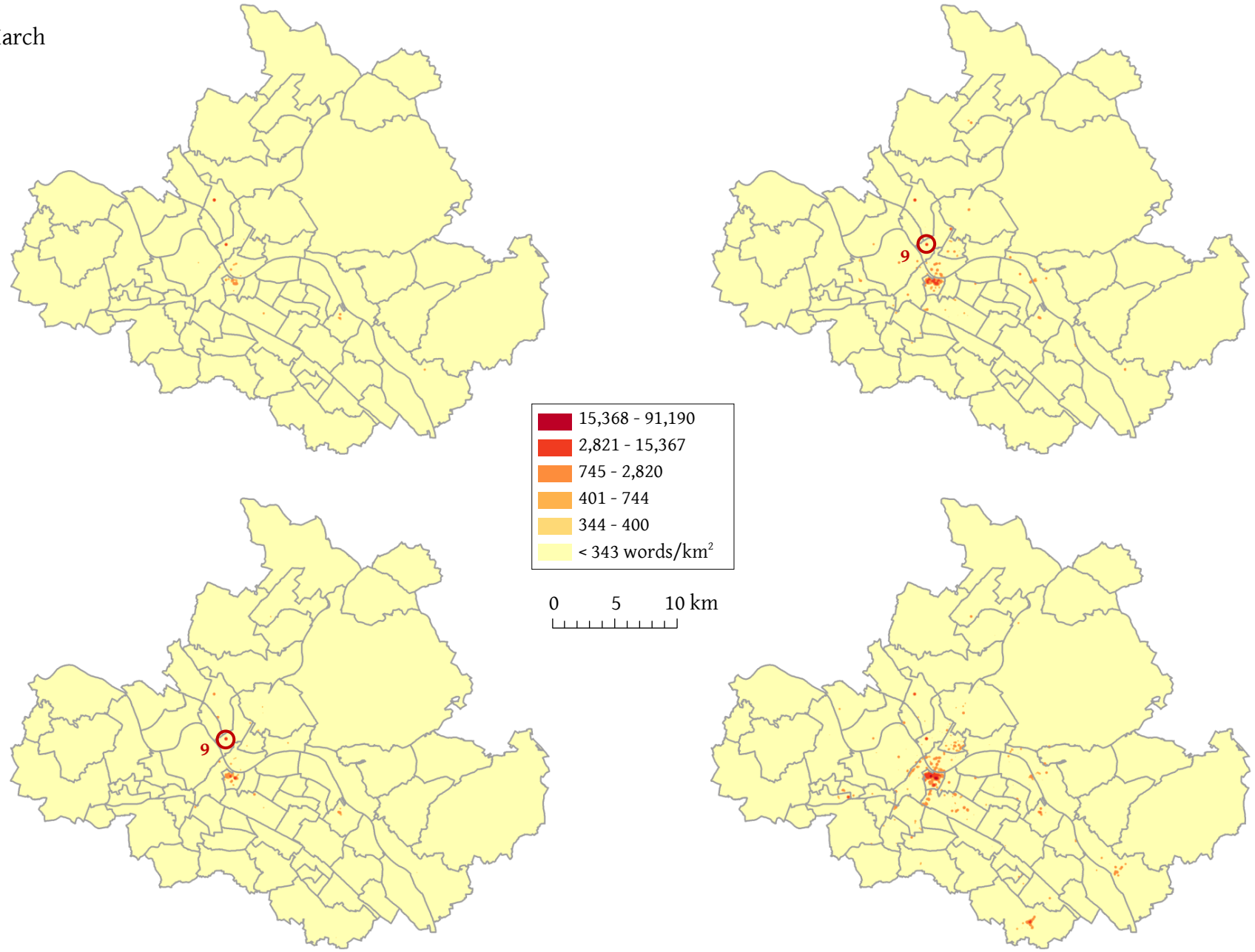
(2a) January


15,368 - 91,190
2,821 - 15,367
745 - 2,820
401 - 744
344 - 400
< 343 words/km²
0
5
10 km

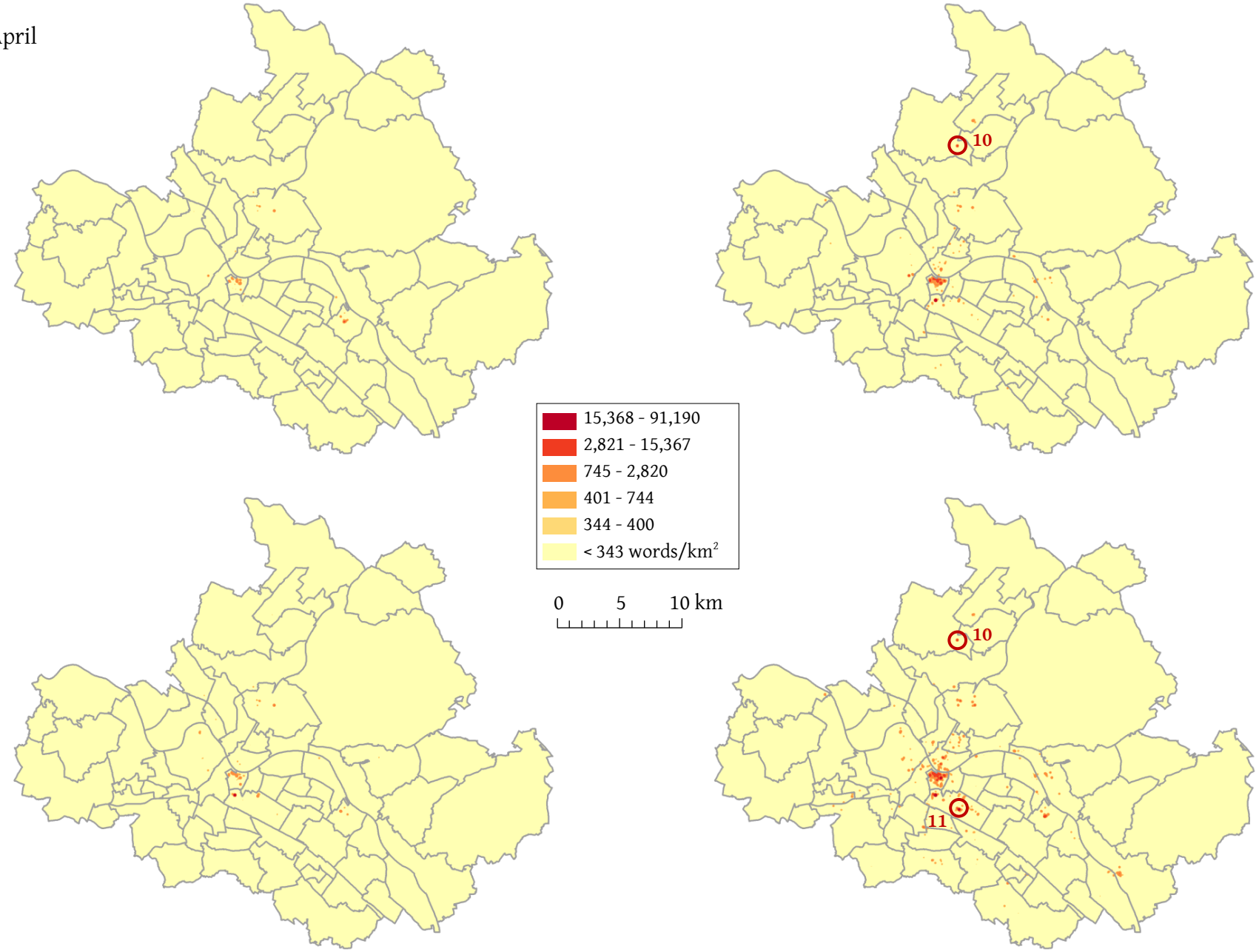
(2b) February


15,368 - 91,190
2,821 - 15,367
745 - 2,820
401 - 744
344 - 400
< 343 words/km²
0
5
10 km
7
7
8

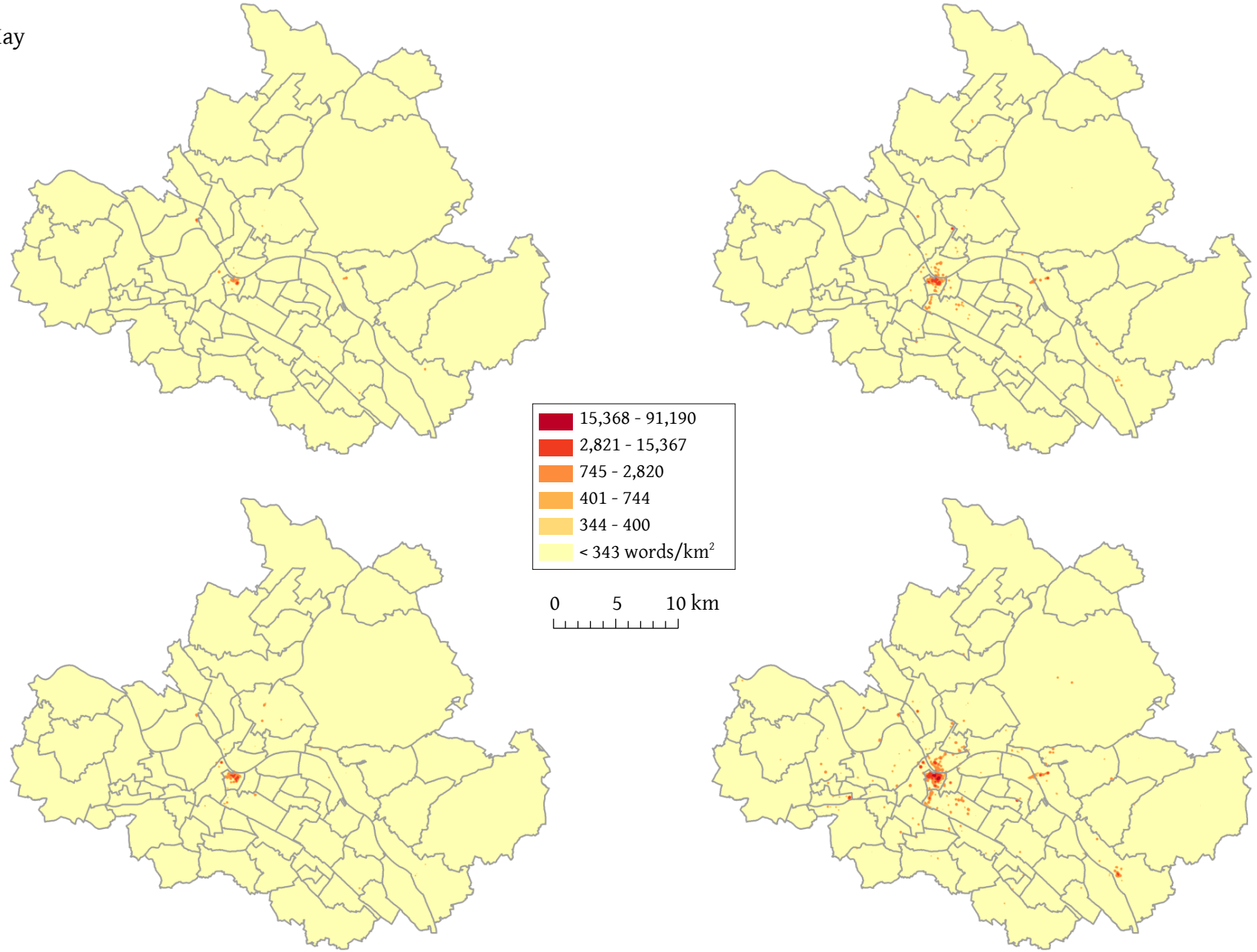
(2c) March


9
9
15,368 - 91,190
2,821 - 15,367
745 - 2,820
401 - 744
344 - 400
< 343 words/km²
0
5
10 km

