

WEB-APPLICATION FOR A GIS-BASED TRAFFIC-DATABASE

*Univ.-Prof. Dr.-Ing. Jürgen Steinbrecher, University of Siegen, Department of Civil Engineering, Division of Transportation Planning;
juergen.steinbrecher@uni-siegen.de*

*Dipl.-Ing. Christoph Helmert, CEO Software-Kontor Helmert, Aachen;
helmert@software-kontor.de*

*Dipl. Verk.-Wirt. Kathrin Henninger, Software-Kontor Helmert, Aachen;
henninger@software-kontor.de*

ABSTRACT

Traffic census data still poses the basis for decision taking processes in traffic circulation and environmental planning. Only in few cities the data gathered is systematically archived and it rarely is made accessible for other internal administrative departments or external traffic planning companies. This although in almost all major German cities a comprehensive pool of traffic census data is available, that has been collected over numerous years. This data normally is accessible to selected planning specialists only.

Today the internet offers an uncomplicated platform to make all traffic census data easily accessible for planning specialist as well as to the broader public. In addition it offers the possibility to monitor traffic development measures. For concrete projects people affected by the measure can be included in the planning process and the decision making data base can be communicated directly and transparently.

Keywords: traffic census data base, traffic census, automatic counting, manual counting, web-based traffic counting data base.

INITIAL POSITION

In periodical time intervals German local authorities, cities and municipalities enforce traffic census. Often this voluminous pool of traffic census data gathered over the years is available in separated data bases or even in hardcopy form only. Still these traffic data are the basic input data for crossroad capacity calculations, traffic models and traffic development estimations for road planning and research in general.

AUTOMATIC, CONTINUOUS COUNTING ON NATIONAL LEVEL

Since 1975, traffic volumes on selected motorways and main roads outside municipal limits are registered by automatic, continuous counting stations. The data are acquired by the federal states under commission of the federal government and submitted to the Federal Highway Research Institute on a quarterly basis. In consequence the traffic development can be tracked back without gap over several decades.

The counting network on federal trunk roads in 2004 incorporated roughly 1,300 continuous counting stations. About 600 of these are located on motorways, the remaining 700 on main roads. All motor vehicles are registered by the continuous counting stations. Depending on the selected device, it is possible to differentiate between up to 9 vehicle types (including a category for miscellaneous vehicles).

The data from the continuous counting stations are used to perform annual evaluations of individual counting points and calculations of average daily traffic intensities as well as annual mileages on motorways and main roads outside municipal limits. They are also used as a basis for the manual counts carried out every five years nationwide.

MANUAL COUNTS ON NATIONAL LEVEL

Manual counts on the classified road net are performed to register traffic intensities on motorways and federal roads at five-year intervals (last time in 2005). These manual counts involve random sampling of traffic on the entire, extra-municipal trunk road network over selected days / hours in a particular year.

The counts are organized by the state road building authorities according to standardized directives. The surveys cover the entire extra-municipal federal trunk road network. In addition, the states at their own discretion schedule counts on country, district and municipal roads; a standard nationwide procedure is used for these surveys. Detailed results on nearly every network segment are available for the specified roads in the stipulated areas.

The succeeding table 1 shows the number of census points in the federal states and their distribution on the different road classes.

In between the federal states the net of census points is very differently pronounced. In the city states Hamburg, Bremen and Berlin, each being a federal state of its own, a completely different picture is found as compared to the wide open spaced federal states. Census points are here concentrated on federal city motorways and federal main roads in the urban area.

In the other federal states motorways are being counted only to a small amount (among 3% and 24%). Main focus for the federal states is on federal state main roads, on which 28% to 55% of the census points are located. On federal main roads the percentage of the census points as compared to the total amount of census points within the federal state fluctuates

between 14% and 76%. Minor roads are counted only periodically and partially the census activities of the federal states concentrate on federal motorways and federal main roads only.

Federal State (Bundesland)	Number of stations	Federal motorway	Federal main road	Federal State main road	Minor road
Schleswig-Holstein	1,049	8 %	26 %	50 %	16 %
Hamburg	37	95 %	5 %		
Niedersachsen	1,124	24 %	76 %		
Bremen	50	46 %	54 %		
Nordrhein-Westfalen	6,801	9 %	19 %	43 %	29 %
Hessen	2,949	7 %	28 %	50 %	15 %
Rheinland-Pfalz	5,959	3 %	14 %	28 %	55 %
Baden-Württemberg	1,809	7 %	44 %	36 %	13 %
Bayern	8,327	5 %	15 %	28 %	52 %
Saarland	619	13 %	19 %	38 %	30 %
Berlin	64	63 %	37 %		
Brandenburg	910	12 %	37 %	51 %	
Mecklenburg-Vorpommern	576	9 %	39 %	43 %	9 %
Sachsen	1,402	6 %	28 %	53 %	13 %
Sachsen-Anhalt	1,038	6 %	44 %	50 %	
Thüringen	906	6 %	39 %	55 %	

Table 1: Number of census points and their distribution according to the road classes in the federal states.¹

The percentages given do not reflect the total coverage of the road net itself, as they have to be taken in relation to the total length of the road net within that federal state. E.g. for federal motorways in Schleswig-Holstein, the given 8 % of the total amount of counting points represents a complete coverage of the motorway net within that federal state.

