Regional accessibility of supermarkets and discounters in Germany – a quantitative assessment –

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Abstract

Services of general interest fulfill the public's daily needs and are important for well-being. In Europe, interacting socioeconomic and demographic processes lead at present to a spatial concentration of basic services. Especially rural areas are thought to be affected by these processes, resulting in a deterioration of the living conditions of people living in these regions. Although this subject is being discussed intensively in policy as well as science, still little quantitative information on the consequences of these processes on people is available. By analyzing the accessibility of supermarkets and discounters, as an important part of the infrastructure of services of general interest near the place of residence in Germany, with a GIS accessibility analysis, this article aims to underscore this discussion with quantitative data.

Thereby it is shown that despite the processes of spatial concentration found in retail sales, supermarkets and discounters are well accessible by car throughout Germany. Nevertheless, considering the accessibility by foot, it becomes apparent that only in cities can supermarkets and discounters be accessed in a reasonable amount of time. So, especially in rural areas, especially in the eastern federal states, supermarkets and discounters are poorly accessible for less mobile people, mainly the elderly or young adults.

Keywords: *Rural development, local supply, supermarkets, discounters, raster based GIS accessibility analysis*

Zusammenfassung

Regionale Erreichbarkeit von Supermärkten und Discountern in Deutschland – eine quantitative Abschätzung –

Daseinsvorsorgeinfrastrukturen decken Bedürfnisse des täglichen Bedarfs und wirken sich auf die Lebensbedingungen der Bürger aus. Aktuell führen in Europa sich wechselseitig beeinflussende sozioökonomische und demographische Prozesse zu einer räumlichen Konzentration von Daseinsvorsorgeinfrastrukturen. Es wird davon ausgegangen, dass von diesen Prozessen besonders ländliche Räume betroffen sind und diese zu einer Verschlechterung der Lebensbedingungen der dort lebenden Bürger führen. Obwohl diese Aspekte aktuell sowohl in der Politik als auch der Wissenschaft thematisiert werden, gibt es bislang kaum quantitative Informationen über die Konsequenzen für die Bürger. Vor diesem Hintergrund befasst sich der Artikel mit der Situation der wohnortnahen Erreichbarkeit von Supermärkten und Discountern in Deutschland als ein für die Bürger wichtiger Teilbereich der Daseinsvorsorgeinfrastruktur basierend auf einer GIS-Erreichbarkeitsanalyse mit dem Ziel, die aktuelle Diskussion mit quantitativen Daten zu unterfüttern.

Als Ergebnis lässt sich festhalten, dass derzeit in Deutschland trotz der zu beobachtenden Konzentrationsprozesse im Lebensmitteleinzelhandel Supermärkte und Discounter mit dem Auto flächendeckend gut zu erreichen sind. Betrachtet man hingegen die fußläufige Erreichbarkeit von Supermärkten und Discountern, so lässt sich feststellen, dass diese nur in den Städten gegeben ist. In ländlichen Räumen und hier besonders in den östlichen Bundesländern sind Supermarkt und Discounter somit für weniger mobile Bürger wie Senioren und junge Erwachsene vergleichsweise schlecht erreichbar.

Schlüsselwörter: *Entwicklung ländlicher Räume, Nahversorgung, Supermärkte, Discounter, Rasterbasierte GIS Erreichbarkeitsanalyse*

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1 Introduction

In Europe, at present interacting socioeconomic and demographic processes are leading to a spatial concentration of basic services (see Küpper and Eberhardt, 2012).

In the food retail sector this development is characterized by concentration processes (in favor of enterprises with greater sales floors and locations with sufficient parking spaces and good transport connections), the reduction of personal services as well as a structural change of the types of offer – away from independent retailers towards standardized retail formats like supermarkets, consumer markets and discounters (KPMG, 2005; Valée and Lenz, 2007; Kuhlicke et al., 2005; Lein, 2012). As a consequence, a closing of enterprises serving the local supply as well as specialized markets not belonging to market-chains can be observed (Kuhlicke et al., 2005; Lein, 2012). Especially in rural areas, this development is supported by the current demographic processes that are characterized by an overall population decrease, an increase in the expectancy of life together with lower birth rates (Statistisches Bundesamt, 2009; Kollmann and Sieker, 2006; Gatzweiler and Kocks, 2004; Tönnies, 2004), and an aging and depopulation of rural areas. That means: demographic processes are causing a change in demand, which in turn leads to an abandonment of unprofitable locations (see Higgs and White, 1997). Expressed in simplified terms, these shrinking processes may lead to a spiraling down, where shrinking leads to a decrease in attractiveness, which in turn leads to further shrinking (Specht et al., 2013). As a consequence, people living in these areas often have to cover greater distances to reach certain parts of the infrastructure (see Higgs and White, 1997; Küpper and Eberhardt, 2012). To counteract these processes, the European Union complemented its cohesion policy with the concept of territorial cohesion. Amongst others, one objective of this policy is to ensure adequate access to basic services (see European Commission, 2014). For this purpose, information on the accessibility of basic services is needed to form an objective and realistic impression of the current situation. This information can function as input for future policy action and intervention (see Schulz and Bröcker, 2007). Although the spatial concentration of basic services is a heavily debated issue (for more information on this discourse see for example Favry et al., 2006; Born, 2009; Jens, 2009; Neu, 2009; Küpper, 2011; Küpper and Eberhard, 2013; Steinführer et al., 2014; Steinführer, 2014), to date, in Germany, little is known about its true dimensions (see Küpper and Eberhardt, 2012). That is, studies available presenting quantitative data generally focus on selected spatially limited regions only (e.g., a single community or county) – nationwide quantitative data is not known. In this context, one subject area attracting particular attention is the availability and accessibility of retail sales outlets. Against this background we analyze the accessibility of supermarkets and discounters, as an important part of the infrastructure of daily needs, with a raster-based GIS [1] accessibility analysis for Germany based on the EWZ250 250 m raster, commercial street data and the a-star shortest path algorithm. Thereby special attention is paid to the situation in rural areas. The analysis at hand focuses on the modeling of the nationwide accessibility of supermarkets and discounters in Germany in order to get quantitative data on the current accessibility of services of general interest with retail sales near the place of residence.

The aim of the article is threefold: First, it aims at presenting a methodology for deriving small scale accessibility data on services of general interest. Second, it underscores the discussion about the accessibility of services of general interest with spatially differentiated, reliable, nationwide quantitative data on the accessibility situation of supermarkets and discounters. Third, the article wants to motivate the generation of similar analyzes for other services of general interest. The article does not explicitly aim to derive recommendations for action, to discuss reasons and consequences of the spatial concentration of services of general interest, or the determinants of different living conditions in rural areas, or to discuss accessibility against the background of the discourse on poverty or social justice, as such considerations can already be found elsewhere (e. g., Neu, 2009; Faber, 2013; Kötter et al., 2013; Eib and Braun, 2014; Yeager and Gatrell, 2014).

The remainder of the article is divided into four sections. In Section 2, key data on supermarkets and discounters as well as consumer behavior regarding means of transport selection for shopping purposes and preferred locations for food shopping are presented. This information serves as background information in order to correctly assess the status quo in retail sales concerning supermarkets and discounters as main locations for food shopping. Section 3 introduces the concept of accessibility as well as the data sources and methodology the analysis builds upon. Based on the accessibility model in Section 4, the regional accessibility of supermarkets and discounters in Germany is discussed. The article closes with a conclusion summarizing the main findings.

2 Key information on supermarkets and discounters in Germany

When talking about supermarkets, experts differentiate between the following three categories of markets that are defined according to the sales floor, the number of articles offered as well as the composition of the assortment of goods: supermarkets, consumer markets and SB-warehouses (self-service warehouses) (Table 1).

In the past, discounters could not fully function as true local suppliers because of their limited assortment. Nevertheless, more recently, discounters have gradually developed towards a true local supplier by augmenting their assortment of goods, especially that of fresh foods (Kuhlicke and Petschow, 2005; KPMG, 2005). Nevertheless, today the assortment of discounters is still limited compared to the assortment of supermarkets. Thus, people living in regions where only a discounter is accessible are comparably more

[1] GIS: Geographic Information System.

Table 1
Differentiating characteristics of supermarkets, consumer markets, sb-warehouses and discounters.

	Supermarket	Consumer market	SB-warehouse	Discounter
sales floor in m²	400 to 2,500	2,500 to 5,000	≥ 5,000	400 to 1,200
Ø sales floor in m²	1,370	3,254	7,449	761
Ø nr. of articles	10,500	25,016	50,979	800 to 1,700
sortiment	full service grocery store Nonfood I articles small amount of Nonfood II articles	full service grocery store Nonfood I articles Nonfood II articles	full service grocery store Nonfood I articles Nonfood II articles	narrow and flat assortment of goodes with high shares of private labels
Ø customers per day	1,531	2,773	3,991	n.s.
Ø annual sales in €	6,250,000	14,480,000	32,930,000	n.s.

Sources: Bernreuther, 2011; Borutta et al., 2012; Bundesverband des deutschen Lebensmitteleinzelhandels, 2013; EHI, 2013; Küpper and Eberhardt, 2013

disadvantaged due to the available range of goods than people with an accessible supermarket. To be able to also take this aspect into account, in the remainder of the article we decided not only to analyze supermarket and discounter accessibility as a whole, but also to differentiate between supermarkets and discounters as well.

2.1 Spatial development of supermarket and discounters

A spatial concentration of basic services in favour of more central locations can be registered throughout Europe as a result of interacting socioeconomic and demographic processes. Especially in rural areas this development leads to a withdrawal of basic services. In Germany, a decrease in retail food businesses from 85,000 in 1990 to 41,348 in 2008 could be observed. Although the decline has lessened since 2008 it still continues, so that in 2012 only 38,866 food retail sale businesses existed in Germany (www 1, 01.10.2013; Handelsverband Deutschland, 2013). Thereby it is striking that since 2008, mainly small scale retail food sale businesses with a sales floor of up to 400 m² closed (2008: 13,900; 2012: 10,064) whereas a slight increase in supermarkets (2008: 9,660; 2012: 10,505); consumer markets (2008: 931; 2012: 10,010); sb-warehouses (2008: 877; 2012: 894), and discounters (2008: 15,970; 2012: 16,393) could be observed at the same time (www 1, 01.10.2013; Handelsverband Deutschland, 2013).

All in all, characteristic for the development of the retail sales are processes of concentration (in favour of businesses with greater sales floors, and locations with sufficient parking spaces and good accessibility by car), the reduction of services and a structural change towards standardized business types like supermarkets and discounters instead of small-scale, privately owned businesses (KPMG, 2005; Vallée and Lenz, 2007, 20; Kuhlicke et al., 2005; Lein, 2012). Simultaneously it can be observed that business locations are increasingly relocated from the city centers to the peripheries of the cities (Valée and Lenz, 2007). Altogether the development resulted in a more wide-meshed grid of food retail sales businesses (Handelsverband Deutschland, 2013). A concentration of businesses can be registered in densely populated regions with high purchasing power (Lein, 2012; Kuhlicke and Petschow, 2005) and a thinning in sparsely populated peripheral regions that are affected by the demographic changes (Kuhlicke and Petschow, 2005).