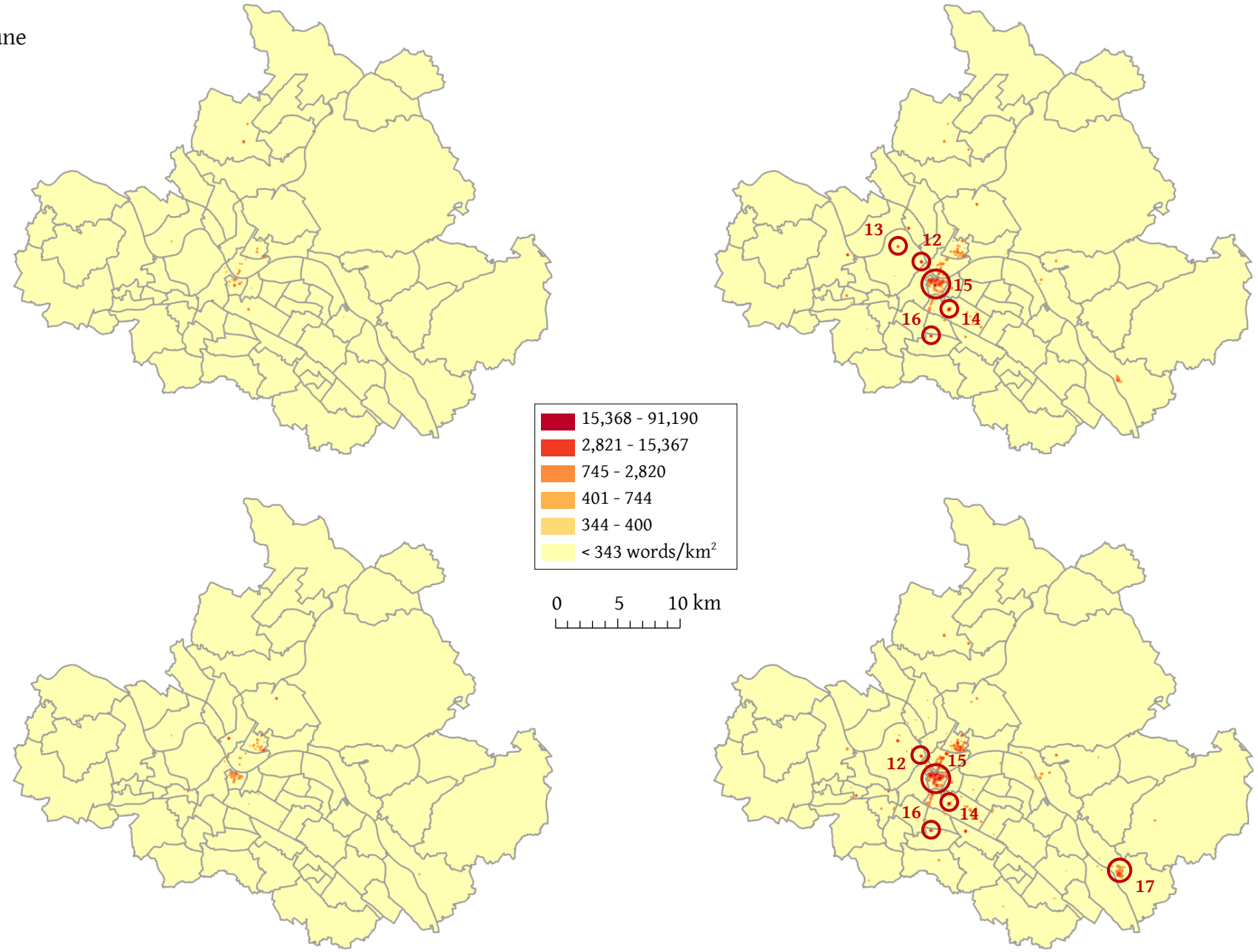
(2d) April


10
10
11
15,368 - 91,190
2,821 - 15,367
745 - 2,820
401 - 744
344 - 400
< 343 words/km²
0
5
10 km

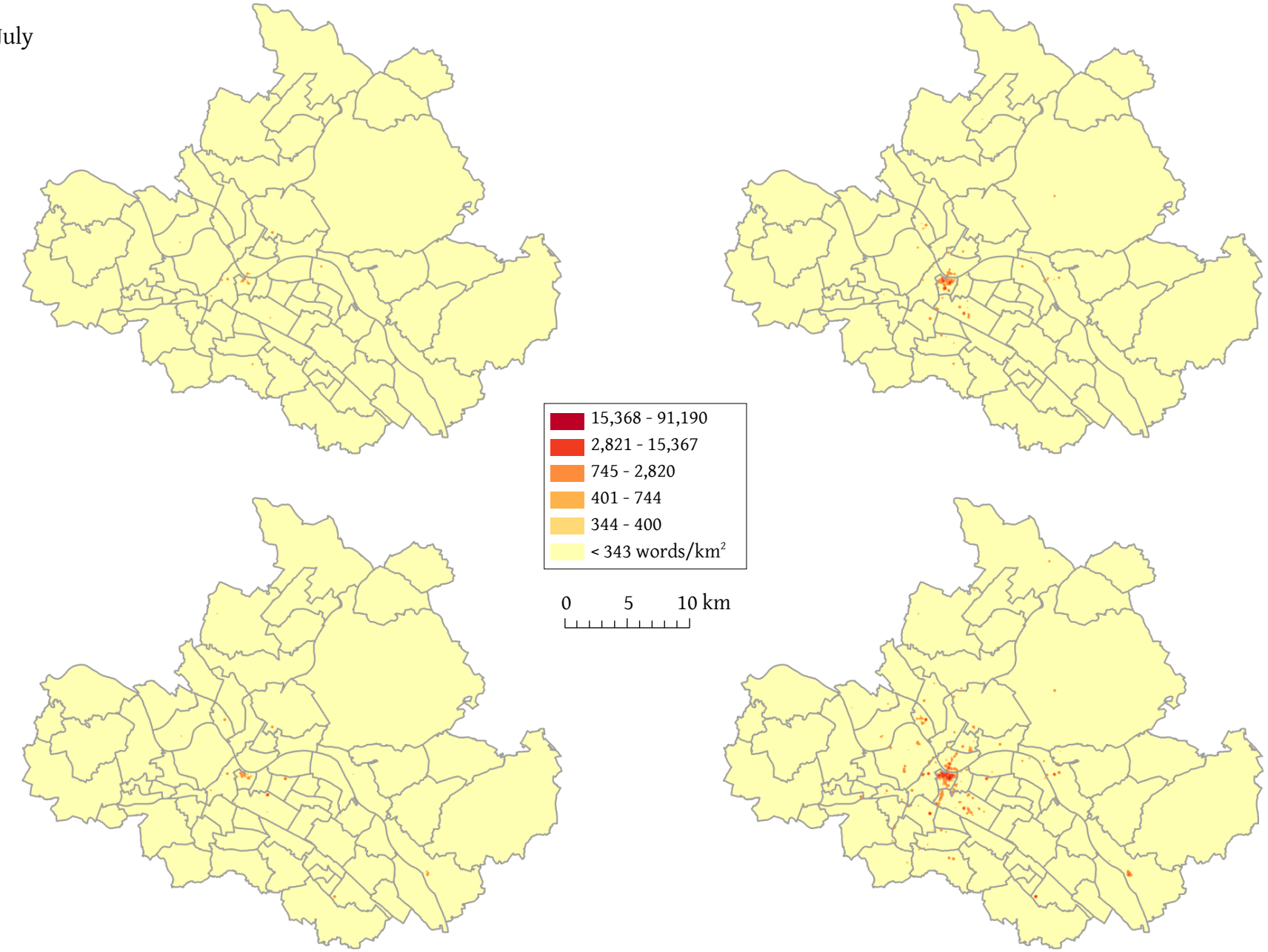
(2e) May


15,368 - 91,190
2,821 - 15,367
745 - 2,820
401 - 744
344 - 400
< 343 words/km²
0
5
10 km

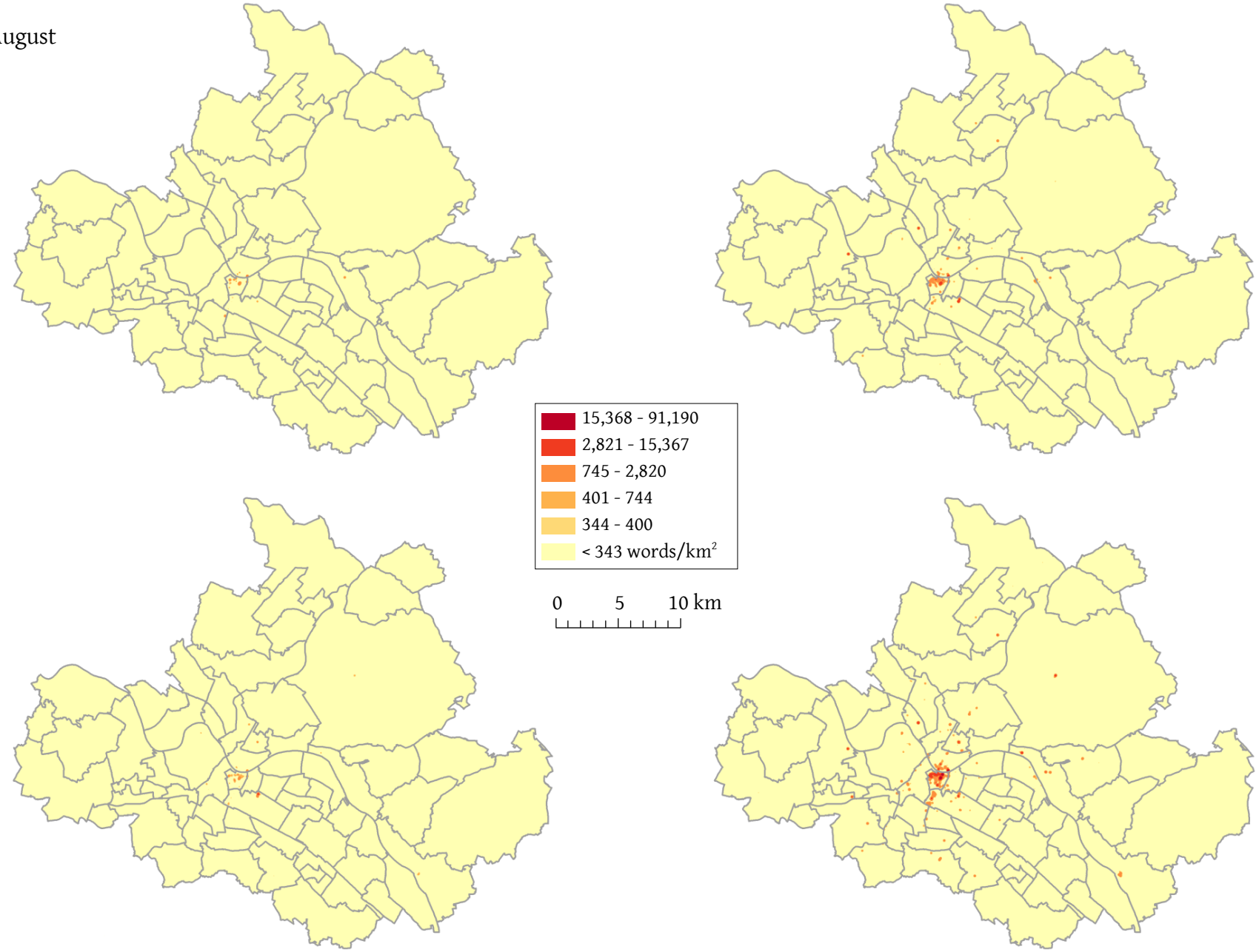
(2f) June


13
12
15
16
14
15,368 - 91,190
2,821 - 15,367
745 - 2,820
401 - 744
344 - 400
< 343 words/km²
0
5
10 km
12
15
16
14
17

