Modelling leisure day trips between Berlin and its surrounding

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Abstract

Existing studies estimate the number of day trips from Berlin to the region of Brandenburg at about 40 Mio per year. In this paper, demand-oriented figures are combined with attraction-related datasets and mode dependent travel time information of all potential destinations in order to develop a GIS-based spatial distribution model of leisure day trips. This model is then calibrated and validated using independent datasets, e.g. traffic census data. Finally, potential applications of the model are shown.

Keywords

Tourism planning, day trips, leisure & recreation, spatial modeling, gravity models

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1 Introduction

Driven by the spread of flexible labour organization and by the development of new telecommunication technologies, many industrialized countries are experiencing a change of time usage patterns. People are becoming more sovereign in terms of time allocation and due to efficiency gains (e.g. by telecommunication) the overall time budget for leisure activities is increasing (STATISTISCHES BUNDESAMT, 2004b). This development is accompanied by a general trend towards individualized lifestyles. As a consequence of these individualized time usage patterns, the coordination of (leisure) activities among several people is becoming more difficult, leading to a growth in spontaneous, short term leisure activities.

From a regional planning perspective, these developments provide interesting economical perspectives for rural tourist regions in the proximity of urban conurbations. These regions can act as recreational areas for the urban residents and thereby set up a complementary partnership with the urban conurbations in their proximity. Usually, they are reachable in reasonable times and as in the case of the study region of this paper, they offer opportunities for many different interest. But due to the recent developments in low-cost air travel, these regions are now competing with distant destinations. Furthermore, leisure activities are often related to natural resources, which are themselves affected by the travellers and their mobility (HEINZE, 2004). It is therefore essential for regional planning to find a good balance between economic benefits and resource consumption.

As most leisure activities are associated with some form of traffic, these developments are also of major interest for traffic science. Although traffic related to leisure and recreation accounts for more than 50% of total traffic volumes and is one of the strongest growing traffic sectors (BVBW, 2003), it has widely been neglected in transportation planning.

This paper addresses a specific form of leisure or recreational traffic- day trips on weekends from urban areas to the surroundings. Neither trips which take longer than a day and therefore include overnight stays nor leisure trips of the population living in the recreational areas themselves are taken into account. The focus of the study is on the model development process, but a practical approach is followed which aims to produce meaningful results mostly out of existing data. This is achieved by making assumptions and simplifications and neglecting the development of theoretical concepts at some points. The study is focussed on the urban conurbation of Berlin, Germany and the surrounding potential recreation areas which are defined as the entire area of the federal state Brandenburg. This study region, referred to as Berlin-Brandenburg, is of particular interest because even 15 years after the fall of the Berlin Wall it is continuously transforming and regional planning policies are still under development. Quantitative spatial models could be a helpful tool for policy development, e.g. for the evaluation of effects from measures like the enhancement of accessibility of certain areas by rail. In this study, a spatial trip distribution model for leisure and recreation trips is being developed, validated and applied to the study region for different means of transport.

The study on which this paper is based has been done in 2000 and was preparatory work for a more detailed similar study done in 2000-2003 (KLUGE, VOGEL & VOGEL, 2004) which only covered a corridor within the study area. Therefore some of the datasets are relatively old – but were up-to-date at the time of the study.

In section 2 of the paper, some general aspects of leisure and recreational activities which are important to this study will be highlighted. Section 3 describes the study region and provides an overview of existing surveys of recreation and leisure activities in the study region. In section 4 a spatial trip distribution model for leisure and recreation trips is developed The application of the model to the study region is shown in section 5 and section 6 uses the model results to highlight possible applications of the model. Section7 closes with some conclusions and an outlook on possible extensions of the model.

2 Regional structure of the study region Berlin-Brandenburg

The study region has a very unique spatial structure. The city of Berlin is a very compact urban area of about 3.5 mio. residents which is completely enclosed by the federal state of Brandenburg. Due to the long former isolation (of the western part) from the surroundings and regional planning policies, urban sprawl has only begun to show up in the recent years. Together with the very rural structure and the low population densities of Brandenburg, this leads to a sharp contrast between the two areas.

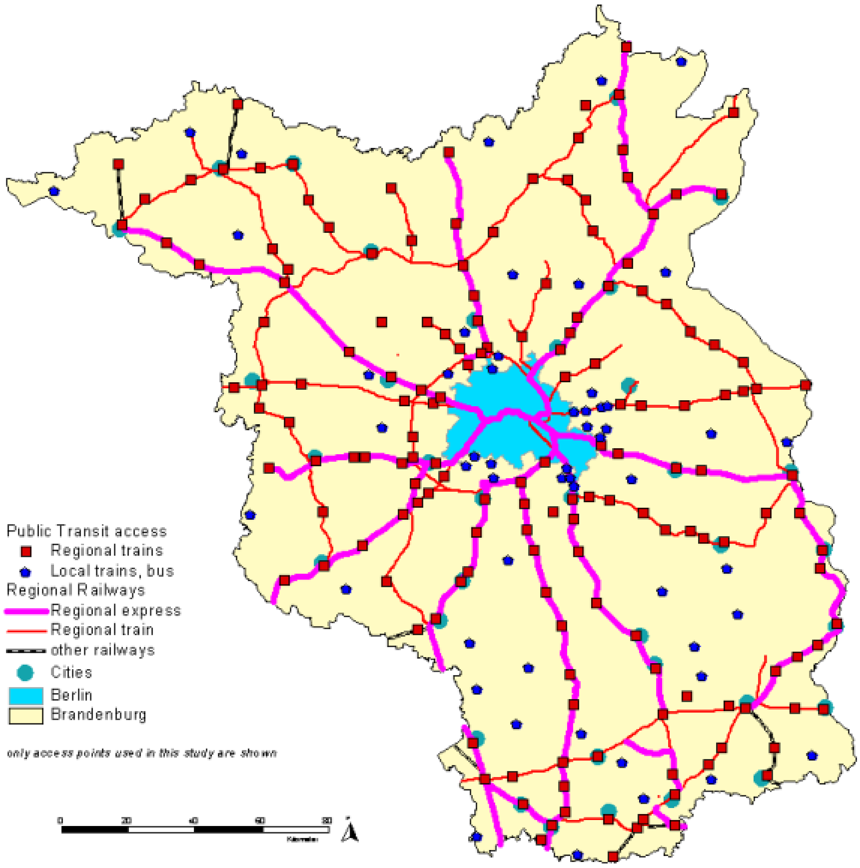
The federal state of Brandenburg has a population of ca. 2.5 mio. people which yields a very low population density of 87 residents per km^2 compared to 3880 residents per km^2 in Berlin. (STATISTISCHES BUNDESAMT, 2004a) The region offers plenty of opportunities for all kinds of leisure and recreation activities. Especially the northern part is known for its natural beauty with many forests, clear lakes and hills which form a very heterogeneous landscape. This patchwork of different landscape elements is very attractive and allows many different outdoor activities like hiking, swimming and cycling. Large parts of this area are declared as

