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'Real' versus 'mental' food deserts from the consumer perspective – concepts and quantitative methods applied to rural areas of Germany

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Abstract

Developments in food retail in Germany have for decades tended to lead to ever larger retail units, the filling of these units with ever broader and deeper product ranges, and an increasingly oligopolistic market dominated by chain stores. However, as the large chain stores only choose the 'best possible' sites according to population density, absolute purchasing power and transport networks, there has been a dramatic thinning out of food-retail facilities in large, particularly rural areas. Has this made it possible to detect supply gaps or, more polemically expressed, food deserts? The term 'food deserts', in particular, has achieved a certain amount of acclaim in the Anglo-American context since the 2000s. However, the concept has neither been transferred to nor empirically verified for the German context. In this paper quantitative and qualitative methods are applied to investigate the situation in the rural regions of the most northerly state of Germany (Schleswig-Holstein), in order that food deserts no longer be understood only as 'real', tangible and bounded patterns arising from the thinning out of infrastructure but rather as cognitive, perceived patterns (mental food deserts). It is suggested that customer (groups) have long-term and varied shopping predispositions so that diverse groups no longer perceive the loss of supply options and actually create local supply gaps for others through their shopping behaviour. Cluster, discriminant and network analyses are used to complement an inventory of tangible retail facilities with 'lived' mental attitudes and shopping behaviour, distinctly broadening the present understanding of food deserts.

Zusammenfassung

Die Entwicklungen im deutschen Lebensmitteleinzelhandel hin zu tendenziell immer noch größer werdenden Ladeneinheiten, die Ausfüllung dieser Einheiten mit immer breiteren und tieferen Sortimenten und die fortschreitende Oligopolisierung unter den Filialketten schreiten seit Jahrzehnten voran. Weil sich aber die Großketten nur die „bestmöglichen“ Standorte nach Bevölkerungsdichte, absoluter Kaufkraft und verkehrlicher Logistik sichern, dünnen großflächige, vor allem ländliche Territorien in ihrer Lebensmittelversorgung dramatisch aus. Lassen sich hierdurch Versorgungslücken oder, semantisch verschärft, gar Versorgungswüsten konstatieren? Vor allem der Begriff der *food deserts* hat seit den 2000er Jahren für den angloamerikanischen Kontext eine gewisse Berühmtheit erlangt. Ein Transfer von Konzeption und empirischem Nachweis auf die deutsche Situation steht noch aus. Anhand quantitativer und qualitativer Methoden, die auf ländliche Regionen im nördlichsten Bundesland Deutschlands, Schleswig-Holstein, Anwendung finden, sollen *food deserts* nicht mehr nur als

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„reale“ und abgrenzbare Muster infrastruktureller Ausdünnung, sondern als kognitive, wahrgenommene Ausdünnungsmuster verstanden werden (mentale *food deserts*). Unterstellt wird, dass Kunden(gruppen) in ihrem Einkaufsverhalten langfristig und unterschiedlich prädisponiert sind, sodass diverse Gruppen den Verlust an Versorgungsangeboten nicht mehr wahrnehmen und durch ihr Einkaufsverhalten Nahversorgungslücken für andere erst schaffen. Hierfür werden Cluster-, Diskriminanz- und Netzwerkanalysen durchgeführt, um reale Ausstattungsinventare mit „gelebten“ mentalen Einstellungen und Einkaufsverhalten zu spiegeln und das bisherige Verständnis von *food deserts* deutlich zu erweitern.

Keywords food deserts, local shopping, food retail, cognition, network, rural areas, Germany

1. Introduction

The academic field of retail research is particularly interdisciplinary, involving subjects such as a) business administration, concerned with marketing and the internal processes of firms; b) politics and planning, which influence the expansion and locational decisions of businesses; c) food science, medicine and ecotrophology, which focus on the composition and healthiness of food products and through their specialist knowledge positively or negatively impact the sales results of individual shops; d) psychology, product marketing and market research, concerned with customer types and attitudes; e) geographical retail research, which takes a spatial perspective on varying scales (from the micro to the macro level) and thus focuses not on individual shops or products but on identifying spatial-temporal patterns of retail ownership and analysing their consequences, considering the diverse actors involved. In comparison with other disciplines, geographical retail research is particularly distinguished by its systematic consideration of mutually determining groups of actors in their interacting (spatial) networks, subjecting them to diverse methodological approaches such as GIS, statistical investigation and network analysis. There is clearly considerable diversity in current research on food supplies, convenience shopping and the thinning out of retail facilities that results from processes of concentration on the supply side and the focus on private cars and mobility on the customer side. The perspective taken by geographical retail research competes with the perspectives of many other disciplines for dominance of the discourse about the most appropriate assessment criteria and approaches to local food retail, of relevance both now and in the future. It follows that over the last two decades the concepts, definitions, operationalisation, applied methods and empirical findings concerned with so-called food deserts have been diverse and not always mutually

compatible. Is the focus on areas where there are no more shops due to closures? Or on regions where the diversity of providers is limited to one well-known supermarket? Or is the range of products within one retail system too limited or 'unhealthy'? Or do groups of people have very different subjective perceptions of the thinning out of retail facilities?

These deliberations determine the structure of the following paper. First, the state of research is reviewed, tracing the different perspectives taken on food deserts. A concept from the field of psychological market research is presented, widening the present understanding of food deserts. This is followed by a description of the methodology and implementation of an empirical survey undertaken by the author and the deconstruction of 'real' food deserts (via GIS) to mental food deserts and cognitive maps. The conclusion and discussion of future developments focus on possible applications of 'mental' food deserts.

2. State of research

Strand 1 – The health discourse: Food deserts are primarily identified where there is no sufficient supply of so-called healthy and nonetheless affordable food for residents in the catchment area of a shop, usually normatively defined in terms of minutes or kilometres (Leete et al. 2012: 207). Healthy food is, e.g., characterised by a varied supply of fruit and vegetables (Farley et al. 2009), although it remains unclear whether potential customers can also afford, know about or prepare such supplies (Pettygrove and Ghose 2016: 271; Wright et al. 2016: 176). Especially in the US-American context, the methodology of the Chicago School of Sociology has been used to analyse big data from censuses, finding correlations between population structures (ethnicity, social status, automobility, age, etc.), and (disadvantageous) food supply

(Thibodeaux 2016). Such correlations may then be manifested in striking patterns of disease such as obesity and diabetes (Morland et al. 2006; Moore and Roux 2006). Food deserts have been declared dystopian spaces (especially in urban areas and inner cities) in which people are not starving but are rather leading 'unhealthy' and, at worst, through personal negligence, 'undisciplined' lives.

Strand 2 – GIS (Geographical Information Systems) analyses: Spatial representations of food deserts created using computerised systems and based on retail occupancy and accessibility networks have repeatedly triggered questions about whether more realistic GIS models could not be created, with the aim of breaking down the container-like and spatially and temporally static image of food deserts (Widener et al. 2013: 1). It has been suggested that:

- a) All shops may not be equally weighted by customers in terms of perception, recognition, acceptance, image, diversity of supply and accessibility (physical, financial, informational access, culturally appropriate access) and may indeed not all actually represent food-supply options (Eckert and Shetty 2011: 1216; Chen and Clark 2013: 82);
- b) Spatial accessibility may vary over time ("deserts appear in the period of a day"; Chen and Clark 2013: 84), whether this refers to opening times set by the supplier or to the travel times and mobility of various customer groups on a daily or even life-cycle scale (Kestens et al. 2010: 1095; Chen and Clark 2016: 176);
- c) Food-shopping trips may not necessarily always start at home and may take the form of chain trips (Widener et al. 2013: 2) so that food environments or food deserts are located not only in local residential environments but in the much more complex activity spaces of each individual (Kestens et al. 2010);
- d) Food deserts cannot be represented as bounded and 'absolute' spatial islands. Due to different levels of personal disadvantages (age, mobility, travel speed, finances, etc.) they rather reflect "different levels of relative hardship in accessing food sources" (Russell and Heidkamp 2011: 1201).

Three fundamental challenges emerge from these considerations: 1. With their complexity and supposed accuracy, GIS maps make a strong visual impact and can develop a powerful momentum of their own, particularly with planners and politicians; 2. GIS only

produces spatial models, potential studies (potential access; Eckert and Shetty 2011: 1222) and catchment area scenarios for individual groups; these then need to be scrutinised and elaborated using empirical data from outside the GIS-cosmos; 3. The GIS literature itself identifies types of accessibility that can no longer be simply equated with the (quantitative 'objective') physical access of potential customers to a shop. Subjective spaces of perception and information overlap these 'objective' spaces as mental availability (Goodman and Remaud 2015: 118) and push these GIS representations of food deserts to their limits.