With the census carried out the ordering parties pursue the goal of a strategic traffic planning. For the local planning authorities the data collection is a fundamental basis for the dimensioning of the traffic infrastructure and the calculation of noise and amount of respirable dust contamination. The census is carried out over several days subdivided over the complete year, with the aim to also gather data in low traffic periods as weekends or holiday seasons. The execution of the census is most often administered by the respective main road board departments. There the data is collected and subsequently evaluated. The traffic census data is very sophisticatedly broken down according 80 classes as e.g. holiday season, weekend, night.

The nationwide road traffic census 2005 (Straßenverkehrszählung - SVZ 2005) was carried out as a part of the usual five-yearly rota to monitor traffic development and determine traffic volumes on federal trunk roads - federal motorways and federal roads. The count also

¹ Source: Kathmann, T., H. Ziegler and B. Thomas (2009). Straßenverkehrszählung 2005, Methoden, Berichte der Bundesanstalt für Straßenwesen, Heft V 179, Wirtschaftsverlag NW, Bremerhaven.

included a sufficient number of state roads for representative statements to be made regarding traffic volumes on these roads as well. As only a small number of municipal roads were counted, representative statements for these roads cannot be made.

In the SVZ 2005 complete survey on all free sections of the federal motorways and main roads were carried out. The average lengths of the road sections surveyed amount to 5.0 kilometres on federal motorways and 4.0 kilometres on federal main roads. Coverage of roads was 100%.

In many federal states good coverage rates close to 100% can be found for federal state main roads. Baden-Württemberg, Thüringen and Schleswig-Holstein exhibit only a coverage rate of 50% to 65%, in Niedersachsen no census was carried out on federal state main roads in 2005 at all. For minor roads only in four federal states a good coverage close to 80% can be found, in other states the coverage is below 20%, so that no statements can be deduced for them.

In the studies to date the census has been carried out by counting personnel on a plurality of appointed dates given. For the current census 2010 automatized counting machines are being used in some federal states, that, as side radar cameras, measure the traffic volume over multiple days.

REQUIREMENTS IN LOCAL TERMS

The federal-wide census data pose for the local authorities only the skeletal structure of traffic data, which is intensified by own surveys. While the above described nationwide census is carried out on road sections, in the urban and city areas the task is appointed to calculate the capacity on intersections as well. Therefore for one intersection all turning relationships must be captured. A periodic traffic census as basis for a strategic infrastructure planning is carried out by few municipalities only. The demand for current census data rather originates from traffic political requirements. Therefore traffic census is often carried out in the subordinate road net where problem pressure - e.g. due to public complaints - is severely felt. To this adds current planning to develop commercial and shopping as well as residential areas. In the course of the census often measurement systems are employed by which in addition to the pure traffic also the amount of heavy goods traffic as well as the traffic velocity is being quantified.

TRAFFIC CENSUS AND THEIR EXECUTION IN GERMAN MUNICIPALITY

Census data as input parameter in environmental-, noise-, exhaust emission- and capacity calculation are gaining especially today more and more importance:

- Cities with more than 250,000 inhabitants are required by law to generate noise maps.

- For road construction activities road capacity calculations are required.
- The constitution and discrimination of environmental green zones with obligatory badge in Germany is strongly based on detailed traffic- and respiral dust exposure measurements.