National Parks and are therefore specially protected. Due to the historical development of the region as a “cultural landscape”, many cultural sites like small castles, churches and museums can be found throughout the entire area. The world heritage of the city of Potsdam with its castles and parks is a famous “hot spot” of both, local recreation and global tourism.

The “urban island” of Berlin is very well connected to the surroundings. Radial highways are leading from the inner city ring roads in all directions through the entire area of Brandenburg and allow almost all parts of the region to be reached within 2 hours (see Map 1). Nine regional express railway connections are also leading outside radial from the city centre, (partially blocked by ongoing construction). But the areas between the corridors formed by these radial links are accessible only by busses which usually offer only very limited or even no service at all on the weekends (see Map 2). These areas are therefore quite inaccessible for leisure and recreation day trips by public transit.

The spatial configuration of the study region therefore consists of a large source of demand for leisure and recreation which is centred within a region of high potentials which is well accessible by road and rail transport.

Map 1: Road infrastructure of the study area



Map 2: Public Transit infrastructure of the study area

3 Existing studies of leisure and recreation activities in Berlin-Brandenburg

Leisure and recreation activities in Germany and particularly in the region of Berlin-Brandenburg have been covered by several studies throughout the recent years. These studies provide information on number of trips, activities, modes of transport and travel distances. Furthermore, the surveys focusing on the region Berlin-Brandenburg do provide some information about trip destinations, although the data provided is based only on selected and arbitrarily named destination areas which are not well spatially defined. The information available from the regional surveys is widely used throughout this study in order to define the demand side of the model and the behavioural parameters. The information on trip destinations is only used for the validation of the model. Additional data source for the validation of the model are available from traffic counts on roads and from counts of passenger interchanges in regional rail transport.

It is very notable that the results of the DWIF study "Das Tagesausflugsverhalten der Deutschen" (DWIF, 1995) which covers all of Germany differ from local surveys of the "Willy Scharnow Institut für Tourismus" (FU BERLIN, 1999) which have been carried out for the region Berlin-Brandenburg. Whereas the DWIF study reports an average number of 10.7 leisure day trips per person, the regional surveys report as many as 12.7 trips per person and year. Another difference shows up in the modal split for leisure travel. The DWIF study reports a share of 77,5% for private cars and only 10% for public transit, whereas the regional studies of the "Willy Scharnow Institut" report a share of 71% for private cars and 21% for public transit. It is not clear whether these differences are caused by methodical differences or if they are signs of diverging travel behaviour of the population of Berlin.

Taking the actual population of Berlin this yields to a number of 43 mio. leisure day trips from Berlin to Brandenburg. If we multiply this number by the average spending of €17.30 per leisure day trip (DWIF, 1995) this sums up to financial returns of €750 Mio. solely from one day leisure trips origination in Berlin, which is approx. one third of the total returns of the tourism sector in Brandenburg. As the Figure 1 illustrates, the ratio between leisure trips from the urban area to the recreation areas and vice versa is much more biased in the case of Berlin-Brandenburg than in some other regions of Germany which is in accordance with the diverging findings of the different studies mentioned above.

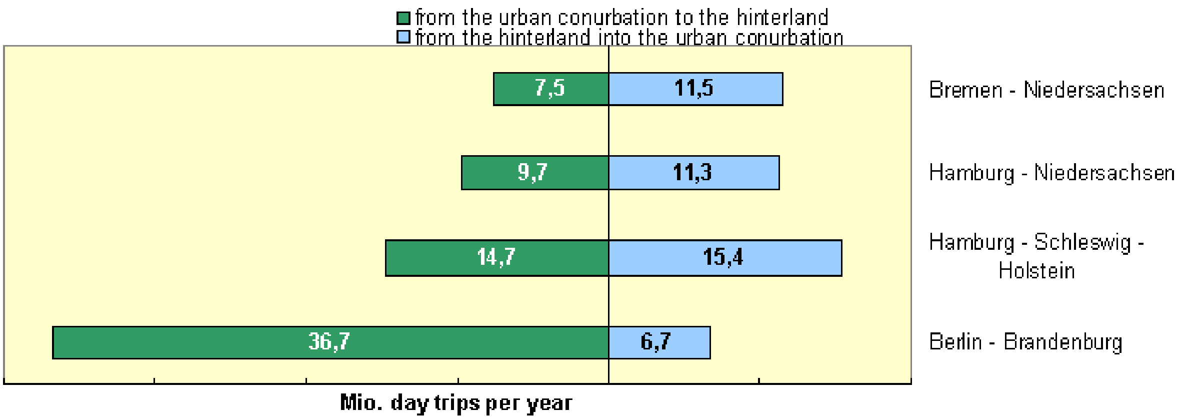


Figure 1 : Relationships in laisure day travel for some urban conurbations in Germany