Strand 3 – Discussion of concepts: More recent work contradicts the original definition of food deserts as covering fixed 'pre-existing areal units' within the boundaries of which demographic criteria can be correlated with the accessibility and levels of use of food retail. Acceptance is growing for the notion that accessibility represents only a 'measure of supply' and 'not a descriptor of behavior' of customers (quoted from Choi and Suzuki 2013: 87); individual accessibility can thus differ from locational accessibility. Choi and Suzuki (2013: 88) define individual accessibility as the 'proximity or number of opportunities that one perceives on a personal level'. The focus is thus no longer on the area-based identification of food deserts as compact and homogeneous spaces. Rather attention has also turned to the individual level of groups of people with different propensities and problems related to food shopping, who thus have their own and group-specific food-desert experiences, some of which overlap (Ver Ploeg et al. 2015: 206). Very few investigations have thus far been able to integrate a temporal component to reflect the changeability of 'spatial' or 'mental' food deserts ("atemporal data"; Widener and Shannon 2014: 1), firstly to prove that they actually exist ("fabricate food deserts"; Sadler et al. 2016: 445), secondly to discover whether intervention in retail occupancy can trigger new patterns of shopping and satisfaction.

Strand 4 – The German discourse on local supply: With a few exceptions (Jürgens 2016; Augustin 2014; Sperk and Kistemann 2012), neither the term nor the concept of food deserts has thus far had a lasting impact on German-language retail research. At the same time, there has been increased academic interest in local food supplies in distinctly rural areas – not the so-called commuter-belts of larger cities or popular tourist districts but areas threatened by demographic trends leading to the decline and aging of the population (Warburg 2011; Zibell et al. 2015; IEL 2015; Helmle and Kuczera 2015; Hahne 2016).

Food retail is seen (from the planning point of view) as an anchor for other service-oriented institutions, and as long as local grocery stores are in operation it is said that the settlement's 'heart' continues to beat (Zibell et al. 2015: 149). Long-term studies (Helmle and Kuczera 2015; Küpper and Scheibe 2015: 49) cast doubt on this finding: it is not possible to prove that the disappearance of food retail is linked to subjective satisfaction levels. Residents adjust to the structures (Hahne 2016: 177) or accept them, so that levels of satisfaction among the population are much better than the objective conditions. Steinröx (2013: 166f) believes that individual residents ignore the danger that the diminishing attractiveness of the focal point of everyday life may accelerate population decline, especially as people find it increasingly necessary to travel to neighbouring towns for other public and private services.

Much research thus identifies rural municipalities (and also urban districts; Baaser and Zehner 2014) as potential food crisis regions although, in contrast to the Anglo-American discussion, attention is directed more towards the existence of supplies than to the 'healthiness' of those supplies. Best-case alternatives to the world of discount stores and supermarkets are thus debated – also in comparison to the rest of Europe (Schaloske 2013; Küpper and Tautz 2015; Schenk 2016). Quantitative accessibility studies (Segeer 2014; Neumeier 2015) on the one hand, and strategy-oriented governance analyses of civic involvement and private sector initiatives to safeguard local food retail on the other hand (Warburg 2011; Schaloske 2013), feature prominently among recent analyses of 'quality' local supply and village shops. Long-term analyses of the extent to which structural and constructional changes in retail also impact on the behaviour and 'basic emotional attitudes' of customers are to date as rare in German-speaking geographical retail research (Meyer 2005; Monheim and Heller 2016) as consideration of individual accessibility, which goes beyond locational accessibility measured by travel time. The spatial and temporal dynamics of supply systems and, on the customer side, of structures of perceptions and use can demonstrate that 'foodscapes' or even food deserts are 'not simply based on proximity and accessibility' (Del Casino 2015: 801) but rather comprise complex social interactions between diverse actor groups.

3. Extending the food desert discussion and investigation

It is clear that the research strands presented above utilise very different perspectives, definitions, and (technical) methods to discuss the nature of food deserts. They have in common that they focus on the 'real' food desert in its spatial extent, facilities, and accessibility. The deeper-lying, 'hidden' mental structures that influence reality and exist behind the tangible food deserts have not yet been embraced by the well-known literature on food deserts. However, other disciplines such as environmental psychology have already adopted such subject matter.

The psychological approach assumes that due to differing levels of knowledge and different motives people perceive their environment in different ways and store it as a context-dependent or -independent memory. This can take the form of abstract categories or units of meaning (Swoboda 1996: 320), semantic knowledge that is responsible more for a consistency of attitude than for concrete satisfaction. This knowledge is stored in the long-term memory, becoming part of the short-term memory after activation (Holzmann and Wührer 2000: 431), and can thus be involved in relevant mental processes of perception and memory, e.g. in a shop (Swoboda 1996: 324). The literature discusses semantic networks consisting of a multitude of propositions that each emerge from a combination of 'argument' and 'relation'. Through external or internal stimuli, a person becomes individually aware (again) of these arguments and reacts to them mentally or with concrete action. As this tends to involve stable 'recallable information in consumers' minds' (Maggioni 2016: 121), the semantic networks of individuals can be used to predict their behaviour (Holzmann and Wührer 2000: 431f.; Seitz 2015).

Cognitive psychology argues that human memory is made up of a network of associations that encompasses, on the one hand, criteria and, on the other hand, relations between criteria and their relative weightings; this then allows cognitive maps for the individual or aggregated level to be derived (Wühler 2001: 777). These 'maps' are based on a) existing positive and negative experiences; b) individual processing, knowledge capacities and possibilities for new learning or the reinterpretation of old knowledge and experience and c) imaginings or expectations that may be stored independently of experience (Swoboda 1996: 322f.). This gives rise to comprehensive 'knowledge

structures' that exist both consciously and to a large extent unconsciously in human memory and that, e.g., marketing planning aims to expose and then influence through external communication tools. The utilisation of network analysis or associative networks is relatively new in the field of retail research and takes the form, e.g., of investigations into customer loyalty or brand marketing (Hellmann and Marschall 2010: 647).

In the literature to date there is no indication that this approach has ever been used for the investigation of food deserts. This paper therefore not only applies GIS to analyse the development of retail facilities in tangible areas but also investigates 'mental representations' (Teichert and Schöntag 2010: 370) of supply areas from the consumer perspective. This allows networks of associations between retail formats and places to be uncovered and thus patterns of experiences, knowledge, uses, alternatives and features of local supply to be identified as problematic (analogous to Holzmann and Wührer 2000: 438).

Are supply gaps perceived by consumers? Are these gaps seen as being problematic (Küpper and Scheibe 2015: 49)? Are people interested in options that could eradicate food deserts? Who uses a village shop (Broadbridge and Calderwood 2002)? What types of customers identify themselves with 'alternative' offerings beyond the world of supermarkets and discounters, what types identify themselves only with the dominant discount store? These questions are at the center of the following discussion.

4. Methods and locations

The investigation thus focuses on the demand-oriented perspective. Use is made of a mix of quantitative and qualitative methods, applied in 2016 firstly for the entire area of the federal state of Schleswig-Holstein (SH), and secondly for five selected rural municipalities. The GIS investigations with ESRI-ArcGIS used areal data on the spatial distribution of supermarkets, food discount stores and smaller grocery stores (sales area under 400 m²), provided by Nielsen Company (2015) in the form of a professionally managed databank. This dataset includes the various operating names of the supermarkets and discount stores and also the outlets' sales area, year of opening and status ('active' or 'non-active'). The data are not complete for all premises. The status 'non-active'

and thus 'closed premises' is only held in the system as long as the premises show no subsequent use, at which point it is overwritten in the Nielsen Company databank. The GIS coordinates were manually determined for all premises using Google Maps and entered in the databank. In addition, all bakeries (in particular their branch networks) were identified through an internet search of the bakers' guild, the Yellow Pages and the web pages of the bakery chains, as bakers (unlike butchers) provide an alternative food-retail network thanks to their continued high numbers, spatial convenience and additional food offerings.

This approach aims to provide a representation of stationary food supply networks and accessibility gaps that is more realistic than that achieved by many Anglo-American analyses, which are limited by a frequent fixation on supermarkets and department stores with food departments. GIS analyses using structural data are thus an initial technical approach towards a) identifying areal patterns of the distribution, concentration and thinning out of stationary food retail; b) using a spatial approach to identify the quantitative relevance of individual patterns as the generalisable variables of many individual cases; c) modelling the accessibility of food supplies for various customer groups (of differing age and social mobility) by using changeable speeds and transport modes (car, bicycle, pedestrian); d) no longer defining the accessibility of food retail according to nameless and supposedly interchangeable retail premises. Rather, the Nielsen Company dataset makes it possible to reconstruct the entire spatial networks of the supermarkets and discount stores of various operators, and thus to identify the various supply options ('not just any shop') available to customers; e) modelling the different spatial scales because it is possible to zoom in on large-scale case studies from the small-scale area of an entire federal state.