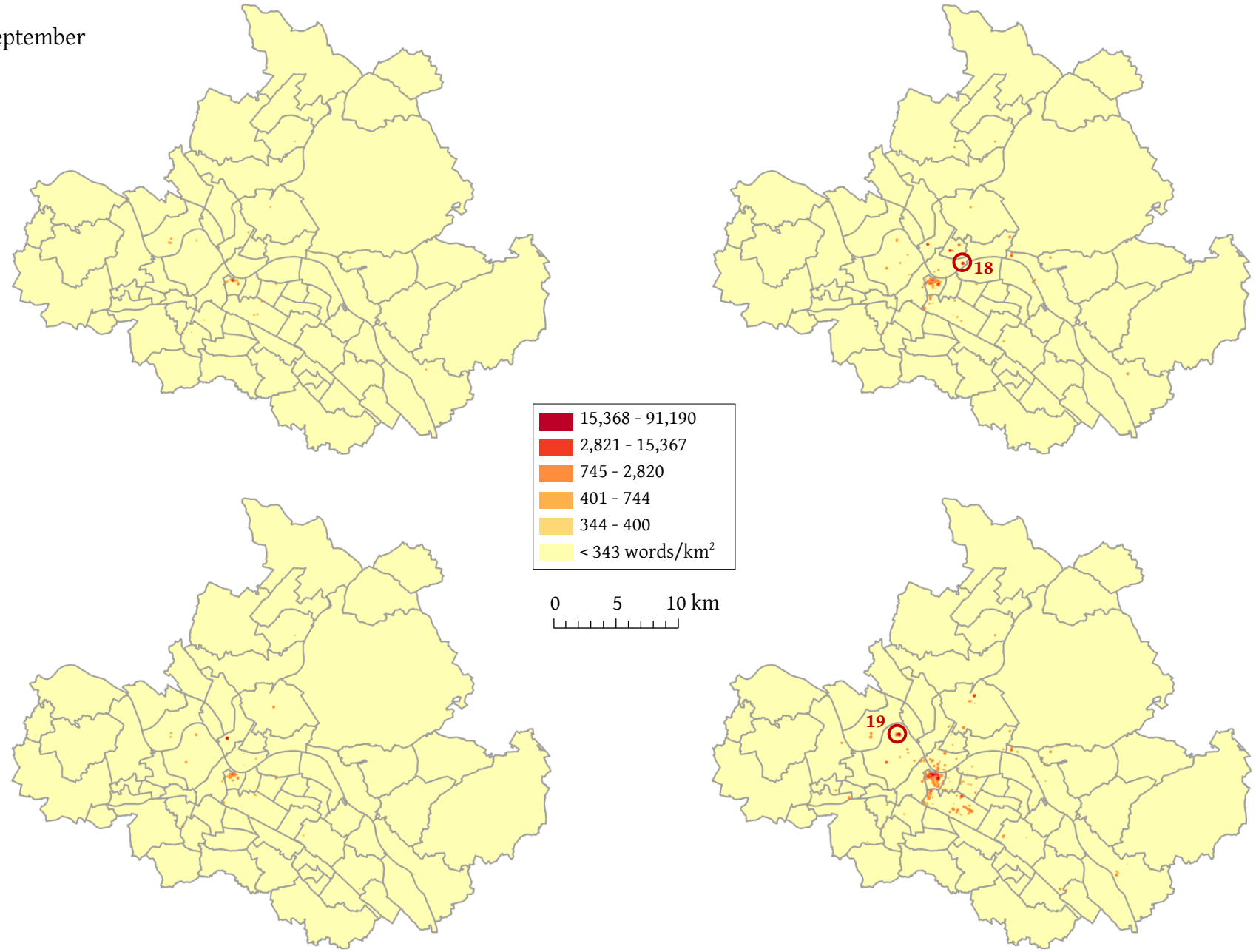
(2g) July


15,368 - 91,190
2,821 - 15,367
745 - 2,820
401 - 744
344 - 400
< 343 words/km²
0
5
10 km

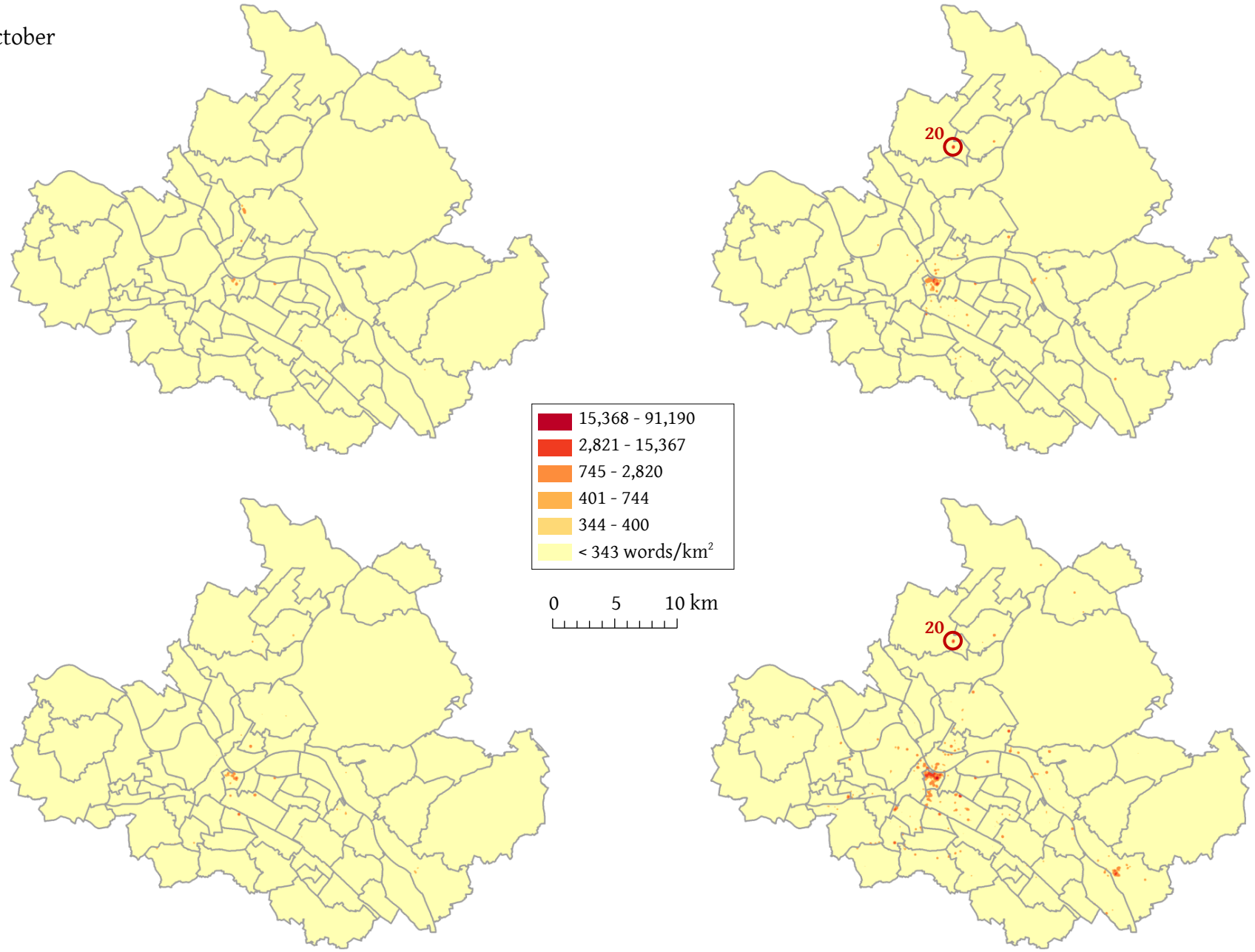
(2h) August


15,368 - 91,190
2,821 - 15,367
745 - 2,820
401 - 744
344 - 400
< 343 words/km²
0
5
10 km