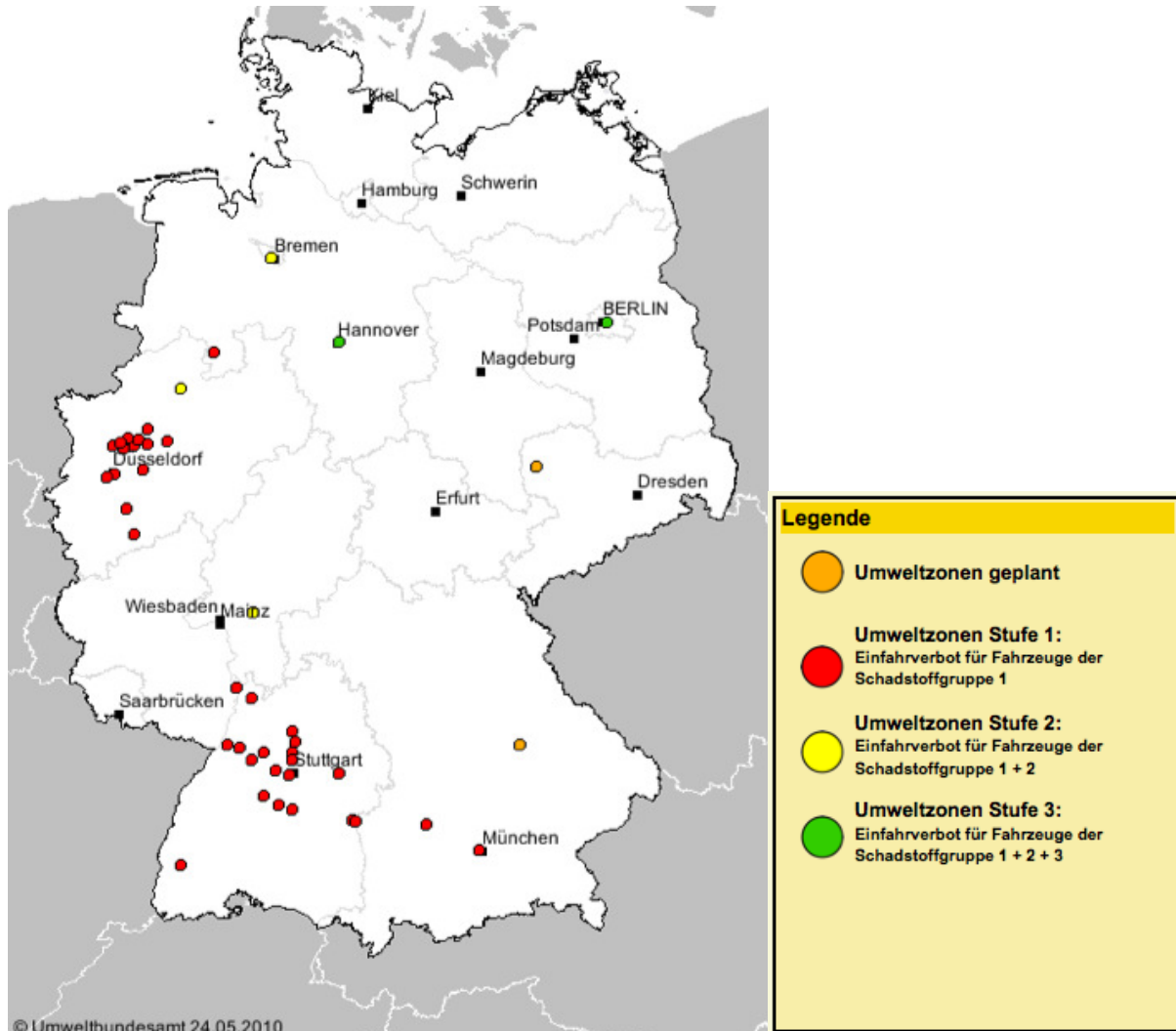


Figure 1: Overview of green zones existing in Germany (1/2010)²

This being the situation an opinion survey on the census data creation process was carried out by Software-Kontor Helmert GmbH amongst German cities in 2009.

The sample encompassed 101 cities with a size in between 35,000 and 3.5 Mio inhabitants. Amongst others the following topics were touched:

- Scope and nature of the census,
- Counting personnel employed,
- Priority and relevance of the census,
- Data management.

² <http://gis.uba.de/Website/umweltzonen/index.htm>

In general there is a broad correlation in traffic data handling with the city dimensions as can be seen in Figure 2.



Figure 2: Correlation in handling of traffic data with city dimension.

Figure 3 shows the detailed results of all interviewed cities.

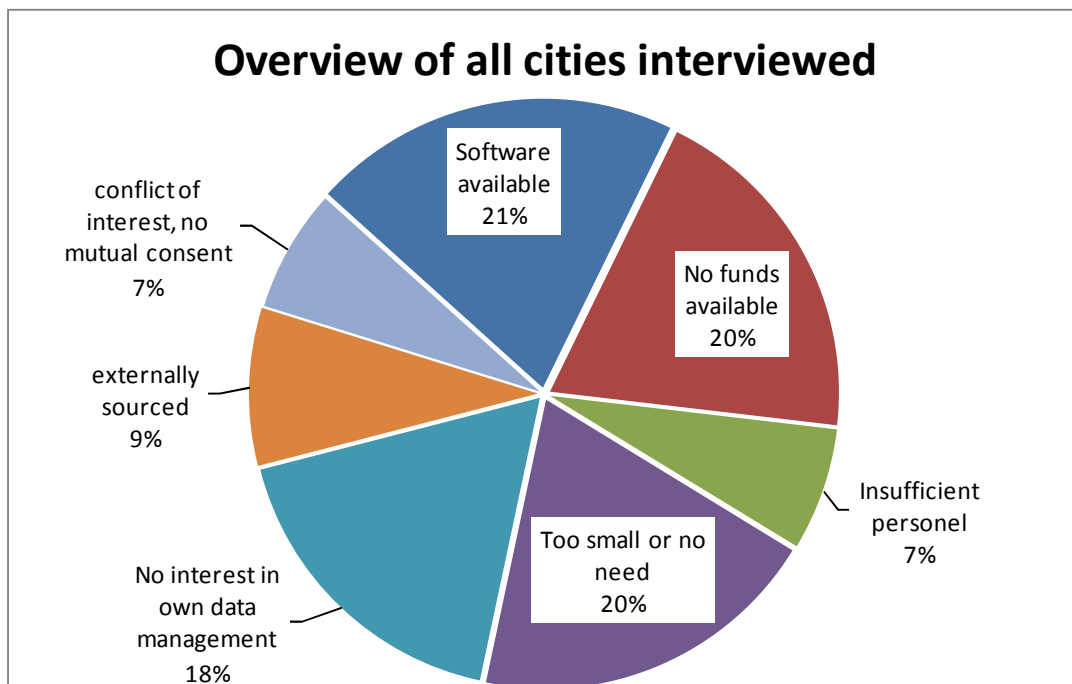


Figure 3: Overview of the traffic census behaviour in all interviewed cities (n=101).³

From Figure 3 one can see that one fifth of all interviewed cities perform traffic census under their own supervision and that the data gathered is being evaluated with available traffic census evaluation software. This means on the other hand that, for various reasons, 80% of

³Due to single value rounding the total sum may differ from 100.

the interviewed cities do not collect traffic census data on their own, but either contract external companies (9%) or do not deal with traffic census at all (71%). As main reasons for the latter lack of funding or personnel (20% and 7% respectively) is mentioned, or the cities feel to be too small to enforce traffic census of their own (20%).