The latter possibility allows detailed patterns of the thinning out of food retail in rural regions to be depicted. Social-empirical methods on the 'lived' micro-level are required to show whether these supply gaps are perceived as problematic, which alternative food retail options elsewhere are used, the nature of local discussions about these supply gaps, and whether local supply alternatives are commercially successful.

In 2016, quantitative empirical investigations were carried out in selected rural regions of Schleswig-Holstein with the aim of improving the understanding

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of the food desert phenomenon in the German context and advancing discussions on ways of operationalising food deserts. Standardised questionnaires were distributed to all households in the case-study municipalities via postal delivery. The response rate over all municipalities was 15.4% (385 questionnaires). The survey was conducted with the agreement of the mayors or village shops, firstly to increase residents' acceptance of the questionnaire and, secondly, to allow anonymous locations for responses to be established. In three cases, the questionnaire was combined with a prize-winning competition. However, response rates were similar to those in the two municipalities without the competition. Further information on the structure of the questionnaire, the locations and the technical implementation is found in *Tables 1* and *2*.

A political planning debate concerning local supply facilities is currently being conducted at all locations, so there is likely to be sufficient sensitivity for the topic among local experts and stakeholders, on the one hand, and among local residents, on the other hand. Naturally, the municipalities differ in their micro-contexts, i.e. in terms of size, age distribution, proximity to rural towns with clusters of well-known

supermarkets or discount stores as alternatives to village retail options, and in their past experience with village shops. As quantitative-statistical investigations (at a given probability) on the micro-level of individual municipalities require a negligible non-response rate, the following findings are discussed with reference to all the case studies as a rural type involved in a discourse of decline and out-migration. This approach allows the full statistical spectrum of generalised patterns of perceptions concerning food supply to be identified. Women and older individuals (over 49 years of age) were over-represented among the responses. This clearly makes sense, as they are the household members mainly responsible for food shopping and are also viewed by the public discourse as particularly important customers for village shops. The analysis is thus not based on a normal distribution. However, these variations are the same for all the case-study municipalities. Significances were tested using non-parametric procedures.

Qualitative research took the form of focus group discussions and interviews with mayors and the owners of shops. However, this is not further considered in this paper.

Section	Topic	Indicators
A	Self-assessment as customer	40 statements on the importance of food formats, supplies and structures (Likert scale 1-5)
B	Food-retail structures	Shopping locations, frequency of shopping
C	Self-assessment as actual or potential customer	12 statements on the relevance of use (Likert scale 1-5)
D	Profile of the interviewed individual and household data	Socio-economic and socio-demographic indicators
Locations	Rural municipalities SH (Schleswig-Holstein)	
Sample size	n=385 (April-November 2016)	
Procedure (standardised)	Postal questionnaire (2016)	

Table 1
Structure of the questionnaire and technical implementation information. Source: own elaboration

Municipality	Number of postal questionnaires distributed (n)	Response n (%)	Basic interest	Date	Type of location
Groß Vollstedt	430	64 (14.9)	Saving the village shop discourse	2016	periphery
Holzunge	150	55 (36.7)	Threat of closure for filling station shop	2016	periphery
Borgstedt	650	109 (16.8)	New opening discourse (spring 2017)	2016	peri-urban
Hollingstedt	370	61 (16.5)	Independent village shop	2016	periphery
Kirchbarkau/ Barkauer Land	900	96 (10.7)	New opening (October 2016)	2016	periphery
n total	2.500	385 (15,4)			

Table 2
Scope and locations of the quantitative surveys conducted in 2016. Source: Jürgens (postal questionnaire) 2016

5. Finding I – GIS worlds and food deserts

An initial depiction of food retail in a larger region is shown in *Figure 1*. Here supermarkets, food discount stores, active and – in 2015 – non-active grocery stores are mapped for the federal state of Schleswig-Holstein, and their distribution underlain with a representation of accessibility by car showing the areas from which supermarkets and discount stores can be reached in under ten minutes. Accessibility was calculated using the network module of ESRI-ArcGIS, realistically based on the various types of streets drawn from OpenStreetMap (motorways, main roads, local roads) and the average speeds defined for them. The uneven distribution of supermarkets and discount stores reflects the settlement structure of the state, with only five larger cities of over 75,000 residents and the densely developed commuter belt that adjoins Hamburg to the south.

Large areas of the state are of rural character with very low population densities (*Fig. 2*). These regions are correspondingly uninteresting for the operators of supermarkets and discount stores. The population

of these municipalities is therefore largely dependent on shopping in the rural central places, where strategically planned clusters consisting of supermarket and discount store are often found on greenfield sites on the outskirts. The rural municipalities face further problems caused by the large number of closures of so-called smaller stores (sales area under 400 m²) seen in recent years (*Fig. 2*). As of 2015, this had resulted in 802 of about 1,100 municipalities having not a single grocery store (not taking other suppliers such as bakeries or filling station shops into account). This affects about every fifth resident of the federal state as a whole. 1,917 active retail premises (including filling stations and other units larger than supermarkets) are concentrated in only 291 settlements; of these, 142 municipalities have only one point of sale (including filling stations). *Figure 3* clearly shows that many municipalities have no retail facilities or have lost their only shop and thus acquired the status of 'no local supply'. It is obvious that not only is the network of local retail supply very uneven, but also that it leaves much of the population with no choice of supplier in their local proximity without resorting to longer car trips.

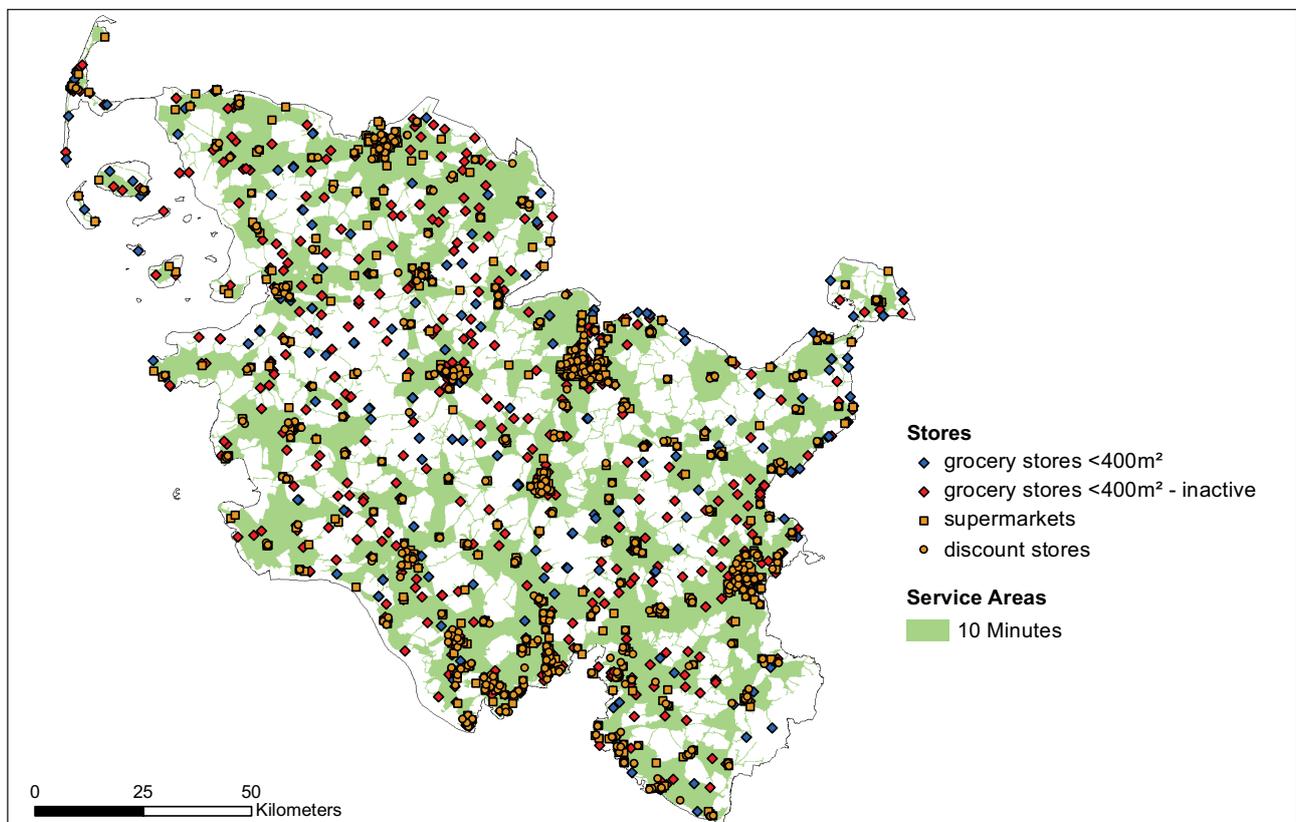


Fig. 1 Service areas of supermarkets (sales area 400+ m²) and food discount stores by car accessibility in minutes in the province of Schleswig-Holstein, 2015; unconsidered are service areas from bordering provinces. Source: Own elaboration based on Nielsen Company (2015); ESRI-ArcGIS, OpenStreetMap; Landesvermessungsamt Schleswig-Holstein (2015); Cartography: Fuhrmann

