Geographically referenced data for social science

Hintze, Peter; Lakes, Tobia

Veröffentlichungsversion / Published Version
Arbeitspapier / working paper

German Council for Social
and Economic Data (RatSWD)

www.ratswd.de

RatSWD
Working Paper Series

Working Paper No. 125

Geographically Referenced Data for Social Science

Peter Hintze and Tobia Lakes

October 2009

Federal Ministry
of Education
and Research

Working Paper Series of the Council for Social and Economic Data (RatSWD)

The *RatSWD Working Papers* series was launched at the end of 2007. Since 2009, the series has been publishing exclusively conceptual and historical works dealing with the organization of the German statistical infrastructure and research infrastructure in the social, behavioral, and economic sciences. Papers that have appeared in the series deal primarily with the organization of Germany's official statistical system, government agency research, and academic research infrastructure, as well as directly with the work of the RatSWD. Papers addressing the aforementioned topics in other countries as well as supranational aspects are particularly welcome.

RatSWD Working Papers are non-exclusive, which means that there is nothing to prevent you from publishing your work in another venue as well: all papers can and should also appear in professionally, institutionally, and locally specialized journals. The *RatSWD Working Papers* are not available in bookstores but can be ordered online through the RatSWD.

In order to make the series more accessible to readers not fluent in German, the English section of the *RatSWD Working Papers* website presents only those papers published in English, while the the German section lists the complete contents of all issues in the series in chronological order.

Starting in 2009, some of the empirical research papers that originally appeared in the *RatSWD Working Papers* series will be published in the series *RatSWD Research Notes*.

The views expressed in the *RatSWD Working Papers* are exclusively the opinions of their authors and not those of the RatSWD.

Geographically Referenced Data for Social Science

Peter Hintze and Tobia Lakes

peter.hintze[at]gmail.com; tobia.lakes[at]geo.hu-berlin.de

Table of Contents:

1. Introduction

An estimated 80% of all information has a spatial reference. Information about households as well as environmental data can be linked to precise locations in the real world. This offers benefits for combining different datasets via the spatial location and, furthermore, spatial indicators such as distance and accessibility can be included in analyses and models. HSpatial patterns of real-world social phenomena can be identified and described and possible interrelationships between datasets can be studied.

Michael F. GOODCHILD, a Professor of Geography at the University of California, Santa Barbara and principal investigator at the Center for Spatially Integrated Social Science (CSISS), summarizes the growing significance of space, spatiality, location, and place in social science research as follows:

"(...) for many social scientists, location is just another attribute in a table and not a very important one at that. After all, the processes that lead to social deprivation, crime, or family dysfunction are more or less the same everywhere, and, in the minds of social scientists, many other variables, such as education, unemployment, or age, are far more interesting as explanatory factors of social phenomena than geographic location. Geographers have been almost alone among social scientists in their concern for space; to economists, sociologists, political scientists, demographers, and anthropologists, space has been a minor issue and one that these disciplines have often been happy to leave to geographers.
But that situation is changing, and many social scientists have begun to talk about a "spatial turn," a new interest in location, and a new "spatial social science" that crosses the traditional boundaries between disciplines. Interest is rising in GIS (Geographic Information Systems) and in what GIS makes possible: mapping, spatial analysis, and spatial modelling. At the same time, new tools are becoming available that give GIS users access to some of the big ideas of social science."[1]

1.1 Survey Data from a spatial perspective

The objective of this data documentation is to show the additional benefits of using Geographically Referenced Data (Geodata) with Survey Data. In order to use this data documentation as a practical guide on how to combine Geodata and geospatial analyses in the social sciences, the first chapter begins with the description of Geodata and Geographic Information Systems (GIS). The second chapter follows with a description of the target user group, a definition of the Geodata covered in this documentation and an evaluation showing the benefits and challenges of using Geodata in the social sciences. Chapter 3 shows the potential of using Geodata as an additional information source for studies in the social sciences. This includes the description of tasks carried out with GIS and valuable examples on how Geodata is used in social research. Finally, an overview of available Geodata in Germany is given with a focus on the most frequent data demands in the social sciences. Additionally, Internet links for data resources, available GIS software and further information are listed in the appendix.

1 http://www.geographymatters.com/news/arcnews/spring04articles/social-sciences.html

In this documentation, the following questions will be addressed:

- What are Geographically Referenced Data (Geodata) and GIS?
- What is the potential of combining Geodata with SOEP data?
- What are the benefits and challenges for the target user group?
- How can Geodata and GIS operations be applied in research practice?
- Which studies already combine Survey Data with spatial data?
- What are the characteristics of Geodata in Germany; where and under which conditions are they available?

1.2 What is Geographically Referenced Data?

Geographic location is the element that distinguishes geographic information from all other types. Geodata describe both the location and the characteristics of spatial features such as households, roads, land parcels and water bodies. Geodata represent real-world objects (also called features) in a digital data format. A geographically referenced object has two main components: spatial data representing its location, and attribute data representing its characteristics. While attribute data of objects, such as the number of people living in a household or the status of employment, are frequently used in socio-economic analyses, the information about the location of an object and the existing interrelationships between datasets is rarely exploited.

To define an object's position on the earth, a spatial reference known as a georeference is used. In the case of a direct spatial reference, the information about the location is defined by two- or three-dimensional coordinates in a coordinate reference system. The most commonly used systems in Germany are the Gauss-Krüger and WGS84 coordinate systems.

In case of an indirect spatial reference, systems closer to everyday human experience are used to georeference the locations of real-world objects, such as administrative areas, postal addresses, postal codes and place names.

Real-world objects are very complex. In order to store them digitally, they must be simplified and – in most cases – they are modelled on the basis of two main approaches: discrete objects and continuous fields. Discrete objects are individually distinguishable features and include points (e.g., trees, cities), lines (e.g., roads, rivers) and areas/polygons (e.g., city parcels, administrative boundaries). Continuous features are, for example, elevation, precipitation or air quality. These two approaches follow the two most frequent ways of data abstraction: the vector model (discrete) and the raster model (continuous) with their respective digital storage type and visual representation (see fig. 1).

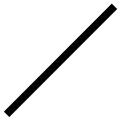
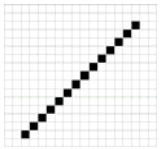
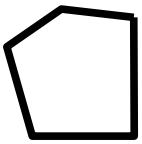
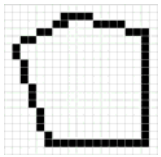
Geometric Element	Vector		Raster	
	Digital Storage	Representation	Digital Storage	Representation
Point	x, y coordinates (e.g. 3,4)		Pixel	
Line	series of x, y coordinates (e.g. 3,4; 4,5)		Pixel	
Polygon	a closed series of x, y coordinates (e.g. 3,4; 4,4; 4,7; 3,7; 2,6)		Pixel	

Figure 1: Table of geometric elements in the Vector- and Raster model, the storage type and representations

Vector data are often derived from digitized analogue maps or from the input of GPS (Global Positioning System)-based coordinates. In the vector model every object is composed out of a series of x,y coordinate pairs and is generally stored in tables with an unique identification number (ID) for each object, spatial properties (e.g., coordinates, altitude) and further optional attributes.

The raster data model, on the other hand, consists of cells within a rectangular grid. Each cell carries a value and can be used to represent real-world phenomena such as land use. Raster data are often derived from scanned maps or from remote sensing data such as satellite images. The spatial reference of a raster image is accomplished by relating the pixels in the grid to an absolute coordinate system and thus georeferencing the entire image. The spatial accuracy, i.e., the spatial resolution, depends on the pixel size and hence on what area of the real world is covered by each pixel.

In order to exploit the available Geodata specialized applications, Geographic Information Systems can be applied.

1.3 What is a Geographic Information System?

A Geographic Information System (GIS) is a computer system for capturing, managing, analysing, and displaying Geodata. GIS includes hardware, software, networks, standards and protocols for data handling and analysis (LONGLEY et. al. 2005).

The benefits of GIS and similar information systems have been proven in various applications and research projects to analyse, relate and visualize spatial data . Since the 1980s, the use of GIS has been rapidly growing in fields like natural resource management, land-use planning and natural hazard assessment (BILL 1999). In recent years, GIS is increasingly being used in a wider spectrum of fields, such as market analysis, social science research, crime analysis, and transportation. The evolving interest in GIS is linked to a growing amount of available Geodata and is further supported by improved user-friendly software, widely distributed GPS-based systems (e.g., location-based services, navigation systems) and new Internet technologies (e.g., web-mapping and online data distribution).

1.3.1 Types of GIS software systems

Today many professional GIS products are available: There are Desktop GIS (see fig. 2), Server GIS, Hand-held/mobile GIS, Developer GIS and products like Computer Aided Design (CAD) and statistical software that offer similar functionalities. Like many other software applications, the graphical user interface of a Desktop-GIS lets the user control the application through menu commands and toolbars.

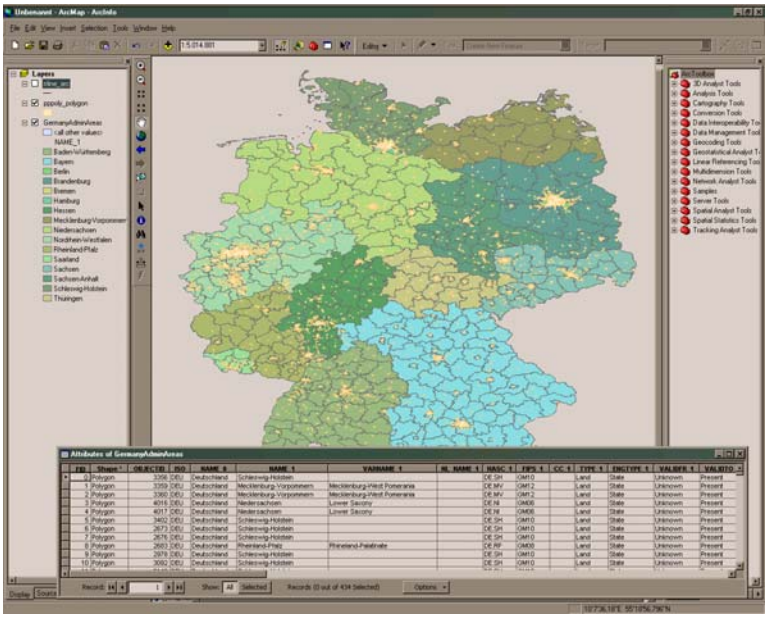


Figure 2: Graphical user interface of a typical Desktop GIS

One example of a widespread sophisticated commercial GIS software product is ArcGIS by the company ESRI.[2] Vector data is commonly stored in the ESRI shapefile format with the file extension .shp. It is a quasi-standard and many data products are distributed in this format. Besides such a file-based storage method, Geodata are often stored in databases that support spatial extensions, such as Oracle Spatial.[3] Its spatial database management systems allows GIS-functions to directly access and modify the database, enabling the user to manage and manipulate Geodata with all its spatial characteristics. Besides the more sophisticated storage systems, Geodata can also be stored in a simple relational database such as an MS Excel Table, MS Access Database or dBase as well as in simple text or .csv files. As in most cases, the lower the file format level the better the compatibility for applications such as SPSS, Stata and SAS. Nevertheless, an increasing number of software applications support spatial data formats and are thus "spatially enabled". This development supports scientific research in other fields by making work with Geodata less system-dependent and also by allowing the results to be visualized and distributed via Internet software like Google Earth.[4]

The following table shows a selection of frequently used data formats.

Vector formats	Raster formats	Other formats	Database
SHP (SHAPE)	BMP	ASCII	ESRI Geodatabase
DXF	TIFF (GEOTIFF)	XLS (EXCEL)	Oracle Spatial
KML/KMZ	PNG	PDF	MS Access
E00	AGF	CSV	PostGIS
	JPG	TXT	EDBS

Open Source GIS and databases increasingly provide an interesting alternative to proprietary software. They often offer sufficient functionalities to accomplish basic tasks such as converting data, as well as more complex operations[5]. A noteworthy example is PostGIS or GeoDA from the SCISS project[6]. The later one is specialized in the spatial analysis of socio-economic data combining statistical analysis with spatial analysis and visualization. For further information on available GIS software please refer to the list in the appendix.