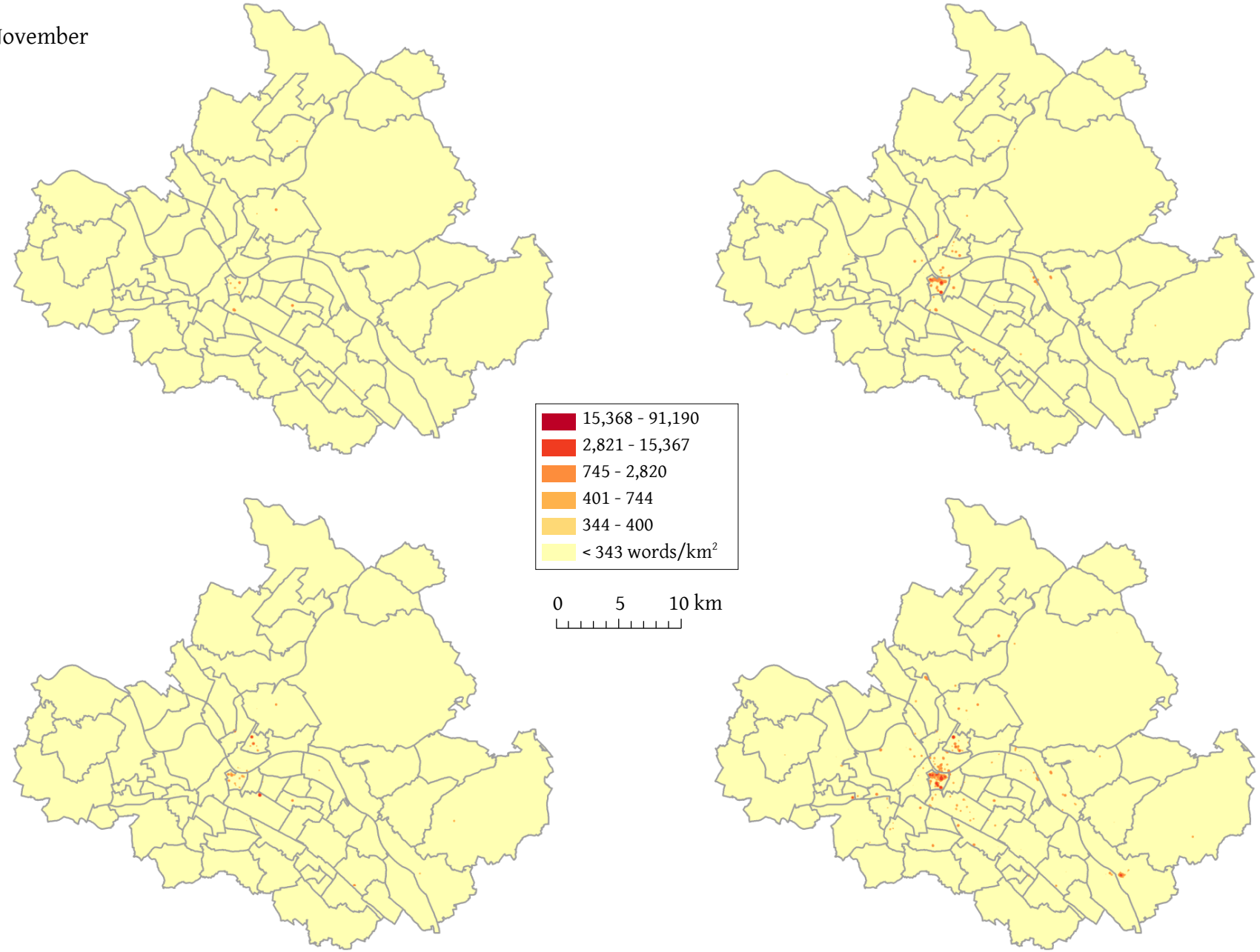
(2i) September



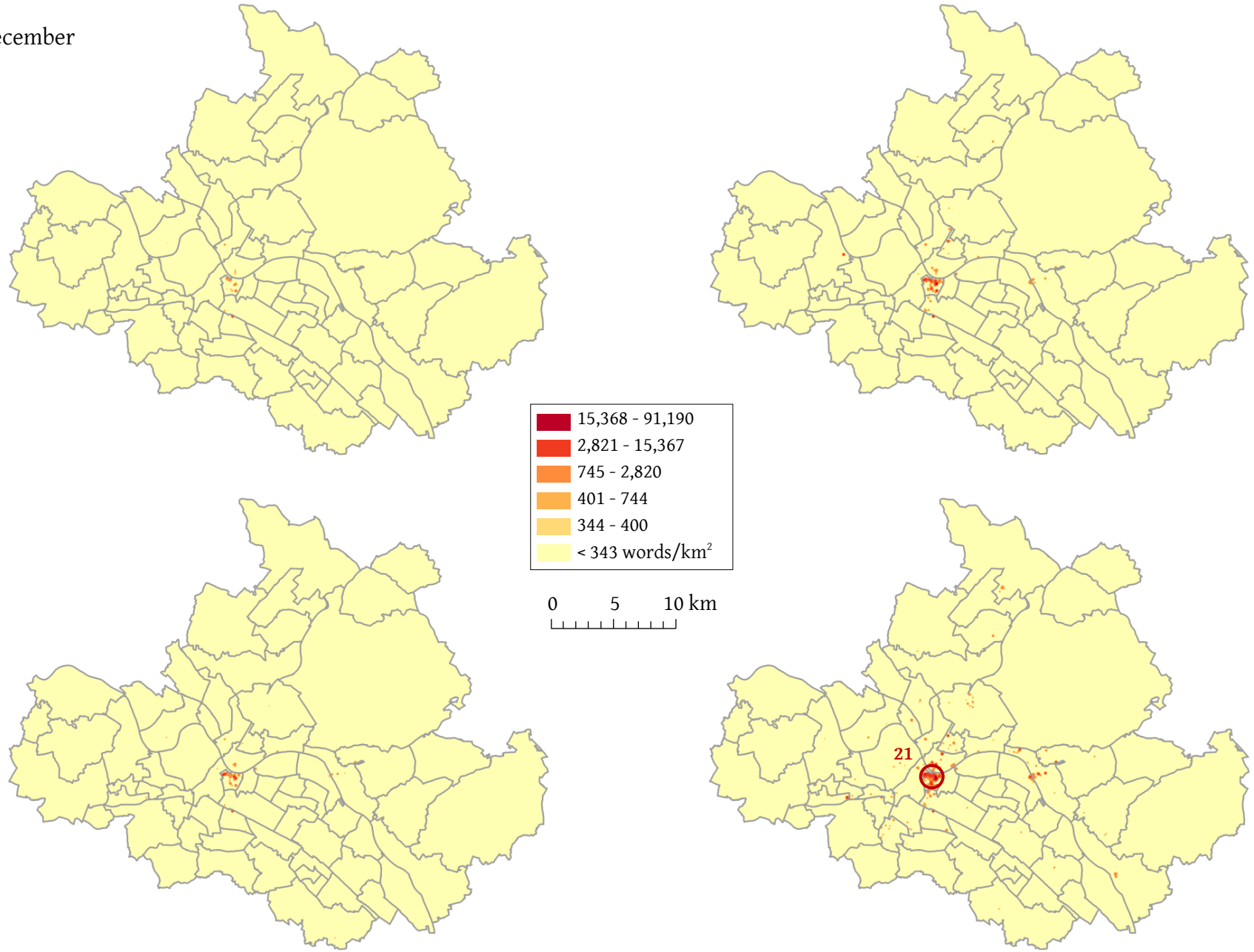
(2j) October


20
20
15,368 - 91,190
2,821 - 15,367
745 - 2,820
401 - 744
344 - 400
< 343 words/km²
0
5
10 km

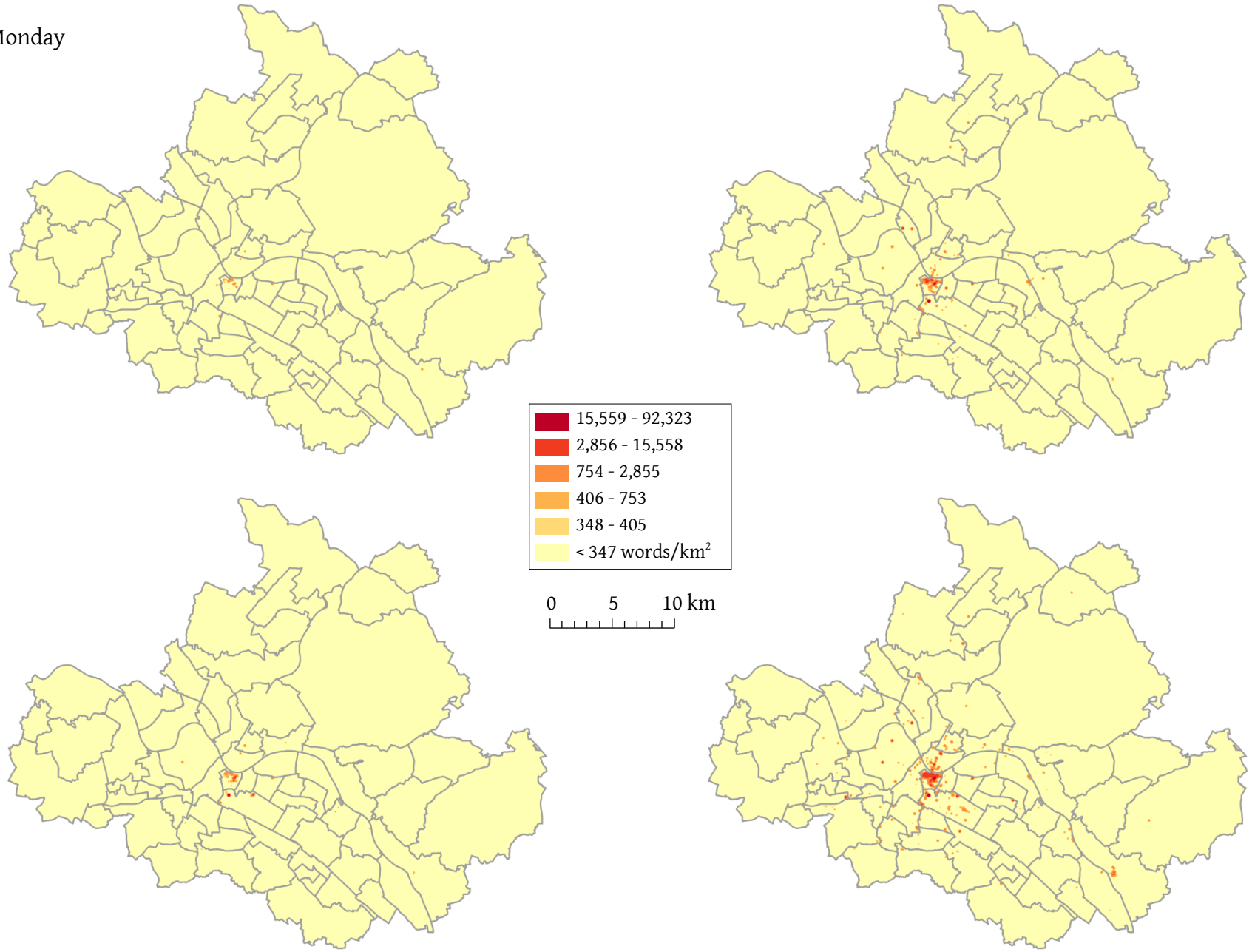
(2k) November


15,368 - 91,190
2,821 - 15,367
745 - 2,820
401 - 744
344 - 400
< 343 words/km²
0
5
10 km

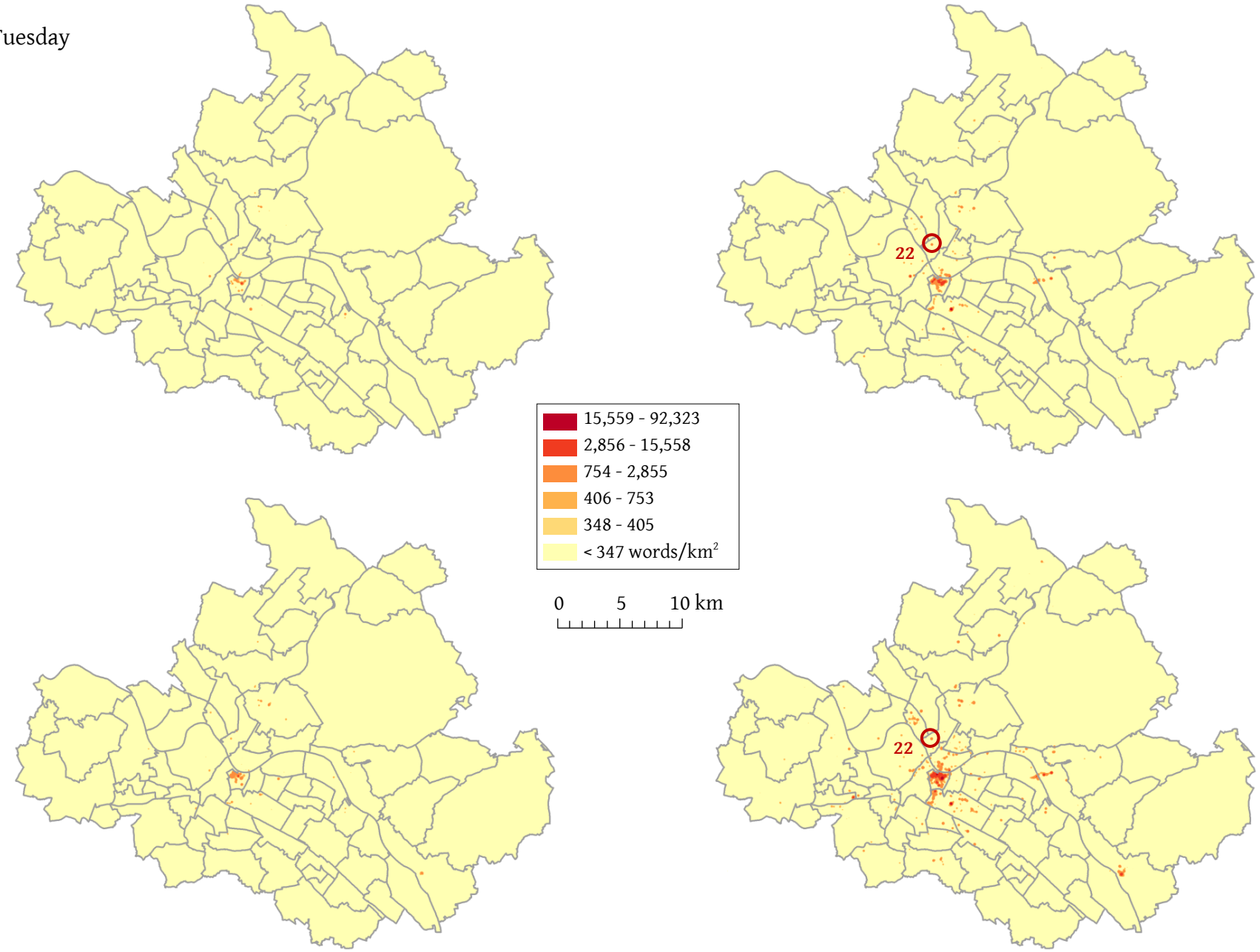
(2l) December


15,368 - 91,190
2,821 - 15,367
745 - 2,820
401 - 744
344 - 400
< 343 words/km²
0
5
10 km
21

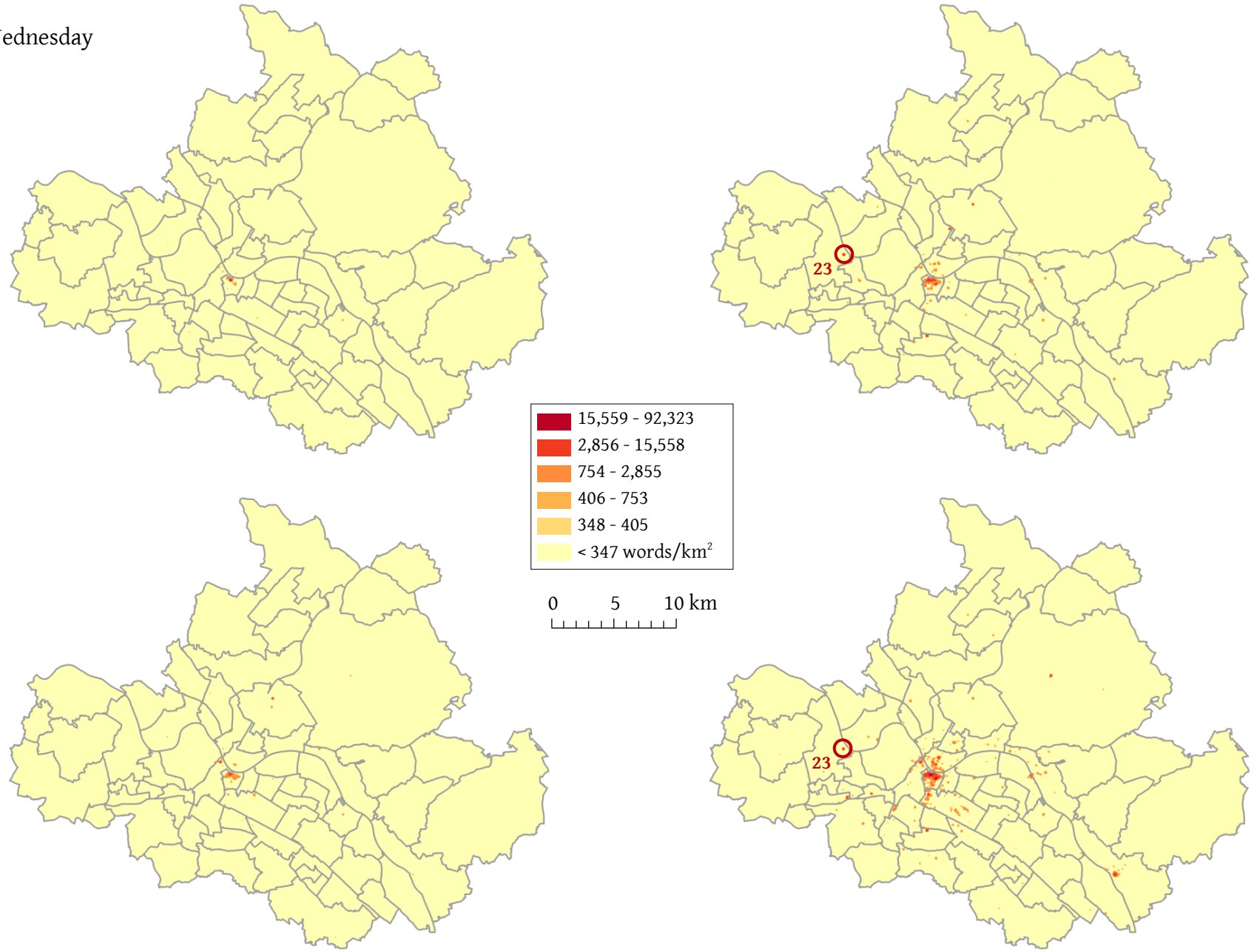
(3a) Monday


15,559 - 92,323
2,856 - 15,558
754 - 2,855
406 - 753
348 - 405
< 347 words/km²
0
5
10 km