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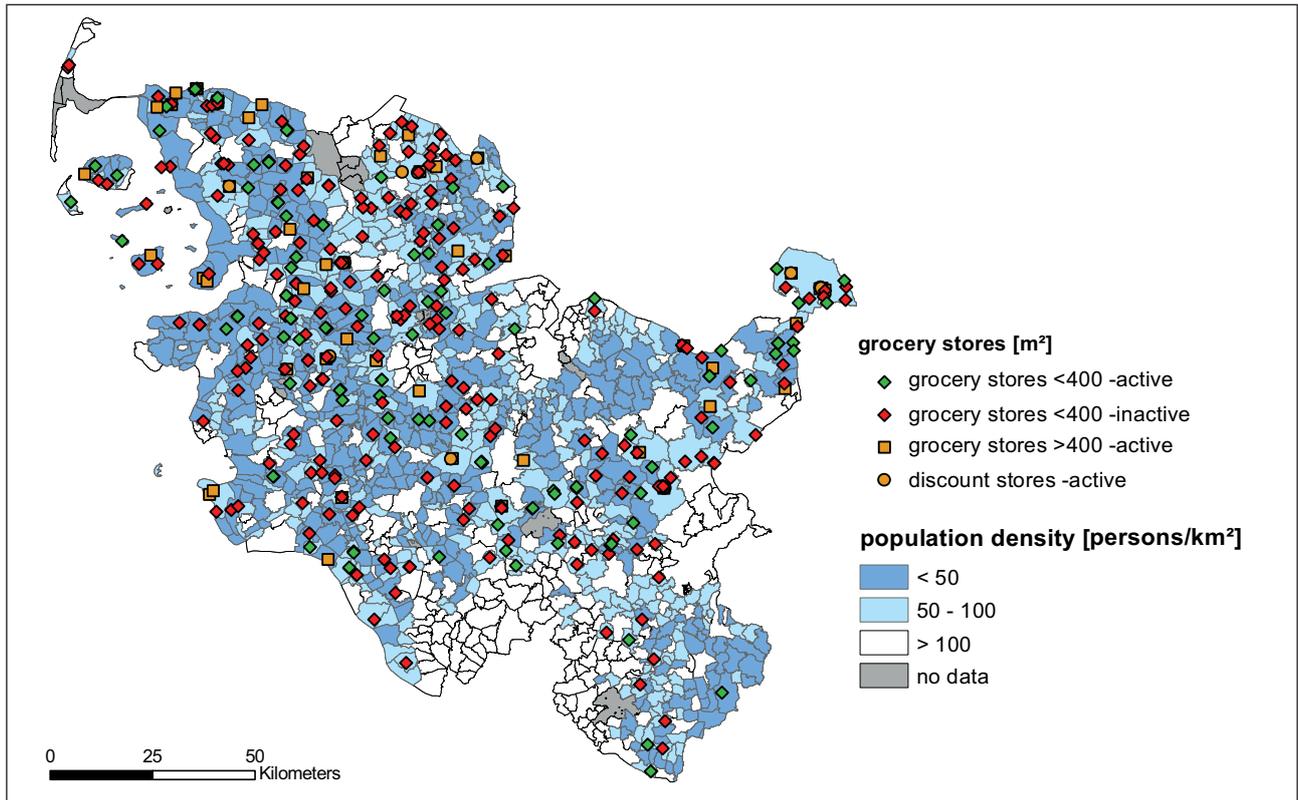


Fig. 2 Spatial distribution of grocery stores in municipalities with low population densities in the province of Schleswig-Holstein, 2015. Source: Own elaboration based on Nielsen Company (2015); Statistical Office SH (2011); ESRI-ArcGIS, Cartography: Johst

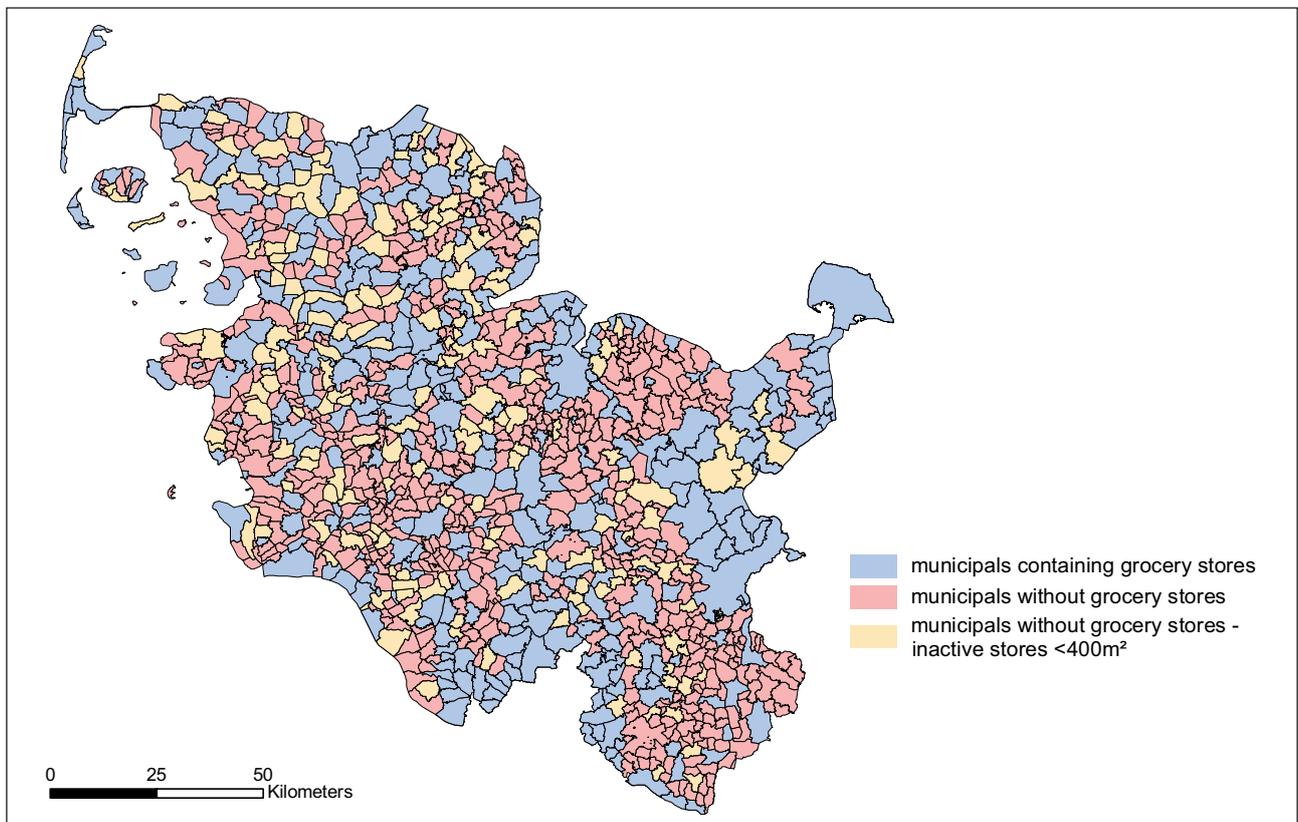


Fig. 3 Spatial distribution of municipalities without grocery stores in the province of Schleswig-Holstein, 2015. Source: Own elaboration based on Nielsen Company (2015); ESRI-ArcGIS, Cartography: Johst

The supply situation is presented at a larger scale for the case study of Groß Vollstedt (Fig. 4), demonstrating that the potential of GIS networks goes beyond 'container-like' portrayals based on municipal boundaries. The temporal variation of the catchment areas of supermarkets and discount stores shows where the length of a one-way car trip for food shopping (e.g. spontaneous, short-term and convenience shopping) may well reach the limits of tolerability for customers. With the exception of a supermarket on a greenfield site and a shopping cluster in the rural central place of Nortorf, there is no store south of Westensee – with a single exception in Groß Vollstedt. The strategically positive location of this shop in relation to Nortorf may seem to suggest that it has good chances of survival as a convenience store. There is, however, an ongoing discussion around saving the store, which reveals the limits of 'objective' GIS analysis. In addition to locational accessibility, subjective criteria must be taken into consideration when judging the success or otherwise of local retail.