2.2 Key information on means of transport selection for shopping purposes

According to a study conducted by the CIMA GMBH, 61.1 % of the consumers use cars, 26.6 % bicycles, 3 % public transportation, 8.7 % walk and 0.5 % use other means of transport like taxis for food shopping (Lein 2012). The study "Mobilität in Deutschland"[2] (MID), conducted by the Federal Ministry of Transport, Building and City Development (BMVBS), considers the use of means of transport for shopping and comes to slightly different results. According to this study 58 % use cars, 10 % bicycles, 4 % public transportation and 27 % walk. Thereby the time spent for travel to shopping locations amounts on average 13.1 minutes (BMVBS, 2011). Although the results of both studies differ from one another – partly because of the special status of food shopping compared to the shopping behavior in general – both studies allow the conclusion that the majority of customers use cars as the means of transport for food shopping purposes. In this regard it can be observed that in rural areas, more customers use cars than in agglomerations and cities by comparable distances covered (Handelsverband Deutschland, 2013).

2.3 Preferred locations of food supply and subjective satisfaction with the food shopping situation as seen by the customers

According to a study conducted by the CIMA GMBH, analyzing transport use for food shopping, 89 % of the consumers prefer supermarkets (55.3 %) or discounters (33.6 %), whereas only 11 % prefer consumer markets (4.9 %), specialized stores (2.8 %), wholefood-markets (1.5 %) or farmer's markets (1.3 %) (Lein, 2012).

Altogether a survey analyzing the satisfaction with the local supply condition conducted by the Handelsverband Deutschland e.V. (HDE), based on a household survey in

[2] Mobility in Germany

4,000 selected households throughout all BBSR district types [3], revealed that the majority of questioned households are very satisfied or satisfied with the local shopping situation (Handelsverband Deutschland, 2013). Similarly, Heinritz et al. (2003) found that throughout all community classes, only 12 % to 15 % of the consumers are not satisfied with the local shopping situation. For these consumers, not only poor accessibility, but also a lack of alternative shopping possibilities, as well as an insufficient offering, are the main reasons for their dissatisfaction. Nevertheless, at present, all in all the subjective satisfaction with the food supply is relatively high (Handelsverband Deutschland, 2013). Thereby, according to Adamovicz et al. (2009) the subjective satisfaction is slightly higher in metropolises than in rural areas. Nevertheless Ellger (2000), as well as Born (2009), concentrating on rural areas, found that also in rural areas a high share of the population is quite satisfied with the local retail situation, even if the shops cannot be accessed by foot in a reasonable amount of time (Ellger: 91.6 %; Born: 64 %). In addition, Born (2009) states that this applies to all age classes.

This high subjective satisfaction can be explained by the fact that because of the high availability of a car, especially in rural areas, the accessibility at the place of residence is losing its importance (Küpper and Eberhardt, 2013) and leads to an increase in shopping mobility (Kuhlicke et al., 2005). So, at present, poor accessibility by foot is not perceived as problematic (Küpper and Eberhardt, 2013).

3 Analysis of supermarket and discounter accessibility: theoretical background, data sources and methodology

The following chapter introduces the concept of accessibility and deals with common approaches to acquire accessibility indicators followed by a description of the accessibility approach and data sources utilized for the analysis. The chapter concludes with a detailed description of the specific method applied in this paper.

3.1 Theoretical background: Accessibility and accessibility indicators

The concept accessibility is used with slightly different definitions in several fields including city or infrastructure planning, or marketing. But generally accessibility can be conceptionalized as the number of opportunities for economic and social life that can be reached with a reasonable effort. All in all, accessibility defines the quality of a point in space constituted by its traffic connections to other points in space. So, accessibility is a main product of the available transport system (see Bleisch and Koellreuter, 2003; Schürmann et al., 1997; Schwarze, 2005). Accessibility indicators are a measurement of the benefits accruing from the available transport infrastructures (see Bleisch and Koellreuter, 2003). Thereby accessibility indicators can be simple supply indi-cators (e.g., length of road network, number of pharmacies per community) as well as complex generic indicators (e.g., travel times). Different methods exist to gain accessibility values that can roughly be grouped into three categories: (1) approaches common in transport sciences based on a prognosis of the traffic situation (e.g., gravitation models, opportunity models, random utility theory) (see Bleisch, 2005; Schulz and Bröcker, 2007), (2) approaches common mainly in regional economy based on spatial interaction models (gravitation models, logit-models) (see Bleisch, 2005; Schulz and Bröcker, 2007) and (3) approaches focusing on the geographic accessibility (Euclidean distance, distance within street networks) (see Hemetsberger and Ortner, 2008). One peculiarity of geographic accessibility is that in regions with a dense road network like in urban areas, the Euclidean distance provides accurate enough results, whereas in regions with sparse road networks like in rural areas, the determina-tion of the Euclidean distance is insuffi-cient. This is because the circumvention of anthropogenic and natural barriers is more likely to extend the distances to be covered (see Dahlgren, 2008). Therefore in such regions accessibility within road networks have been shown to deliver more accurate results.

3.2 Accessibility approach followed

The analysis at hand is based on geographic accessibility by considering distances within road networks. Thereby a raster-based approach has been followed (see for example Hemetsberger and Ortner, 2007, 2008; Schürmann, 2008). That means the area under consideration (Germany) is overlain by a vector raster with a specific cell size. The centroids of the single raster cells represent the starting points of the analysis, meaning that the shortest street distance to the next supermarket/discounter is determined from every centroid. The resulting value is attributed to the raster cell representing the distance of this cell. All in all, the accessibility analysis is implicitly based on the simplified assumption that the next supermarket or discounter is chosen according to the shortest street distance from every starting-point. The result is a raster-based statistic that allows supermarket and discounter accessibility to be analyzed below the level of administrative regions or census regions [4]. Furthermore, calculation of areas can easily be achieved based on the single raster cells, e.g., by computing the arithmetic mean of the values attributed to raster-cells covering an area of interest.

3.3 Data sources

The analysis is based on the address data set of supermarkets and discounters of the commercial address re-seller "wer-zu-wem.de". This data set contains the addresses of 15,281

[3] In 2009, the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) developed the nine so-called BBSR district types that are meant to assist in an interregional comparison of different types of regions within Germany (NUTS 3). For further information to the BBSR district types please see Section 3.2.

[4] A detailed introduction on the nature of raster based regional statistics is given by Kaup and Rieffel, 2013

supermarkets and consumer markets, and addresses of 16,080 discounters as of September 2013.

The following supermarkets and consumer markets are included: Edeka with Neukauf; nah&gut; E aktiv markt; Treff 3000; Akzent; AEZRewe (Rewe, Nahkauf, Toom); Kaufland; Bünting (Combi, Famila); Bartels & Langness (Famila); Markant (Bünting, Offenburg); Coop (Sky, Plaza); Kaisers Tengelmann incl. Mema; Real; as well as the regional providers Coma; Feneberg; Globus; Hit; Inkoop; Jibi; Konsum Leipzig; Konsum Dresden; K+K; Markant Saxony; Mini-Preis; Multi; Novo; SBK; Tegut; Ullrich; V-Markt; Wasgau; WEZ; diverse biomarkets; Karstadt Perfetto, Grenzshops and Italo-Supermarkets and the C+C providers like Metro, Fegro, SB-Union.

The following discounters are included: Aldi Nord and Süd; Lidl; Penny; Norma; NP-Markt; Netto Marken-Discount, und Netto Stavenhagen.

According to the present statistics of the Bundesverband des deutschen Lebensmitteleinzelhandels (BVLH) in 2012 12,409 supermarkets and 16,393 discounters existed in Germany. The deviation of the "wer-zu-wem.de" dataset from the BVLH statistics can in part be explained by the dynamic in the food-retail sector between the two different acquisition periods (31.12.2012 BVLH; September 2013 "wer-zu-wem.de"), as well as the fact that it is quite likely that differences in the companies considered and allocation to the categories "supermarket" and "discounter" exist. The supermarket and discounter addresses have been geocoded by methods of address geocoding. Thereby one should be aware that a 100 % correct geocoding of addresses can, because of different ways of registering addresses, only be achieved by manually supervising the whole process. This is not possible with a greater stock of addresses as applicable here, so that single misassignments are probable and inevitable. This might in a few regions lead to an under-, respectively, overestimation of the supermarket and discounter accessibility. Thereby single spatially distributed misassignments are less problematic than regional/local cumulative misassignments. The spatial distribution of the geocoded supermarkets and discounter is shown in Figure 1. As can be seen, the density is relatively high in the agglomerations and decreases towards the more rural areas.

The data set EWZ250, developed by the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR), has been used as the raster of reference. This raster has a cell size of 250 m and contains disaggregated population values based on official population statistics [5] as well as population data of urban districts for raster cells identified as inhabited based on the ATKIS Basis DLM [6]. More detailed information on these aspects can be found in Burgdorf (2010).

All in all, as common with disaggregated rasterized population data sets, the population counts are to a certain extent underestimated in urbanized areas and overestimated in rural areas (see Burgdorf, 2010). In order to reduce computation costs, only cells defined as inhabited have been incorporated in the accessibility analysis. That means cells of the EWZ250 containing population values greater than zero, plus cells containing buildings according to the data set of building coordinates of the GVHK [7]/AdV [8]. Altogether the analysis raster contains 1,667,191 cells identified as populated.

The street network utilized is based on commercial street data. Due to computation costs it was decided not to consider single lane traffic in the accessibility analysis.

In addition nine "BBSR district types 2009", developed by the BBSR (see BBSR, 2009b) in order to assist in an interregional comparison of different region types within Germany on the level of administrative districts, have been used as an analytical framework (see Krieh, 2011) [9]:

- Type 1: Core cities in agglomerations (core cities, urban districts > 100,000 citizens);
- Type 2: Densely populated districts in agglomerations (more than 300 citizens per km²);
- Type 3: Highly populated districts in agglomerations (more than 150 citizens per km²);
- Type 4: Rural districts in agglomerations (districts with less than 150 citizens per km²);
- Type 5: Core cities in urbanised areas (cities > 100,000 citizens);
- Type 6: Densely populated areas in urbanised areas (more than 150 citizens per km²);
- Type 7: Rural districts in urbanised areas (districts with less than 150 citizens per km²);
- Type 8: Densely populated rural areas (districts with more than 100 citizens per km²);
- Type 9: Sparsely populated rural areas (districts with less than 100 citizens per km²);

3.4 Method of the accessibility analysis

Prior to the distance calculations, the raster centroids as well as the locations of supermarkets and discounters were connected with the route network by adding a vertical line from every start/target point to the nearest street in the route network. The distance calculation was based on the "a-star shortest path" algorithm (see Hart et al.,1968 for further information) and was performed with PostgreSQL using the pg_dijkstra extension. In order to reduce computation costs for the supermarket and discounter locations, voronoi polygons [10] were defined prior to the accessibility

[5] Unfortunately Burgdorf (2010) does not specify the year of reference for the population values the dissaggregation is based on. Considering that in the references he lists a „Qualitätsbericht – Fortschreibung des Bevölkerungsstandes" of the Federal Statistical Office from 2008, it can be assumed that the population data used for the dissaggregation is based on the population as of 2008, too.

[6] The ATKIS Basis DLM is a digital base landscape model for Germany.

[7] GVHK: Association for the distribution of building coordinates.

[8] AdV: Working Committee of the Surveying Authorities of the States of the Federal Republic of Germany.