1.3.2 Performing basic tasks with GIS

Regardless of the application, all GIS provide a range of operations to carry out tasks like data capturing and management, data analysis, data export, and presentation[7].

2 ESRI: http://www.esri.com
3 Oracle: http://www.oracle.com
4 Google Earth: http://earth.google.com/
5 MapWindow: http://www.mapwindow.com
6 GeoDA and CSISS: www.csiss.org/clearinghouse/geoda
7 ESRI Developer Network and Help Documentation: http://edn.esri.com/ and http://webhelp.esri.com/

Data collection and Data management

Data capturing and management is accomplished by tools for digitizing maps, data import, geodatabase development, and geographic data modelling.

Data analysis

Data analysis is carried out by geoprocessing tools that include overlay analysis, proximity analysis, table management, selection and extraction of features, topology analysis, and geostatistical analyses.

An overlay analysis addresses the question “What is on top of what?”. Depending on the research objectives, two or more datasets in the form of data layers are related in the GIS. In most cases an overlay of two datasets simply creates a new output dataset under different specified conditions, for example “Which household lies in which county?” or “Which postal zones have the most households with the highest income?”.

A proximity analysis addresses the question “What is the distance between locations?”. Distances between cities, find the catchment area of a school, or calculate traffic emissions around streets and highways. Questions could be “How far is the residence from the next hospital, park, etc.?” or “Which school is closest to a residence?”.

Table management involves functionalities such as adding or deleting fields, creating relationships between tables, or creating features from tables that contain coordinates. Table management also includes joining tables and converting spatial objects from coordinates or coordinates to spatial objects. The process of geocoding, for example, includes the conversion of street addresses (house numbers) to coordinates. With reverse geocoding, coordinates are, for example, compared to house coordinates and then converted into house numbers.

The extraction of Geodata includes a set of tasks to reduce or extract data from larger, more complex datasets. One can modify data by clipping, splitting, or unifying it. It is also possible to interpolate and aggregate data by user defined specifications[8].

Besides the knowledge about the exact location or distances, these methods enable to gather topological information that refers to the spatial relations between features, such as “next to” or “lies within”. These spatially relative queries include, for example, neighbourhood analysis (which area borders on which), routing in a network (find shortest way between locations) and calculations such as whether an object is inside or outside a specific area.

8 For further information on geoprocessing and geoanalysis please refer to examples in chapter 3 and the appendix.

Data export/ Data presentation

Analysis results can be displayed and exported in various ways. While maps are the standard for geographic data, other visualisations and export forms are possible such as histograms, scatter plots, 3d-views, tables, and diagrams. Finally these results can be displayed on screen, converted, or printed. Additionally, the data can either be distributed via file libraries on CD-ROM or accessed interactively via web-mapping on the Internet.

2. Geodata and its use in the social sciences

2.1 Target user group

To what extent Geodata can be utilized in social sciences varies according to the specific research objectives. However, it is also very much the required data and software knowledge of the user that frames the possible applications combining Geodata with SOEP data. The target user group considered in this data documentation are social scientists. No matter the extent to which Geodata will be integrated into the particular research project, it can be valuable at all levels.

An exemplary level of Geodata integration involves relating Geodata to SOEP data while mainly using advanced statistical software such as Stata, SPSS, or SAS for the research process. Here, the user regards Geodata only as an additional information source to the already existing main dataset, the SOEP data, while maintaining the current workflow within the research process. A more advanced usage includes employing GIS in order to conduct spatial analyses combining SOEP data with Geodata. Here, Geodata may be one of the basic data sources for the research. In order to answer Survey research questions, a primary task at both levels is to produce spatial indicators (e.g., regional variation of income) to provide additional spatial information for the household dataset.[9]

Although an increasing number of research projects show a high level of spatial data integration in the social sciences (e.g., CSISS, SEDAC), up to now analysis of SOEP data shows a relatively low level of Geodata integration and is in most cases accomplished with statistical software such as SPSS, SAS, or Stata.

2.2 Geodata focus

Geodata can be used to address a number of scientific problems when working with SOEP data. Hence, the identification of the data for a specific problem represents one of the most

9 See chapter 3.1.2 for examples of possible spatial indicators.

challenging tasks. In Germany, a large variety of different types of Geodata is available. In order to narrow down appropriate and standardized datasets from reliable official sources, this documentation focuses on Geodata,

- which is suitable for research in the social sciences,
- which is available in digital format,
- which can be obtained from official federal agencies,
- which is available nationwide for Germany as well as for the two city-states Berlin and Hamburg as well as for the densely populated countries of Bavaria, North Rhine-Westphalia, and Baden-Württemberg),
- which is available from 1984 onwards; of particular interest is data available since 2000 due to the extension of the SOEP data, and
- which is (or can be made) suitable to use with the SOEP data.

The continuously growing Geodata market requires searching large amounts of Geodata. To find the requested data, search algorithms scan through the available meta-information. In order to find and characterize the Geodata surveyed in this data documentation, the following meta-information will be provided:

- Content
- Data format
- Date
- Distribution / accessibility
- Price and payment conditions
- Accuracy (spatial resolution, temporal resolution)
- Other data specific information (suitable applications, etc.)

2.3 Benefits and challenges of using Geodata

The following list provides an overview of the main benefits and challenges of integrating Geodata into Survey Data analyses.

Benefits of using Geodata	Challenges of using Geodata
Geodata is an additional information source to existing socio-economic data	GIS requires basic knowledge about GIS data management and analysis methods
GIS analysis allows the examination and verification of spatial patterns and non-spatial variables	Acquiring data that might not be available, up-to-date, or affordable
A database allows all georeferenced data to be queried, organized, and stored	Data conversion time extensive due to interoperability problems between different systems
Detailed and descriptive information in the form of maps, spreadsheets, or scatter plots	
Data distributable and accessible via online interfaces and interactive web-maps	

3. Combining Geodata and Survey Data

3.1 The potential of spatial analysis: the case of SOEP social scientists

The SOEP is an annual survey of Germans, foreigners and immigrants in the old and new federal states of Germany since 1984. The sample in the survey year 2006 included almost 11,000 households with more than 20,000 members. The SOEP data contains household information about income, living, as well as subjective indicators such as satisfaction. Main topics include, e.g., household composition, work and family biography, labour force participation and occupational mobility, income histories, health, and life satisfaction.

Regional-level data on the Postal Code/ZIP (PLZ), county/administrative district (Landkreis) or community (Gemeinde) has been available since the 1990s. Since 2000, the SOEP data expanded into a larger sample and the households are now georeferenced through geographic coordinates (house coordinates, GPS). This spatial information allows linking the SOEP data with additional Geodata and thus makes extended regional analyses possible.

The SOEP data is provided to higher education and research institutions in Germany and abroad. The data is available in SPSS, SAS, Stata, and ASCII formats. Extensive documentation is available online in German and English[10].

3.1.1 Georeferencing SOEP data

One of the main objectives of social scientists employing Geodata is to locate and identify the SOEP data in the form of precise household information as well as aggregate data. Georeferencing and GIS analyses can be carried out on different accuracy levels (scales), depending on the available data and the permitted spatial accuracy of the household locations. SOEP-remote supports analysis jobs even outside the DIW Berlin by securely automating the

10 Please refer to the appendix for further information about the SOEP

regional query and anonymising the identification of each household. In doing so, it enables the SOEP user to accomplish regional analyses on a county level from the workplace without having access to the location of a household.

Linking the information supplied by the SOEP dataset to the exact household locations is highly restricted due to data security regulations. Therefore the spatial linking and assignment of SOEP household data may only be done with aggregated information. This aggregated and thus anonymous information can then be used on a less precise level (e.g., ZIP-codes or communities).

Accuracy-levels of Georeferencing SOEP households		
Spatial accuracy level	Dataset	Application scales
Country	National boundaries (Polygons)	National, regional
Federal State (Bundesland)	Administrative boundaries of the federal states, administrative boundaries (Polygons)	National, regional
Administrative District (Landkreis)	Administrative district areas and the official district reference (Amtliche Kreisschlüssel / Kreiskennziffer) (Polygons)	National, regional
Community (Gemeinde)	Community areas and the official community reference (Amtlicher Gemeindeschlüssel / Gemeindekennziffer) (Polygons)	National, regional
Postal Code (Postleitzahlbezirke)	ZIP-Code areas (PLZ Gebiete) (Polygons)	National, regional, more exact scales
Postal Address (House number)	House coordinates (Hauskoordinaten) (Points)	National, regional, more exact scales

3.1.2 Producing spatial indicators

A spatial indicator provides information about a research problem with a spatial component. Thus, spatial indicators help to understand the relationships between household data and spatial phenomena. Depending on what socio-economic issue is to be addressed, the required information and thus the parameters of the spatial indicators change. These are produced based on different Geodata. The following table shows examples of research issues, the required information and possible spatial indicators.

Issues with a spatial component	**Required information**	**Spatial indicators**
Quality of life		
Living quality in the residential area	Household locations, emission and contamination data, data on green space, built-up area,	Share of green space and built-up area in the living environment Traffic and industry emissions in

Issues with a spatial component	Required information	Spatial indicators
	street types (highways or residential streets)	community x Density of streets and type of traffic in county x
Economy in the living environment		
Land price in the residential area	Registered land value, household locations	Land value in district x compared to the household's income
Social status in the living environment		
Influences of unemployment	Administrative borders, household locations, household data on life satisfaction, employment status	Total unemployment rate in community x (compared to the households status)
Infrastructure in the living environment		
Accessibility of households to general infrastructure	Household locations, locations of different infrastructure, quality and quantity of infrastructure in an area	Household distances to hospitals, culture centres, public transport, schools (e.g., schools within a radius of 500 metres to a household)
Environmental impact in the living environment		
Air pollution	Emission and contamination data, household locations	Air quality spatially differentiated (e.g., air quality in each county)
Noise pollution	Emission and contamination data, household locations	Household distance to noise sources (e.g., streets, airports)
Time series and location change		
Household mobility (social and spatial mobility)	Household locations, moving behaviour and dates, administrative borders	Moving Rate between different cities, within a city (e.g. , moving between the districts of a city)

3.2 Processing Geodata and typical GIS tasks of interest for social scientists

In order to prepare geospatial indicators for use with Survey Data, one has to preprocess the Geodata. Some of the typical GIS tasks of interest will be described in the following chapter. The example will be a link between the data of the German Socio-Economic Panel (SOEP) with Geo-coded data. For the examples, the open source GIS software MapWindow and mainly freely available Geodata will be used in place of many similar software applications.

3.2.1 Obtaining Geodata from the Internet

Geodata can be obtained from a range of data providers, among them public and commercial data providers (see chapter 4). Geodata freely available in the Internet has played an increasingly important role within the last few years.

Figure 3: Online Geodata distribution centers (GADM, Geocomm, OSM, DCW)

The following Geodata were downloaded to use with the examples [11]:

- Administrative boundaries data from Global Administrative Areas (GADM)
- Roads, railways, POI, buildings, natural from Open Street Map Project (OSM)
- Populated places from GeoComm
- Other data from Digital Chart of the World DCW
- OSM dataset for Germany (Roads, Natural)
- DDS Testdata (Administrative Boundaries, Socio-Street dataset with information about the population on the street level, e.g., age, purchasing power, children/no children, etc.)

3.2.2 Manage and explore Geodata

In order to display and explore the Geodata, one can import the data files into the MapWindow GIS as single data layers. In fig. 4 major Germany cities and the federal states are imported as data layers.