6. Finding II – (quantitative) customer worlds and mental food deserts?

In order to collect a comprehensive self-assessment of food customers, the survey participants were given 40 statements to grade on a gradual scale from 1 (= not important) to 5 (= very important). The statements concerned the following areas: a) use of differing retail formats; b) interest in food; c) forms of mobility and accessibility; d) awareness of price, service, and product range. Drawing on Shaw (2006), the aim here was to cover three basic concepts: attitude (what is important to me as a customer), household assets (e.g. car availability, computer use, purchasing power), and ability to shop (e.g. availability of a retail format, flexible opening times). All items are categorised according to whether they can strengthen or weaken local retail supplies. In the further analysis all items are initially equally weighted. The constraints undertaken allow the model to be multiply adjusted:

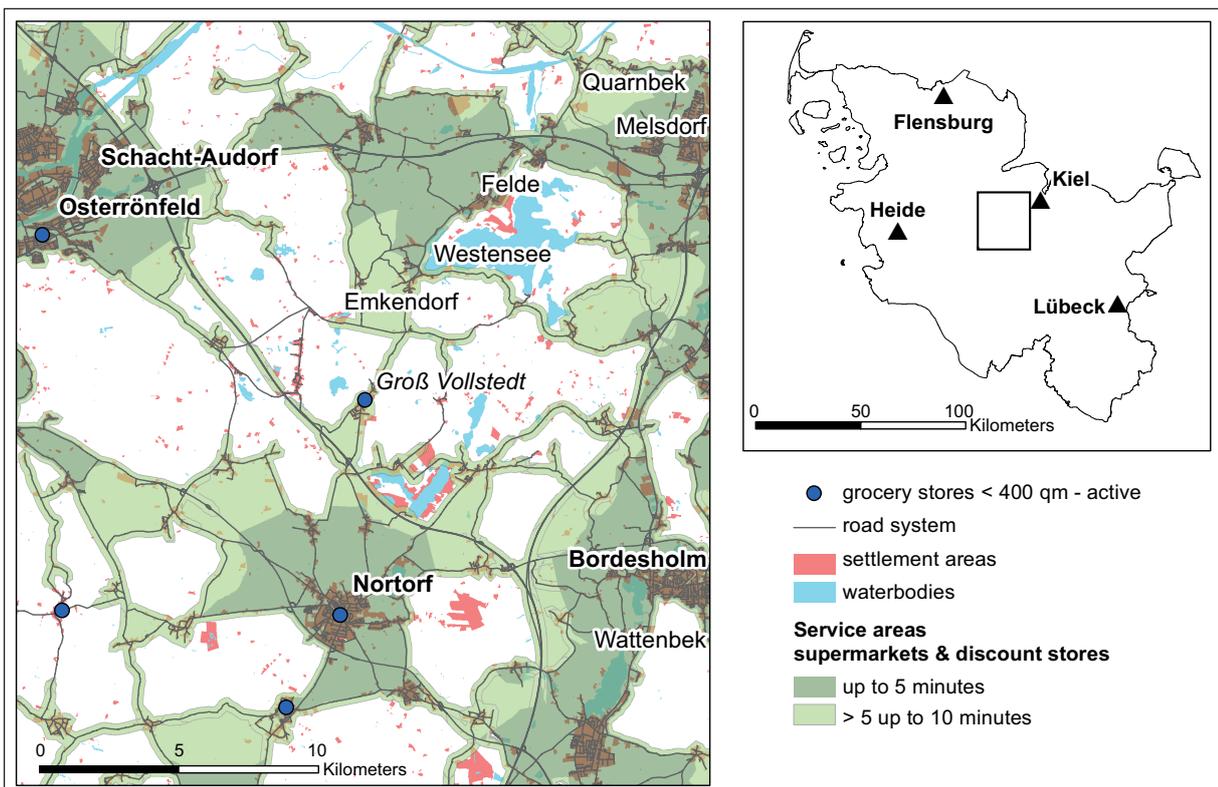


Fig. 4 Food supplies for the municipality of Groß Vollstedt, province of Schleswig-Holstein, in the service area of supermarkets and food discount stores by car accessibility in minutes, 2015. Source: Own elaboration based on Nielsen Company (2015); Landesvermessungsamt Schleswig-Holstein (2015); ESRI-ArcGIS, Cartography: Fuhrmann

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a) by altering the number of items and 'correct' contents; b) by assigning these items to the constructs attitude, asset or ability; c) by aggregating the items to other basic constructs; d) by varying judgements as to whether items can strengthen or weaken supply gaps; e) by questioning whether all items are of equal importance for all survey participants.

Taking note of these constraints, cluster and discriminant analysis was used (with the help of the software SPSS23) to develop a model to compress and differentiate the dataset not only by item contents but also by survey participants (Table 3). Taking all 40 items into account, are there individuals in the total sample who are more similar to one another than to other survey participants and who, thus, form a noticeable cluster? The number of clusters is initially calculated randomly and a discriminant analysis used to determine which items are relevant for maximising between-cluster differences and the explanatory value of these items for the selected number of clusters. The assignment of the number of clusters and the relevant items for each case results in a specific profile for each cluster that covers age, gender, place of origin, etc. (information gathered in the questionnaire). These profile groups can be used for policy and planning and for specific marketing strategies (e.g. for different retail formats), because they allow the fundamental openness of survey participants towards the various retail formats and the strengths and weaknesses of those formats to be deduced. In the present case three clusters were formed. 19 of 40 items had the highest explanatory value here and could explain 91% of the content of the clusters. The discriminant analysis allows us to look within the clusters and discover pat-

terns. All other items have only diffuse explanatory power. The high level of significance of the cluster division is confirmed by the use of Wilks' Lambda. Figure 5 visualises the extent of cluster separation using the discriminant function. Table 4 shows the differentiation of the clusters according to the means for each of the items and the (ANOVA) significance values compared to the means.

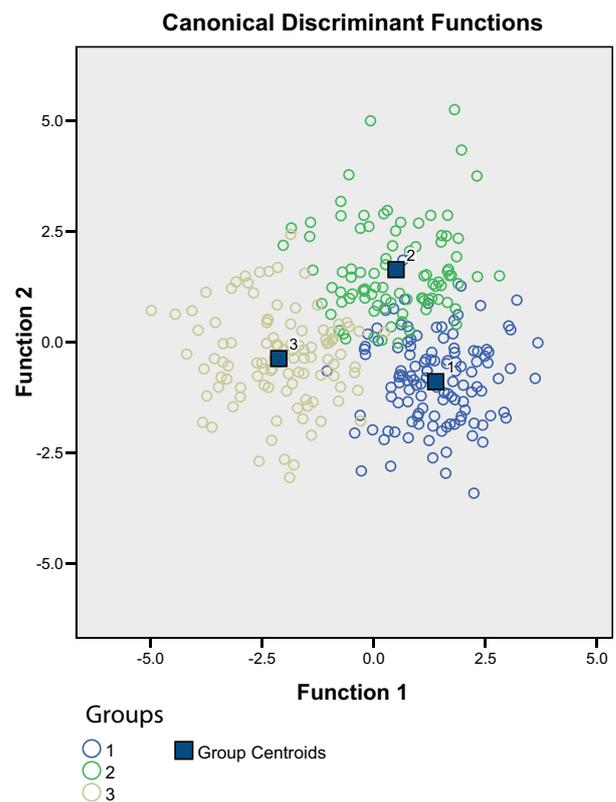


Fig. 5 Separation of cases using 19 items and discriminant analysis. Source: Data Jürgens 2016; SPSS23

Methods	Implementation
Cluster analysis	K-means-clustering of 40 items; pairwise deletion; number of clusters = 4 Cluster 1 = 148 cases Cluster 2 = 109 cases Cluster 3 = 124 cases Cluster 4 = 4 cases Cluster 4 is disregarded so 3 clusters and 381 cases are included
Discriminant analysis	Question: <i>which items influence cases within the clusters and are decisive for correct cluster allocation?</i> Wilks' method; cases included = 381 Used for classification = 318 cases 19 of 40 items were included in the analysis 91.2% of the originally grouped cases were classified correctly: Groups 1-3 = 118/96/104 cases Discriminant function 1 explains 67.1% of the group separation Discriminant function 2 explains 32.9% of the group separation Wilks' Lambda (Test1-2) .142 (Significance .000) Wilks' Lambda (Test2) .469 (Significance .000)

Table 3
Technical information on the cluster and discriminant analyses. Source: Data Jürgens 2016; SPSS23

Table 4 Items relevant for the discriminant analysis of the clusters (means). Source: Data collection Jürgens 2016, SPSS23. (1) Schendera (2010: 341) points out that univariate significance does not automatically also indicate discriminant relevance, as can be seen here.