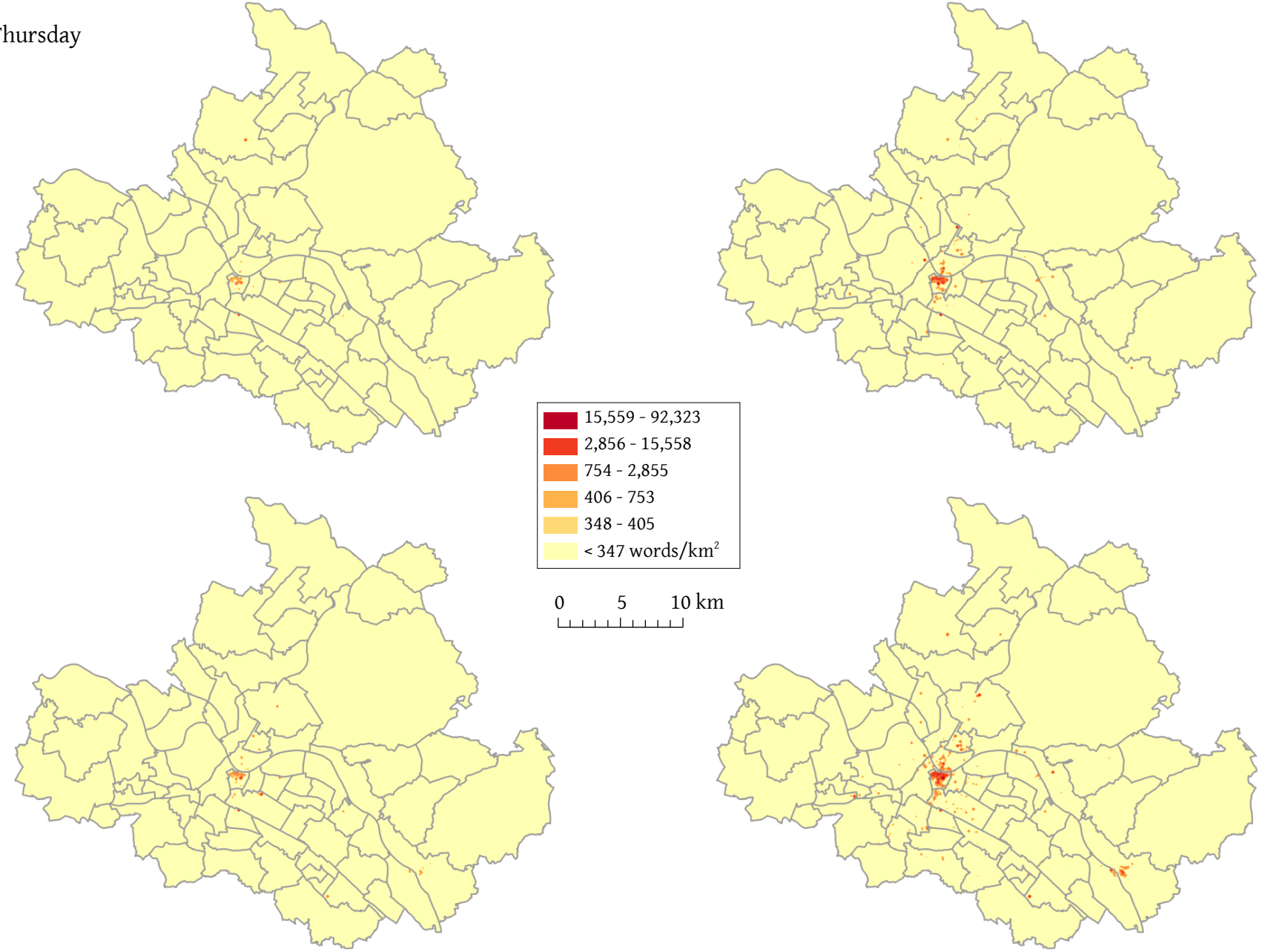
(3b) Tuesday


22
22
15,559 - 92,323
2,856 - 15,558
754 - 2,855
406 - 753
348 - 405
< 347 words/km²
0
5
10 km

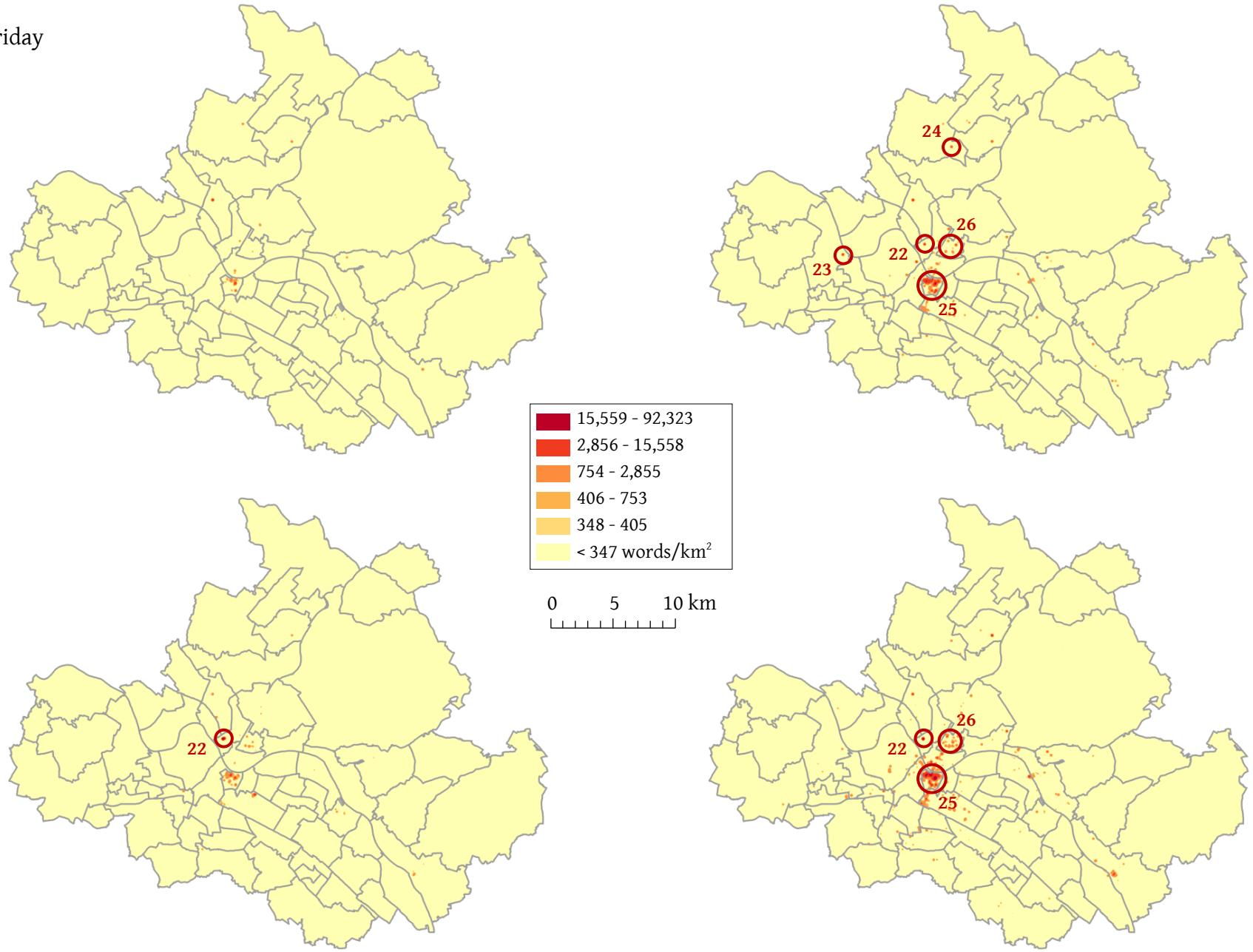
(3c) Wednesday



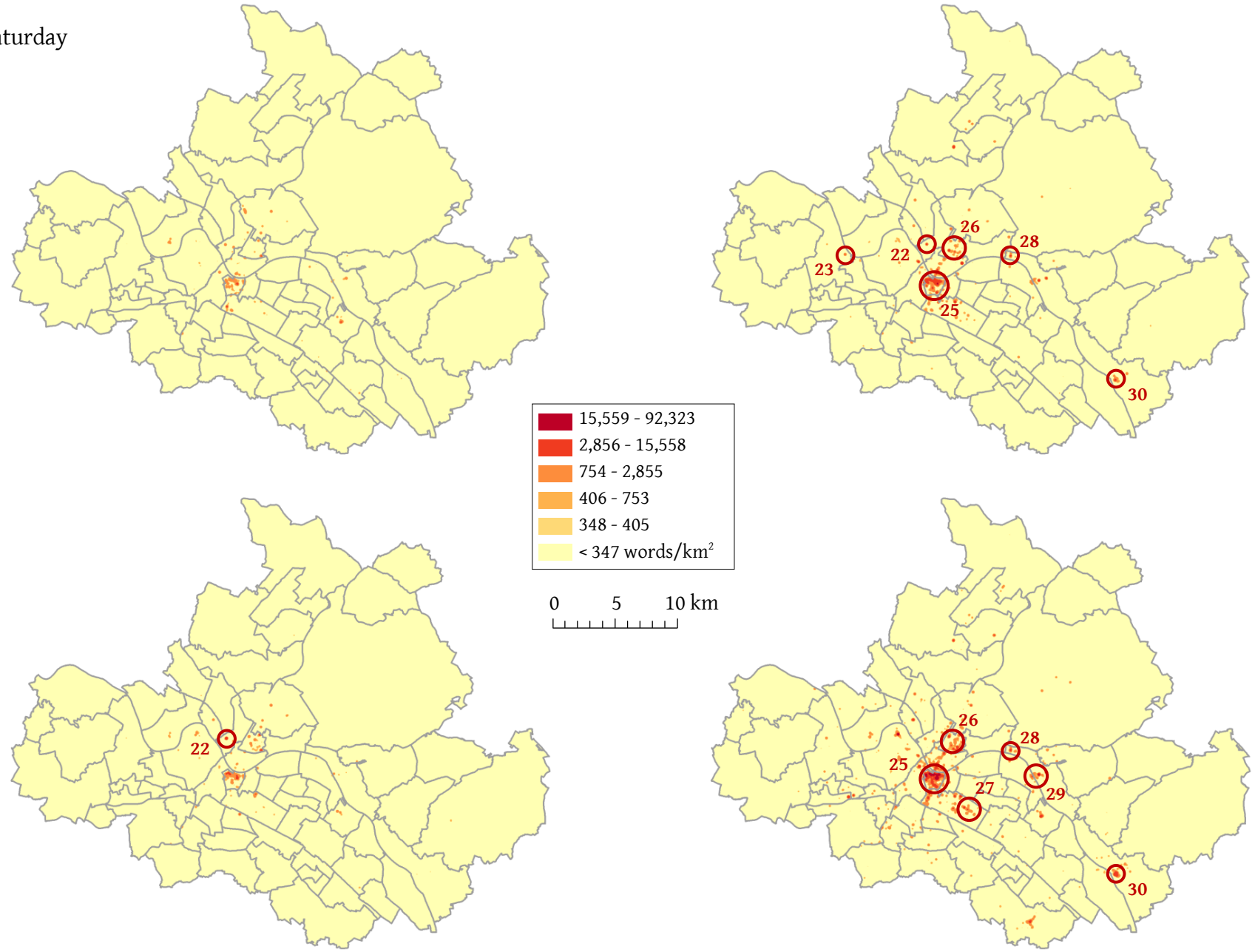
(3d) Thursday


15,559 - 92,323
2,856 - 15,558
754 - 2,855
406 - 753
348 - 405
< 347 words/km²
0
5
10 km