4 A regional distribution model for leisure day trips

One major goal of this study is to evaluate how traditional models of regional science can be applied to questions dealing with the diffuse field of leisure and recreation activities. It was therefore decided to develop a regionalized model based on the Gravity model approach, which has been successfully applied in many fields of spatial research and transportation science (ISARD, 1998).

4.1 General model structure

In the case of this study, the model is supposed to provide information about the spatial distribution of trips. The production or demand side of the model can be easily derived from the surveys mentioned in section 3, therefore the model can be developed in the form of a production constrained gravity model.

Gravity models as used in spatial science are aggregate models which describe the interaction of populations of discrete spatial units. The choice of the units used for the model is essential for the spatial resolution of the results. In this study, the 219 “Ämter” of the federal state Brandenburg are taken as the model units. These “Ämter” represent an administrative level right above the community level which unique to Brandenburg. This level is chosen because of the adequate number and size of the “Ämter” and because of the data availability.

In order to keep the model simple and transparent the production side is modelled as being concentrated in a single source of demand located at the centre of Berlin at the Brandenburg Gate.

The general structure of the model is shown in Figure 2, detailed descriptions of the components are given further down in this section.

$$T_{iB} = \frac{\frac{W_i x P_B}{D_{iB}^{\beta}}}{\sum_i \frac{W_i x P_B}{D_{iB}^{\beta}}} x P_B$$

T_{iB}: Number of leisure day trips from Berlin to Brandenburg

W_i: recreational attractivity for Amt i

P_B: Total demand for day trips (in Berlin)

D_{iB}: Distance (measure dependent on sub-model) between the Amt and the demand source

β: Distance sensitivity (dependent on sub-model)

Figure 2: Structure of the Gravity model

4.2 Specific aspects of the model implementation

In order to represent the significance of the different means of transport, the model is separated into three sub-models which are based on different distance or travel time measures (see section 0). These sub-models are run with different demand volumes which are derived from the information on modal split provided in the surveys. A mode independent model is run with the total demand and the straight line distance from Berlin to the Ämter as a distance measure. For the modes “private car” and “public transit”, the sub-models are run with the corresponding shares of the total demand and with the travel times of the modes.

An important aspect of the model specification is the time-dependency of some of the input datasets. The demand for day trips will be calculated from the average number of leisure day trips per person reported in the survey of the Willy Scharnow Institut. It is obvious that the number of trips is not equally distributed through the year but clustered in certain months and on the weekends. Furthermore, the travel times in public transit on weekends are very different from the travel times on working days and they also vary throughout the year, e.g. due to modified schedules in school holidays. These time-dependencies render it difficult to develop a model which would yield total yearly trip numbers for the destination regions. It was therefore decided to limit the study to model the spatial leisure day trip distribution for one single Sunday which is representative for the general distribution. A Sunday in July outside of school holidays was chosen as the target day, because all different datasets were available for this period and, according to the study of the DWIF (DWIF, 1995), July is amongst the months with the highest share of leisure day trips.

Throughout the study, all data processing was done using GIS software (ArcView). The gravity model was implemented as a standalone software which can access the GIS-database and which also can load the trips distributed by the model onto the shortest routes generated by the road distance calculation procedures described in chapter 0. The GIS-based implementation facilitated the integration of the different sources of data and the visualization and plausibility checks of the model results.

4.3 Estimation of the demand for leisure day trips

The restriction of the model to a specific target-day required the disaggregation of the demand for leisure day trips from Berlin to Brandenburg for this day. Furthermore, the demand had to be divided between the sub-models according to the shares of the different means of transport. The calculation was done in a straight forward way using information from the studies of the DWIF (DWIF, 1995) and the regional studies of the Willy Scharnow Institut. These studies cover some leisure activities which are not represented by the attractiveness measures developed in section 4.4 e.g. shopping or attendance at events. The available data does not allow a separation of these activities; therefore the demand calculation includes all activities and does thereby not correctly correspond to the attraction side of the model. The error generated by this approach is considered negligible.

The seasonal distribution of leisure day trips is shown in the following table

	January	February	March	April	Mai	June	July	August	September	Oktober	November	Dezember
Share of leisure day trips %	9,4	7,7	9,2	9,4	9,6	8,5	9,1	8,3	7,9	6,7	6,8	7,4

Source: DWIF, 1995

Table 1: Seasonal Distribution of leisure day trips

The next table shows the distribution of leisure day trips among the weekdays

Day	Share of leisure day trips in %
Monday	4,9
Tuesday	5,3
Wednesday	8,2
Thursday	8,2
Friday	9,9
Saturday	32,8
Sunday	30,7

Source: DWIF, 1995

Table 2 : Distribution of leisure day trips among the weekdays

Using the shares from table 1 and table 2, the demand for leisure day trips on Sundays in July can be calculated as follows:

	Residents in Berlin 1998	3.458.763	
x 12,7	Trips per person and year	43.926.290	
9,1%	of the trips happen in July	3.997.292	
25%	of the trips in a month happen in one week	999.323	
30,7%	of the trips in a week happen on Sundays	**306.792**	Day trips on Sundays in July

Table 3 : Calculation of demand on the target day

For the different sub-models, this total number of day trips has to be divided between the two means of transport considered in this study. The shares for the different modes are taken from the survey of the Willy Scharnow Institut (FU Berlin, 1999).