As a further problem the conflict of interests between various offices can be noticed. As already described traffic census data are often collected by civil engineering offices and are rarely being made available to other public authorities that wish to have access to the data. Due to this often no common, public authority-wide available software can be used, which, in consequence, leads to information losses for the city due to lack of internal communication.

If one differentiates the cities according to their size one obtains a more differentiated picture (see figures 4 and 5).

In small cities traffic census is barely carried out under own supervision, only a few (4%) own software to evaluate and administer the data if available. In cities up to 100,000 inhabitants in 15% of the cases census is carried out as contract work by external companies, for larger cities this supplies only for 2% of the cases. In particular for small cities the lack of personnel is a reason why no census is being carried out. Of course also fewer problem areas exist in these cities that require traffic census on a regular basis.

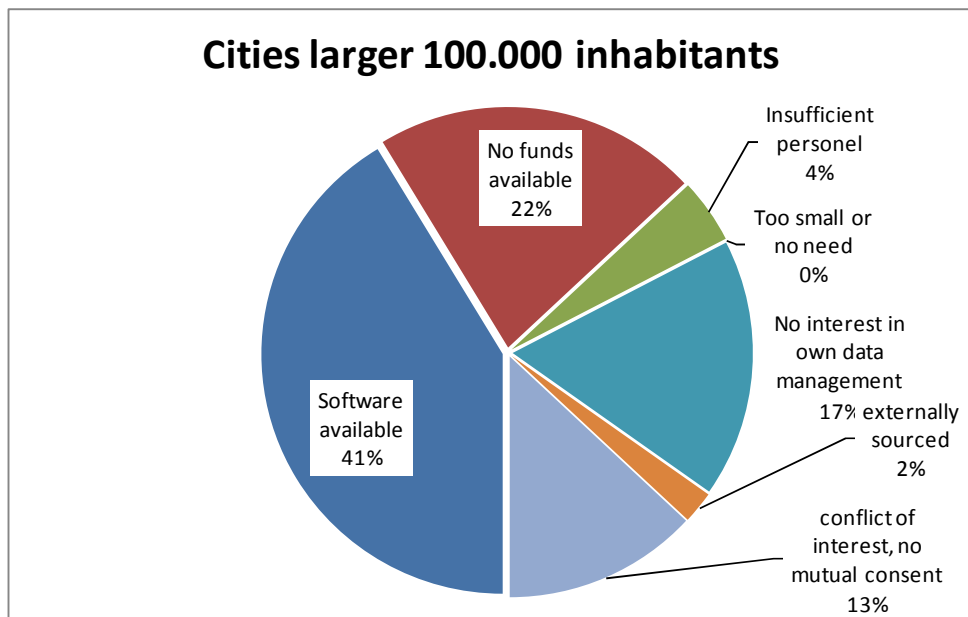


Figure 4: Overview of the traffic census behaviour for cities with more than 100.000 inhabitants. ³

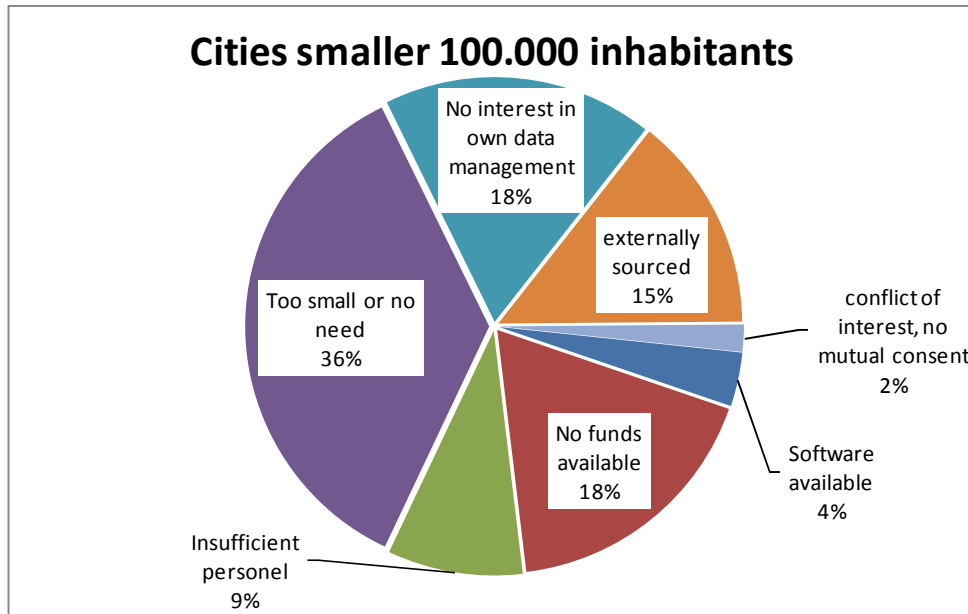


Figure 5: Overview of the traffic census behaviour for cities with less than 100.000 inhabitants. ³

Independent of the size of the city lack of funding is a problem. The response rate is here with 18% and 22% comparable for both entities. Evenly often lack of interest in an own data keeping was mentioned. This statement is again independent of the size of the cities. Obviously many cities prefer to obtain data from thirds.