[9] Detailed information on the „BBSR district types" can be found on the homepage of the BBSR: <http://www.bbsr.bund.de/nn_1067242/BBSR/DE/Raumbeobachtung/Raumabgrenzungen/Siedlungsstrukturelle Gebietstypen/Kreistypen/kreistypen__node.html> (29.04.2013).

[10] These are polygons containing the area closest to the single locations (here, the single supermarket/discounter).

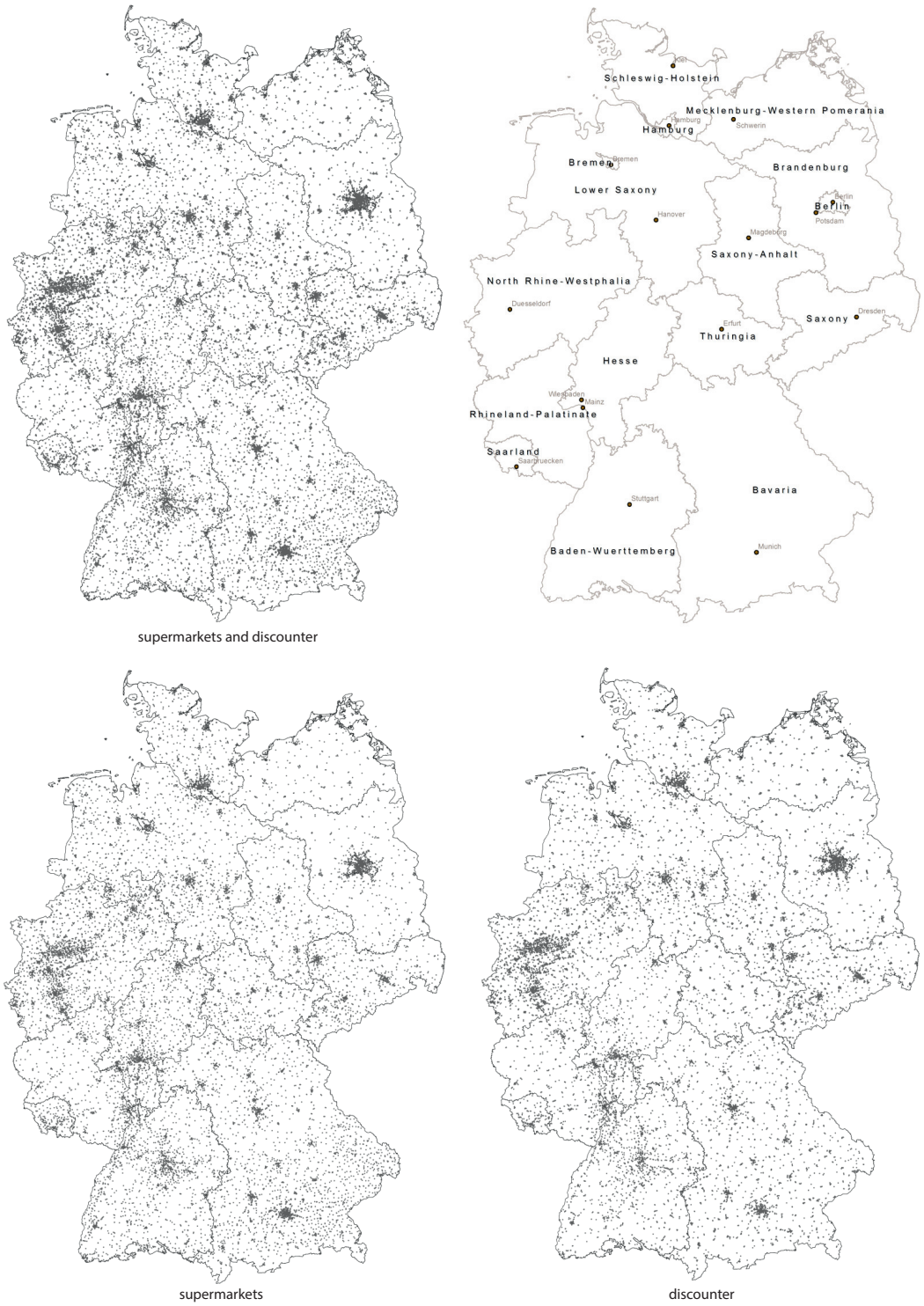


Figure 1

Spatial distribution of the geocoded supermarket and discounter addresses.
(Sources: Administrative boundaries: Bundesamt für Kartographie und Geodäsie, 2010; geocoded supermarkets and discounters: Own calculations based on data from wer-zu-wem.de, Esri's™ "Europe Geocode Service, GVHK/AdV).

analysis (Figure 2). Based on these polygons, the street distance was calculated from every supermarket and discounter to every raster centroid within the single voronoi polygons. This simplification proved to be necessary as otherwise the distance calculation would not have been possible in a reasonable amount of time. Nevertheless, as a result, the analysis builds upon a simplified image of reality, that may in some regions influence the analysis results to a greater degree, leading to a greater deviation of the estimated accessibility values from reality than on average (e.g., if a river or

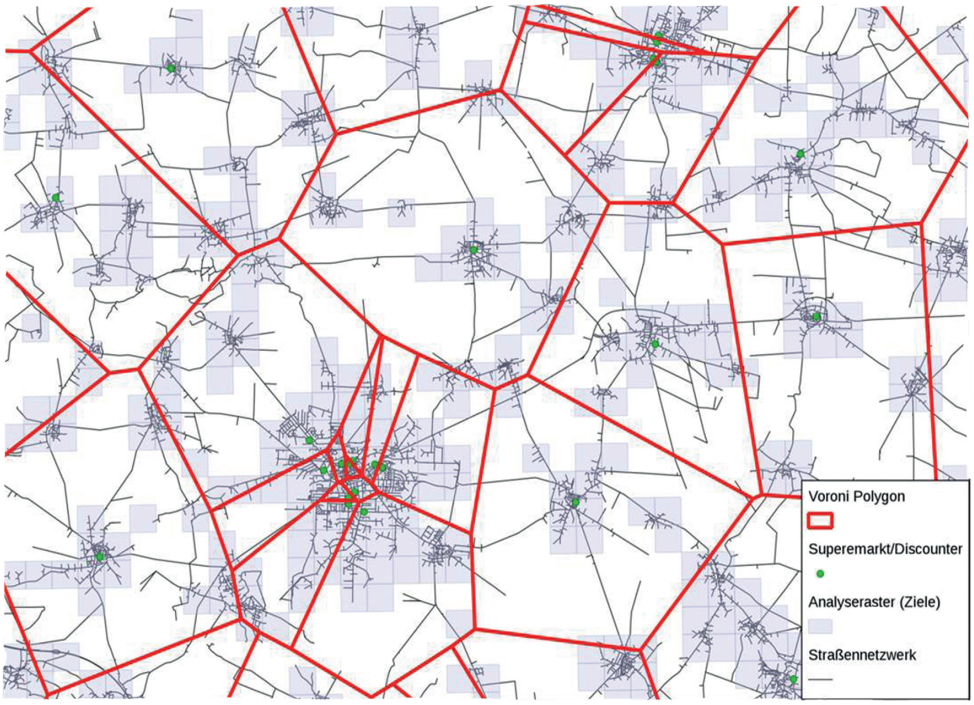


Figure 2
Method of accessibility analysis

highway constitutes a situation where the next supermarket/discounter reachable by street is not that within the voronoi polygon under consideration).

In the result data sets of the accessibility analysis, potential outliers that could mainly be attributed to topological inconsistencies in the route network or to unavoidable simplifications within the accessibility model have been corrected. Thereby distance values above the upper quartile of the value distribution plus three times the interquartile distance have been identified as outliers as this is a well-proved method to detect outliers in uneven distributions.

4 Accessibility of supermarkets and discounter

Before the results on supermarket and discounter accessibility in Germany are presented, the reader shall be reminded that accessibility situations are not static but likely to change during the course of time. In this sense the results represent a snap-shot for the reference years 2013/2014. Furthermore, the results are strongly dependent on the accessibility model used; they do not represent reality, but an ideal typical situation (see Johnston et al., 2000).

A framework of assessment is necessary in order to be able to determine whether a service is close to the place of residence. When discussing the accessibility of basic services in policy, ten minutes by foot or a distance of 500 to 1,000 meters is commonly considered an optimal threshold (see Adamovicz et al., 2009; Beckmann, 2007; Muschwitz et al., 2011; Schrader and Paasche, 2010). Considering the population's expectations, the office of spatial development and geoinformation of the canton St. Gallen, Switzerland found out that a travel time of 15 minutes to reach a service of basic needs is accepted by most people (see Amt für Raumentwicklung und Geoinformation, Kanton St. Gallen, 2008). In Germany, on average, people need 12 to 17 minutes to reach a shopping opportunity (BMVBS, 2011). Concentrating on the accessibility situation as experienced by the citizens, accessibility values up to 15 minutes can therefore be considered acceptable. Assuming an average speed by car of 60 km/h this corresponds to a distance of 15 kilometers. By foot people commonly have an average walking speed between1.3 m/s (4.7 km/h) and 1.45 m/s (5.2 km/h) subject to certain socioeconomic characteristics (age, gender, health status,…) (Perry, 1992; Götz-Neumann, 2006; Morgenroth, 2008; Granacher et al., 2010). So, shops at a maximum distance of 1,170 m (1.3 m/s) to 1,305 m (1.45 m/s) can be reached by foot in 15 minutes. In the remainder of the article the lower walking speed of 1.3 m/s will be considered to take special account of less mobile, slow-walking persons. The political limit of 1,000 m will be included in the figures for those who are interested in it, but not be commented on any further as it is merely a synthetic rather than a theoretically grounded value.

4. 1 Regional accessibility of supermarkets and discounter

The statistical parameters of the calculated accessibility raster depicted in Table 2 give a first overview of the accessibility situation of supermarkets and discounters in Germany.

Considering supermarkets and discounters as a whole, as well as separately, the distribution of the accessibility values is left skewed. That means, there are many raster cells with short distances to be covered to the next market, and with increasing distance the number of raster cells affected decreases.

Table 2
Summary of statistical parameters of the accessibility analysis

Supermarkets and discounters			
parameter	supermarkets and discounters	supermarkets	discounters
	(values are rounded)		
Minimum in meters	3	3	3
Maximum in meters	89,009	89,001	90,010
1. Quartile in meters	1,277	1,763	1,532
3. Quartile in meters	4,805	6,432	5,251
Median in meters	2,725	3,775	3,073
Mean in meters	3,413	4,523	3,786
Standard error of mean in meters	2	3	2
standard deviation in meters	2,811	3,490	2,983
Variance in meters	7,898,695	12,183,107	8,899,946

All in all, on average, the distance to the next supermarket or discounter amounts to 3.4 km.

Considering only supermarket accessibility, on average the distance amounts to 4.5 km. Last but not least, considering discounter accessibility, on average the distance to the next discounter amounts to 3.8 km. Considering supermarket and discounter accessibility differentiated by federal states and BBSR district types (see Table 3), great differences can be noticed. Tendentially, the distances to be covered increase from the core cities in agglomerations towards the sparsely populated rural areas. Partly the distances to be covered within a BBSR-Kreistyp 2009 differ greatly between the different federal states. So, quite noticeable are the comparably great distances in Brandenburg in "highly populated districts in agglomerations" or in "rural districts in agglomerations" in North Rhine-Westphalia.