Mode	Share	Sub-model	Model share	Trips (rounded)
Private car	71,2 %	PRIVATE CAR	71,2 %	218436 (218.000)
S-Bahn, Regional train	18,5 %	PUBLIC TRANSIT	21,3 %	65345 (65.000)
Bus	2,8 %			
Coach	5,7 %	Not considered	10,7 %	32827
Motorbike	1,1 %	Not considered		
Bike	2,9 %	Not considered		
Boat	1,0 %	Not considered		

Own calculations, mode shares from FU Berlin, 1999a

Table 4 : Modal split for leisure day trips and distribution of demand among the sub-models

The demand volumes used in the models are rounded because of the uncertain nature of the input values. The estimation yields a total demand of 283.000 persons on leisure day trips for a Sunday in July of which approx. 218.000 are using private car and approx. 65.000 are using public transit. Assuming an average car occupancy of 2.3 persons on leisure day trips (DWIF, 1995), this results in a number of 94.780 car trips.

4.4 Calculation of leisure and recreation attractiveness of the destination regions

4.4.1 Quantifying the attractiveness of destination regions

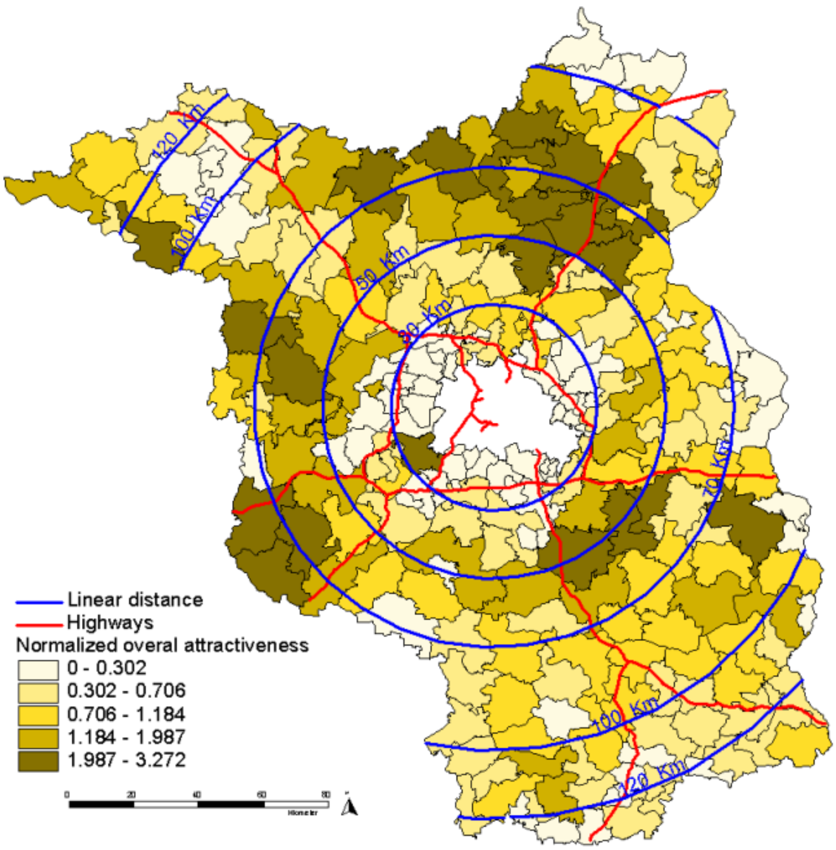
The quantification of the potential or suitability of regions for leisure and recreation has been a matter of discussion in the literature for many years (BENTHIEN, 1996; WIEMANN, 1985). Because the perception of the suitability for recreation is very subjective, concepts which try to directly relate the occurrence of landscape elements, tourist sites or cultural institutions to numbers of visitors attracted are considered problematic. As this study uses a production constrained model and therefore does only realize the distribution of a given number of trips, it is nevertheless possible to follow an approach which tries to quantify the attractiveness of the individual destination regions. The attractiveness values generated by the procedure developed in this section are abstract figures without a dimension which can only represent the relative attractiveness of the destination regions.

This study accounts for the heterogenity of leisure and recreation opportunities offered in Brandenburg described in section 2 by considering the overall attractiveness of a destination region to be composed of three components which are related to certain leisure activities reported in the studies of the DWIF and the Willy Scharnow Institut. The frequencies by which the activities are carried out according to these studies are converted into weights for the components in the overall attractiveness.

Measure of attractiveness		Related activities	Weight used in composition
W_L	Attractiveness for recreation	Hiking, Cycling	60%
W_K	Cultural attractiveness	Visits of castles, museums, theatres etc.	23%
W_S	Attractiveness for leisure	Activities like swimming, sports etc.	17%

Table 5: components of the destination attractiveness measure

For each of these components, an attractiveness value was calculated by a procedure specific to this component (described in the following sections) and based on available data for the destination regions as described in the following paragraphs. The three attractiveness values were then normalized, weighted according to Table 5 and combined into a single overall attractiveness measure. The results are shown in Map 3.