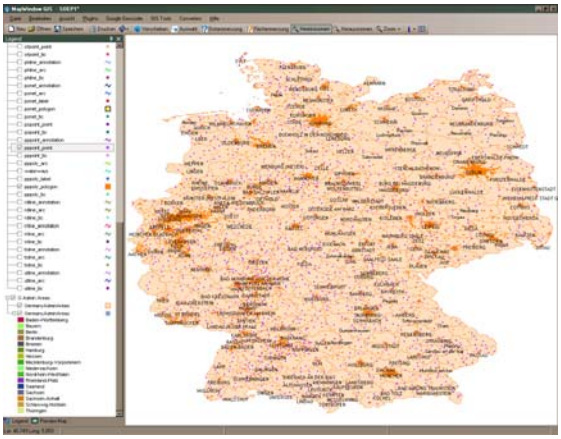


Figure 4: Germany Geodata layers

11 Please refer to the appendix for a list of Geodata resources

One can display information based on vector data. In fig. 5 the information about the federal states in the polygon layer's table is coloured via a symbolization menu producing a simple map of the federal states of Germany.

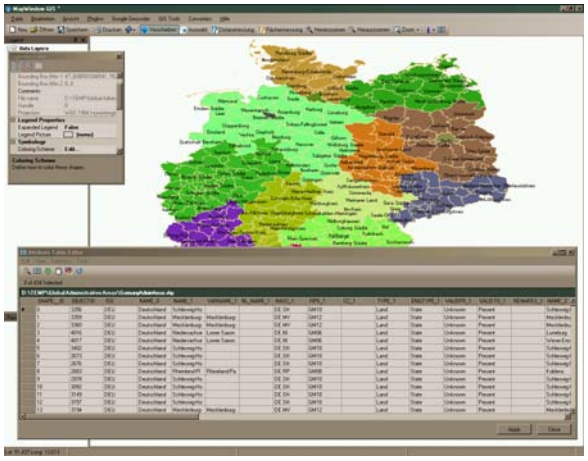


Figure 5: Produced map of the federal states in Germany

In fig. 6, all data layers that contain information about the city of Berlin have been selected and extracted as new data layers.

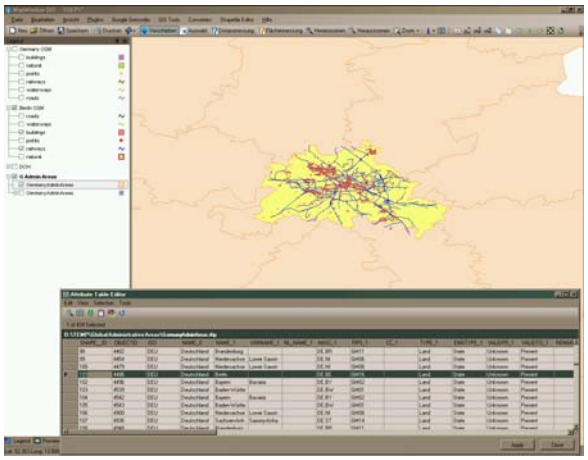


Figure 6: Extracted data layers of Berlin, Germany

3.2.3 Visualizing information on a map

As seen, with the vector model, attributes can be attached to vector objects via identification numbers. This way, spatial and attribute data can be linked. A simple application using this method is to produce a map with the locations of different cities and in addition labelling these points with their corresponding city names (see fig. 4). Figure 7 shows another example of a more precise scale in the district of Mitte in Berlin in the area of the Mohrenstraße, where the DIW Berlin is located. Here street data is imported and the the street names are labelled. This allows the exact location of different streets and houses. It shows that precise scales and thus analyses on the street level are possible with a few simple GIS methods. While official

Geodata products offer better accuracy, this example shows that freely available Geodata are a valuable alternative for meeting the accuracy demands.

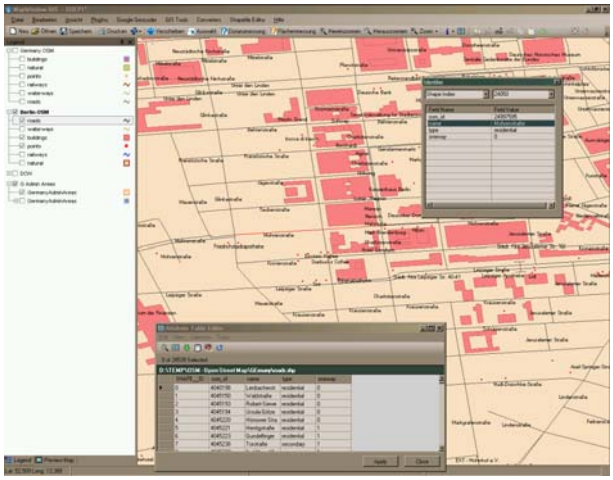


Image 7: Streets and street names on a precise scale

3.2.4 Georeferencing Postal Addresses – Geocoding

One of the most frequently needed tasks is to locate or georeference data by postal address. In this example, schools are chosen for identification on a map.

1. Preparing a list of school addresses

In order to compile a list of schools, postal addresses of existing schools are needed. The data source can be an official school address list.

SchoolNr	SchoolName	SchoolType	City	District	District2
05Y05	Lily-Braun-Oberschule	Gymnasium	Berlin	Spandau	Spandau
03Y13	Felix-Mendelssohn-Bartholdy-Schule	Gymnasium	Berlin	Pankow	Prenzlauer Berg
04G08	Mierendorff-Grundschule	Grundschule	Berlin	Charlottenburg-Wilmersdorf	Charlottenburg
01V02	Oberschule am Brunnenplatz	Hauptschule	Berlin	Mitte	Gesundbrunnen

2. Geocoding of postal addresses in order to obtain coordinates for each address entry

There are many Geocoders available. In MapWindow a Geocoding functionality is already integrated. The user can import a simple text file that includes a list of the postal addresses. Starting the Geocoding, this list will be processed using the GoogleMaps Street Map and house coordinate database. It returns system-independent x and y coordinates for each address entry.

SchoolNr	Schoolname	Schooltype	City	District	District2	Street	HouseNr	ZIP	Xcoord	Ycoord
01G28	Brüder-Grimm-Grundschule	Grundschule	Berlin	Mitte	Wedding	Tegeler Str.	18-19	13353	13.357578	52.541205

3. Map the coordinate point onto a map

The two columns containing the coordinates can be used to map the schools' locations exactly. This table can be imported in MapWindow (or any other GIS). Using the function “make XY events from coordinates” then produces points showing the schools' locations on a map (see fig. 8).

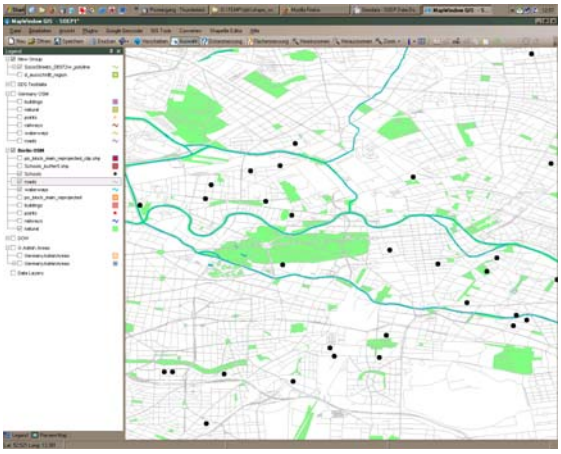


Figure 8: Geocoded School locations on a map

3.2.5 Proximity and Overlay analysis - Catchment area of schools

Based on the location data produced and additional Geodata, one can now answer a question like “Which areas/households have access to schools within a perimeter of 500 meter (for households with young children who can to walk this distance by themselves)?”

First one can calculate a 500 meter buffer around the schools' locations with the operation “Buffer”.

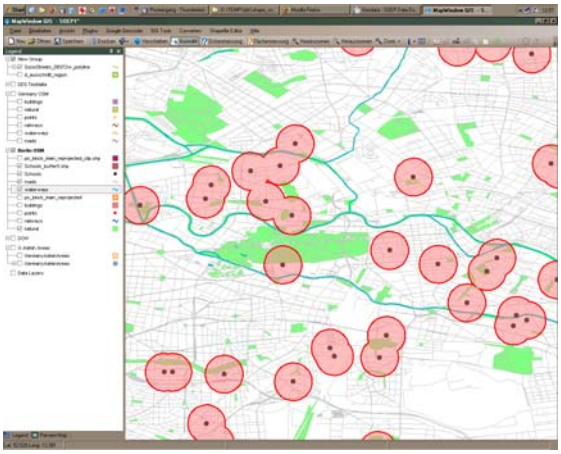


Figure 9: 500 meter buffer around the schools locations

Then import ATKIS data to show the built-up areas in the district Berlin-Mitte.

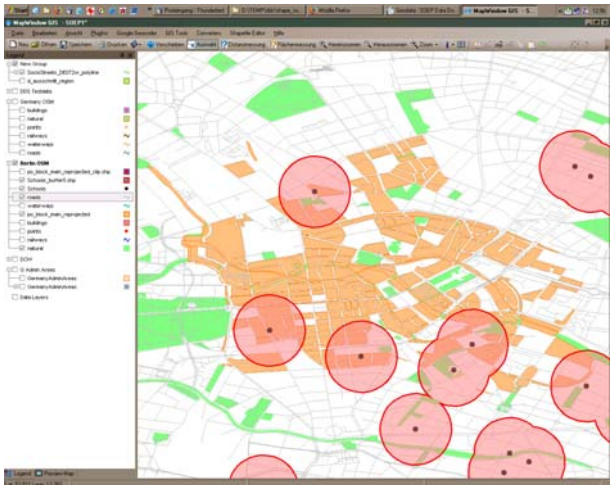


Image 10: Schools location, Buffer and Built-up areas

Next the function “Clip (Overlay) two shapefiles” can be used to select and extract the buildings that are within a radius of 500 meters of existing schools.

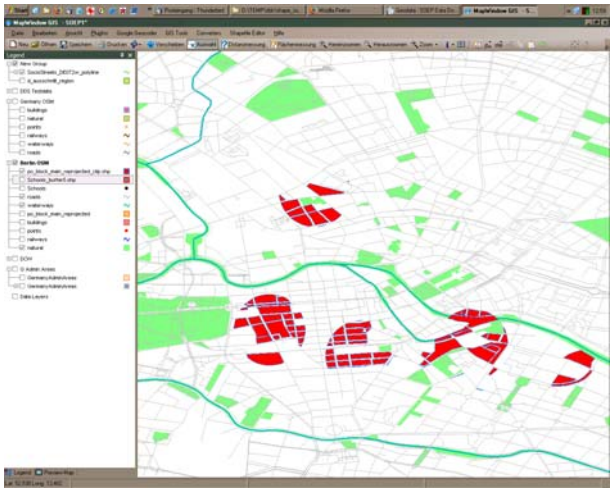


Image 11: Built-up areas within a perimeter of 500 meter to a school

Regardless of the SOEP data security aspects, such newly produced spatial data can now be analysed with the households' locations to see which households are located in these areas. There are many more applications possible; these example only show a small range of the analysis benefits offered by GIS and Geodata.

3.2.6 Overlay analysis – Percentage of green space in residential areas

A good example of overlay analysis is to find out if there is a relation between the percentage of green space and the different residential areas of a city, with the specified condition of examining areas with a high income (purchasing power).

The DDS Test data consists of street data as vector data and connected socio-economic information around south-east Munich. The information is stored in a table that is connected to the spatial line objects via identification numbers. According to the Column “purchasing power” in this table, one can represent the more and less affluent streets.