Question	Statement (1=not important; 5=very important) + Food desert – favourable criteria - Food desert – countering criteria	Cluster 1 Need satisfiers	Cluster 2 Smart shoppers	Cluster 3 Alternative shoppers	Single factor ANOVA
1	I shop in a discount store +	3.7	4.3	2.7	.000
7	I always buy everything in one shop of my choice	2.3	2.3	1.9	.029
9	I choose the shop that is closest to my place of work +	2.0	3.0	2.3	.000
10	I would like the shop to be easily accessible by car +	4.4	4.1	3.5	.000
11	I would like the shop to be easily accessible on foot -	1.8	3.3	3.7	.000
14	I would like many different shops nearby so I can compare products and prices -	2.7	3.3	1.8	.000
15	When shopping for food, prices are especially important to me +	3.0	3.8	2.1	.000
21	Organic products are important to me -	2.4	2.8	3.9	.000
23	I come primarily for the special offers +	2.8	3.4	1.8	.000
24	If I can save a bit again, then especially with food +	2.2	3.1	1.5	.000
25	I want to be able to buy non-groceries too +	2.6	3.0	2.0	.000
26	I also come because of the more convenient parking +	3.6	3.4	2.3	.000
27	I like to make use of the longer opening times +	2.6	3.4	2.6	.000
28	I come because I feel comfortable in the shop -	3.4	4.1	4.0	.000
30	I like to buy food spontaneously +	2.2	3.4	3.3	.000
32	I can enjoy shopping for food -	2.3	3.3	3.5	.000
38	I also use other alternatives like a farm shop -	1.6	2.0	2.7	.000
39	I also use other alternatives like the weekly market -	2.5	2.4	2.6	.444 (1)
40	I also use other alternatives like a delivery service +	1.1	1.1	1.0	.223 (1)

The description of the clusters is subjective and is not performed by SPSS. The statements are model-like in character, because the number of clusters and discriminant functions can only relate to this set of data.

For Cluster 1 the focus is on planned and joyless shopping at a discount store or supermarket that can be easily reached by car. Parking thus plays an important role in the choice of retail facility. Accessibility on foot and thus local convenience is insignificant for Cluster 1. Food shopping is primarily a necessary activity rather than something that involves emotional satisfaction. Cluster 2 describes itself as committed discount shoppers, who are particularly motivated by price and thus prioritise selection, very flexible opening times and spontaneity in order to get the best bargains. It is no contradiction that these smart shoppers also want to feel comfortable in the shops. Cluster 3 comprises those customers who, from their self-assessment, can be described as committed convenience and alternative customers. Neither the need to economise nor an extreme focus on choice of offer-

ings is relevant for this group. This does not minimise the importance of feeling comfortable and enjoying shopping (Table 5).

Examination of actual shopping behaviour is necessary to ascertain whether this reflects the self-assessments of the survey participants, and thus whether the predispositions within the clusters are relevant to the market. Are Clusters 1 and 2 really a lost cause as far as convenience shopping in a local village shop is concerned, and is the importance of Cluster 3 for local shopping as great as the self-assessments suggest?

Table 6 shows that the attitudes from Table 4 have differing relevance for shopping in local retail facilities, and are completely independent of popular segmentations based on age, gender or income. Surprisingly, car availability per household plays no role here. Institutional involvement, being a member of a village-shop cooperative, is reflected in local shopping behaviour.

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Cluster value	Description	Summary
Cluster 1	Emphasis on car, it follows that accessibility on foot is irrelevant; alternatives such as organic or farm shop of little importance; neither spontaneity nor enjoyment of food shopping play a large role.	Highly mobile and joyless food shoppers Need satisfiers
Cluster 2	Committed to discount stores and shopping with the car, focuses on prices and special offers; product range and feeling comfortable in the shop important; not necessarily concerned with proximity to place of residence.	Cheap – mobile – satisfied Smart shoppers
Cluster 3	Local convenience shopper; interested in alternative offerings, enjoys shopping, tends not to depend on low prices, high enjoyment and satisfaction factor.	Nearby – alternative – enjoyment Alternative shoppers

*Table 5
Characteristics of the clusters. Source: Data collection Jürgens 2016, see Table 4*

*Table 6
Actual shopping behaviour in each cluster. Source: Data collection Jürgens 2016, SPSS23*

	Cluster 1	Cluster 2	Cluster 3	Significance test
Make use of alternative local offerings (mean 1 not important to 5 very important)	1.6	2.0	2.5	.000*
Use no alternative retail formats (in %)	59.5	52.7	17.3	.000*
Food shops per week (mean)	2.2	2.5	2.6	.022**
Spending per week in the village shop (mean in euros). Only relevant for Kirchbarkau	30.67	32.50	52.10	.006**
Cars per household (mean)	1.6	1.8	1.6	.350**
Co-operative member in % (only Kirchbarkau)	35.3	22.2	66.7	.002*

*Kruskal-Wallis-Test **(ANOVA)

Descriptive segmentation in line with *Table 7* is required to clarify the socio-demographic structures of the clusters and thus to indicate which customer is characterised by which attitudes and type of behaviour. It can be seen that Cluster 1 tends to comprise the old-established population with longer lengths of residency, here the older age groups are over-represented and there is a large proportion of pensioners. Contrary to the notion that such individuals are precisely the clientele targeted by convenience shops, they frequently do not use their village shop (68% of those aged over 74 are in Cluster 1 and 2; N=25 for all three clusters). Clusters 2 and 3 are distinctly younger. Comparing Clusters 1 and 3 reveals no link between higher incomes and interest in alternative and more expensive products. A comparison between the clusters shows clearer differences between the individual municipalities in terms of the basic attitudes of those questioned towards alternative offerings and local convenience shops. In Groß Vollstedt, Hollingstedt and Kirchbarkau there is currently a shop, in Borgstedt only a bakery, and in Holzbunge a

filling station shop. The question as to whether and how quickly local shops can influence their customers with their sales behaviour cannot be answered on the basis of this statistical dataset. Similarly unclear is how successful a planned shop in Borgstedt can be when the current predisposition of residents seems clearly unfavourable for local convenience offerings.

*Table 7
Socio-demographic structures within the clusters in %. Source: Data collection Jürgens 2016, SPSS23*

	Cluster 1	Cluster 2	Cluster 3
Length of residence (years)	25.7	19.9	21.8
Size of household (people)	2.4	2.9	2.5
Under 35	6.2	16.1	4.9
35-49	23.9	37.6	31.1
50-64	34.5	32.3	42.7
65-74	23.9	9.7	13.6
Over 74	11.5	4.3	7.8
Mean household income (per month in euros)	2,285	2,200	2,310
Over 3,500 euros	35.0	23.7	34.4
Up to 2,000 euros	15.1	18.7	11.4
Pensioners	35.1	15.6	20.8
Employees	36.0	60.0	41.6
Female	52.2	71.0	69.9
Borgstedt	51.7	34.8	13.5
Hollingstedt	35.4	33.3	31.3
Holzbunge	51.1	25.5	23.4
Kirchbarkau	21.3	22.5	56.3
Groß Vollstedt	25.9	35.2	38.9

The items for the three clusters can be captured in a network diagram, depicting mental food deserts of different extents (Likert scales). These lead to the emergence of actual food deserts due to the lack of purchases being made (shop closures following disinterest on the part of customers) (Fig. 6a and b). Figure 6a visualises criteria that favour the development of food deserts, because based on a focus on the car and on prices they tend to endanger food retail close to the place of residence. Figure 6b covers shopping segments and emotions that tend to counter food deserts outside the supermarket world.