Summarizing one can conclude that in larger cities more often and more regularly traffic census is being carried out, that small cities often contract external companies with the census data acquisition and that in all German cities often the lack of funding or personnel prohibits to continuously enforce census, although the importance of these data for municipal decision taking is more and more increasing and is felt as lacking for municipal tasks.

TRAFFIC CENSUS DATA BASE

Traffic data are - as described above - mostly collected problem-oriented and are often made available to project partners only. Additional the kind of the survey changes depending on the needs of the project between manual counting or automatized counting or making use of data collected as side product from the cities' traffic control computer. The census results of different years and sources are gathered and stored in different places and even sometimes in hardcopy form only.

Due to these circumstances municipalities, city and federal state authorities can fast loose track of all data ever collected, especially if personnel changes take place. Rarely interested departments of thirds get information where and when census data collection took place. The development of a traffic census data base offers a solution that allows archiving, visualization and documentation of traffic census data collection results. Here data of multiple years and multiple sources (manual counts, side radar systems, slab count systems, inductive loops, traffic light control systems) can be consolidated.

CASE STUDIES

By means of three case studies the handling of traffic census data is presented in the following paragraph. In all three cities the commercial software VerkehrsZählungsApplikation (VZA, TrafficCensusApplication) developed by Software-Kontor Helmert GmbH is in use.

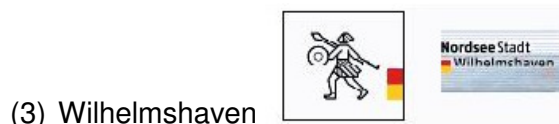


For more than 20 years the federal state capital Mainz consequently conducts the acquisition of traffic census data on main city roads using induction loops for counting. Since the 90ies more than 180 automatic counting stations supply data on traffic streams continuously. This data set is complemented by single counts of traffic flows on intersections as well as automatized cross section counts with slab count systems. Since 1999 the city of Mainz uses the VZA based on MS Access. Throughout the years a data pool has developed that allows to gapless trace back traffic evolutions within the city of Mainz.



In the federal state capital of Nordrhein-Westfalen, a major city with 580,000 inhabitants, one consequently follows the trend of the past years to make data available to an enlarged circle of users, and to connect the census data collected to the city owned traffic data base. Up to date data of traffic loads is an essential to determine noise- and respiral dust exposure, specify street dimensions, etc..

In a pilot project the street data base of the city has been supplied with the comprehensive census data stored in the VZA. In Düsseldorf the traffic census data base is in use since 2009. It encompasses about 500 sets of intersection census data as well as numerous cross section counts from different data sources. The richness of data consolidated composes a data base that documents traffic developments of meanwhile 10 years and improves considerably the evaluation quality and the availability of data.



In Wilhelmshaven, a city of 81,000 inhabitants on the North Sea shore line, currently with the construction of the Jade-Weser-Port one of the largest infrastructure development projects within Germany is being realized. To supervise the traffic streams a traffic census data base has been implemented, to continuously monitor traffic before, during and after the construction duration. Main focus of the

investigation lies in a close meshed supervision of traffic shifts in the vicinity of the building activity. The concept of counting stations encompasses 50 counting stations with 3 activity periods of one week each. The data analysis finally allows to identify, to quantify and to evaluate the impact of the construction activity on the city and on the environment.

AN EVOLUTION OF THE VZA - THE WEB-BASED VZAWEB

An evolution of the stationary access-based VZA software solution constitutes the web-based Internet Software Solution *VZAweb*. Especially German local authorities have a remarkable interest in such a web-based solution. More than 20 authorities already participated in different informative meetings. Actually the Beta version of the application is running on the Internet (<http://85.183.108.137/>), in cooperation with 5 German city authorities, amongst them Essen with 570,000 habitants. In 2010 a first version with the whole range of functionalities will become available.

The advantages are obvious. The demand the software poses on the workstation is low, the data becomes is no longer accessible from one or a few computers only on which the specialized software has been installed. Every computer with internet connection gets the possibility to visualize census data via a known URL. The data base employs without exception Open-Source-Components and is designed to be multilingual.

In the *VZAweb* census data is being kept as Geodata in a free data base management system.

*Web-Application for a GIS-Based Traffic-Database
STEINBRECHER, Jürgen; HELMERT, Christoph; HENNINGER, Kathrin*