As a consequence of the concentration processes in the food retail sale sector, today, no supermarket exists in approximately 57 % of the communities. In approximately 53 % of the communities neither a supermarket nor a discounter exists. Especially rural communities are affected by this development. In this regard it is quite evident that the grid of supermarket and discounter locations is comparably wide-meshed in the federal states Schleswig-Holstein, Mecklenburg-Western Pomerania, Rhineland Palatinate as well as in great parts of rural Brandenburg, Thuringia and Bayern (see Figure 3). This pattern is also reflected when considering the accessibility of supermarkets and discounters per

Table 3
Average distances to the next supermarket or discounter, supermarket, discounter within federal states and BBSR district types

supermarket or discounter										
federal state	average federal state	BBSR district type 2009								
		urban district types					rural district types			
		1	2	3	5	6	4	7	8	9
		average distance to the next supermarket or discounter in m								
Schleswig-Holstein	3,941	2,026	3,073	3,748	1,751	3,839	4,027	4,261	4,000	4,410
Hamburg	1,961	1,959	918	3,300						
Lower Saxony	3,455	892	2,064	3,246	1,686	3,135	3,826	3,970	3,711	4,363
Bremen	2,061	2,137			1,713		817			
North Rhine-Westphalia	2,549	1,477	2,391	3,092	1,965	2,954	6,505	3,666		
Hesse	2,663	1,285	2,196	2,925	1,219	2,546		3,409	2,946	
Rhineland-Palatinate	3,989	1,300	1,768	3,044	1,793	3,681		5,111		
Baden-Württemberg	3,147	1,368	2,087		1,620	3,315	3,823	4,164	5,821	
Bavaria	3,313	1,131	2,264	2,922	1,370	3,054	3,273	3,601	3,346	3,911
Saarland	2,509	1,881	2,375	3,147		6,220				
Berlin	1,107	1,106					3,730			
Brandenburg	5,052	2,489		8,025	3,135		4,679	4,645	2,161	6,811
Mecklenburg-Western Pomerania	5,701	1,484			1,782			5,462	5,223	5,955
Saxony	3,194			3,503	1,560	3,193	3,197	3,614	3,558	4,551
Saxony-Anhalt	3,833				1,459	3,034	6,234	3,725	3,295	4,952
Thuringia	3,574				2,223	3,475		4,057	3,286	3,988
Gesamt	3,412	1,487	2,299	3,194	1,750	3,190	4,194	4,083	3,510	4,984

supermarket										
federal state	average federal state	BBSR district type 2009								
		urban district types					rural district types			
		1	2	3	5	6	4	7	8	9
		average distance to the next supermarket in m								
Schleswig-Holstein	4,130	2,257	3,311	3,928	1,808	3,988	4,344	4,430	4,274	4,535
Hamburg	2,229	2,228	1,128	3,327						
Lower Saxony	3,704	2,538	2,287	3,625	1,956	3,371	3,993	4,288	3,878	4,547
Bremen	2,330	2,404			1,989		817			
North Rhine-Westphalia	2,782	1,699	2,659	3,352	2,068	3,148	6,505	3,846		
Hesse	2,824	1,430	2,485	3,127	1,303	2,661		3,520	3,025	
Rhineland-Palatinate	4,378	1,629	2,181	3,603	2,000	4,151		5,367		
Baden-Württemberg	3,579	1,577	2,445		1,862	3,712	4,736	4,753	7,204	
Bavaria	3,607	1,361	2,541	3,238	1,537	3,369	3,368	3,995	3,589	4,265
Saarland	2,719	2,114	2,538	3,415		6,621				
Berlin	1,305	1,304					3,934			
Brandenburg	5,742	2,664		8,025	3,452		5,498	5,088	2,161	7,404
Mecklenburg-Western Pomerania	6,668	1,785			2,232			6,682	6,405	6,838
Saxony	4,019			4,252	2,091	3,859	3,705	3,781	5,059	4,778
Saxony-Anhalt	4,281				1,915	3,326	7,935	4,199	3,783	5,383
Thuringia	3,948				2,684	3,868		4,584	3,512	4,213
Gesamt	3,783	1,714	2,580	3,561	2,021	3,521	4,747	4,492	3,884	5,473

discounter										
federal state	average federal state	BBSR district type 2009								
		urban district types					rural district types			
		1	2	3	5	6	4	7	8	9
		average distance to the next discounter in m								
Schleswig-Holstein	5,429	2,210	3,628	4,662	2,062	5,896	4,701	5,097	5,322	7,087
Hamburg	2,345	2,343	918	3,567						
Lower Saxony	4,577	892	2,508	4,291	2,010	4,113	5,800	4,895	5,210	5,461
Bremen	2,163	2,255			1,732		2,734			
North Rhine-Westphalia	3,149	1,695	2,870	3,863	2,494	3,740	7,706	5,015		
Hesse	4,123	1,687	2,821	4,115	1,695	3,872		5,813	5,648	
Rhineland-Palatinate	5,093	1,658	2,004	3,976	2,203	4,410		6,925		
Baden-Württemberg	4,187	1,637	2,793		2,326	4,498	4,812	5,372	5,510	
Bavaria	4,967	1,374	3,150	4,074	1,733	4,175	5,598	5,175	5,323	5,728
Saarland	3,459	2,338	3,202	4,628		6,220				
Berlin	1,288	1,288					1,159			
Brandenburg	5,989	3,166		7,948	3,321		5,492	5,255	5,245	8,460
Mecklenburg-Western Pomerania	6,690	1,781			2,310			6,089	5,647	7,143
Saxony	3,935			4,315	1,778	3,908	4,464	3,795	4,277	4,917
Saxony-Anhalt	4,498				1,580	3,337	6,234	4,326	3,933	5,971
Thuringia	5,042				2,925	4,924		5,343	5,023	5,795
Gesamt	4,519	1,749	2,862	4,157	2,151	4,196	5,457	5,307	5,186	6,579

1 core cities in agglomerations
2 densely populated districts in agglomerations
3 highly populated districts in agglomerations
4 rural districts in agglomerations
5 core cities in urbanised areas"
6 densely populated areas in urbanised areas
7 rural districts in urbanised areas
8 densely populated rural areas
9 sparsely populated rural areas

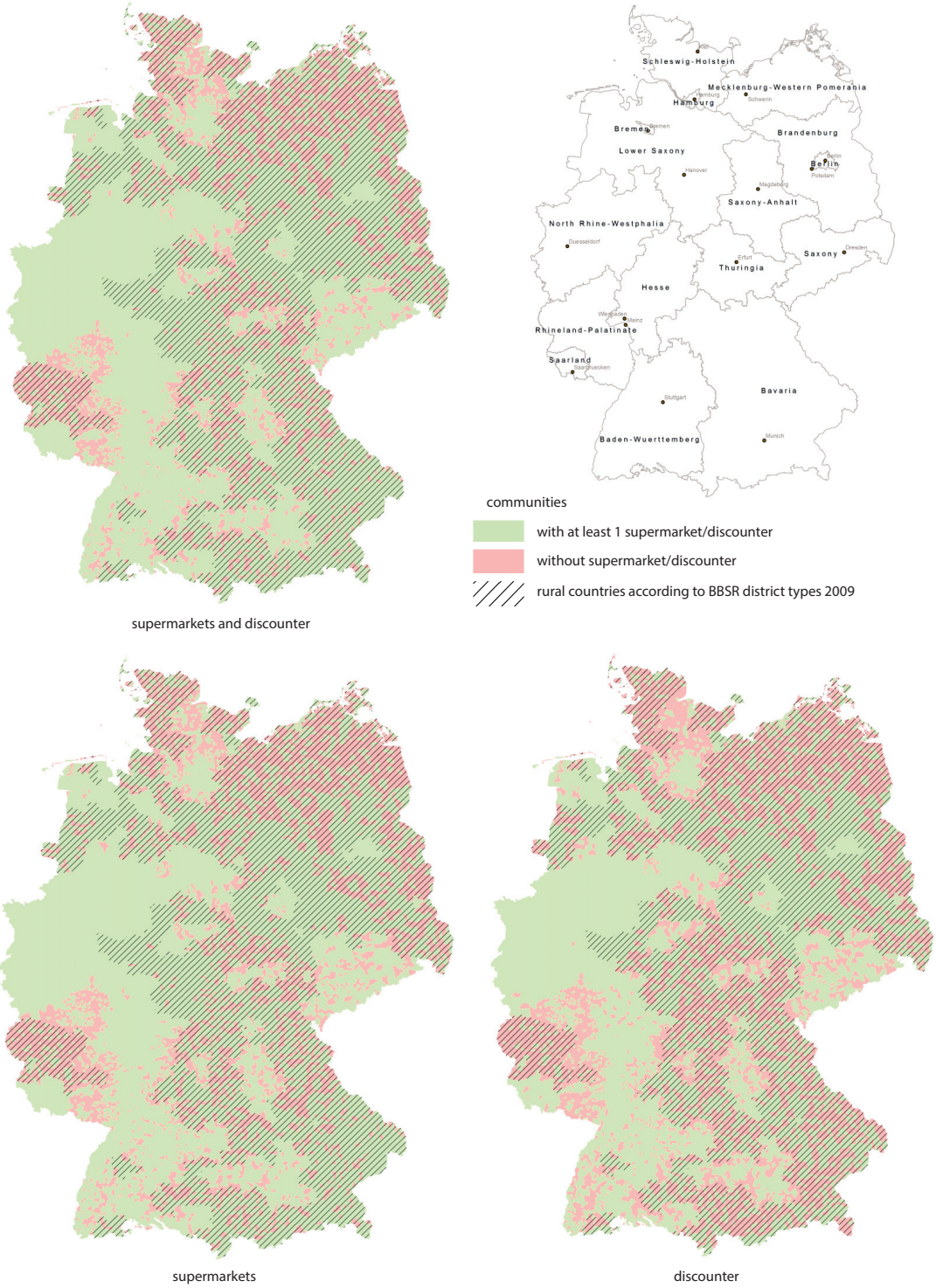


Figure 3
Communities with and without supermarket/discounter. (Sources: Administrative boundaries: Bundesamt für Kartographie und Geodäsie, 2010; BBSR district types: BBSR; Own calculations).

community average (see Figure 4). Nevertheless considering the accessibility by car (Table 4), in 99.2 % of the communities, a supermarket or discounter can on average be reached within 15 minutes driving time (60 km/h). Considering community averages, a supermarket is reachable in this time in 99 % of the communities and a discounter in 97.9 % of the communities. In contrast, by foot, based on a 1000 m distance often used in policy, supermarkets and discounters are only reachable in 1.3 % of the communities, supermarkets in 0.8 % and discounter in 0.2 % of the communities. Supposing a slow walking speed of 1.3 m/s, supermarkets and discounters can be reached in 15 minutes (this corresponds to a