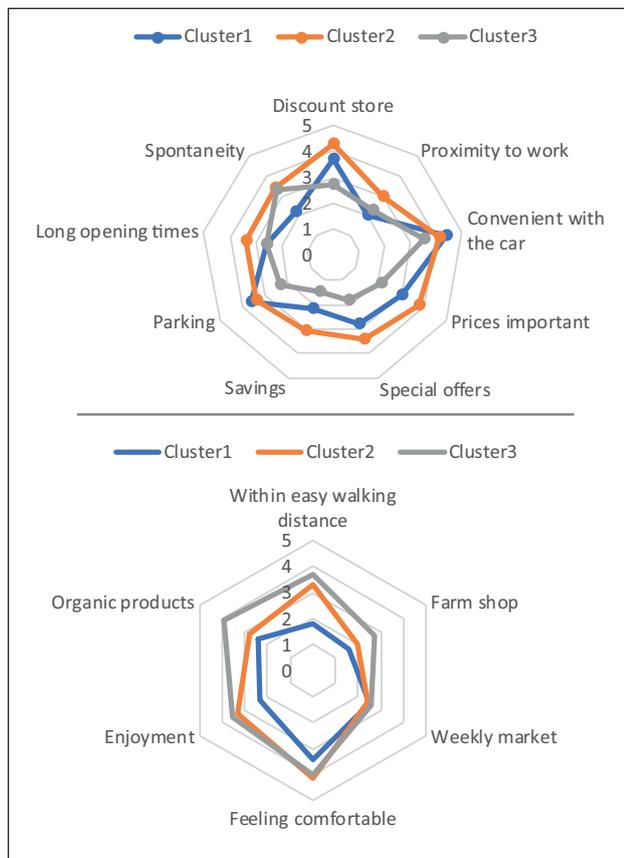


Fig. 6a and 6b
Mental food deserts based on customer clusters. Fig. 6a (above): favourable criteria, Fig. 6b (below): counteracting criteria in rural municipalities of Schleswig-Holstein, 2016; 1= low importance; 5= highest importance; Source: Jürgens (2016)

With very few exceptions, the perception networks of the three clusters neither intersect nor touch one another. They thus work in opposing directions, for instance the attitudes in Cluster 1 that favour food deserts are supplemented by the logical lack of interest in 'alternative' food retail.

7. Finding III – cognitive maps – networks of qualitative knowledge

The extent to which mental networks of attitudes (Fig. 6a and 6b) are reflected in relational networks of actual shopping decisions is shown in Figures 7 and 8. They summarise all mentions of regular food shopping locations and formats for Clusters 1 and 3, taking into account all the municipalities investigated. This leads to the depiction of networks that are independent of 'real' space and GIS-space and that represent the frequency of mentions and their weighted relations to one another, drawn from aggregation of the information. A new form of generalised mapping of the behaviour of study participants is created that: a) demonstrates the 'main roads and side roads' or connections of their food shopping trips; b) pinpoints 'central places' for shopping; c) presents niche shopping through a lack of connections or edges; d) pools shopping locations similarly perceived as dominant, varied or monotone in coloured clusters or cliques; e) visualises shopping options and local alternatives; f) presents the 'others', i.e. missing forms of supply. These networks thus express which providers are important to customers and which primarily occur to them for spontaneous food shopping. The maps can be interpreted, firstly, as the activity spaces of shopping behaviour and, secondly, as the cognitive spaces of relevant shopping associations.

The following explanations are intended to aid interpretation of the figures.

- A distinction is made between nodes and edges or connections.
- The size of the nodes is defined by the number of mentions of all ingoing and outgoing edges. As the nodes can be very small or large, variations in size are nonlinear so that the nodes are not to be interpreted in causal, quantitative or absolute terms but rather in relation to one another.
- The connections (edges) show the complete networking of all nodes with one another. The connections are nonlinearly weighted on the basis of mentions in the system. These edges reflect the frequencies (in our case) of the use of the individual nodes.
- The allocation of colours allows clusters of nodes and connections to be identified. In each of these clusters the nodes and connections and thus dominant mentions in the system are more similar to one another than to others.

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e) The aim is to present a visualisation of complex interrelations with their mutual networks and influences, in order to, firstly, describe and investigate focuses and features in a data-cloud and, secondly, to address gaps between these focuses. Traditional cartography and statistics are insufficient for this end.

The comparison between need satisfiers (Fig. 7) and 'alternative' customers (Fig. 8) shows that:

- a) Food deserts emerge less due to a lack of offerings than (also) due to the monotony of popular retail structures. Not only are discount stores or supermarkets like Aldi and Edeka (resp. Penny, Lidl, Famila, Rewe, Real or Sky) available nearly everywhere (expressed through the size of the nodes), but are the focus of food shopping for nearly all the study participants from Cluster 1.
- b) The monotony of the large suppliers is not inconsistent with their ability to attract customers and this minimises demand for small-scale, 'different' retail formats. The distinctiveness of these specialist non-chain or independent retailers is underpinned with dedicated micro-clusters and colour assignments in Figures 7 and 8, as they show no linking of nodes or edges with other formats or spaces.

- c) The shopping interest of Cluster 1 is necessarily connected to larger central places and convenience shopping and relevant shopping associations are primarily defined in terms of accessibility by car. The nearest neighbourhood stores, i.e. village shops that are easily accessible on foot, are mentioned five times less by Cluster 1 than by Cluster 3 (Table 8). The information from Cluster 3 also confirms more sustained interest in quality, product origin and 'healthy' food than that found in Clusters 1 and 2.
- d) The perceptions from the cluster-/discriminant analysis are to a significant extent reflected in tangible, differing patterns of demand. This reveals that the differences between Clusters 1 and 2 on the one hand and Cluster 3 on the other hand may be explained by a long-term process of moving away from local suppliers, socialisation, and high customer loyalty for discount stores, and a lack of interest in discourse concerning local suppliers or food shops.

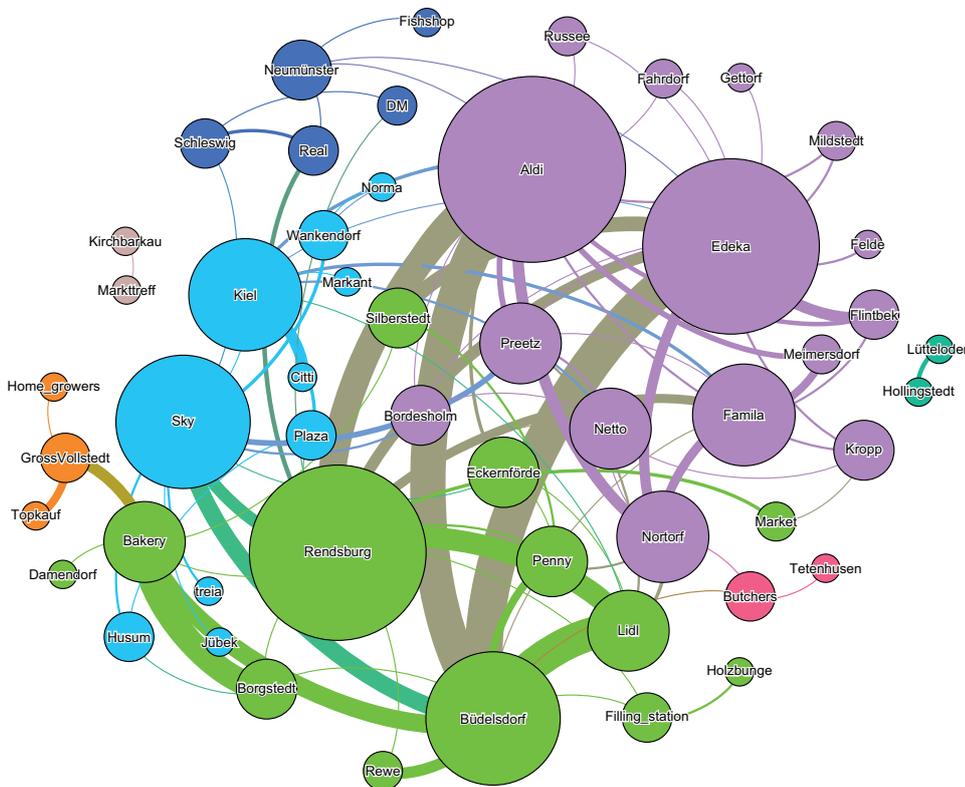


Fig. 7
Regular food shopping trips - Shopping networks for Cluster 1 based on retail format and location. Dataset Jürgens 2016; Bastian et al. 2009; Cherven 2015