Map 3 : Attractiveness measures of the destination regions

4.4.2 Attractiveness for recreation

The estimation of attractiveness for recreation applied in this study follows approaches described in BENTHIEN, 1996, mostly the approach to landscape evaluation developed by SCHÖNEICH in the 1970ies. These approaches combine measures of land use and landscape heterogeneity into measures for natural attractiveness or suitability for recreation. In this study, only land use is considered in the form of shares of land cover types related to recreation and an additional component of the area enclosed in biological reserves. The data was generated from statistical data on land use (LDS, 1997a) and GIS datasets of reserve boundaries digitized from paper maps (MUNR, 1999).

$$W_L = A_F + A_W + A_R + A_{GSG}$$

W_L : Attractiveness for recreation
A_F : Area of forests
A_W : Area of water bodies
Area in ha A_R : Area of recreation facilities (parks etc.)
A_{GSG} : Area of biological reserves

Figure 3 : Computation of attractiveness for recreation

4.4.3 Cultural attractiveness

Besides the world heritages sites of Potsdam, the federal state of Brandenburg offers plenty of smaller cultural sites like castles, churches, museums and historic estates or other (agricultural) buildings. Because no complete dataset of these sites and no capacity information or visitor numbers were available, the cultural attractiveness was derived solely from the number of such sites in the destination zones. In order to account for the different prominence of the sites, famous sites were weighted by a factor of three. The information on cultural sites was taken from common tourist maps (VBB, 1999). Travel guides – which could provide more detailed information on some sites – have not been considered, because they usually don't cover the entire study region and are more selective on the set of sites they cover than maps.

$$\boldsymbol{W_K} = \boldsymbol{C_S} + \boldsymbol{C_B} + \boldsymbol{C_H} + \boldsymbol{C_D} + \boldsymbol{C_M} + (3 \times \boldsymbol{C_X})$$

W_K = Cultural attractiveness
C_S = # of castles
C_B = # of fortresses
C_H = # of historic estates
C_D = # of memorial sites
C_M = # of museums
C_X = # of famous tourist sites

Figure 4 : Calculation of cultural attractiveness

4.4.4 Attractiveness for leisure

The computation of the attractiveness of the destination regions for leisure activities is conducted in a similar fashion as fort he cultural attractiveness. The number of facilities for leisure activities such as golf courses, zoological gardens etc. is taken from tourist maps which cover the entire region (VBB, 1999). As an additional source of information, a dataset on swimming sites on lakes with a classification of their importance (~"capacity") was used (LUA, 2000).

$$W_S = C_F + (B_{loc} + 2 \times B_{reg})$$

W_s : Attractiveness for leisure
C_F : # of leisure facilities
B_{loc} : # of swimming sites (local importance)
B_{reg} : # of swimming sites (regional importance)

Figure 5 : Calculation of attractiveness for leisure

4.5 Distance measures for the different sub-models

The literature on leisure travel emphasizes the importance of travel time (opposed to distance) for destination choice of leisure activities (OPASCHOWSKI, 1995). Therefore, this study uses travel times for private cars and public transit as "distance" or "cost" measures for the gravity model. A third model, which is considered mode-independent uses linear distance as the cost measure.

The computation of the different distance measures requires a careful selection of start and destination locations and parameters. As the study considers the demand for leisure day trips to be concentrated in a single source, no distinction is made of the area of Berlin and the trip starting points are set to the Brandenburg Gate at the centre of Berlin and the railway station "Friedrichstrasse" nearby. Because the destination regions cover larger areas and the connection quality of public transit is highly dependent on the timetable of the station chosen as a destination (especially on weekends), the locations and public transit stations representing the destination regions have to be selected manually.

The road travel times are computed by a routing algorithm integrated in the GIS used for the entire study using some reasonable speed factors for different road types. The travel times generated by this approach were validated against travel times computed by different online route planners. Using the GIS algorithm instead of directly taking travel times from online route planners has the advantage of providing also the routes as GIS datasets which can later be used for comparison with traffic counts.

For public transport, travel times where taken from the actual online schedule (*www.fahrinfo-online.de*). In order to account for connection quality, travel time was defined as the time between a desired departure on 9:00 am on the target-date and the earliest possible arrival time. Some of the destination regions can not be reached by public transit on Sundays, leading to travel times of almost a day.

5 Model calibration and evaluation

5.1 Calibration procedure

Besides the input datasets, gravity models have one open parameter, the “distance exponent” β which represents the sensitivity on distance of the activity type considered in the model, with higher values leading to a stronger effect of distance and thereby to higher shares of the demand assigned to locations in the proximity of the demand sources. This parameter has to be calibrated for each of the three sub-models individually. The best way to find the matching values would be to compare the demand assigned to the different destinations to field count data, e.g. by statistical methods like OLS which allow to compute the β-parameter directly. In the case of this study, no such count data is available and a more general approach has to be taken for model calibration. This is achieved by evaluating the model for different values of the β-parameter. During each model evaluation, the average travel cost (distance) of all trips is computed and then compared with a value known from existing studies (see ESRI, 1997). The β-value for which the average trip cost from the model matches the value derived from survey is considered to adequately represent the travel behaviour of the respective activity type. In this study, an average trip distance of 48 km was used as the benchmarking average distance value, which was derived from a trip distance distribution reported in DWIF, 1995. As the private car and public transit sub-models use travel time as the distance measure, the gravity model algorithm was modified in order to compute average trip cost values based on linear distance simultaneously to the trip distribution based on travel times.