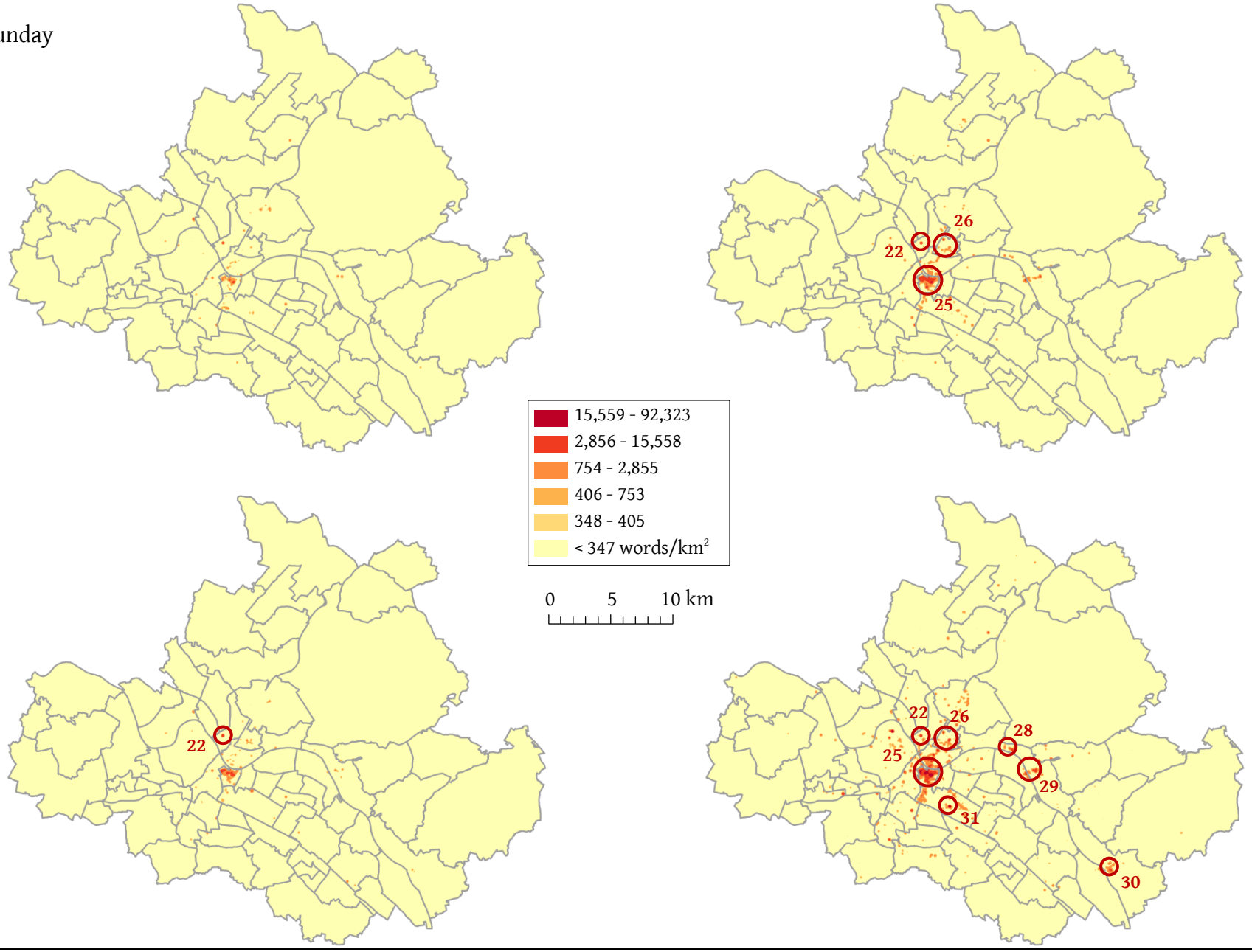
(3e) Friday


24
26
22
23
25
15,559 - 92,323
2,856 - 15,558
754 - 2,855
406 - 753
348 - 405
< 347 words/km²
0
5
10 km
22
26
22
25

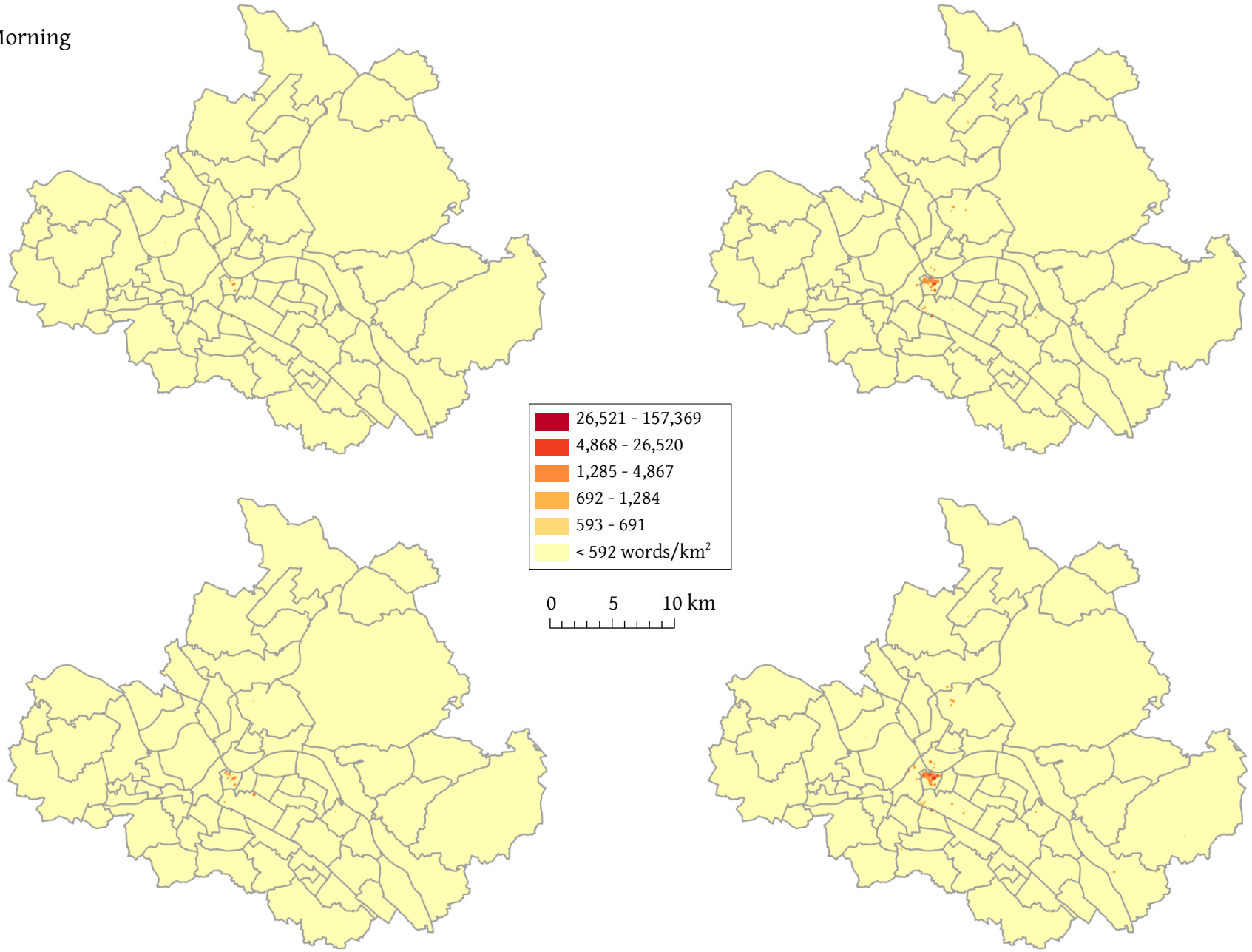
(3f) Saturday


15,559 - 92,323
2,856 - 15,558
754 - 2,855
406 - 753
348 - 405
< 347 words/km²
0
5
10 km
22
23
22
26
28
25
30
22
26
28
25
27
29
30

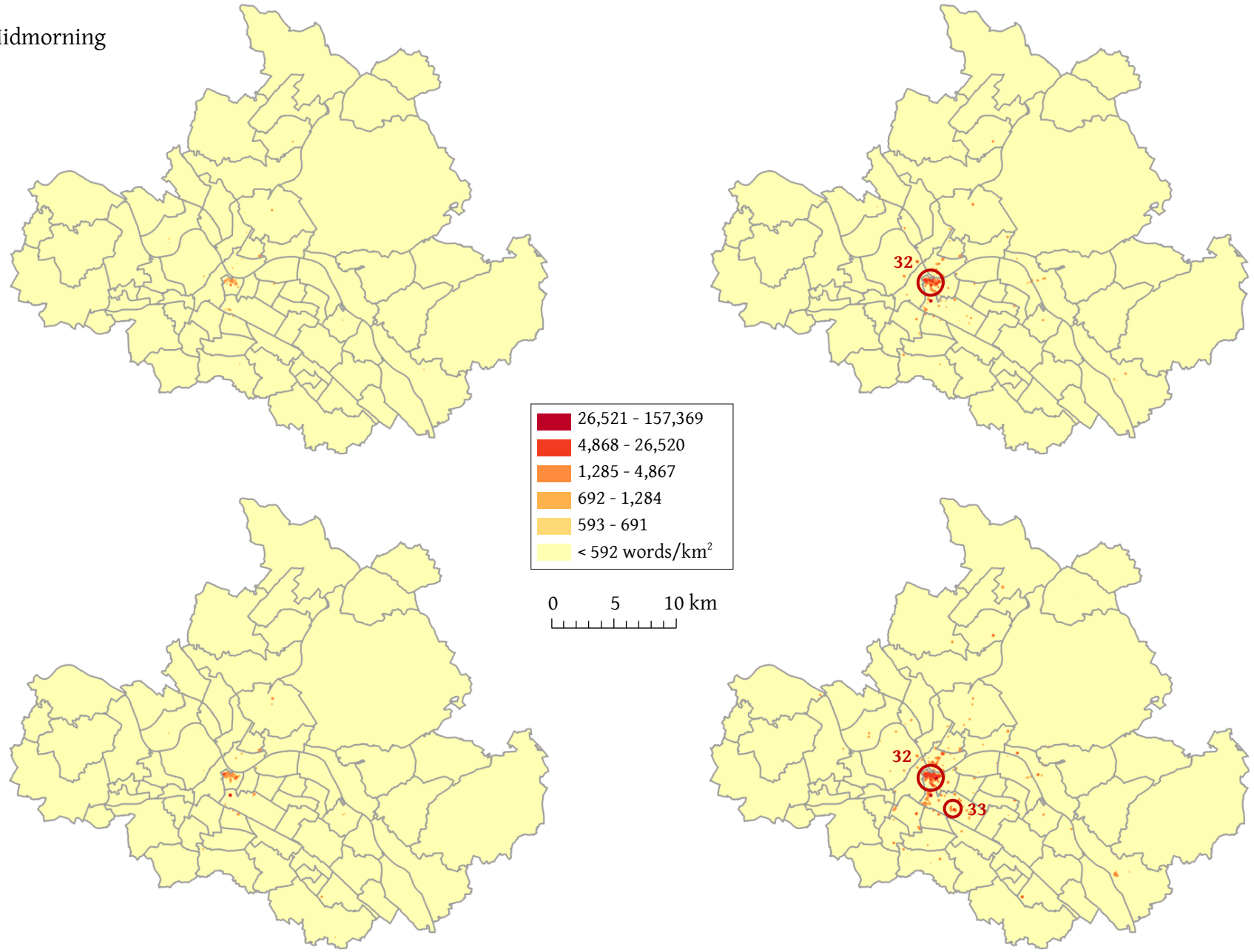
(3g) Sunday


15,559 - 92,323
2,856 - 15,558
754 - 2,855
406 - 753
348 - 405
< 347 words/km²
0 5 10 km
22
26
25
22
22
26
28
25
29
31
30