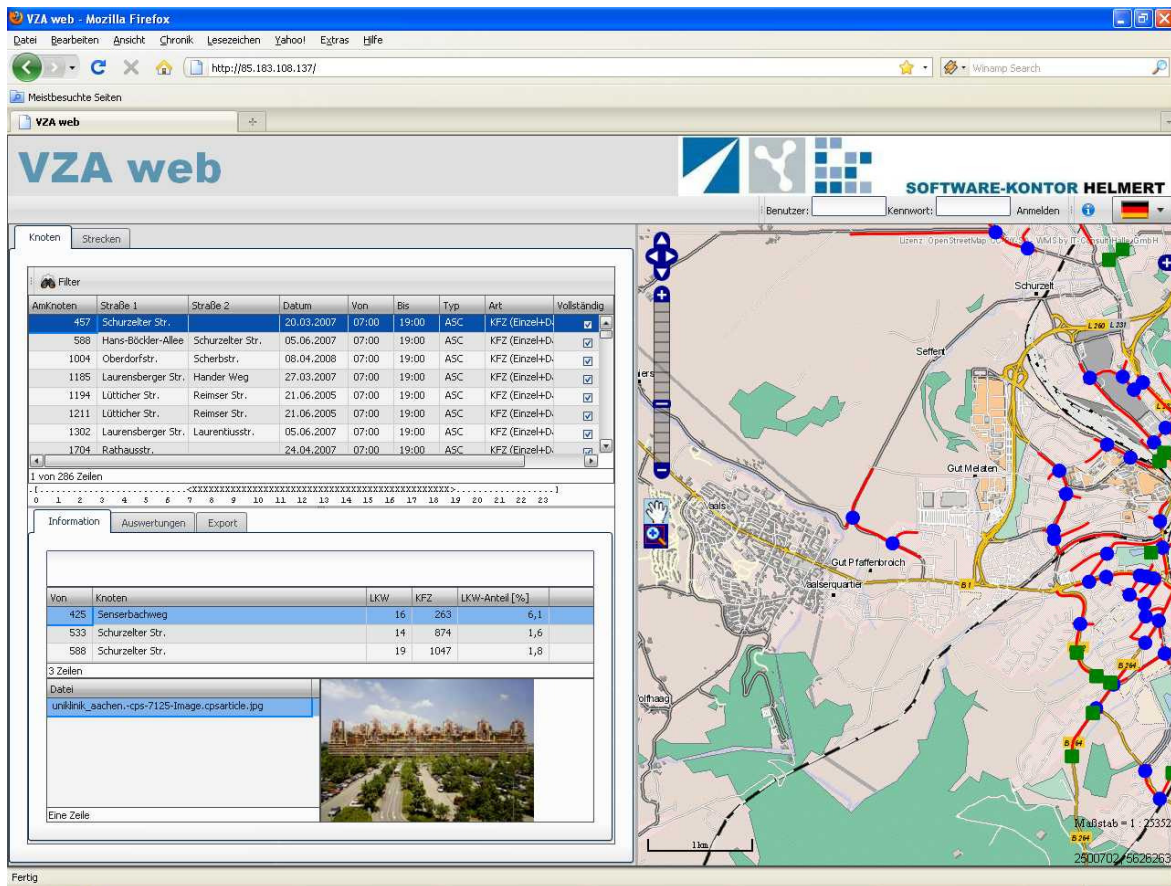
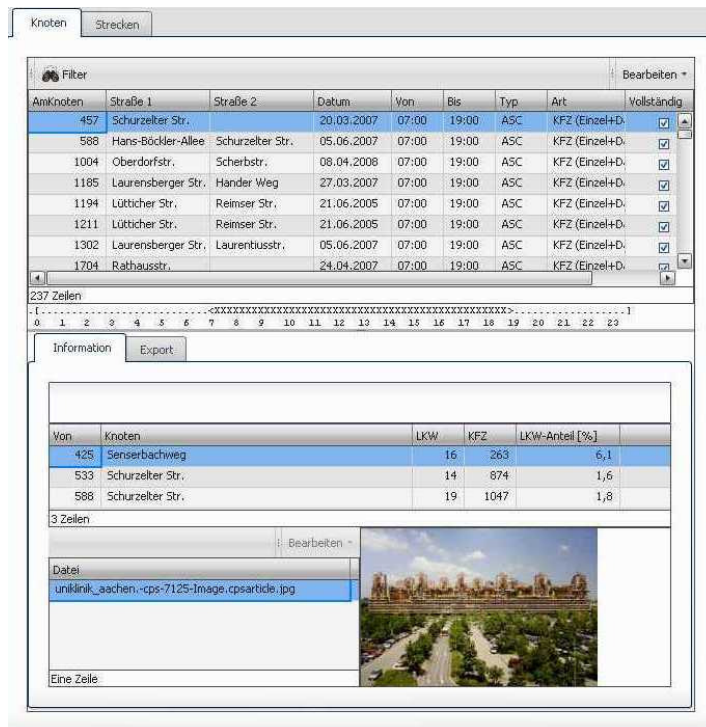


Figure 6: Browser window in VZAweb.

The census data encompasses beside the data sets on the amounts of vehicles (in different sub division as motorcycle, automobiles, trucks, bicycle ...) additional information of:



- Day of census
- Time of census
- Kind of census (intersection or cross section)
- Census system
- Written remarks (e.g. of important major event in the vicinity of the census, as weather condition, sportive events, etc.) and
- Pictured information as on the exact position and arrangement of the census point

Figure 7: Tabulation part of the VZAweb with census data sets.