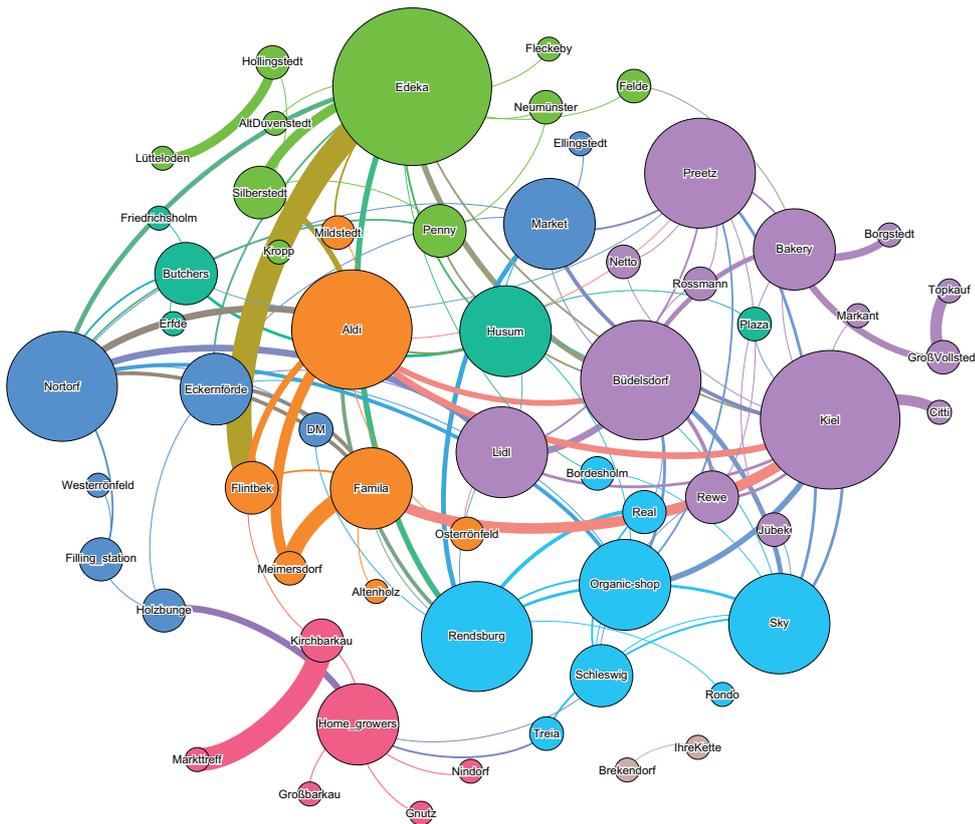


Fig. 8 Regular food shopping trips - Shopping networks for Cluster 3 based on retail format and location. Dataset Jürgens 2016; Bastian et al. 2009; Cherven 2015

Table 8 Regular food-retail formats for Clusters 1-3 (in %). Source: Data Jürgens 2016, SPSS23; 'other' formats at 100% are not included in the table

	Cluster 1	Cluster 2	Cluster 3
Number of nodes	52	60	60
Number of edges	468	396	383
Mentions discount stores	40.0	41.9	21.9
Mentions supermarkets	40.6	37.4	38.4
Mentions village shops	2.6	4.0	12.0
Mentions farm shops, organic shops, weekly markets	0.9	2.8	13.1
Mentions specialist shops (bakery, butcher, fish shop)	11.8	9.3	8.6
Average number of mentions per survey participant	4	4.3	3.7
Total number of mentions (survey participants)	468 (115)	396 (93)	383 (103)

8. Conclusion and prospects

1. Do food deserts exist? If consideration is confined exclusively to GIS analyses, then food deserts can be 'calculated'. If potential local customers are considered, then it is clear that they contribute in varying degrees to the prevention or creation of food deserts. It is especially the case that inhabitants create food deserts *for others* because, due to perceived higher prices and a more limited range of goods etc., a large proportion of the population does not use the village shopping alternatives to a sufficient extent. A significant number of those questioned can be described as 'rejecters of the village shop'.
2. The question then arises as to how the current residents of rural areas will in the future deal with the supply gaps for which they themselves are responsible; this is especially important with a view to the aging of the current population. What kind of local marketing by suppliers and planning authorities can help to change the predispositions that disadvantage local providers? Another trend that has a negative impact on local food supplies is that discount stores and supermarkets are also tending to thin out their branch networks in favour of focusing on larger stores.

3. The discussion about food deserts is multi-dimensional. As individual factors, aspects such as mobility or age play a negligible role for the explicit use of village shops. In addition to convenience and prices, lifestyle attitudes – underpinned by purchasing power – favour organic articles, fresh food and regional specialities, demands that are completely independent of age.

The investigation focuses on operationalising food deserts from the perspective of potential consumers and demonstrating the consequences of different perceptual patterns for the emergence of tangible food deserts. The latter result from mentally consolidated sets of predispositions that correlate with tangible patterns of consumption and that can lead to disadvantageous local retail supply for the individuals concerned over the course of their life cycle (due to the market exit of retail structures for which there is no demand) or for other groups with social and mobility disadvantages. In line with the notions of *Thomas Schelling* (1978), customers do not realise the cumulative disadvantage of their individual behaviour for the whole of society and are unaware of the effects and the 'victims' of their actions. Food deserts identified in tangible space via GIS analyses are thus the consequence of abstract mental or psychological developments that promote food deserts, rather than a reflection of the result or cause of the thinning out of local supply.

The article does not tackle the question of the contribution of suppliers to the development of food deserts, e.g. how the individual providers manage to ensure customer loyalty. What are the niches that local retail must fill in order to keep their patrons or regain a sceptical clientele? What is the significance of local retail in local governance and why are the chances of commercial success and social acceptance more promising in one municipality than in another? Investigation further requires a temporal, dynamic approach in order to demonstrate the effects that the closing or re-opening of a shop has on local perceptions and discourse, how the population adjusts to the altered conditions, and whether their predispositions are changeable (*Cummins et al.* 2014; *Corapi* 2014). This would then reveal whether the threat of potential food deserts can be managed and minimised. The first step in the German context is the realisation that food deserts are not only an Anglo-American phenomenon.

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Appendix: Criteria surveyed in rural municipalities 2016. Source: Data collection Jürgens 2016

	I strongly disagree	I disagree	I neither agree nor disagree	I agree	I strongly agree
1. I shop in a discount store (Aldi, Lidl, Penny).	1	2	3	4	5
2. I shop in a supermarket (Edeka, Sky, Rewe).	1	2	3	4	5
3. The choice of products in a discount store is enough for me.	1	2	3	4	5
4. The choice of products in a supermarket is enough for me.	1	2	3	4	5
5. I combine food shopping in discount stores and supermarkets.	1	2	3	4	5
6. I am a patron (regular customer) in my supermarket or discount store.	1	2	3	4	5
7. I always buy everything in one shop of my choice.	1	2	3	4	5
8. I choose the shop that is closest to home.	1	2	3	4	5
9. I choose the shop that is closest to my place of work.	1	2	3	4	5
10. I would like the shop to be easily accessible by car.	1	2	3	4	5
11. I would like the shop to be easily accessible on foot.	1	2	3	4	5
12. I would like the shop to be easily accessible by bicycle.	1	2	3	4	5
13. I would like the shop to be easily accessible by bus.	1	2	3	4	5
14. I would like many different shops nearby so I can compare products and prices.	1	2	3	4	5
15. When shopping for food the price is especially important to me.	1	2	3	4	5
16. I like to cook and buy the food for cooking.	1	2	3	4	5
17. Branded (food) products are especially important to me.	1	2	3	4	5
18. I don't care about brands at all, the main thing is to get the right quality.	1	2	3	4	5
19. A large choice of food is important to me.	1	2	3	4	5
20. Fresh products are important to me.	1	2	3	4	5
21. Organic products are important to me.	1	2	3	4	5
22. Being served/advised at a shop counter is important to me.	1	2	3	4	5
23. I come primarily for the special offers.	1	2	3	4	5
24. If I can save a bit again, then especially with food.	1	2	3	4	5
25. I want to be able to buy non-groceries too (e.g. textiles, computers, books, gardening articles)	1	2	3	4	5
26. I also come because of the more convenient parking.	1	2	3	4	5
27. I like to make use of the longer opening times.	1	2	3	4	5
28. I come because I feel comfortable in the shop.	1	2	3	4	5
29. I go shopping on a fixed schedule.	1	2	3	4	5
30. I like to buy food spontaneously.	1	2	3	4	5
31. Occasionally I would also like to treat myself when food shopping.	1	2	3	4	5
32. I can enjoy shopping for food.	1	2	3	4	5
33. Shopping for food is simply something I HAVE to do.	1	2	3	4	5
34. I like to go shopping in the bakery 'round the corner' (a traditional baker's shop).	1	2	3	4	5
35. I like to go shopping in the butchers (a traditional butcher's shop) 'round the corner'.	1	2	3	4	5
36. I also use other alternatives like online food shopping.	1	2	3	4	5
37. I also use other alternatives like a mobile supermarket.	1	2	3	4	5
38. I also use other alternatives like a farm shop.	1	2	3	4	5
39. I also use other alternatives like the weekly market.	1	2	3	4	5
40. I also use other alternatives like a delivery service e.g. from Rewe, Sky, Edeka.	1	2	3	4	5