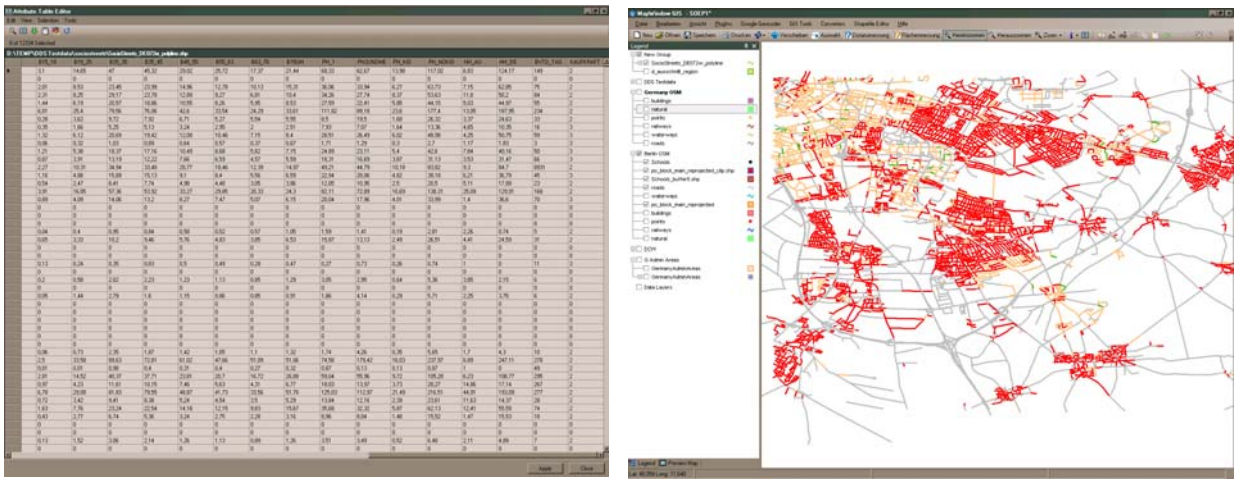


Figure 12: Table and map visualization of socio-economic street data

The OSM data consists of polygon data that shows the amount of green space around south-east Munich. When overlaying both data layers, one can clearly see that, at least in this case, streets containing households with a purchase power (red) are concentrated close to green space (woods, parks) in the outskirts of the Munich city centre.

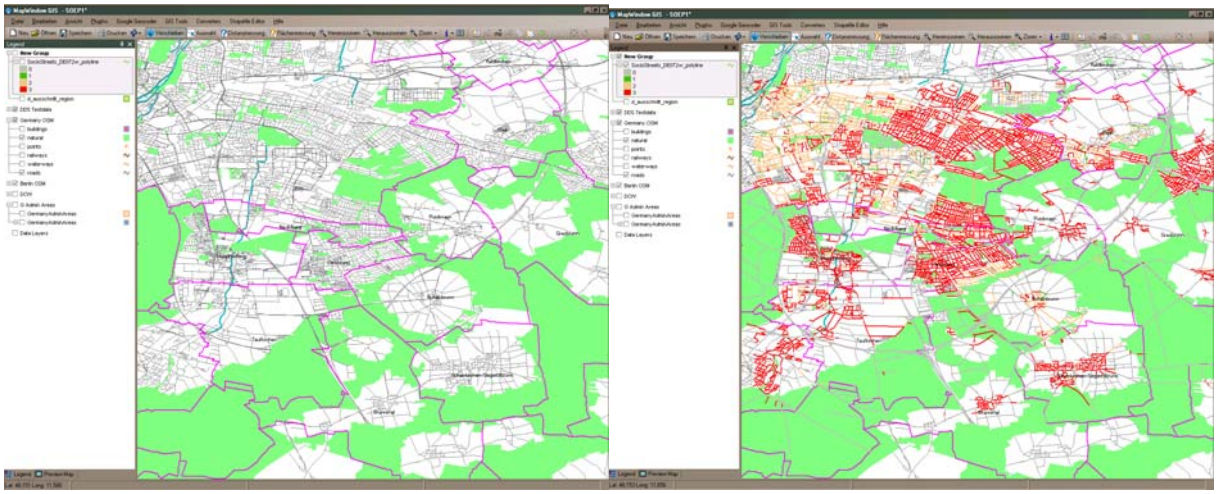


Image 13: Streets with high income and location of green space areas

3.3 Socio-economic studies using Geodata

The following chapter presents three socio-economic studies that combine Geodata and GIS methods with the SOEP data or similar datasets.

3.3.1 Accessibility of University locations

In a study about the decision of Abiturienten (academic-track high school seniors) on the choice of further education, spatial information was used in addition to different parameters of the SOEP household data ranging from academic status to parental income. An indirect spatial reference was used for each household and University by relying on the postal zip codes. In a first step, the distances between the households and Universities were calculated and the nearest one was determined. In a second step, a spatial interpolation method was used to derive a Germany-wide map of estimated nearest distances to Universities. By using this spatial analysis method, area-wide information is generated by interpolating distributed point information. Within the overall model, distance turns out to be of high significance for explaining the choice of career.

Further information about this study	
Title	Accessibility of University locations
Author	Katharina Spieß, DIW Berlin
Author	Tobia Lakes, Geomatics Lab, Geography Department, Humboldt-Universität zu Berlin

3.3.2 Valuing air quality using the life satisfaction approach

In this study the life satisfaction approach is used to value air quality, combining individual-level panel and high-resolution SO2 data. It has has two major objectives. First, the effect of SO2 concentration on life satisfaction and housing rent is estimated using high-resolution pollution data (raster data) and a large panel survey for Germany (SOEP data). Second, using the results of the hedonic housing regression and the life satisfaction regressions, the total willingness-to-pay (WTP) for improvements in air quality is calculated as the sum of the estimates based on the two different methods.

The Umweltbundesamt (German federal environmental agency, UBA) provides data on the annual mean SO2 concentration measured at the monitors belonging to the monitoring networks of the 16 Landesumweltämter (state environmental agencies) and the UBA from 1985 to 2003. The study is based on SO2 data from 553 monitors or, in individual years, between 196 monitors in 1985 and 416 monitors in 1994. There are fewer locations of

monitors in 1985. In order to estimate the SO2 concentration at all other locations, GIS is used to interpolate the monitor readings on a grid with cell size of 1 km² covering the whole area of Germany (see fig. 14).

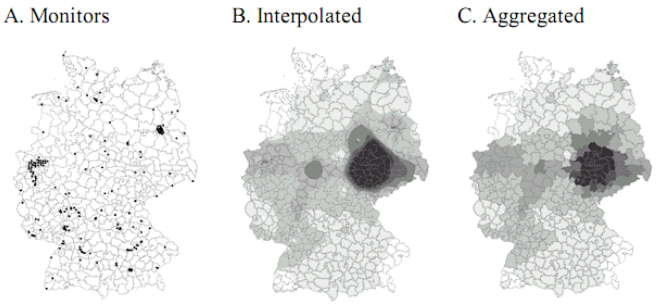


Figure 15: Air quality monitors, interpolated and aggregated SO_2 concentration at county level, 1985

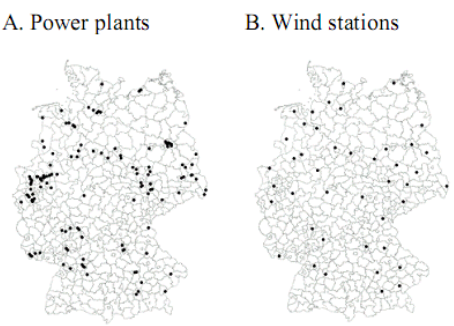


Figure 14: Locations of power plants (fossil fuel) and wind stations

The data are from the UBA, the operating companies and a survey mailed to the operating companies and statutory provisions. The power plants were georeferenced using a route planner. The locations of the power plants as well as the wind stations are depicted in fig. 15.

In order to examine the impact of air pollution on life satisfaction and housing rents, information from the German Socio-Economic Panel (SOEP) on both individual life satisfaction and rents is used. The SOEP survey data is related to the pollution data at the county level. In the post-reunification years, county mergers in East Germany reduced the number of counties from 543 in 1993 to 439 in 2001. As the polygon data describe the boundaries of the 445 existing counties in 1996, the same SO2 concentration to several counties in earlier years and calculate area-weighted averages for later years is assigned.

Further information about this study	
Title	Valuing Air Quality Using the Life Satisfaction Approach
Author	Simon Luechinger, University of Zurich, Swiss Federal Institute of Technology

3.3.3 Distance from urban agglomeration economies and rural poverty

This study does not use SOEP data but data available in the United States. It is interesting as it examines the interrelationships between spatial distance from urban areas and rural poverty. Despite the strong national growth and significant reduction in the late 1990s, high poverty persists in rural areas. A Geographical Information System in connection with a county database is used to examine the nexus between rural U.S. poverty and remoteness. One result of this study is that poverty rates increase with growing rural distances from larger metropolitan areas. This is explained as arising from the attenuation of urban agglomeration

effects at greater distances and incomplete commuting and migration responses to lower labour demand in rural areas. One implication is that remote areas in particular may experience greater reductions in poverty from place-based economic development policies.

Further information about this study	
Title	Distance from urban agglomeration economies and rural poverty
Author	Mark D. Partidge, Ohio State University
Author	Dan S. Rickman, Ohio State University

3.4 Conclusions

Using Geodata allows one to expand the analysis of socio-economic data – such as SOEP data – to incorporate a spatial dimension. This permits new scientific questions to be addressed at the intersection of socio-economics and geography. A variety of possible relations and linkages between Survey Data and Geodata is possible. However, it is not only the additional information provided by Geodata but also geographic analysis techniques, such as proximity or overlay, that offer new benefits. While simple analysis and presentation tasks may be done by non-experienced Geodata and GIS-users, more complex analyses need to be based on profound knowledge of spatial technologies. Increasingly, GIS can be combined with widely distributed statistical analysis software packages such as SPSS and SAS. In addition to desktop technology, web mapping applications and web-server technologies open up possibilities for data exchange and presentation that have not yet been exploited to a wide extent.

4. Survey of Geodata for Germany

Primary sources for Geodata in Germany include governmental organisations, universities, and scientific institutes. Geodata is available on a nationwide level, federal state level (single federal states), and also on a regional level (cities, specific regions), as well as on street and house level.

The types of available Geodata can be divided into two main categories – Geobasedata (Geobasisdaten – see fig. 16) and Specialized Geodata (Geofachdaten). Specialized data exists in very heterogeneous types derived from different sources, and thus a specific description would go beyond the scope of this data documentation. The primary focus will therefore be on the Geobasedata.

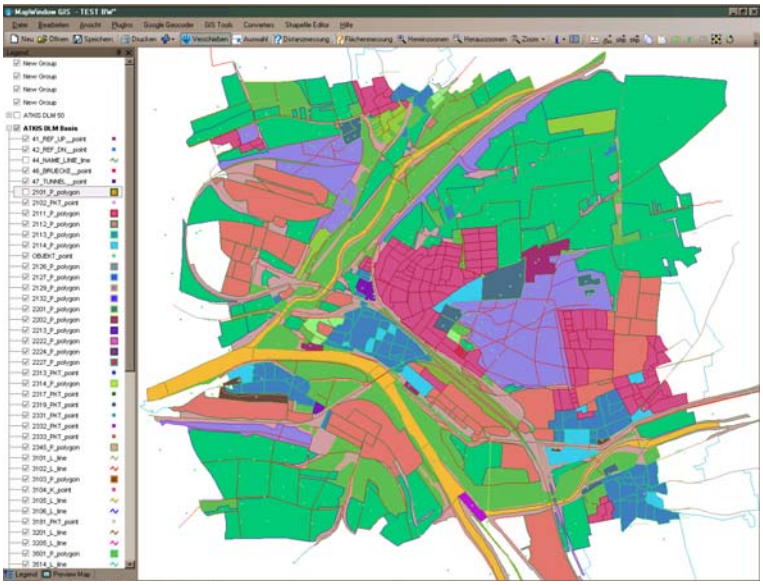


Figure 16: Example for Geobasedata: the ATKIS - Digital Landscape Model (Basis DLM)

Geobasedata

Geobasedata (Geobasisdaten) are data that reflect and describe the landscape (topography), the real estate and the consistent geodetic reference of Germany. Geobasedata are collected, made available, and maintained by federal state surveying agencies in each federal state. Effort is made to combine all the data into one standardized dataset to create data that are fully interoperable with other data and applications. The Geobasedata are available for police, civil protection, economics and management, as well as modern navigation systems. They form the basis of specialized spatial applications and for specialized Geodata as well as for official map series (German Base Map, topographic maps). The general public uses them as walking, cycling, leisure, and regional overview maps, aerial photos, and historical maps.