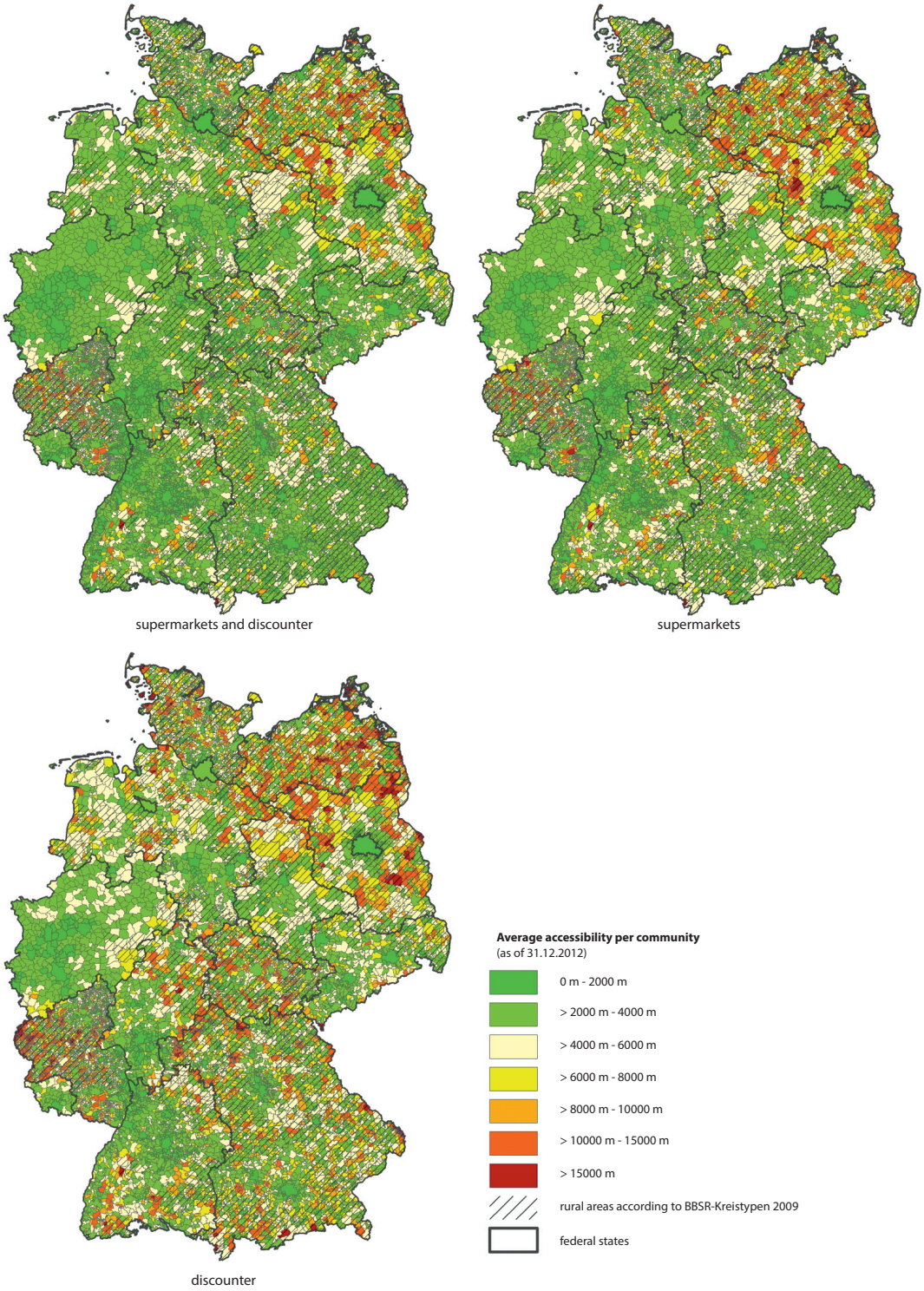


Figure 4
Average accessibility of supermarkets/discounters per community. (Sources: Administrative boundaries: Bundesamt für Kartographie und Geodäsie, 2010; BBSR district types: BBSR; Own calculations).

distance of <= 1,305 m) in 3.2 % of the communities, supermarkets in 2 % and discounters in 0.9 %.

Thereby considering accessibility by foot (1.3 m/s, 15 minutes) on community averages it is quite noticeable that the accessibility decreases from the "core cities in agglomerations" to the "sparsely populated rural areas" .

Although these figures give a first comprehensive summary of supermarket and discounter accessibility within different types of regions, they say nothing about existing intra-regional differences. But this information is necessary to fully assess the accessibility situation. Such information can be taken from Figures 5 and 6 showing spatially inclusive and

Table4
Average distances to the next supermarket/discounter within communities and BBSR district types

BBSR district types 2009	distance in meters								
	0 to ≤ 1,000 (political context)			0 to ≤ 1,170 (accessible up to 15 minutes by foot [1.3 m/s])			0 to ≤ 15,000 (accessible by car up to 15 minutes [60 km/h]))		
	supermarket and discounter	supermarket	discounter	supermarket and discounter	supermarket	discounter	supermarket and discounter	supermarket	discounter
	% of communities								
Germany	1.3	0.8	0.2	3.2	2.0	0.9	99.2	99.0	97.9
no allocation possible*	9.1	9.1	0.0	9.1	9.1	0.0	36.4	90.9	81.8
1: Core cities in agglomerations	2.0	0.0	0.0	17.6	2.0	2.0	100.0	100.0	100.0
2: Densely populated districts in agglomerations	2.5	0.8	0.5	9.8	4.5	3.4	99.7	99.7	99.7
3: Highly populated districts in agglomerations	1.3	0.3	0.1	3.1	1.8	1.1	99.4	99.3	99.3
4: Rural districts in agglomerations	1.1	0.5	0.3	1.9	1.6	0.6	99.8	99.2	98.4
5: Core cities in urbanised areas	3.3	3.3	0.0	10.0	3.3	0.0	100.0	100.0	100.0
6: Densely populated areas in urbanised areas	1.8	1.1	0.5	3.7	2.4	1.1	99.2	99.0	98.6
7: Rural districts in urbanised areas	0.9	0.6	0.1	2.4	1.7	0.7	99.6	99.6	97.4
8: Densely populated rural areas	1.0	0.7	0.1	2.1	1.6	0.2	99.2	99.2	99.0
9: Sparsely populated rural areas	0.7	0.6	0.0	1.7	1.2	0.5	97.9	97.3	94.5

* this are areas that could because of inconsistencies in the official datasets not be allocated to the BBSR-2009 Kreistypen.

comprehensive heat maps [11] of the modeling results for accessibility by car (60 km/h) and foot (1.3 m/s). The above described accessibility patterns are also mirrored in the maps based on the accessibility values attributed to the single raster cells of the analysis raster. All in all, it can be concluded that within the commonly accepted time of 15 minutes to reach a basic service, a supermarket and discounter, supermarket or discounter can be accessed by car with only a few exceptions (mainly in rural Mecklenburg-Western Pomerania, Brandenburg and north-east Saxony-Anhalt) nationwide in urban as well as in rural areas. In contrast, disadvantageous supermarket/discounter as well as supermarket or discounter accessibilities by foot can be registered outside cities and major settlements, so that especially in rural areas they are less accessible for people without a car.

This might to some extent be compensated by the fact that the share of households without cars is lowest in rural areas (see BMVBS, 2009; 2009a) and the willingness to cover greater distances to reach basic services is greater (see Higgs and White, 1997).

But in summary, drawing on findings due to mobility in rural areas, it can be reasoned that especially retired persons and young adults are most affected by disadvantageous accessibility situations, as these have been identified as the two major groups of people with no car available (see BMVBS, 2009; 2009a). In many rural areas the lack of a car cannot be easily compensated by using public transport as in such areas often only rudimentary public transport exists, or suboptimal station times prevail. The reason is that in rural areas the public transport is often mainly oriented to the requirements of school transport (see Steinrück and Küpper, 2010). So, in short, especially for less mobile people, supermarket and discounter accessibility proves to be comparably disadvantageous in rural areas throughout the country.

4. 3 Estimation of the portion of population affected from different supermarket and discounter accessibilities

Identifying regions with good, respectively disadvantageous, supermarket and discounter accessibility draws a comprehensive image of supermarket and discounter provision in Germany, but this does not suffice to comprehensively assess the situation. This requires an assessment of the portion of the population affected by specific accessibility conditions. Based on the disaggregated population data of the EWZ250, it is possible to estimate the share of population affected by a certain supermarket/discounter accessibility. First of all it is not surprising that a weak negative correlation of r = 0.29 [12]

[11] For representative purposes not the actual raster of reference is depicted, but a so-called heat map computed by applying a majority filter (considering the nine neighbouring cells of the cell under consideration) to the result raster. This representation has the advantage that spatial trends are visually enhanced and can therefore be interpreted more easily, but, as with every method of generalisation, at the cost of a certain loss in accuracy (see Meyer, 2006; Fina, 2012).

[12] Pearson product-moment correlation coefficient.

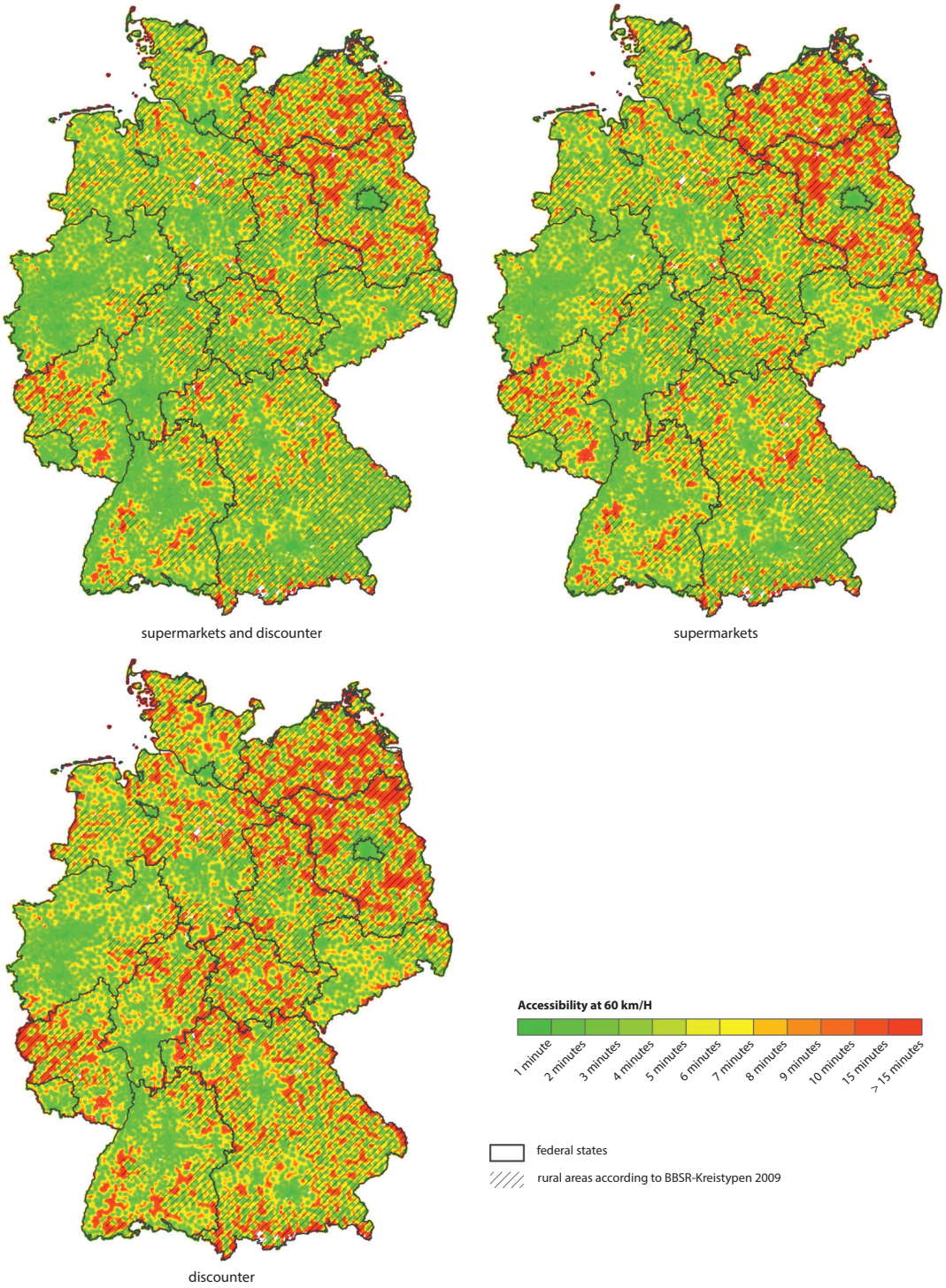


Figure 5
Heat map accessibility of supermarkets/discounter by car. (Administrative boundaries: Bundesamt für Kartographie und Geodäsie, 2012; BBSR district types: BBSR; Data: Own calculations).

exists between the distances to be covered to reach the next supermarket and discounter, respectively supermarket, and population of a raster cell of the EWZ250. Between the accessibility of a discounter and the population a moderate negative correlation of r = -0.3 exists. Together with the modeling results this allows the conclusion that in tendency the distances to be covered increase with a decreasing population density. This finding is first evidence that disadvantageous supermarket/discounter accessibilities can be mainly found in areas with a low population density, respectively few potential customers.