The data is being connected to GeoInformation and may be spatially pictured in front of different map views in the map application section:

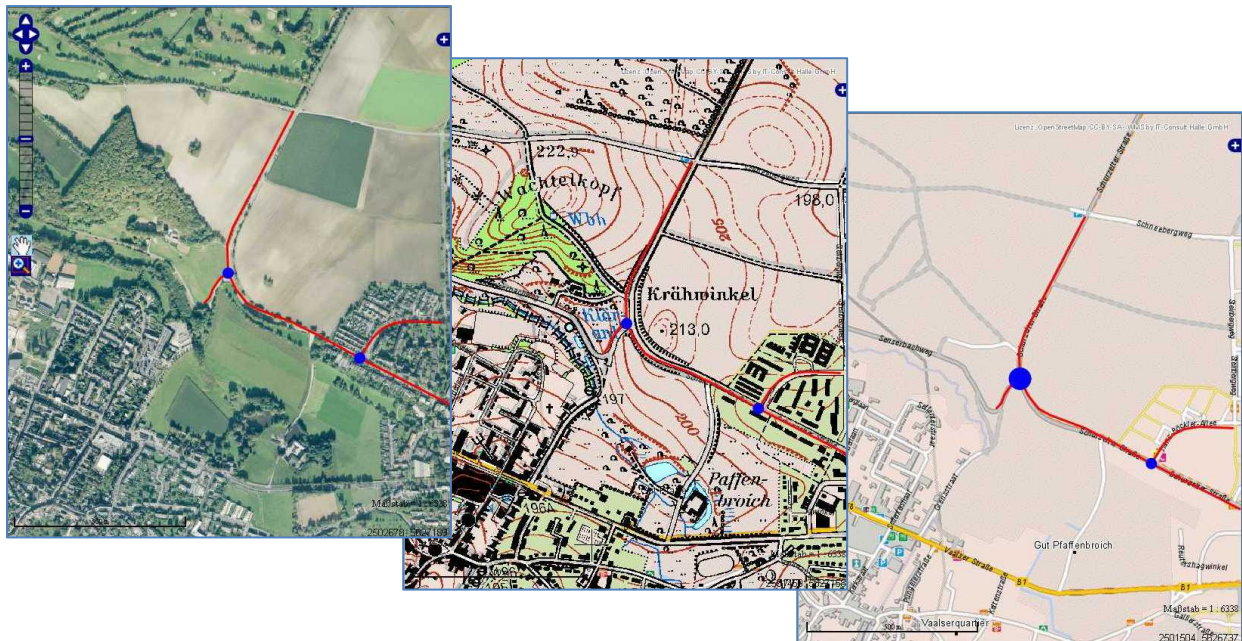


Figure 8: Background maps in the VZAweb (from left: aerial picture, Topographic map TK25, OpenStreetMap).

Via the map view window a direct overview of all available census points can be obtained. By this the user can recognize for his concrete question at a glance if at the chosen location census has been carried out at all and if yes what kind of census it was. Via Tooltips first information about every census point are figured at the census points.

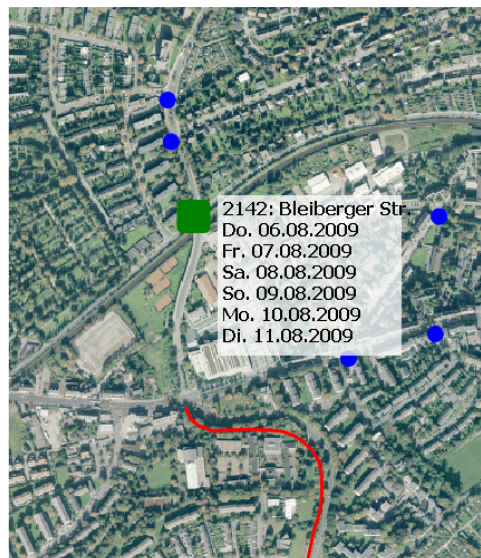


Figure 9: Information box at an intersection census point.

With a click on the mouse the desired intersection or cross census data in the left part is being filtered out and made available for detailed analysis.

In the tables section information of the counting points can be filtered by different criteria, e.g.:

- intersection number
- street name
- census date
- census period
- census system
- type of vehicle

So various evaluations can be realized, e.g. the bicycle census data of the year 2007 can be extracted. The map view window now displays only the matching data sets, all non-matching data sets are filtered out.

The results of the evaluation can be exported in free configurable report formats or visualized in directional volume flow diagram as DXF- or GIS-files. The creation of directional volume flow diagrams is an implemented network service of the *VZAweb*.

Additionally the traffic census data can be made available for other software programs. The *VZAweb* has two implemented interfaces to other transportation planning software that is commonly used by traffic planners:

- PSV (ProgrammSystemVerkehr)
- Visum (PTV Vision)

Via these interfaces traffic census data are directly connected to the corresponding objects (intersections or section) within the traffic model and are available for model calculations or visualizations in these software programs.

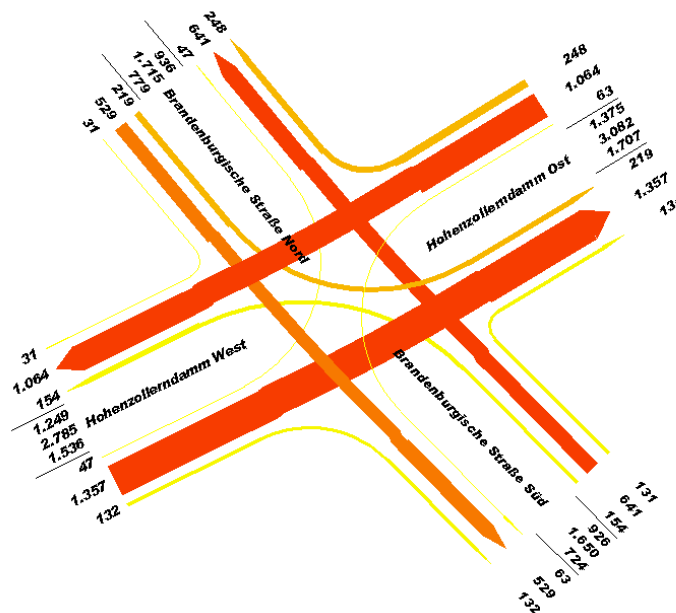


Figure 10: Directional volume flow diagram.