Federal Office for Cartography and Geodesy

The Federal Office for Cartography and Geodesy (Bundesamt für Kartographie und Geodäsie, BKG) compiles the Geodata collected by the federal state survey agencies. Its main task is to prepare Geobasedata for the area of the Federal Republic of Germany (thus with a nationwide coverage) and to advise the federal government in the areas of geodesy and geoinformatics.

The BKG provides, in cooperation with the association of the survey administrations of the federal states (Arbeitsgemeinschaft der Vermessungsverwaltung der Länder der Bundesrepublik Deutschland, AdV), spatial data in the form of vector data (digital landscape models, administrative boundaries, and geographical names) and raster data (digital elevation models, digital topographic maps).

The meta information system of the BKG's Geodata Centre (Geodatenzentrum) provides information about the availability and quality of the available Geodata. It is the central distribution service of the German national survey agencies and provides Geodata ordered via their website.

Geobasedata at national level

Geobasedata are currently available within the following three datasets:

- ATKIS (Amtliches Topographisch-Kartographisches Informationssystem, Official Topographic-Cartographic Information System)
- ALKIS (Automatisiertes Liegenschaftskataster Informationssystem, Automated Real Estate and Cadastre Information System)
- AFIS (Festpunkt Information System - The AFIS forms the basis for all surveying activities, e.g., property measurements, but is not of significant interest to the reader of this documentation as it does not contain any usable data).

In the future, the combined AFIS-ALKIS-ATKIS data (the AAA model) will serve as a standardized basis for specialized information systems. The data products available today will be described in the following.

4.1 The ATKIS

The ATKIS describes the surface of the earth with digital landscape and terrain models. The topography (landscape) includes the objects, such as settlements, transport networks, vegetation, water, terrain, and the boundaries of political and administrative units with names and other descriptive information throughout the entire federal territory. The type of objects that are included and how they are described is defined in the ATKIS object type catalogues (ATKIS OK). Four main datasets are included in the ATKIS: the Digital Landscape Models (DLM), the Digital terrain models - Digitale Geländemodelle (DGM), the Digital Topographical Maps - Digitale Topographische Karten (DTK) and the Digital Orthophotos (DOP).

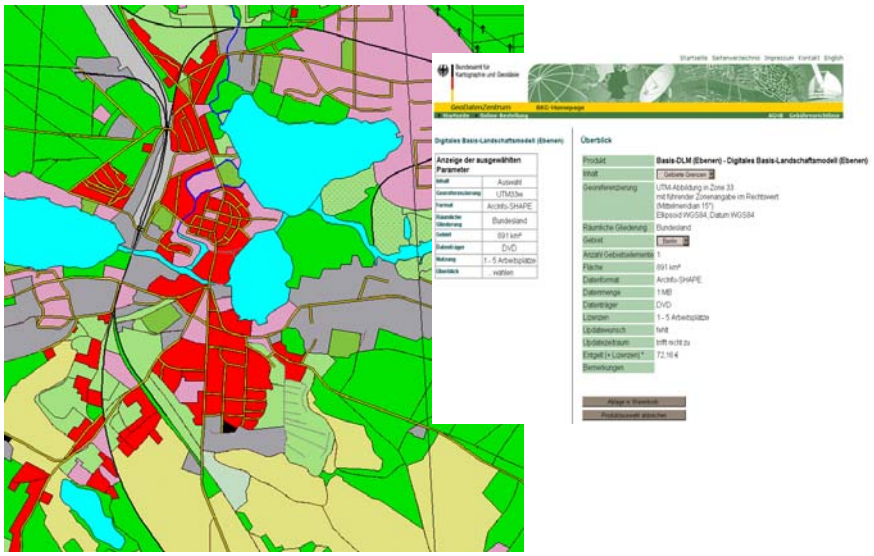
All primary ATKIS datasets are shown in the following table. Due to generalisation processes, the information provided by the datasets depends on the scale or resolution.

Data Group	Data	Dataset Name	Abbrevi-ation	Scale/ Resolution
ATKIS	Digital Land Models (DLM)	Digital Base Land Model	DLM-B	-
		Digital Land Model	DLM 250	1:250.000
	Digital Elevation Models (DEM)	Digital Elevation Model	DGM-B	-
		Digital Elevation Model	DGM 250	1:250.000
		Digital Elevation Model	DGM 1000	1:1.000.000
	Digital Orthophotos	Digital Orthophotos	DOP 20	20 cm
		Digital Orthophotos	DOP 40	40 cm
	Digital Topographic Maps	Digital Topographic Map	DTK 25	1:25.000
		Digital Topographic Map	DTK 50	1:50.000
		Digital Topographic Map	DTK 100	1:100.000
		Digital Topographic Map	DTK 200	1:200.000
		Digital Topographic Map	DTK 500	1:500.000
	Other digital products	Digital Street Map	DSM	1:25.000
		Geographic Names	GN	1:250.000
		Geographic Names	GN	1:1.000.000
		Administrative borders	VG	1:250.000

4.1.1 Digital Landscape Models (DLM)

The DLM describes the topographical landscape and the relief of the earth's surface in vector format. The objects are listed in the ATKIS object catalogue (ATKIS OK DLM) and are described by its geometric type, descriptive attributes and relationships to other objects. Each object in Germany has a unique identification number (identifier).

Basic Digital Landscape Models (Basis DLM)	
Content	The dataset contains about 160 object types and their main attributes. It includes streets, roads, railways, water and borders. The landscape elements include land use, residential areas, industrial and commercial areas, agricultural land and forests, water areas, communal areas
Scales available	Digitales Basis-Landschaftsmodell (Basis-DLM) Digitales Landschaftsmodell 50 (DLM50) 1:5.000, DLM250 (1:250.000), DLM1000 (1:1.000.000)

Coverage	Germany in its borders as polygons (Nationwide)
Date	ATKIS DLM: depending on the federal state, at least 20.10.2000 ATKIS OK DLM: 01.07.2003
Source	Federal state survey offices, BKG, AdV, Geodatenzentrum
Price and payment conditions	Basic unit: 1 km² For pricing examples, see table on page 37 Individual object areas are priced in proportion, such as Municipal 25%, Traffic 40%. For more than single-user license prices are increased in relationship to number of workstations. Charges for data updates and exploitation rights on demand.
Data format	Vector format: ESRI Geodatabase (8.3), EDBS, DXF, SHAPE, ArcInfo-EXPORT, ArcInfo-COVERAGE
Spatial Accuracy	Absolute accuracy for position or height: approximately 15 m
Applicability	Application areas: energy, forestry, agriculture, administration, demography, housing, land, regional and route planning, road management, traffic navigation, transport, mining, water science, ecology, environmental protection, geodesy, geology, but also culture, recreation, leisure, communication etc.
Example	

The following table shows examples of objects classified in the ATKIS DLM Object catalogue. All of the objects are merged into object groups 12:

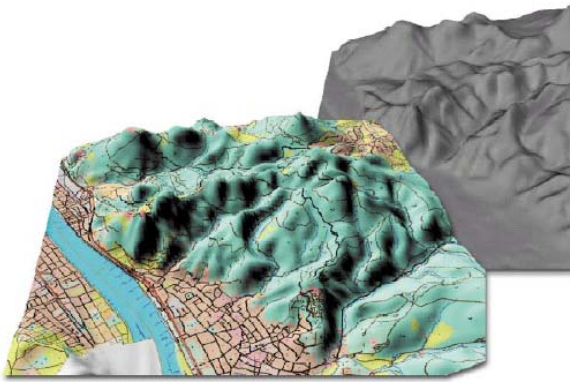
Objects	**Object groups (Examples)**	**Object types (Examples)**
1000 Objects		
2000 Siedlung (Settlement)	2100 Baulich geprägte Flächen (construction surfaces) 2200 Siedlungsfreiflächen (urban free spaces)	2111 Wohnbauflächen 2121 Sportanlage

12 For a full list of all objects that are covered by the ATKIS object-catalogue, refer to the ATKIS website listed in the appendix.

3000 Verkehr (Traffic)	3100 Straßen (roads) 3200 Bahnstrecke (rail Tracks)	3101 Straße 3107 Gemeindestraße
4000 Vegetation (Vegetation)	4100 Vegetationstyp 01 (vegetation areas)	4101 Ackerland 4107 Wald
5000 Gewässer (Waterbodies)	5100 Gewässer (water bodies)	5101 Strom, Fluss, Bach 5102 Kanal
6000 Relief (Relief)	6200 Geländehöhen (terrain elevation)	6201 Damm, Wall
7000 Gebiete (Areas)	7100 Verwaltungsgebiete (administrative areas) 7300 Schutzgebiete (protected areas)	7101 Administrative unit 7302 Naturreservat

4.1.2 Digital Terrain Models (DGM)

The Digital Terrain Model (DGM) describes earth's surface by three-dimensional coordinate values within regular or irregular grids.

Digital Elevation Models	
Content	The Digital Terrain Model contains raster data with the earth's terrain information: elevation, special landmarks, etc.
Scales available	Digitales Geländemodell 2 (DGM2) 2 Meter, (DGM5) 5 Meter, (DGM25) 25 Meter, (DGM50) 50 Meter, (DGM250) 250 Meter, (DGM1000) 1000 Meter
Coverage	Nationwide
Source	Collection of elevation data by Land Survey Offices with different methods: laser scanning, photogrammetry and digitization of contour lines.
Distribution	Federal State Survey Offices
Data format	Raster data, grids
Accuracy (Spatial Resolution)	Location: ± 1-5 m, height: ± 1-8 m Grid-size: 25 m /50 m (in Gauß-Krüger-Coordinate System) Altitude information is relative to sea level (NN)
Example	

4.1.3 Digital Topographic Maps (DTK)

The DTK are digital topographical maps that are derived from the corresponding ATKIS-DLM and DGM. They are called DTK (e.g. DTK25) or conventional digital topographical maps that are derived from analogue originals and updated as "Provisional issue" DTK-V (e.g. DTK25-V).

Digital Topographic Maps	
Content	The Topographic Maps (TK) are georeferenced raster data in different scales.
Scales available	DTK10 (1:10.000), DTK25 (1:25.000), DTK50 (1:50.000), DTK100 (1:100.000), , DTK250 (1:250.000), DTK1000 (1:1.000.000)
Data Distribution	Federal State Survey Offices
Data format	Raster data
Coverage	Nationwide
Example	

4.1.4 Digital Orthophotos (DOP)

Digital Orthophotos are georeferenced and geometrically corrected aerial photos that can be used in combination with topographic maps.

Digital Orthophotos	
Content	Digital Orthophotos, Aerial Photos (DOP)
Resolution	DOP 20 with a 20 cm ground resolution DOP 40 with a 40 cm ground resolution
Distribution	Federal State Survey Offices
Data format	Raster data
Coverage	Nationwide

Example	 

4.2 The ALKIS

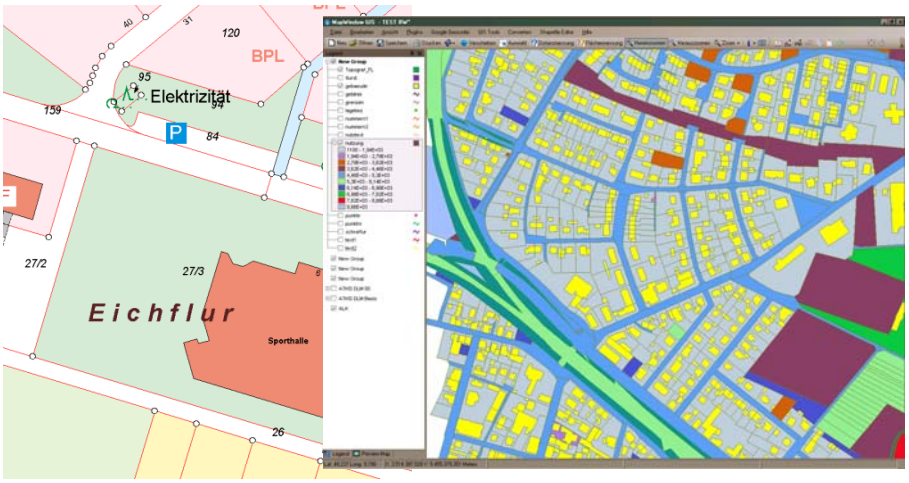
In the Automated Real Estate Information System, real estate such as parcels of land and buildings are listed. They are described within the nationwide datasets ALK and ALB. The ALKIS provides basic functions for legal services, administration and economy, and, in particular the needs of the country planning, soil order, identification of land values, and environmental and nature conservation considerations. In most cases, the official house coordinates datasets are also integrated in the ALKIS data group.