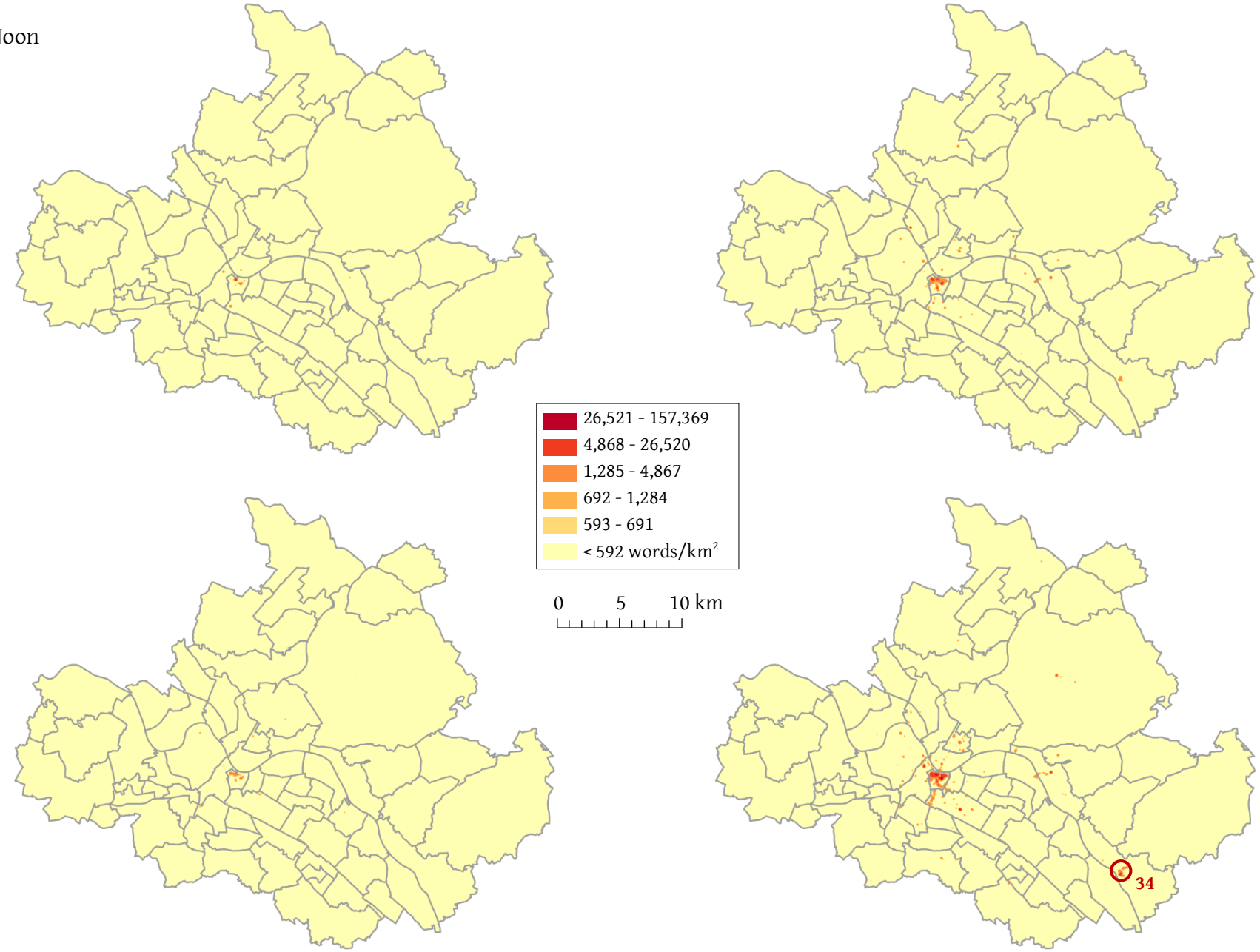
(4a) Morning


26,521 - 157,369
4,868 - 26,520
1,285 - 4,867
692 - 1,284
593 - 691
< 592 words/km²
0
5
10 km

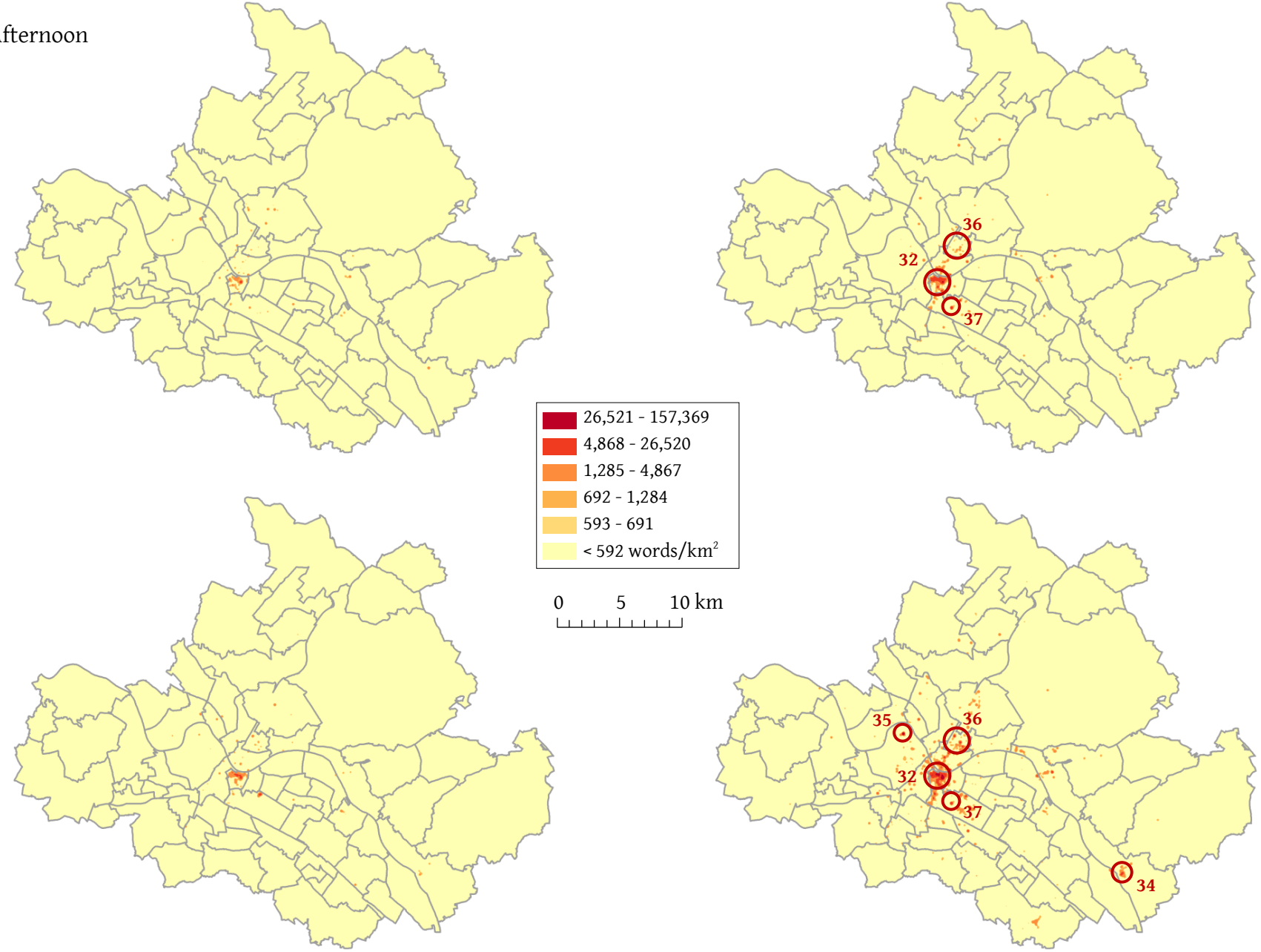
(4b) Midmorning



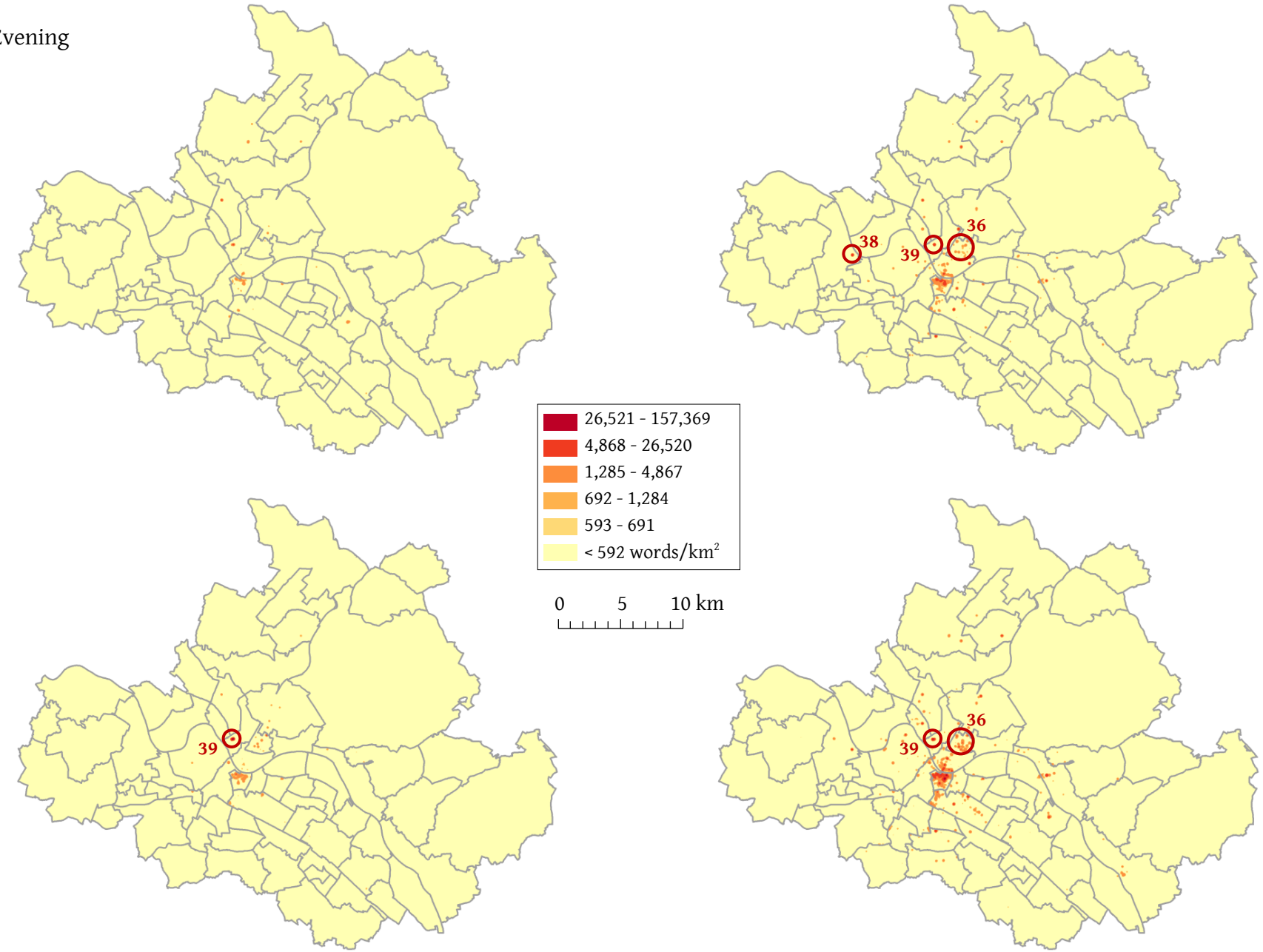
(4c) Noon


26,521 - 157,369
4,868 - 26,520
1,285 - 4,867
692 - 1,284
593 - 691
< 592 words/km²
0
5
10 km
34