TRAFFIC MONITORING

The application opens up new possibilities of traffic monitoring. This is realized in two ways. First the traffic development over a longer time period is monitored, so that no longer various separated traffic census results have to serve as basis of the decision making process. Weekly, monthly or annual fluctuation can be smoothed out.

Secondly the result is being made accessible to a broader public. By publication of the basis of the decision making process (e.g. necessary census data) the planning process becomes much more transparent. This is extremely important for planning projects in the direct vicinity of residential areas with a sensible public.

The changed modality of treating the traffic census data can be shown by the example of the University development and construction project “Campus-Melaten” in Aachen. On a surface area of 27 hectares 10,000 new jobs for technology ventures and research facilities of the University of Aachen shall be created, within the Aachen city limits and in direct neighbourhood to residential areas. Forward-looking the city of Aachen implemented in the summer of 2009 eight census points for the continuous acquisition of traffic flow data in these residential areas. The results are made public through the internet and therefore are available for every citizen interested.

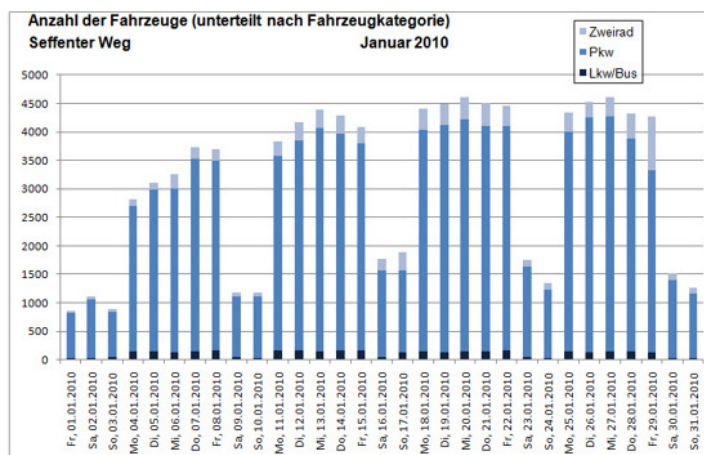


Figure 11: "Aachen – Campus Melaten development project"; Traffic census data „Seffenterweg“ January 2010.⁴

The planning process envisions step by step flow regulation measures to be taken as soon as traffic volumes surpass pre-defined limits. The traffic flow regulation is taken in a multilayered manner and incorporates intersection re-arrangements, truck bans or the implementation of 30 km speed limit zones (Tempo-30). The combination of flow regulation measurements with assigned traffic flow limits have already been successfully tested in the context of the “Fahrtenmodell” during the construction of the shopping centre Sihlcity in Zurich, Switzerland.⁵

⁴ http://www.isb.rwth-aachen.de/aw/cms/website/Themen/dauerzaehlstelle_hoern/~txw/messstationen/?lang=de

⁵ Stadt Zürich (2007). Mobilitätsstrategie der Stadt Zürich, Teilstrategie Einkaufs- und Freizeitverkehr, Zürich

SUMMARY AND PERSPECTIVE

In 5 years intervals traffic census is carried out on the entire, extra-municipal trunk road network in Germany. For municipalities these data collected pose a basis of traffic data that is being flanked by own census measures. Federal and federal state authorities pursue with the census data the goal of a strategic traffic planning, while the municipalities initiate traffic census due to political requirements or construction measures. Over decades an important pool of traffic census data has build up within the municipalities, that is individually archived and accessible to selected planning specialists only.

In 2009 the Software-Kontor Helmert GmbH, carried out an opinion survey amongst more than 100 German cities on scope and nature of the census data creation process as well as on the management of the census data collected.

Only for 20% of the interviewed municipalities the traffic census data is centrally stored in databases. Interest for such data exists in almost all cities surveyed, but the data collection is prohibited by obstacles as lack of personnel, lack of funds or simply lack of competencies. With the aid of three case studies of cities of varying size the mode of traffic census data acquisition, evaluation methods and the goal envisaged was studied.

The web-based traffic census data base *VZAweb* marks the evolution of the access-based stationary data base software *VZA* (VerkehrszählungsApplikation). Currently the beta version of *VZAweb* is available on the net, in cooperation with 5 German city authorities (<http://85.183.108.137/>), among them Essen with 570,000 habitants. The web-based solution offers the following advantages:

- Data-access from all web-enabled workstations at all times
- Differentiated user authorisations
- Minimal requirements on hard- and software

The Beta version is completely based on open-source-components and combines GeoInformation e.g. from OpenstreetMap (OSM) with voluminous filtering functions and a report generator.

The application opens up new possibilities of traffic monitoring. In the city of Aachen traffic monitoring was implemented in the planning process of the “Aachen-Campus Melaten” project where 10,000 new employments are being created. Before the beginning of construction measurements 8 traffic census points were established in the proximate residential area to perceive possible rat-run traffics. The census data are published in the internet and continuously refreshed. In advance the city of Aachen defined traffic flow regulation measures that are linked to traffic flow limits. In this way citizens are early on involved in the decision making process and the traffic census data underlying the decisions taken is made transparent to them.