Data Group	Dataset Name	Abbreviation
ALKIS	Real Estate Map	ALK
	Real Estate Book	ALB

The ALKIS has three basic purposes: It is the official list and proof of land property and ownership. The situation of land ownership in the form of floor pieces are shown and described. If necessary, the boundaries of the plots with local legal effect can be identified. In addition, the AKIS provides of the official soil – estimations (its classical main function). It also provides the basic data for spatial data infrastructure (SDI) in Germany. The spatial data infrastructure in Germany (GDI-DE) is a joint project of federal, state and local authorities. Further, with the establishment of German Geodata infrastructure (GDI-DE), a national and inter-ministerial network of German spatial data has been created to ensure that future geoinformation is used in decision-making within the government administration, the economy, and in policy-making.

4.2.1 Digital Real Estate Cadastre Map (ALK)

The Digital Real Estate Cadastre Map (Automatisierte Liegenschaftskataster Karte, ALK) is one part of the ALKIS and describes and covers the property and real estate in Germany in the form of a map. The real estate map was originally created in analogue form. The digital ALK has in most cases already replaced the analogue property maps.

Digital Real Estate Cadastre Map (ALK)	
Content	The ALK dataset contains the location and geometry of the real estate (parcels of land and buildings). The ALK offers scale-independent ground plan data in analogue or digital form covering the entire surface area of Germany. The individual datasets are the individual parcels of land and their borders, the buildings, the type of land-use and its borders, and in some federal states, the topographical objects and the results of the property value estimates, the real estate map / ground map (with land parcels, buildings, uses, topography, etc.), the real estate map / estimate map (with the information provided by the land estimate), the Cadastral base map (reduced content of the real estate map)
Coverage	Nationwide
Date	The current digital recording status is as of January 1, 2007 at around 96%. Data update rate varies in each the Federal State Survey Office.
Price and payment conditions	Various pricing and payment conditions depending on the Federal State
Data format	The ALK is digital, and the default vector data interchange format is the "single database interface (EDBS)", other vector formats (DXF) as well as raster data (GeoTIFF). The data can be provided electronically.
Example	

4.2.2 Digital Real Estate Cadastre Book (ALB)

The Digital Real Estate Cadastre Book (Automatisiertes Liegenschaftskataster Buch, ALB) is available in digital format. As part of the descriptive ALKIS it contains essential information

on each real estate item, such as identification, area and position description, the type of land use and the public law provisions regarding areas such as nature protection areas.

Excerpts from the real estate book are used for a variety of purposes in different planning areas of the economy and for the administration of justice. They form the basis for the compilation of statistics, for surveys of waste disposal, and for tax purposes. They are especially important in documents of property ownership.

Land owners, government authorities, and other interested parties can obtain information from the real estate book. The extracts are available in digital or analogue format. In specific cases the surveying agencies provide further information.

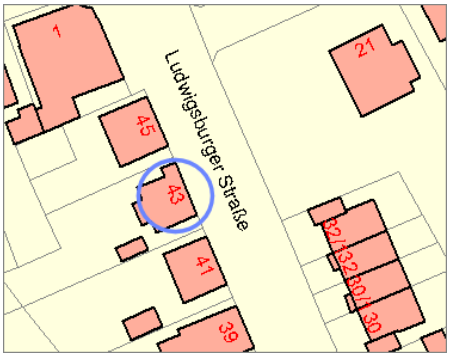
Digital Real Estate Cadastre Map (ALB)	
Content	The data of the ALB describes the location and geometry of the real estate (land parcels and buildings), which uses the distinctive topography and public legal definitions (classification of roads for road law, the water surface of the water law and land for re-routing, renovation, or reparcelling). The ALK offers scale-independent ground plan data in analogue or digital form covering the entire surface area of Germany. The digital real estate cadastre book contains information on: the real estate map with land parcels, buildings, uses, topography, etc. the real estate map with the information provided by the property estimate cadastral base map (reduced content of the real estate map / ground map at the scale 1: 5000, especially without land parcel unit numbers) all ground items such as ground unit mark, area, location names and history, the results of the property estimate the public law provisions on the base areas the owners of the land within the land corridor or the holders of rights to the same
Coverage	Nationwide
Date	The current digital recording status is as of January 1, 2007 at around 96%. Data updating rate depends on the Federal State Survey Offices
Price	Various pricing and payment conditions depending on the federal state
Data format	The ALB is digital, and the default vector data interchange format is the "single database interface (EDBS)", other vector formats (DXF) as well as raster data (GeoTIFF). The data can be provided electronically.

In general, the data from the ALB is to be used in conjunction with the digital ALK.

4.2.3 House Coordinates

The Official House Coordinates (Amtliche Hauskoordinaten) define the exact geographic position of each house in Germany. The datasets are derived from the ALK and the ALB, based on individual surveys, and continuously updated. The database includes about 19.3 million house coordinates. The official house coordinates are used to plan and analyse at the

house level, to navigate accurately and to tap into markets.

Official house coordinates	
Content	The dataset includes the exact geocoordinates of each house, the centre of the road coordinate, the centre of coordinates of the place / community. Each house has a unique ID. It also includes the street name, house number, additional postal information, postcode, postal city name, postal addition to place names depending on the postal address. The coordinates are provided as coordinate pairs in Gauss Krueger, UTM and geographic coordinates.
Source	Detailed information can be obtained at: http://www.lverma.nrw.de/produkte/liegenschaftsinformation/gebaeudeinfo/hauskoordinaten/Hauskoordinaten.htm.
Distribution	The federal state survey agency in North Rhine Westphalia and commercial Geodata distributors.
Data format	ASCII format
Example	

4.3 Specialized Geodata

Specialized Geodata are in most cases based on official Geobasedata. They often are derived from spatial data of an area of expertise, such as demography, epidemiology, soil science, climatology, electoral statistics. Common applications for specialized Geodata are administrative surveys and research in environmental, statistical research or planning fields.

4.3.1 Geographic Names

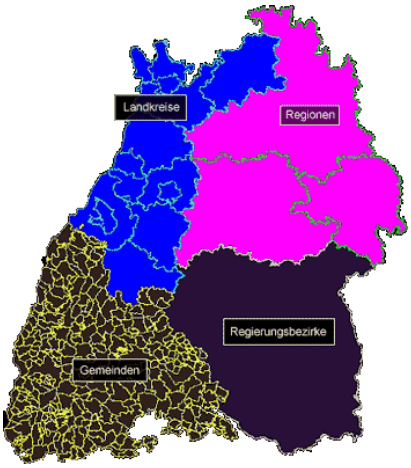
The Geographic Names (Geographische Namen) database lists the names of urban, rural communities and community parts, administrative units, landscapes, mountains, islands, mountains, rivers, canals, lakes, seas and data with similar attributes.

Geographic Names	
Content	The geographical names dataset GN250 covers about 61,000 entries. The data set GN1000 is an extract of the GN250 and covers about 13,000 entries.
Scales available	Geographic Names (GN250) 1: 250,000 and GN1000 (1:1,000,000)
Coverage	Nationwide
Distribution	BKG
Data format	ASCII
Example	

4.3.2 Administrative Boundaries

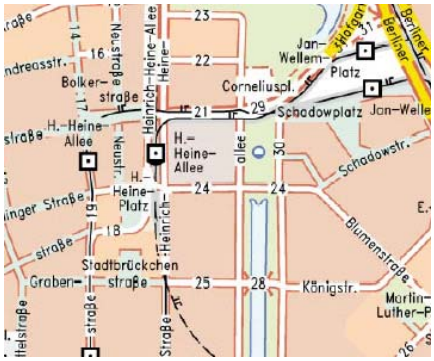
The Administrative Boundaries (Verwaltungsgrenzen) datasets include all administrative units of all hierarchical administration levels as polygon data.

Administrative Boundaries	
Content	According to product definition of the AdV, the dataset from the national state level to the districts VG250, and from state level to the lowest administrative level (municipalities). This includes their borders, statistical key figures, the name of the administrative unit and the specific name of the administrative level in the respective region. The geometry of the borders, in terms of accuracy and resolution is based on the DLM250.
Coverage	Nationwide
Scales available	Administrative boundaries VG250 (1: 250,000) and VG1000 (1:1,000,000)
Source	Initial production: analogue and digital output data from the National Survey facilities. Acquisition scale depends on the federal state: 1: 5,000 to 1: 200,000
Distribution	Federal State Survey Offices
Price and payment conditions	Price for the complete data set: 300.00 EUR (when using the data on 1 DV workstation (single-user license)). Multi-seat licenses includes charges with the following factors: 1.5 by 2 to 5 licenses, 2.0 at 6 to 20 licenses, 2.5 in 21 - 50 licenses 3.0 at 51 - 100 licenses, 3.5 at 101 - 150 licenses, 4.0 at 151 - 200 licenses.
Data format	Vector data

Accuracy	2 meters, with the highest accuracy of all objects at about 100 meters.
Example Administrative territorial boundaries in Baden-Württemberg 1111 municipalities 35 Rural counties 9 Urban counties 12 Regions 4 Regions/districts 1 Federal district	

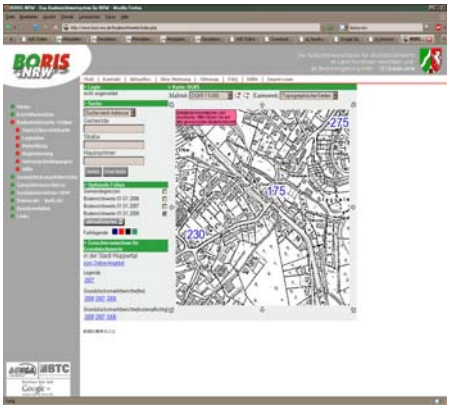
4.3.3 Digital Street Map

The Digital Street Map (Digitale Straßenkarte) visualizes street names, parking lots as raster maps.

Digital Street Map	
Content	The Digital Street Map 1:25,000 contains georeferenced raster data with street names, the road network, and urban representations. The record is updated annually. The digital street map is available exclusively BKG by the federal institutions are.
Coverage	Nationwide
Scales available	Digitale Straßenkarte DSK25 (1:25,000). The maximum grid resolution is 813 dpi.
Data format	TIFF, LZW
Distribution	BKG and federal state survey offices.
Example	

4.3.4 Publicly Registered Land Value

The publicly registered land value indicates the price of a m2 of undeveloped land zoned for development in a certain location. In built-up areas the price describes the value of the undeveloped land. The land values are determined annually by an advisory committee based on actual sales. In areas where no sales are made, the advisory committee compares similar areas.

Publicly Registered Land Value	
Content	The dataset includes the current soil guideline values, ground index series, purchase prices of various real estate and rental overviews, nationwide road structure data and nationwide purchasing power information on street level.
Original dataset title	Amtliche Bodenrichtwerte
Coverage	Nationwide
Distribution	http://www.boris.nrw.de/ or http://www.bodenrichtwerte.com
Data format	Various data formats, e.g. ASCII
Example Bodenrichtwert-Informationssystem: BORIS NRW	

4.3.5 Postal Codes

The available postal codes describe small geographical areas. The ZIP-Code dataset includes the country, postal code/ZIP-code, city, administration number, federal state, district, county.