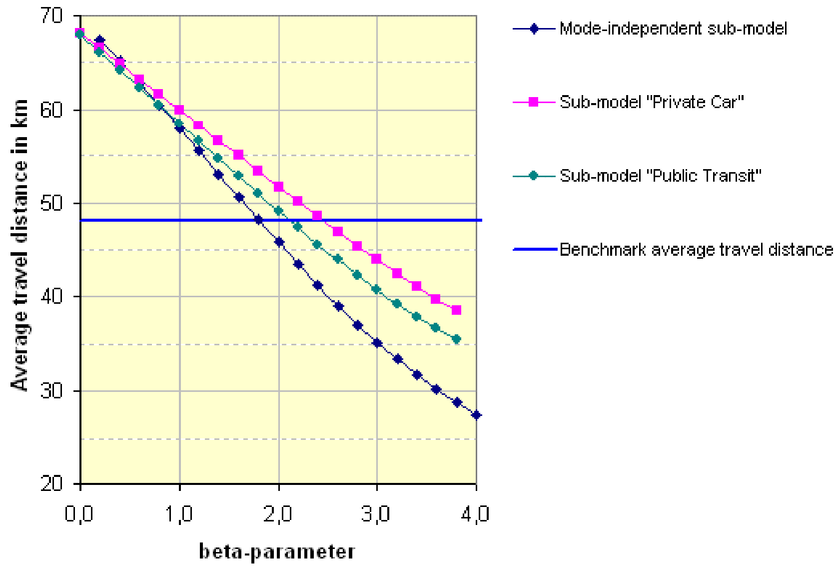
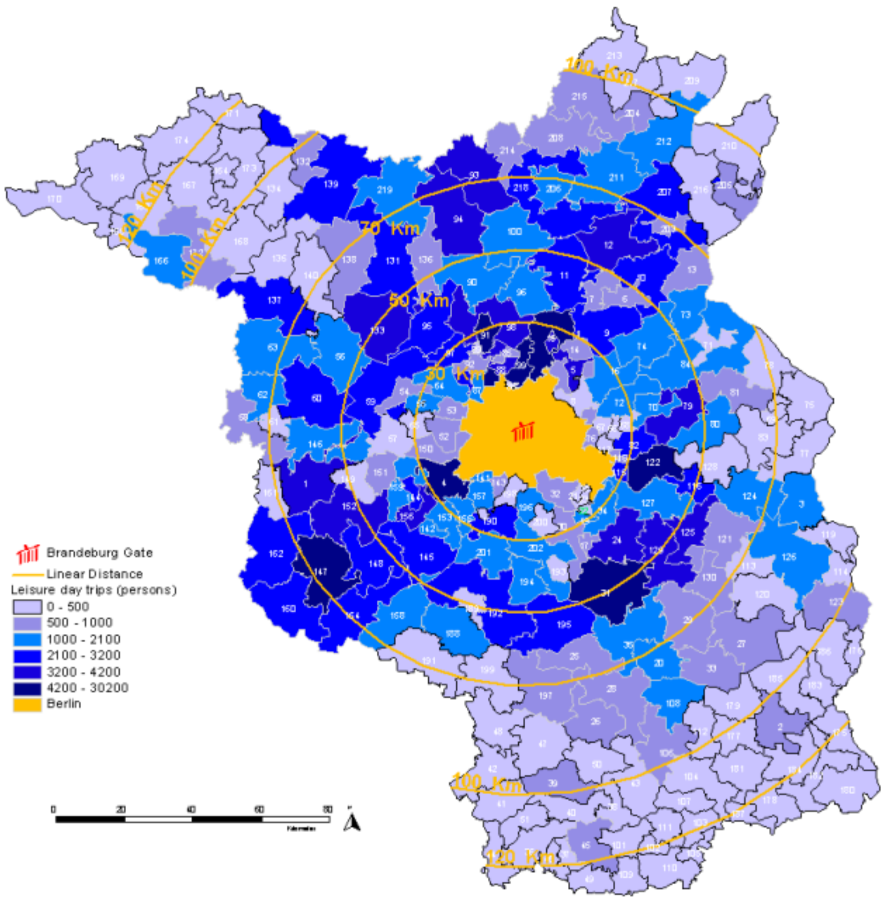


Figure 6 : Model calibration

The results of this calibration procedure as shown in Figure 6 suggest that for private car travel, low β-values which emphasize longer trips lead to proportionally shorter travel times, mainly because of the extended share of motorways with higher speed limits in the selected routes, whereas for public transit, longer travel distance frequently means proportionally longer travel times due to the need to transfer between different trains / busses.

5.2 Results of the model evaluation

The primary output of gravity models as the one developed in this study are OD-matrices of trips between the demand sources and the destination regions. As this study uses a single source of demand, the matrices have the form of simple tables of trips targeted at each destination region, which can therefore easily be displayed and analyzed in a GIS. Each of the three sub-models used in this study produces a trip matrix, and a fourth one can be computed by summing up the results of the private car and the public transit sub-model. In contrast to the trip matrix of the mode-independent sub-model, which is based on linear distance and therefore represents a potential demand for each destination region without regard to the accessibility, this fourth trip matrix can be considered to represent a "realistic" demand for each destination region which also accounts for accessibility (see section 6.1).



Map 4: "Realistic" number of leisure day trips assigned to the destination regions

As Map 4 and Table 6 show, most of the destination regions with high numbers of day trips are in close proximity to the city of Berlin. By far the highest number of trips is assigned to the city of Potsdam, which is known to be a hot spot of tourism combining natural beauty, world heritage cultural sites and good accessibility from Berlin by car and public transit. It can also bee seen, that almost no demand for leisure day trips is assigned to destination regions farer than 100 km from Berlin, which is in accordance with the literature reporting a driving time of 1 hour to be a limit for leisure day trips (OPASCHOWSKI, 1995).