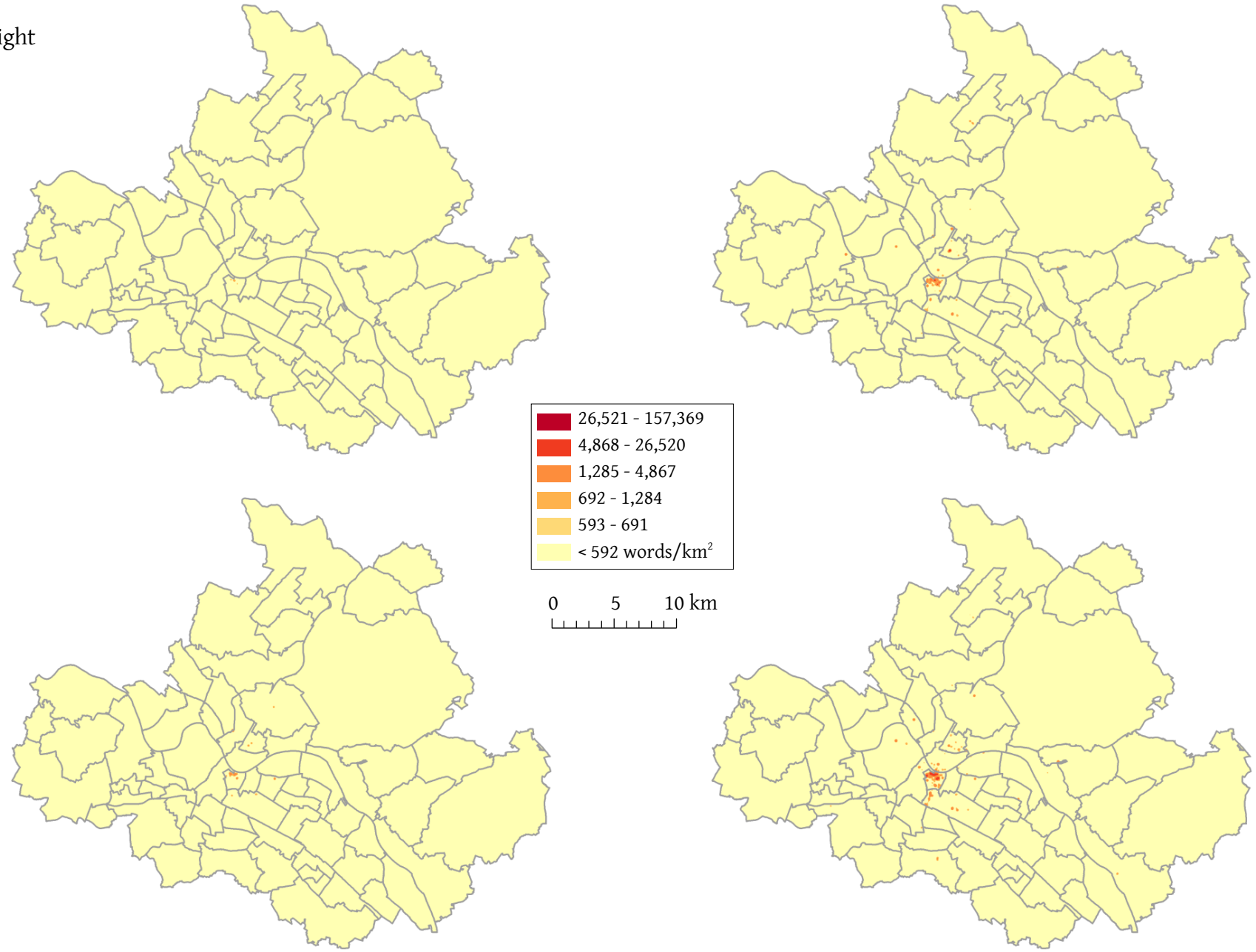
(4d) Afternoon



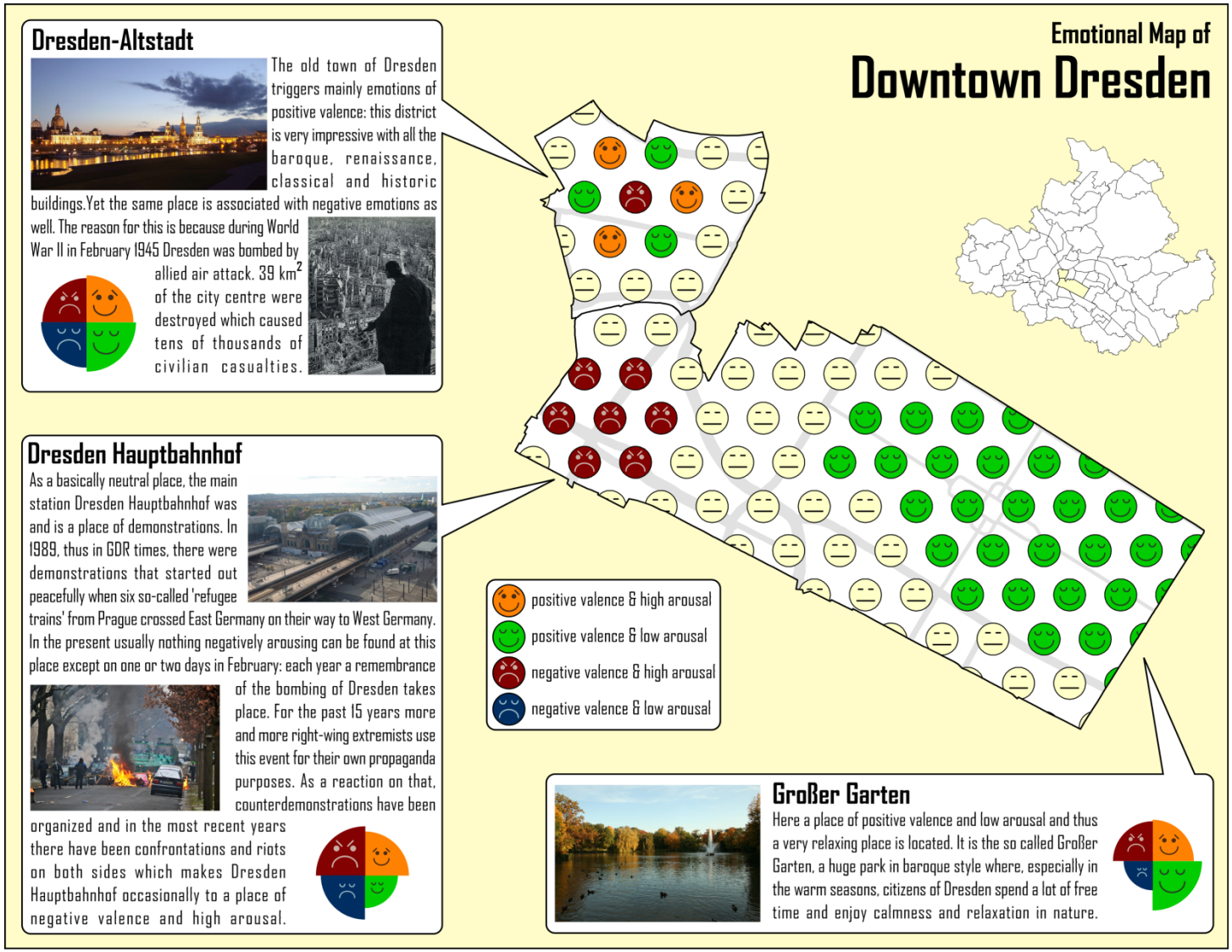
(4e) Evening


26,521 - 157,369
4,868 - 26,520
1,285 - 4,867
692 - 1,284
593 - 691
< 592 words/km²
0
5
10 km
38
39
36
39
39
36

(4f) Night


26,521 - 157,369
4,868 - 26,520
1,285 - 4,867
692 - 1,284
593 - 691
< 592 words/km²
0
5
10 km

Appendix 10 Visualisation of Emotional Places in Downtown Dresden for Tourism Purposes - Version 1

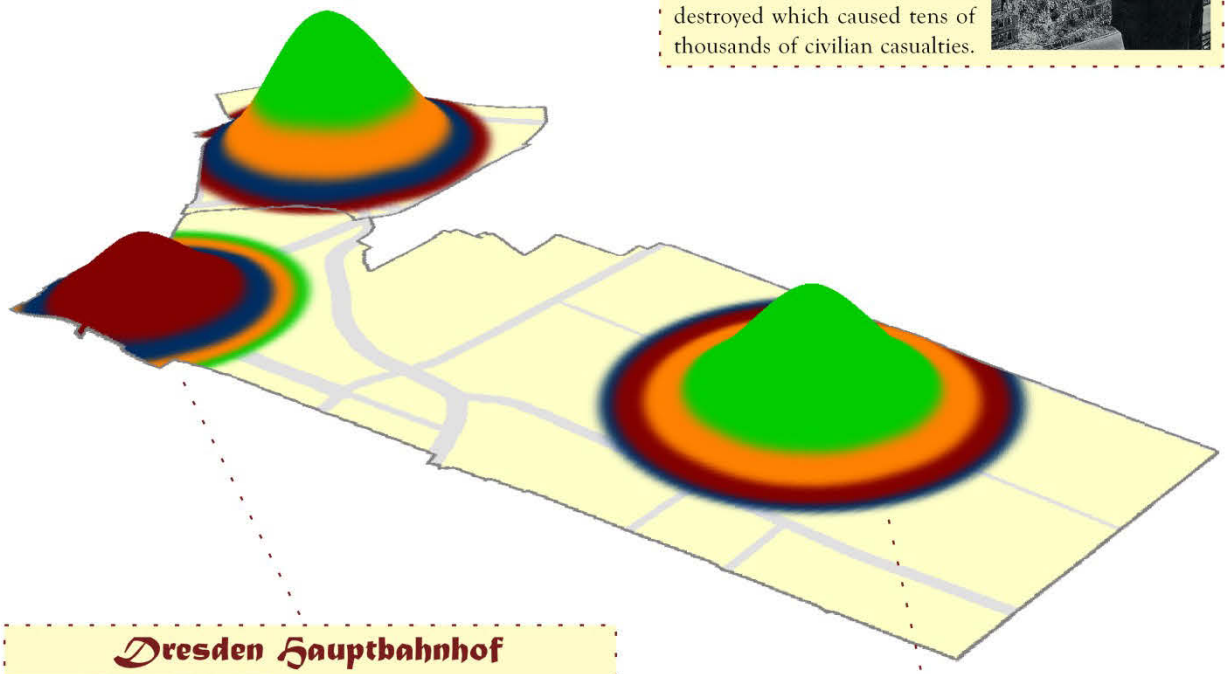


Appendix 11 Visualisation of Emotional Places in Downtown Dresden for Tourism Purposes - Version 2

Emotional Map of Downtown Dresden

Dresden-Altstadt

The old town of Dresden triggers mainly emotions of positive valence: this district is very impressive with all the baroque,renaissance, classical and historic buildings. Yet the same place is associated with negative emotions as well. The reason for this is because during World War II in February 1945 Dresden was bombed by allied air attack. 39 km² of the city centre were destroyed which caused tens of thousands of civilian casualties.



Dresden Hauptbahnhof

As a basically neutral place, the main station Dresden Hauptbahnhof was and is a place of demonstrations. In 1989, thus in GDR times, there were demonstrations that started out peacefully when six so-called 'refugee trains' from Prague crossed East Germany on their way to West Germany. In the present usually nothing negatively arousing can be found at this place except on one or two days in February: each year a remembrance of the bombing of Dresden takes place. For the past 15 years more and more right-wing extremists use this event for their own propaganda purposes. As a reaction on that, counterdemonstrations have been organized and in the most recent years there have been confrontations and riots on both sides which makes Dresden Hauptbahnhof occasionally to a place of negative valence and high arousal.

Großer Garten

Here a place of positive valence and low arousal and thus a very relaxing place is located. It is the so called Großer Garten, a huge park in baroque style where, especially in the warm seasons, citizens of Dresden spend a lot of free time and enjoy calmness and relaxation in nature.

- positive valence & high arousal
- positive valence & low arousal
- negative valence & high arousal
- negative valence & low arousal