Postal/ZIP-Code	
Source	Various Geodata Distributors, e.g., Geokontor (http://www.geokontor.com)
Costs	Depending on the distributor (e.g. 4,316.13 EUR for a nationwide coverage with geocoordinates at Geokontor
Data format	Vector data, latitude and longitude in WGS84 format

4.4 Selected Federal State Survey Offices

Geobasedata (ATKIS and ALKIS) are available nationwide at distribution centres such as the Geodatenzentrum but also at each of the Federal State Survey Offices. Even though there are still minor differences between the Geodata products available at the Federal State Survey Offices (payment and distribution conditions, data update, the state of the data acquisition and the state of analogue-digital conversion processes) in most cases they offer similar standardized Geodata. Therefore - in addition to the contact information - only not yet described Geodata and distribution services available in the selected federal states will be listed.

4.4.1 Baden-Württemberg

Federal State Survey Office – Baden-Württemberg (Landesvermessungsamt Baden-Württemberg)	
Internet address:	http://www.lv-bw.de/
Location:	70174 Stuttgart
Street:	Büchsenstr. 54
Phone Number:	+49 711 123 0
Fax number:	+49 711 123 2979
E-mail address:	lv.vertrieb@vermbw.bwl.de All available data products can be tested by downloading the Testdata at http://www.lv-bw.de/lvshop2/index.htm:

4.4.2 Bavaria

Federal State Survey Office – Bayern (Bavaria)	
Internet address:	http://www.geodaten.bayern.de/
Location:	80538 München
Street:	Alexandrastraße 4
Phone Number:	+49 89 2129 0
Fax number:	+49 89 2129 1537
E-mail address:	poststelle@lvg.bayern.de

4.4.3 Berlin

Federal State Survey Office - Berlin	
Internet address:	http://www.stadtentwicklung.berlin.de/geoinformation/
Location:	10707 Berlin
Street:	Fehrbelliner Platz 1
Phone Number:	+49 (0)30 9012 5594
Fax number:	+49 (0)30 9012 3117
E-mail address:	ingrid.schneider@senstadt.verwalt-berlin.de

There is additional information about the data acquisition state of the ATKIS.

ATKIS
Basis-DLM - Digitales Basis-Landschaftsmodell The positional accuracy of the vector data is + / - 3 m, the reference system is ETRS89 in UTM projection. The establishment of data collection takes place in 3 stages and will be completed in 2008. Data storage is done in a common database for the national surveying and Geobasisinformation Brandenburg in Potsdam.
DLM50 - Digitales Landschaftsmodell 50 Currently the amount of data of the DLM50 is compared to the base-DLM at about 20%. The DLM50 aims to Berlin to be the end of 2007.
Services
The FIS-Broker provides Online – Maps.
The Umweltatlas Berlin provides environmental data for Berlin at http://www.stadtentwicklung.berlin.de/umwelt/umweltatlas/

4.4.4 Hamburg

Federal State Survey Office - Hamburg	
Internet address:	http://www.geoinfo.hamburg.de
Location:	20097 Hamburg
Street:	Sachsenkamp 4
Phone Number:	+49 40 428 26-50 20
Fax number:	+49 40 428 26-59 67
E-mail address:	poststelle@gv.hamburg.de

The official Geodata of Hamburg are divided into five key product groups: DSGK, DK5, DISK, DIRK and DOP.

Digitale Stadtgrundkarte - DSGK (Basic digital city map)	
Content	The DSGK includes Corridor land borders and land parcel numbers, buildings with house numbers and story information, road tours and descriptions (street names with their official key road), administrative boundaries, topography such as water, embankments and street trees as well as land use.
Data format	Deployment: Digital in the form of vector data and raster data or in analogue form as plot or printed on paper
Scales available	Model Scale: 1: 1 000, Applicability : 1: 500 to 1: 2 500
Digitale Stadtkarte 1: 5 000 – DK5 (Digital City Map)	
Content	The representation is done with an accuracy of less than 1 meter. The vertical integration with the DSGK makes it possible, once edited, to combine thematic information with other data.
Data format	Digital in the form of vector data and raster data or in printed as a map
Scales available	Model scale: 1: 5.000, Applicability: 1: 2500 to 1: 10.000
Digitale Stadtkarte – DISK (Digital model city)	
Content	Cartographically generalized depiction of Hamburg, including the surrounding areas. The DISK is a city overview map. The DISK contains the following sections: road transport (including classified network street names and selected house numbers), rail, air and sea transport, urban areas (including representation of public buildings), water bodies, land uses, vegetation, as well as state, county, districts, district data.
Data format	Digital in the form of vector data and raster data or in printed as a map
Scales available	Model scale: 1: 20.000, Applicability: 1: 10.000 to 1: 60.000
Digitale Regionalkarte - DIRK (Digital model Regional map)	
Content	Characteristics: Cartographically generalized depiction of the area of Hamburg, Luebeck, Schwerin, Uelzen, Bremen
Data format	Deployment: Digital in the form of vector data and raster data or in printed form as a map of Hamburg with the scale 1: 5 000.
Scales available	Model scale: 1: 150,000, Applicability: 1: 100,000 to 1: 600,000

4.4.5 North Rhine Westphalia

Federal State Survey Office – Nordrhein-Westfalen (North Rhine Westphalia)	
Internet address:	http://www.lverma.nrw.de/
Location:	53177 Bonn
Street:	Muffendorfer Str. 19-21
Phone Number:	0228-846-4646
Fax number:	0228-846-4648
E-mail address:	shop@lverma.nrw.de

The following table gives an example of the Base-DLM products available at different federal state survey offices

Product Overview - Base-DLM								
Federal State	**Last update**	**State of acquisition**	**Basis**	**Accuracy [+/- m]**	**Date of Capturing**	**Updates [year]**	**Format**	**Price [EUR/km2]**
BE Berlin	15.06.08	Basis-DLM/1 100% Basis-DLM/2 100% Basis-DLM/3 70%	Map of Berlin 1:5000 (K5)	3	2002-2006	1	GIAP, EDBS, DXF, Shape, E00	1-5000 km²: 7.50 EUR
BW Baden-Württemberg	15.06.08	Basis-DLM/1 100% Basis-DLM/2 100% Basis-DLM/3 100%	Orthophoto, topographic Sensing, other data sources	3	1998-2002 since 2003	5	EDBS, SQD, DXF, Shape	1-5000 km²: 7.50 5001-25000 km²: 2.50 from 25001 km²: 1.00
BY Bayern	15.06.08	Basis-DLM/1 100% Basis-DLM/2 100% Basis-DLM/3 100%	Topographical Map 1:25.000, Digital Orthophotos	+/- 3-5m	1996 - 2008	5	EDBS, NAS, Shape, DXF	1 - 500. km²: 7.50
HH Hamburg	15.06.08	Basis-DLM/1 100% Basis-DLM/2 99% Basis-DLM/3 99%	DK5, other data sources, Orthophotos	5-10	1991-2005 2002 - 2005	Updates since 2002	SQD, SICAD/open	1. - 5000 km²: 7.50 5001 - 25000. km²: 2.50 25001. - 50000. km²: 1.00
NW Nordrhein-Westfalen	15.06.08	Basis-DLM/1 100% Basis-DLM/2 100% Basis-DLM/3 100%	DGK5, Orthophoto, other data sources	-	2003-2007	3	EDBS, SHAPE	1. - 5000 km²: 7,50 5001 - 25000. km²: 2.50 25001. - 50000. km²: 1.00

Product overview DLM50						
Federal State	**Last update**	**State of acquisition**	**Basis**	**Accuracy [+/- m]**	**Refresh Period [year]**	**Format**
BW Baden-Württemberg	10.01.2007	100%	ATKIS-Basis-DLM	+/- 10m	3 years	EDBS, SHAPE
NW Nordrhein-Westfalen	06.12.2007	100%	ATKIS-Basis-DLM	+/- 10m	3 years	EDBS, SHAPE

5. Appendix

5.1 SOEP

For further information about SOEP please contact the DIW:

Postal address: DIW Berlin
10108 Berlin

Visiting address: DIW Berlin
Mohrenstraße 58
10117 Berlin (Mitte)

Internet: http://www.diw.de

E-mail: soepmail@diw.de

Phone: (030) 89789-292

Fax: (030) 89789-109

5.2 Original dataset names and translation

Original datasets names and translation		**Abbreviation**
ALKIS		
Automated real estate book	Automatisierten Liegenschaftsbuch	ALB
Automated real estate map	Automatisierten Liegenschaftskarte	ALK
ATKIS		
Digital orthophotos	Digitalen Orthophotos	DOP
Digital landscape model	Digitalen Landschaftsmodell	DLM
Digital terrain model	Digitalen Geländemodell	DGM
Digital elevation model	Digitalen Höhenmodell	DHM
Grid map	Rasterkarte	RK10
Digital topographical map	Digitale Topographischen Karte	DTK
Other maps and coordinates files (Sonstige Karten und Koordinatendateien)		
German basic map	Deutsche Grundkarte	DGK5
House coordinates	Hauskoordinaten	HK
Administrative boundaries	Verwaltungsgrenzen	VG
Residential centre name	Wohnplatznamen	-
Fixed-point data	Festpunktdaten	-
Height fixed points	Höhenfestpunkte	-

5.3 Selected GIS and analysis software

Applications	Description and Specifications	Application level
Professional GIS		
ESRI ArcGIS http://www.esri.com	ArcGIS is a widespread application with professional functionalities. It is a complete system for authoring, serving, and using geographic information. It is an integrated collection of GIS software products for building and deploying a complete GIS on desktops, servers, or custom applications, online or in the field.	difficult, GIS knowledge required
MapInfo http://www.mapinfo.com	MapInfo Professional is a powerful mapping and geographic analysis application. It is designed to visualize the relationships between data and geography, MapInfo Professional helps business analysts, planners, GIS professionals and non-GIS users gain new insights into their markets, share information-rich maps and graphs and improve strategic decision-making.	difficult, GIS knowledge required
Open Source GIS (free)		
MapWindow http://www.mapwindow.org	MapWindow is an open source "Programmable Geographic Information System" that supports manipulation, analysis, and viewing of geospatial data and associated attribute data in several standard GIS data formats. MapWindow is a mapping tool, a GIS modeling system, and a GIS application programming interface (API) all in one redistributable open source form. MapWindow was developed to address the need for a GIS programming tool that could be used in engineering research and project software, without requiring end users to purchase a complete GIS system, or become GIS-experts. MapWindow is both a simple spatial data viewer and a GIS tool that can be modified into a new custom application. The viewer includes a map area, a legend pane and a preview-map pane. Additionally, built-in toolbars allow the user to create, save and open project files (collections of data layers), print, and navigate around the map, add and remove data layers from the map and select and query specific data. MapWindow also enables the user to write plug-ins to add additional functionality (models, special viewers, link handlers, data editors, etc.). Basic functionality is: Shapefile Editor - For editing shape file geometry Grid Wizard - For importing and converting different grid data formats Attribute Table Editor - For viewing and editing shapefile attribute table data Feature Identifier and Labeler - For identifying features and adding labels GIS Tools - For clipping, assigning projections and reprojecting raster and vector data	easy, GIS knowledge required