Nevertheless, as can be seen in Table 5, summarizing the population affected by selected distances, all in all 99.9 % of Germany's population is able to reach the next supermarket

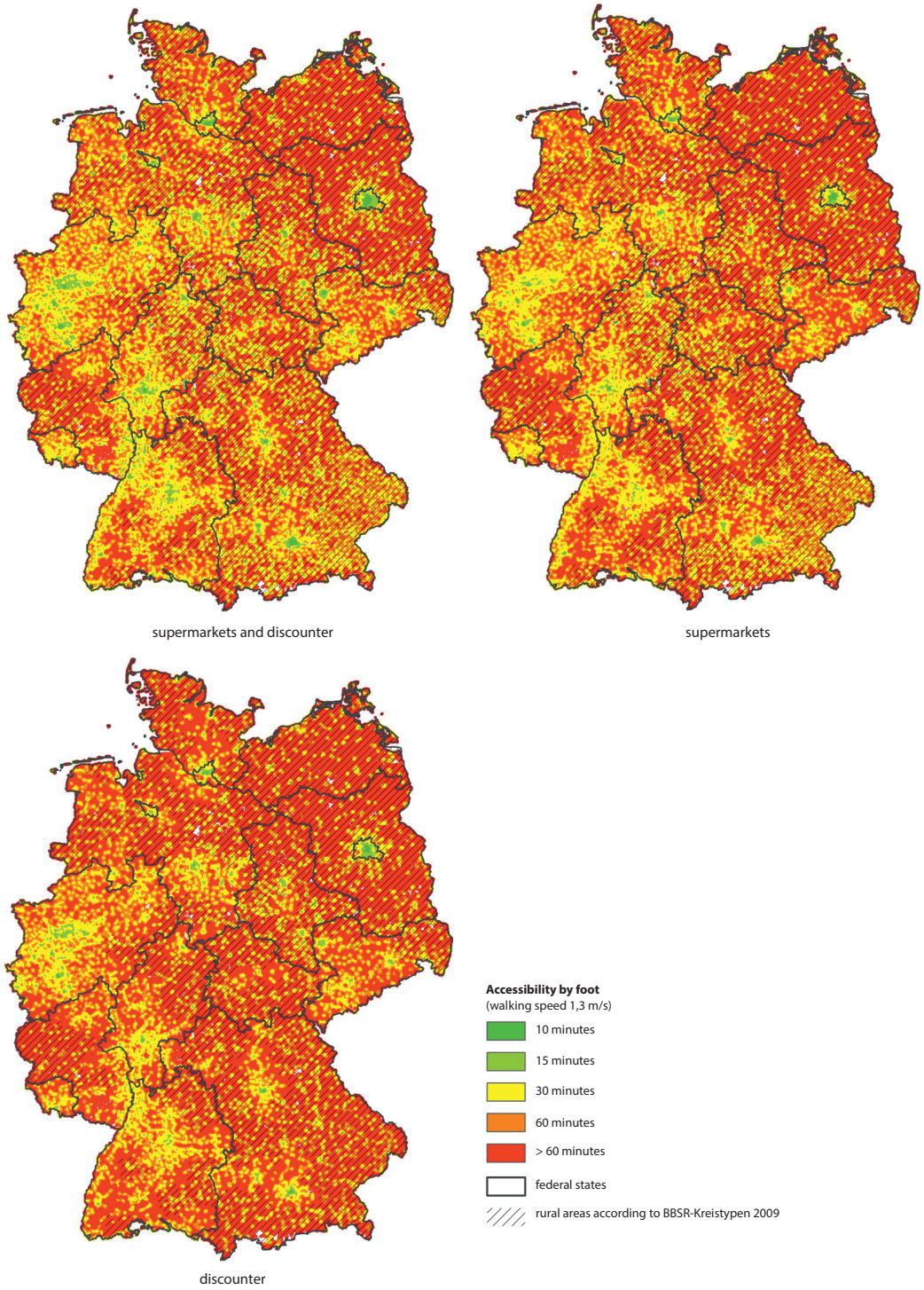


Figure 6
Heat map accessibility of supermarkets/discounter by foot. (Administrative boundaries: Bundesamt für Kartographie und Geodäsie, 2012; BBSR district types: BBSR; Data: Own calculations).

or discounter and supermarket to their home by car (60 km/h) within 15 minutes. 99.7 % reach the next discounter to their home within 15 minutes. In contrast, as can be seen quite obviously, the share of population that is able to reach the next supermarket or discounter by foot (1.3 m/s) in 15 minutes (~ 1,170 m) is 58.1 %, those who reach the next supermarket in the same time is 48.5 % and those who reach the next discounter is 45.5 %. A look at the different BBSR district types reveals that most of the people that are able to walk to the next supermarket or discounter within 15 minutes live in urban areas.

In summary, by car only 0.1 % of Germany's population is affected by a comparatively disadvantageous supermarket and discounter, as well as supermarket accessibility, 0.3 % by

Table 5
Average distances to the next supermarket/discounter by population and BBSR district types

BBSR district types 2009	population according to EWZ205		distance in meters								
			0 to ≤ 1,000 (political context)			0 to ≤ 1,170 (accessible up to 15 minutes by foot [1.3 m/s])			0 to ≤ 15,000 (accessible by car up to 15 minutes [60 km/h])		
			supermarket and discounter	supermarket	discounter	supermarket and discounter	supermarket	discounter	supermarket and discounter	supermarket	discounter
	total	in %	% of population according to EWZ250								
Germany	82,154,373	100.0	51.7	41.4	38.4	58.1	48.5	45.2	99.9	99.9	99.7
1: Core cities in agglomerations	18,920,862	23.0	17.3	14.6	14.5	18.8	16.6	16.5	23.0	23.0	23.0
2: Densely populated districts in agglomerations	14,127,619	17.2	9.3	7.1	6.5	10.7	8.6	7.9	17.2	17.2	17.2
3: Highly populated districts in agglomerations	6,252,935	7.6	2.9	2.3	2.0	3.4	2.8	2.4	7.6	7.6	7.6
4: Rural districts in agglomerations	2,961,253	3.6	1.3	0.9	1.0	1.5	1.1	1.2	3.6	3.6	3.6
5: Core cities in urbanised areas	4,844,255	5.9	4.1	3.4	3.4	4.5	3.9	3.9	5.9	5.9	5.9
6: Densely populated areas in urbanised areas	15,995,065	19.5	8.2	6.5	5.4	9.5	7.8	6.5	19.5	19.5	19.4
7: Rural districts in urbanised areas	8,476,885	10.3	3.3	2.6	2.3	3.8	3.0	2.7	10.3	10.3	10.2
8: Densely populated rural areas	6,921,942	8.4	3.6	2.9	2.3	4.1	3.4	2.8	8.4	8.4	8.4
9: Sparsely populated rural areas	3,653,556	4.4	1.6	1.2	1.1	1.8	1.4	1.3	4.4	4.4	4.4

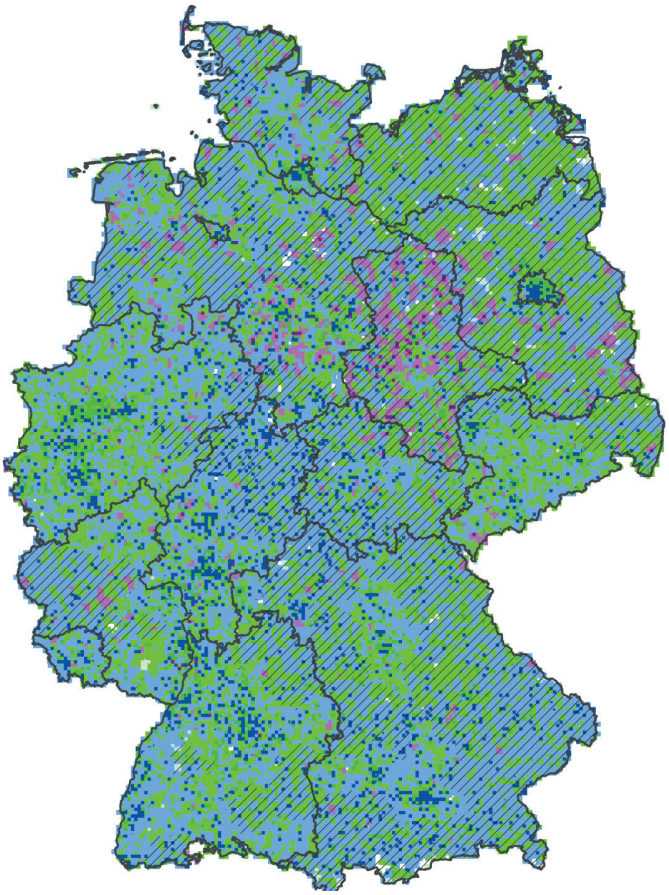
a disadvantageous discounter accessibility. In contrast by foot (1.3 m/s) 41.9 % of Germany's population has to walk longer than 15 minutes to reach the next supermarket or discounter as well as supermarket, 54.8 % to reach the next discounter. Again, considering population and accessibility it becomes obvious that mainly people living in rural areas are affected by a comparatively disadvantageous accessibility situation.