ID	Destination region („Amt“)	#trips “realistic”	# trips Private Car	# trips Public Transit	# trips mode-independent “potential“	Difference ”realistic” – “potential”
4	Potsdam	30119	20673	9445	18898	11221
31	Schenkenländchen	5741	4259	1482	5552	189
122	Grünheide (Mark)	5499	3316	2183	5122	377
148	Belzig	5322	4346	977	3343	1979
91	Oranienburg	4433	3552	881	3115	1318
99	Schildow	4388	3440	948	8199	-3811
15	Wandlitz	4239	2874	1365	5646	-1407
12	Joachimsthal	4057	3370	687	4061	-4
79	Märkische Schweiz	4034	3141	893	4897	-864
88	Hohen Neuendorf	4020	3671	349	3174	846

Table 6: Model results (Top 10 destination regions)

5.3 Validation of model results

An important objective of this study was to evaluate the suitability of a “traditional” gravity model for the modelling of a disperse phenomena like leisure day trips. For that reason, most of the available data from surveys and traffic counts was not used within the model itself, but only for validation purposes.

In order to validate the model, the output of the model was compared to three different datasets. The most important validation dataset is the set of main day trip destinations reported in the study of the Willy Scharnow Institute (FU BERLIN, 1999) which was compared with the output of the mode-independent model. Furthermore, the results of the private car sub-model were compared with traffic counts from the transport authority of Brandenburg (BLVS, 1999) and the results of the public transit sub-model were compared with boarding counts of regional trains (DB REGIO 2000).

Although the comparison could only be done roughly in all cases, the results of the model appear to be in good accordance with the field data. The comparison of trip distribution from the mode-independent model with the surveyed main trip distributions is difficult because of the differing spatial definition of destination regions in the study and the survey of the Willy

Scharnow Institute. The comparison was done based on maps and rankings of the destination regions and showed that the model reproduced most of the destination regions found in the survey and that also the ranking of the different regions was similar.

The comparison of the private car and public transit sub-models with count data was difficult because of the different target days of the modelling and the corresponding surveys and because of the restrictions of the route choice applied in the gravity model. But in both cases, the trip counts generated by the models do not exceed the counts in most locations and therefore seem not to overestimate traffic volumes generated by leisure day trips. This is important if one wants to evaluate the impacts of leisure day traffic e.g. on the environmental quality in tourist regions.

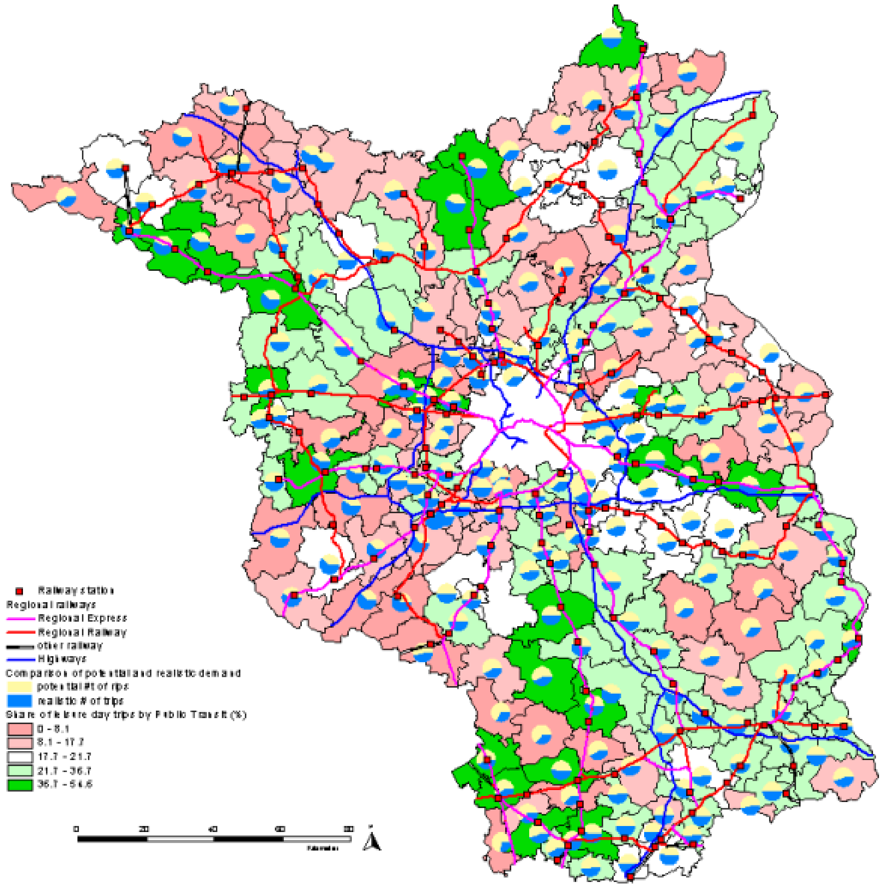
6 Application of the model output

6.1 Applications in transportation planning

One possible application of a model like the one developed in this study is transportation planning. If we define the number of leisure day trips being assigned to a destination region by the mode-independent model to represent the overall potential of that region for leisure and recreation activities of residents of Berlin, we can compare that number to the sum of trips assigned to that region by the private car sub-model and the public transit model. The ratio of both values is a general measure of accessibility of the destination region for leisure day trips and can provide hints to transportation policy about infrastructure improvements required (see Map 5).