Applications	Description and Specifications	Application level
GRASS / Quantum GIS http://www.qgis.org	Quantum GIS runs on Linux, Unix, Mac OSX, and Windows. It supports vector, raster, and database format and allows browsing and creating maps based on geodata. It supports many common spatial data formats (e.g., ESRI ShapeFile, geotiff).	difficult, GIS knowledge required
SAGA http://www.saga-gis.uni-goettingen.de/	SAGA – System for Automated Geoscientific Analyses- is a hybrid GIS software. A first objective of SAGA is to give scientists an effective and easy learnable platform for the implementation of geoscientific methods, which is achieved by SAGA's unique Application Programming Interface (API). The second is to make these methods accessible in a user friendly way. This is mainly done by the Graphical User Interface (GUI). There is a growing set of geoscientific methods, bundled in exchangeable Module Libraries. Currently there are about 120 modules available in SAGA's standard edition. This list gives an overview of the variety of implemented methods.	medium, GIS knowledge required
DIVA http://www.diva-gis.org/	DIVA-GIS is a free mapping program, sometimes called geographic information system (GIS), that can be used for many different purposes. It is particularly useful for mapping and analyzing biodiversity data, such as the distribution of species, or other 'point-distributions'.	easy, GIS knowledge required
GvSIG http://www.gvsig.gva.es/	gvSIG is a tool to manage geographic information. It is characterized by a user-friendly interface, with a quick access to the most usual raster and vector formats. It is aimed at users of geographic information, whether professionals or civil servants (city councils, councils, regional councils or ministries).	easy, GIS knowledge required
PostGIS http://postgis.refractions.net/	PostGIS adds support for geographic objects to the PostgreSQL object-relational database. In effect, PostGIS "spatially enables" the PostgreSQL server, allowing it to be used as a backend spatial database for geographic information systems (GIS), compared to ESRI's SDE or Oracle's Spatial extension.	difficult, GIS and Databse knowledge required
Statistics and GIS		
GeoDA https://www.geoda.uiuc.edu/	GeoDa is software tool developed in the Department of Geography at the University of Illinois, Urbana-Champaign. It is designed to implement techniques for exploratory spatial data analysis (ESDA) on lattice data (points and polygons). The free program provides a user friendly and graphical interface to methods of descriptive spatial data analysis, such as spatial autocorrelation statistics, as well as basic spatial regression functionality. The latest version contains several new features such as a cartogram, a refined map movie, parallel coordinate plot, 3D visualization, conditional plots (and maps) and spatial regression.	medium, statistical knowledge required

Applications	Description and Specifications	Application level
Geodatabase Systems		
Oracle Spatial http://www.oracle.com/	Oracle Spatial forms a separately-licensed option component of the Oracle Database. Oracle Spatial aids users in managing geographic and location-data in a native type within an Oracle database, potentially supporting a wide range of applications — from automated mapping/facilities-management and geographic information systems (GIS), to wireless location services and location-enabled e-business.	difficult, Database knowledge required
PostgreSQL http://www.postgresql.org/	PostgreSQL is a powerful, open source relational database system. It runs on all major operating systems, including Linux, UNIX, Mac OS X and Windows.	difficult, Database knowledge required
Geo-Visualization		
Google Earth http://www.earth.google.de/	Present, visualize and distribute data based on a 3D-globe. Supported file format is KML/KMZ.	easy, no knowledge required
Google Maps http://maps.google.com/ **Microsoft Live** http://maps.live.com	Present, visualize and distribute data in a standard browser. Common file format is KML/KMZ.	easy, no knowledge required

5.4 Further information and resources

5.4.1 Research centres - Geodata and social science

CSISS - Center for Spatially Integrated Social Science

"The CSISS Mission recognizes the growing significance of space, spatiality, location, and place in social science research. It seeks to develop unrestricted access to tools and perspectives that will advance the spatial analytic capabilities of researchers throughout the social science. CSISS was funded in 1999 with support from the National Science Foundation under its program to promote research infrastructure in the social and behavioural sciences."

http://www.csiss.org/

SEDAC

"SEDAC's mission is to develop and operate applications that support the integration of socioeconomic and earth science data and to serve as an "information gateway" between the earth sciences and social science."

http://sedac.ciesin.columbia.edu/

Akademie für Raumforschung und Landesplanung (ARL) / Academy for Spatial Research and Planning

Founded in 1946 the Academy for Spatial Research and Planning (ARL) undertakes research into the spatial impacts of human activities in the economic, social, ecological and cultural spheres, and analyse the scope for sustainable spatial development. The ARL`s role includes undertaking research and facilitating knowledge transfer in the field of spatial research and spatial development.

http://arl-net.org/index.php?option=com_content&task=view&id=63&Itemid=115

Leibniz-Institut für Regionalentwicklung und Strukturplanung (IRS)

Under its statute, the IRS explores the problems and opportunities of the development of national and international cities and regions, especially in the European context. The research department deals with the relationship between knowledge and space development dynamics.

http://www.irs-net.de/

5.4.2 Data resources

5.4.2.1 Official Geobasedata

The national spatial data can be ordered online from the BKG centre responsible for spatial data (Geodatenzentrum). Here the user can download test data, data sheets, documentation and details of the delivery and the terms of use.

Survey Offices – Nationwide Distribution Centers (a selection)		
Geodata - Centre	Internet Address	Description
AdV - Arbeitsgemeinschaft der Vermessungsverwaltungen der Länder der Bundesrepublik Deutschland	http://www.adv—online.de	Arbeitsgemeinschaft der deutschen Vermessungsverwaltungen. (Association of the German surveying services.)
BKG	http://www.bkg.de	Bundesamt für Kartographie und Geodäsie (Federal Office of Geodesy and Cartography)
Geodatenzentrum	http://www. geodatenzentrum.de	Official Distribution Center nationwide available Geodata. The Deutschland-Viewer of the BKG provides interactive maps with different geodata of the federal Office for Cartography and Geodesy as well as data from 4 federal states.
Geoportal Bund	http://geoportal.bkg.bund.de	Official Distribution and Information Portal.
ATKIS - Amtliches Topographisch-Kartographisches Informationssystem	http://www.atkis.de/	Official Distribution and Information Portal for ATKIS data.
ALKIS – Automatisiertes Liegenschaftskataster- Informationsystem	http://www.lverma.nrw.de/produkte/liegenschaftsinformation/katasterinfo/alkis/ALKIS.htm	Official Distribution and Information Portal for ALKIS data.
Landesanstalt für Umwelt, Messungen und Naturschutz	http://brsweb.lubw.baden-wuerttemberg.de	The interactive service UDO (environmental data and maps online) of the general LUBW allows access to selected environmental data and digital map data. The data come from measurement and programmes of the LUBW and from the information network of local and state environmental departments of the state of Baden-Württemberg.
Geodaten Deutschland-Online	http://www.do-geodaten.nrw.de	The aim of this project is the cartographic representation of the DLM50 nationwide in a single key signatures without the use of cartographic generalization processes. The presentation are made available through web-services.
FIS-Broker - Berlin	http://fbinter.stadt-berlin.de	The FIS broker provides online access to maps, plans and other data from the Ministry of Urban Development. The offer currently includes over 100 topics and is constantly being updated.

Survey Offices – Nationwide Distribution Centers (a selection)		
Geodata - Centre	Internet Address	Description
BayernViewer	http://www.gdi.bayern.de/	The BayernViewer presents topographic maps and aerial photographs of Bavaria. http://deutschlandviewer.bayern.de
Deutschlandviewer	http://deutschlandviewer.bayern.de	The Deutschlandviewer is currently presenting digital topographic maps from nine provinces and the BKG as well as from Austria. Additional programs are orthophotos and geological maps of different countries.
TIM Online	http://www.tim-online.nrw.de	The LVermA NRW offers the e-government portal TIM online (www.tim-online.nrw.de) for the nationwide access to all topographical maps and aerial photographs of North Rhine-Westphalia. In addition, the soil guideline values for North Rhine-Westphalia are available at www.boris. nrw.de be.

Brochures on ATKIS and ALK are available at the Ordnance Survey offices. Detailed information such as object figure catalogues (OBAK), Objektschlüsselkatloge (OSKA), sign regulations (ZV-Aut), etc. are also at the Ordnance Survey offices. An overview of the availability of geotopographical data and digital data from the real estate map has been published by the AdV (Association of Survey Administrations).

5.4.2.2 Environment (a selection)

Umweltbundesamt

German environmental data is provided by the Umweltbundesamt (German federal environmental agency, UBA). The German Environmental Information Portal (PortalU) is a cooperative project by the federal government and the federal states. It offers access to web pages and database entries of public institutions and organizations.

http://www.umweltbundesamt.de/; http://www.portalu.de ; http://www.env-it.de/luftdaten

GISU - Geographisches Informationssystem Umwelt

The State Environmental Protection Agency offers with its service GISU an extensive collection of information and spatial information from the field of environmental monitoring data.

http://gisu.uba.de

Räumliches Informations- und Planungssystem (RIPS) Baden Württemberg

The State Institute of the Environment, Nature Conservation and measurements of Baden-Württemberg (LUBW) provides environmental data on thematic maps on the map service RIPS interactively on the Internet.

http://rips-uis.lfu.baden-wuerttemberg

5.4.2.3 Statistics (a selection)

Statistic offices of the federal states

Statistical data in Germany is provided by the statistical offices of the federal states (Statistikämter der Bundesländer).

http://www.destatis.de/ ; http://www.destatis.de/onlineatlas

Raumbeobachtung.de

The space observation system of the Federal Office for Building and Regional Planning (BBR) offers comprehensive information and indicators, maps, illustrations and tables on different geographic reference levels. An interactive online map module allows to generate maps for about 60 indicators at the district level.

http://www.raumbeobachtung.de/

Zukunftsatlas Deutschland

The future atlas provides information about the future prospects of the 439 German counties, cities and districts. The Prognos AG advises both private and public clients.

www.prognos.com/zukunftsatlas

5.4.3 Other resources

Commercial Geodata Sources

The following list shows the range of Geodata products available at DDS as an example of commercial Geodata distributors. http://www.ddsgeo.de - DDS Digital Data Services GmbH

Original Dataset Name	English Translation
Basisdaten Deutschland	Basic data Germany
Basisdaten Europa	Basic data Europe
Digitale Geographie AND/PTV	Digital geography
Digital Data Streets	Digital Data Streets
Straßenverzeichnisse	Street directories
Schienenverkehr Deutschland	Rail Transport Germany
Deutschlandpaket	German land parcel
Socio Streets	Socio Streets
Demographie- und Kaufkraftdaten	Demographic data and purchasing power
Marktzellen XXL	Market cells XXL
Points Of Interest im Einzelhandel	Points Of Interest in retail trade
Weltkarten	World Maps
Falk Stadtplansubstanzen	Falk map substances
Höhenlinien und Steigungen	Contour lines and pitches
Landnutzungsdaten	Land use data

Free Geodata Sources, Testdata

- http://www.freegis.org/
- http://opengeodb.de – Free Geodatabase
- http://OSGeo.org
- http://www.geonames.org - Webservice for geographical names of locations and countries
- http://download.geofabrik.de/osm/europe/ - OSM Open Street Map database
- http://geodata.gov – U.S. Geodata Center
- http://www.census.gov/geo/www/tiger/tigerua/ua_tgr2k.html – U.S. Census TIGER/Line data
- http://www.usgs.gov/ - U.S. Geodata Center
- http://www.maproom.psu.edu/dcw/ - Digital Chart of the World (DCW), worldwide vector data
- http://biogeo.berkeley.edu/gadm/ - Global administrative areas (GADM)
    - GADM is a database of the location of the world's administrative areas (boundaries). Administrative areas in this database are countries and lower level subdivisions such as federal states, departments or counties. GADM describes where these administrative areas are (the "spatial features"), and for each area it provides some attributes. The data are in ESRI shapefile and geodatabase format. Shapefiles can be used in, or imported into, most mapping and spatial data analysis programs (GIS).
- http://data.geocomm.com/ - Geodata center
- http://opengeodb.hoppe-media.com/ - OpenGeoDB - free database for geocoordinates

- http://www.schulweb.de/de/schulsuche/index.html?auswahl_1=5
- http://www.berlin.de/sen/bildung/schulverzeichnis_und_portraets/anwendung/SchulListe.aspx

Metadata catalogues, Geodata-Search and Online Maps

- http://geolocationdb.myemotions.ch – Free Geodata Webservice
- http://geodata.grid.unep.ch - UNEP's GEO Data Portal
- http://www.geocatalogue.de - GEOcatalogue des Center for Geoinformation
- http://www.geometa.info – Searchengine for geo-services , geodata and online-maps
- http://gis-news.de - Geodata, Testdata, Survey of data distributors

Online GIS tutorials

- http://www.colorado.edu/geography/gcraft/notes/notes.html
- http://www.geoinformatik.uni-rostock.de/default.asp
- http://biogeo.berkeley.edu/gis/courses.html