4.4 Proposal for an accessibility typology of supermarkets and discounters

One way to approach a comprehensive abridged overview of supermarket and discounter accessibility, breaking down the complexity contained in the accessibility data set, is to construct a typology. We did this on the basis of the single raster cells of the EWZ250 by choosing a simple, easily understandable disaggregative approach using a cross tabulation. We took the kind of shop (supermarket or discounter) next to the place of residence into account [3 region types: next market is supermarket/ next market is discounter/ both markets at same distance] as well as whether or not this shop can be reached by foot (1.3 m/s) or car (60 km/h) within 15 minutes [3 distance types: by foot/by car/not in 15 minutes)]. This led to following proposal for a typology for the 250 m raster cells of our base raster (Figure 7). For example, in the blue regions (55 % of the raster cells) the next market reachable is a supermarket. As can be seen, outside the cities there are only a few regions (12 %) where a supermarket can be reached by foot (walking speed 1.3 m/s) in 15 minutes (dark blue). In 42 % of the regions a supermarket can be reached within a maximum driving time (60 km/h) of 15 minutes (medium blue). Only in 0.12 % this supermarket cannot be reached by car within a driving time of 15 minutes (60 km/h) (light blue).

It can be assumed that the accessibility of a market of daily needs is best for people living in the dark and medium purple regions as here both a supermarket and discounter can be reached within 15 minutes either by car or by foot. People living in the dark and medium green regions have access to a supermarket with its large assortment of goods. In contrast, people living in the dark and medium green regions only have access to a discounter with its limited assortment of goods within the accepted walking or driving time of 15 minutes.

Two aspects are quite interesting. First the east-west distinction identifiable in Berlin, where in the western part the



next market	distance type	typ; % cells
next market is a supermarket	accessible by foot in 15 minutes (1.3 m/s; <= 1,170 m)	12.28
	accessible by car in 15 minutes (60 km/h; > 1,305 m <= 15,000 m)	42.41
	neither by foot nor by car accessible in 15 minutes (< 15,000 m)	0.12
next market is a discounter	accessible by foot in 15 minutes (1.3 m/s; <= 1,170 m)	10.11
	accessible by car in 15 minutes (60 km/h; > 1,305 m <= 15,000 m)	30.87
	neither by foot nor by car accessible in 15 minutes (< 15,000 m)	0.08
the distance to a supermarket or discounter is equal	accessible by foot in 15 minutes (1.3 m/s; <= 1,170 m)	0.86
	accessible by car in 15 minutes (60 km/h; > 1,305 m <= 15,000 m)	3.28
	neither by foot nor by car accessible in 15 minutes (< 15,000 m)	0.01
rural areas according to BBSR district types 2009		
unpopulated areas		

Figure 7
Typology supermarket/discounter accessibility. (Raster-cell-map has been visually enhanced by applying a 6 x 6 moving window majority filter to the original raster data). (Administrative boundaries: Bundesamt für Kartographie und Geodäsie, 2012; BBSR district types: BBSR; Data: Own calculations).

next markets are mainly supermarkets and in the eastern part the next markets are mainly discounters. Second, in Saxony-Anhalt, but also in some parts of Brandenburg and Saxony, there are comparably more cells where the next supermarket or discounter is at an equal distance. One reason for this phenomenon could be that here supermarkets and discounters are comparably often located in shopping centers at the outskirts of settlements.

5 Conclusion

Altogether the modeling results suggest that at present in Germany supermarkets and discounters are well accessible nationwide for people with a car available. Nevertheless, compared to the agglomerations in rural areas the driving times are comparably long. But this is relativized by the fact that regions with longer distances to reach the next supermarket/discounter are mainly sparsely populated. In contrast, by foot, only a comparably small amount of the population is able to reach the next supermarket or discounter within a maximal walking time of 15 minutes (supermarket or discounter: 58 %; supermarket: 49 %; discounter: 46 %). A clear urban-rural divide can be registered due to this aspect. That is, the share of the population able to walk to the next supermarket/discounter decreases by increasing rurality. In this regard it is particularly noticeable that a comparably disadvantageous accessibility can mainly be found in the federal states Mecklenburg-Western Pomerania, Brandenburg and the northeast of Saxony-Anhalt. So, especially for less mobile people, in rural areas supermarkets and discounter are quite poorly accessible. Drawing on findings of other studies (see BMVBS, 2009; 2009a) it can be assumed that in rural areas especially elderly people and young adults are affected by the comparably poor supermarket and discounter accessibility. The reason is that members of those two groups have been identified as the people least likely to have a car available. For certain small immobile groups of people and a few sparsely populated rural areas a disadvantageous supermarket and discounter accessibility can be registered. But, against the background that at present the main means of transport for shopping purposes is the car (vgl. BMVBS, 2011; Lein, 2012; Handelsverband Deutschland, 2013), and the fact that people in cities as well as rural areas still seem to be happy with the local retail situation (vgl. Ellger, 2000; Heinritz et al., 2003; Born, 2009; Handelsverband Deutschland, 2013), no urgent need for intervention can be identified at present.

Nevertheless, one should be aware that people living in regions with a comparatively disadvantageous accessibility situation might judge this differently based on their subjective local experience. Here, it can be advised to take such voices seriously and critically assess the specific local situation based on real-life field data, as modeling results cannot mirror the reality of a specific local place in all of its facets.

In conclusion, it has to be noted that a GIS-based accessibility analysis allows a quantitative assessment of the accessibility situation of basic services, provides first indications for potentially disadvantageous accessibility situations, and helps identify potential deficits. As such it can help to identify: a) potential case study regions and b) basic services with disadvantageous accessibility worth being considered in more depth. Although a more technical analysis is an essential precondition to gain important insights in accessibility situations of specific basic services, it says nothing about how people judge and deal with specific disadvantageous accessibility situations. But to fully assess the situation such information is needed in addition to the quantitative data. In this sense, to come to a comprehensive image of the retail situation and to be able to deduce policy recommendations in addition to the quantitative analysis we conducted, further in-depth research, building on detailed case studies of the more qualitative aspects of supermarket and discounter accessibility must be done. The study at hand can help to identify regions qualifying for such in-depth research.

Furthermore, to come to a comprehensive overview and reliable assessment of the situation of basic service provision, the analysis of one single kind of basic service, like for example supermarkets and discounters, is not enough. That is, if we want to identify regions disadvantaged with regard to basic services accessibility we should examine if and in which regions several important services are missing or poorly accessible (see for example (Neumeier. 2013) for the accessibility of street petrol stations or (Neumeier, 2012) for the accessibility of public pharmacies).

References

Adamovicz M, Bernreuther A, Wotruba M (2009) Nahversorgung 2010 : eine Studie der BBE Handelsberatung GmbH und der IPH Handelsimmobilien GmbH. München : BBE, 114 p

Amt für Raumentwicklung und Geoinformation St. Gallen (2008) Erreichbarkeit Grundversorgung [online]. To be found at <http://www.sg.ch/home/bauen__raum___umwelt/raumentwicklung/raumbeobachtung/indikatoren_zur_raeumlichen._____etc_____medialib_____dokument_library_____bauen__raum___umwelt_____raumentwicklung_____raumbeobachtung.Par.0013.FileRef.tmp/ErreichbarkeitGrundversorgung_Kanton.pdf> [quoted 26.06.2014]

BBSR - Bundesinstitut für Bau-, Stadt- und Raumforschung (2009b) Karte siedlungsstrukturelle Kreistypen : Stand 2009 [online]. To be found at <http://www.bbsr.bund.de/BBSR/DE/Raumbeobachtung/Raumabgrenzungen/SiedlungsstrukturelleGebietstypen/Kreistypen/Downloadangebote.html> [quoted 01.07.2014]

Beckmann RM (2007) Nahversorgung als Basis der Zentrenbildung : aktuelle Modelle, Strategien und Konzepte gegen wegbrechende Handels- und Dienstleistungsnutzung. Berlin : DSSW, 131 p, DSSW-Schr 56

Bernreuther A (2011) Struktur- und Marktdaten im Einzelhandel 2010 [online]. To be found at <http://www.stmwivt.bayern.de/fileadmin/user_upload/stmwivt/Publikationen/BBE_Struktur_und_Marktdaten_im_Einzelhandel_2010.pdf> [quoted 26.06.2014]

Bleisch A (2005) Die Erreichbarkeit von Regionen : ein Benchmarking-Modell. Basel : Univ, 228 p

Bleisch A, Koellreuter C (2003) Die Erreichbarkeit von Regionen [online]. To be found at <http://e-collection.ethbib.ethz.ch/eserv/eth:27008/eth-27008-01.pdf> [quoted 26.06.2014]

Born KM (2009) Anpassungsstrategien an schrumpfende Versorgungsstrukturen : Beispiele aus Brandenburg und Niedersachsen. In: Neu C (ed) Daseinsvorsorge : eine gesellschaftswissenschafliche Annäherung. Wiesbaden : VS Verl Sozialwiss, pp 133-153

Borutta A, Neundörfer M, Baum T (2012) Trendreport Discounter [online]. To be found at <http://www.lebensmittelzeitung.net/studien/pdfs/432_.pdf> [quoted 26.06.2014]

BMVBS - Bundesministerium für Verkehr, Bau und Stadtentwicklung (2009) [online]. To be found at <http://www.mobilitaet-in-deutschland.de/pdf/MiD2008_Praesentation_Abschlussveranstaltung_August2009_Fassung-Maerz2010.pdf> [quoted 04.08.2015]

BMVBS - Bundesministerium für Verkehr, Bau und Stadtentwicklung (2009a) Mobilität in Deutschland [online]. To be found at <http://www.mobilitaet-in-deutschland.de/02_MiD2008/publikationen.htm> [quoted 04.08.2015]

BMVBS - Bundesministerium für Verkehr, Bau und Stadtentwicklung (2011) Nahversorgung und Nahmobilität : Verkehrsverhalten und Zufriedenheit [online]. To be found at <http://www.bbsr.bund.de/nn_495526/BBSR/DE/Veroeffentlichungen/BMVBS/Online/2011/ON082011.html> [quoted 26.06.2014]

Bundesverband des deutschen Lebensmitteleinzelhandels (2013) Daten und Fakten [online]. To be found at <http://www.bvlh.net/infothek_daten-fakten.html> [quoted 26.06.2014]

Burgdorf M (2010) Disaggregation von Bevölkerungsdaten mittels ATKIS Basis DLM. In: Strobl J (ed) Angewandte Geoinformatik 2010 : Beiträge zum 22. AGIT-Symposium Salzburg. Berlin : Wichmann, pp 474-483

Dahlgren A (2008) Geographic accessibility analysis : methods and applications [online]. To be found at <http://www.dissertations.se/dissertation/ff24596a13/> [quoted 26.06.2014]

EHI, 2013 [online]. To be found at <http://www.ehi.org/fileadmin/images/contenet_images/Presse/Handel_aktuell/Sortbreite_Definitionen.pdf> [quoted 01.10.2013]

Eib M, Braun D (2014) Demografischer Wandel und Daseinsvorsorge im ländlichen Raum am Beispiel Thüringens. Konrad-Adenauer-Stiftung. Handreichung zur politischen Bildung Band 14. [online]. To be found at <http://www.kas.de/wf/doc/15114-1442-1-30.pdf> [quoted 18.06.2015].