Furthermore, the modal differentiation of the approach allows to compare the accessibility of destination regions for leisure day trips by different means of transport. From the results of the private car and public transit sub-models, a modal split value can be computed for each destination region (see Map 5) and be compared to the overall values (21,3 %) reported in the survey data (FU BERLIN, 1999). Regions with a lower share of public transit than the average, especially when they are important destinations of leisure day trips, are candidates for improvements e.g. the adaptation of schedules to leisure traveller needs.

Because the model developed in this study focuses on the spatial distribution of leisure day trips and does not include a module for mode choice, the impacts of transportation improvements can only be forecasted in terms of their impacts on spatial distribution. Shifts of travellers between the modes can not be determined with this approach.

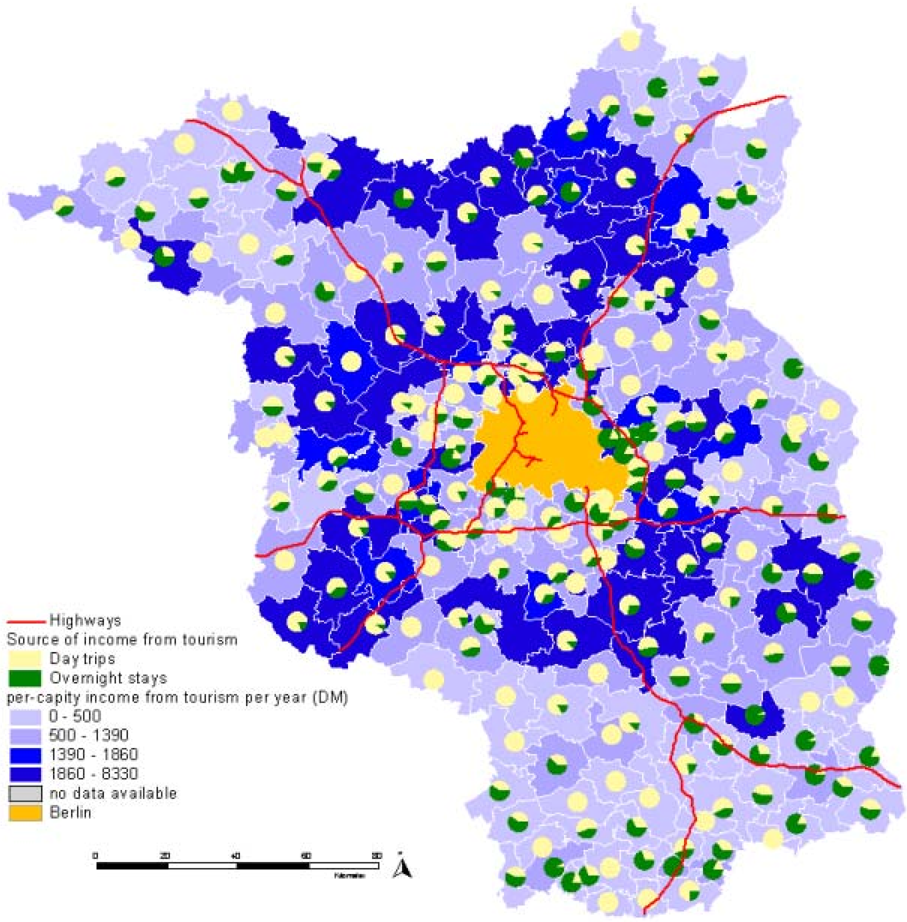


Map 5 : Accessibility indicators and regionalized modal split

6.2 Estimation of economic effects of leisure day trips

The common practice of tourism planning and policy focuses on overnight stays, because these are covered by official statistics and their economic effects are known. In fact the tourism policy of the federal state of Brandenburg of the late 1990ies was mainly focussed on this form of tourism. This view has changed in the recent years because of an increasing awareness of the economic effects of leisure day trips (MW, 2004). Although the average spending on leisure day trips of approx 17.30€ per traveller and day (FU Berlin, 1999) is significantly lower than on overnight stays (approx. 70€ per guest and day), the much higher number of trips (43mio day trips vs. 7,3 mio overnight stays) lets the economic effects of leisure day trips exceed those of longer stays by far (IFT, 1999, MW, 2004). Generally, overnight tourism is more focussed on some prominent destination areas than leisure day trips. Nevertheless, the different activity profiles and traveller preferences of the two forms of tourism are potential sources of conflicts, e.g. caused by traffic of day travellers passing through regions of high importance for overnight tourism.

While the regional structure of overnight tourism is well known from official statistics (LDS, 1997b), day trips are more difficult to investigate. The model developed and configured in this study allows a regionalized quantitative study of leisure day trips an can therefore help to develop tourism strategies which balance between economic benefits and potential conflicts. For example, Map 6 shows, day trips are spread across the area more homogenously than overnight tourism. A policy promoting day trips into regions not touched by overnight tourism can create new economic perspectives while also giving relief to the “hot spots”.



Map 6 : Regionalized economic effects tourism

7 Conclusion

This study has shown that traditional quantitative models of regional science can successfully be applied to the disperse topic of short term leisure travel. The use of GIS throughout the model development process allows to integrate many different available data sources which were not created specifically for this purpose in a creative fashion, and the resulting model configuration generates results which are in accordance with validation data. The availability of a quantitative model allows applications in different areas of regional planning.

Further extensions of the model could include multiple sources of demand and could be based on more complex measures of attractiveness which are based on richer datasets. For transportation planning applications, the inclusion of a mode choice module would be a great enhancement, but this would probably require far-reaching changes to the model structure. A better approach for this might be to transfer the model into standard transportation planning software.

The application of the model to other study areas is generally possible, but it is questionable if comparable results can be achieved in more complex spatial configurations of demand sources and transportation networks.

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