Ellger C (2000) Dienstleistungen im ländlichen Raum : Versorgung aus der Sicht der Nutzer, räumliche Verflechtungsmuster und zentrale Orte untersucht im südlichen Landkreis Dahme-Spreewald ; Projektbericht. Berlin : FU, 63 p, Manuskr empir theor angew Regionalforsch 38

Fina S (2012) Die neue Geographie der Segregation. arcAktuell 4:14-15

European Commission (2014) [online]. To be found at <http://ec.europa.eu/regional_policy/what/cohesion/index_en.cfm> [quoted 30.06.2014]

Faber K (2013) Raumpioniere in ländlichen Regionen : neue Wege der Da seinsvorsorge. Leipzig : Spector Books, 214 p

Favry E (2006) Aufrechterhaltung der Funktionsfähigkeit ländlicher Räume : Dienstleistungen der Daseinsvorsorge und regionale Governance ; Veränderungen, Herausforderungen, Handlungsbedarf. Wien : ÖROK, 135 p, SchR Österr Raumordnungskonf 171

Gatzweiler H-P, Kocks M (2004) Demographischer Wandel. Modellvorhaben der Raumordnung als Handlungsfeld des Bundes. In: Raumforschung und Raumordnung . Volume 62 . Issue 2. 133-148

Götz-Neumann K (2006) Gehen verstehen : Ganganalyse in der Physiotherapie. Stuttgart : Thieme, 200 p

Granacher U, Mühlbauer T, Bridenbaugh S, Wehrle A, Kressig RW (2010) Altersunterschiede beim Gehen unter Einfach- und Mehrfachtätigkeit. Dtsch Zeitschr Sportmedizin 61(11)258-263

Handelsverband Deutschland (Hrsg.) (2013) Qualifizierte Nahversorgung im Lebensmitteleinzelhandel. Endbericht [online]. To be found at <http://www-wiwi-cms.uni-regensburg.de/images/institute/IREBS/Klein/qualifizierte_nahversorgung_endbericht.pdf> [quoted 04.08.2015]

Hart PE, Nilsson NJ, Raphael B (1968) A formal basis for the heuristic determination of minimum cost paths. IEEE Trans Syst Sci Cybern 4(2):100–107

Heinritz G, Klein K, Popp M (2003) Geographische Handelsforschung. Berlin : Borntraeger, 257 p

Hemetsberger M, Ortner S (2007) ERRAM – das Erreichbarkeits–Raster–Raum-Analyse-Modell [online]. To be found at <http://www.raumordnung-noe.at/fileadmin/root_raumordnung/land/landesentwicklungsplanung/erram_broschre.pdf> [quoted 02.07.2015]

Hemetsberger M, Ortner S (2008) Erreichbarkeitsbasierte Raster Raumanalyse – Anwendungen in der Landesplanung. In: Schrenk M, Popovich V, Engelke D, Elisei P (eds) REAL CORP 008: mobility nodes as innovation hubs : proceedings of 13th International Conference on Urban Planning, Regional Development and Information. Schwechat-Rannersdorf : CORP, pp 255-263

Higgs G, White SD (1997) Changes in service provision in rural areas : part 1: The use of GIS in analysing accessibility to services in rural deprivation research. J Rural Stud 13(4):441-450

Jens K (2009) Wandel der Daseinsvorsorge : von der Gleichwertigkeit der Lebensverhältnisse zur wirtschaftlichen, sozialen und territorialen Kohäsion. In: Neu C (ed) Daseinsvorsorge : eine gesellschaftswissenschaftliche Annäherung. Wiesbaden : VS verl Sozialwiss, pp 22-38

Johnston RJ, Gregory D, Pratt G, Watts M (2000) The dictionary of human geography. Oxford : Blackwell, 958 p

Kaup S, Rieffel P (2013) Rasterbasierte Regionalstatistik. ILS-Trends 2/13

Kollmann J, Sieker T (2006) Demografischer Wandel und Einzelhandel [online]. To be found at <http://www.wfo.de/downloads/WFO-broschuere_Demografischer_Wandel_und_Einzelhandel.pdf> [quoted 27.10.2014]

Kötter T, Schuppe T, Maringer S (2013) Anpassungsstrategien für die Daseinsvorsorge in ländlichen Gemeinden mit vielen Ortsteilen [online]. To be found at <http://www.usl.uni-bonn.de/pdf/Forschungsbericht%20175.pdf> [quoted 02.07.2015]

KPMG (2005) Der deutsche Lebensmitteleinzelhandel aus Verbrauchersicht [online]. To be found at <http://www.yumpu.com/de/document/view/318093/der-deutsche-lebensmitteleinzelhandel-aus-verbrauchersicht> [quoted 26.06.2014]

Krieh C (2011) Erwerbstätigkeit in den ländlichen Landkreisen: Strukturen und Entwicklungstrends. Ländlicher Raum 62(20781) pp 4-8.

Kuhlicke C, Petschow U (2005) Sozialräumliche Disparitäten in Deutschland : vom schleichenden Ende der Nahversorgung. Ökol Wirtschaften 4:39-42

Kuhlicke C, Petschow U, Zorn H (2005) Versorgung mit Waren des täglichen Bedarfs im ländlichen Raum : Studie für den Verbraucherzentrale Bundesverband e.V. ; Endbericht [online]. To be found at <http://www.markttreff-sh.de/index.php?getfile=studie_laendlicher_raum_lang.pdf> [quoted 26.06.2014]

Küpper P (2011) Regionale Reaktionen auf den demographischen Wandel in dünn besiedelten, peripheren Räumen. Berlin : Rhombos-Verl, 363 p, IÖR Schr 53

Küpper P, Eberhardt W (2012) Nahversorgung in ländlichen Räumen [online]. To be found at <http://nbn-resolving.de/urn:nbn:de:101:1-2013021914523> [quoted 30.06.2014]

Küpper P, Eberhardt W (2013) Nahversorgung in ländlichen Räumen [online]. To be found at <http://www.bbsr.bund.de/BBSR/DE/Veroeffentlichungen/BMVBS/Online/2013/DL_ON022013.pdf?__blob=publicationFile&v=2> [quoted 26.06.2014]

Lein J (2012) Perspektiven der Nahversorgung : Trends im Konsumverhalten, Villingen-Schwenningen, 13. September 2012 [online].To be found at <http://www.lel-bw.de/pb/site/lel/get/documents/MLR.LEL/PB5Documents/alr/pdf/1/120626_Beitrag_Lein.pdf> [quoted 01.07.2014]

Meyer W (2006) Zeige mir die Achse des Bösen – Geostatistische Welt-Bilder. In: Strobl J, Blaschke T, Griesebner G (eds) Angewandte Geoinformatik 2006 : Beiträge zum 18. AGIT-Symposium Salzburg. Heidelberg : Wichmann, pp 454-459

Morgenroth O (2008) Zeit und Handeln : Psychologie der Zeitbewältigung. Stuttgart : Kohlhammer, 223 p

Muschwitz C, Bauer F, Blatt P, Klos G, Li Y, Ratke T, Speicher M, Strauch M (2011) Nahversorgung näher bringen [online]. To be found at <http://www.google.de/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCIQFjAA&url=http%3A%2F%2Fraumkom.de%2Ffiles%2Fnahversorgung_broschuere&ei=9ASxU6W8EvPb7Ab74YCwCA&usg=AFQjCNFGj8UulaLZvT5faGKjmBglsxwj0w&bvm=bv.69837884,d.ZGU> [quoted 30.06.2014]

Neu C (2009) Daseinsvorsorge : eine gesellschaftswissenschaftliche Annäherung. Wiesbaden : VS Fachverl Sozialwiss, 222 p

Neumeier S (2012) Modellierung der Erreichbarkeit von Straßentankstellen : Untersuchung zum regionalen Versorgungsgrad mit Dienstleistungen der Grundversorgung. Braunschweig : vTI, 90 p, Arbeitsber vTI-Agrarökonomie 2012/09

Neumeier S (2013) Modellierung der Erreichbarkeit öffentlicher Apotheken : Untersuchung zum regionalen Versorgungsgrad mit Dienstleistungen der Grundversorgung. Braunschweig : Johann Heinrich von Tünen-Institut, 66p, Thünen Working Paper 14

Perry J (1992) Gait analysis : normal and pathological function. Thorofare NJ : Slack, 524 p

Schrader H-J, Paasche C (2010) Nahversorgung. Strukturen – Entwicklungen – Chancen : eine empirische Studie [online]. To be found at <https://www.yumpu.com/de/document/view/7234803/nahversorgung-strukturen-bbe-munster-standort> [quoted 30.06.2014]

Schulz A-C, Bröcker J (2007) Die Erreichbarkeit der Arbeitsmärkte für Berufspendler aus den Gemeinden Schleswig-Holsteins [online]. To be found at <http://doku.iab.de/regional/N/2007/regional_n_0107.pdf> [quoted 30.06.2014]

Schürmann C (2008) Berechnung verschiedener Erreichbarkeitsindikatoren für den Ostseeraum mit ArcGIS Network Analyst [online]. To be found at <http://www.brrg.de/_content/documents/publications/dak08_erreichbarkeit.pdf> [quoted 02.07.2015]

Schürmann C, Spiekermann K, Wegener M (1997) Accessibility indicators. Dortmund : Inst Raumplanung, 119 p, Ber Inst Raumplanung 39

Schwarze B (2005) Erreichbarkeitsindikatoren in der Nahverkehrsplanung. Dortmund : IPRUD, 52 p, Arbeitspap Inst Raumplanung 184

Specht J, Wenz K, Häring A M, Braun C L (2013) Wandel im ländlichen Raum: Von Wandlungsprozessen zu neuen Kompetenzbedarfen. Arbeitspapier Fachgebiet Politik und Märkte in der Agrar- und Ernährungswirtschaft. Hochschule für Nachhaltige Entwicklung Eberswalde [online]. To be found at < http://hne.fh-eberswalde.de/_obj/D5F997CE-3EFB-41B1-9F52-423137259546/outline/Wandel_im_laendlichen-Raum_Spechtetal_end.pdf> [quoted 27.10.2014]

Statistisches Bundesamt (2009) Bevölkerung Deutschlands bis 2060. 12. Koordinierte Bevölkerungsvorausrechnung [online]. To be found at https://www.destatis.de/DE/Publikationen/Thematisch/Bevoelkerung/VorausberechnungBevoelkerung/BevoelkerungDeutschland2060Presse5124204099004.pdf?__blob=publicationFile [quoted 27.10.2014]

Steinführer A (2014) Anpassung an den demographischen Wandel - was heißt das eigentlich? Land-Berichte, Band 17. Heft 1. 9-25

Steinführer A, Küpper P, Tautz A (2014) Anpassen und Bewältigen: Strategien zur Sicherung von Lebensqualität in einer schrumpfenden Altersregion. Comparative population studies. Band 39. Heft 2. 319-344

Steinrück B, Küpper P (2010) Mobilität in ländlichen Räumen unter besonderer Berücksichtigung bedarfsgesteuerter Bedienformen des ÖPNV. Braunschweig : vTI, 91 p, Arbeitsber vTI-Agrarökonomie 2010/02

Tönnies G (2004) Forschungen der ARL zu den räumlichen Auswirkungen des demographischen Wandels. In: Raumforschung und Raumordnung Volume 62 . Issue 2. 149-156

Vallée D, Lenz B (2007) Einzelhandel und Einzelhandelsstandorte : Entwicklungstendenzen und Steuerungsmöglichkeiten. Arbeitsmaterial ARL 333:19-45

Yeager, C.; Gatrell, J. (2014): Rural food accessibility: An analysis of travel impedance and the risk of potential grocery closures. In: Applied Geography. Vol. 53. P. 1-10

Websites

www 1: http://ec.europa.eu/regional_policy/what/cohesion/index_en.cfm [quoted 30.06.2014]