Cadastre for the 21st Century – the German Way

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SUMMARY

Starting in the mid 19th century the real property cadastre has a long tradition in Germany. In combination with the land register the real property cadastre guarantees security of tenure and a good working land market.

The German cadastral authorities co-operate in the Working Committee of the Surveying Authorities of the States of the Federal Republic of Germany (AdV). AdV defined the new German standard for cadastral and topographical data ALKIS®. The states started implementing ALKIS® since 2005.

Cadastre in Germany is now on track to be established as an important part of local, regional and federal spatial data infrastructures. With the implementation of ALKIS® it will be much easier to integrate cadastre in these programs because ALKIS® follows international standards.

Cadastre is part of a growing number of E-Government programs. New workflows for data acquisition, administration and distribution will be implemented. E-application and E-conveyance of official data will open new ways of co-operation between the public and private sector in Land Administration.

The technical solutions are more or less already available, but it still is a big task to maintain the data in such a way that the benefits of a complete digital workflow can be earned.

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1. INTRODUCTION

Security of land tenure has a tradition of some centuries in Germany. While in the 19th century the real estate cadastre has been introduced for taxation purposes it became more and more a basic data set for a lot of purposes in the following decades for both the public and private sector. It is now a basic element of the Geodata Infrastructure in Germany (GDI-DE). Since many years two digital systems are in operation, the automated cadastral map (ALK) and the automated property register (ALB). These systems will be replaced by the new integrated cadastral information system ALKIS® during the next few years. ALKIS® represents a cadastral model on the international technical ISO and OGC-standard of high quality and will improve Germany's cadastre as a basic information system to meet the demands in the information society of the 21st century. In some but not all points it follows the statements of the FIG paper Cadastre 2014 (Kaufmann, Steudler 1998).

This paper will describe the current status of Germany's cadastre following the six statements of the FIG paper Cadastre 2014.

2. HISTORICAL BACKGROUND

Until the 19th century Germany was a patchwork of numerous independent kingdoms and principalities. The regulations for selling and buying land and the registration of ownership and other rights related to land were different from state to state.

From the beginning of the 19th century in most of the kingdoms cadastral systems have been established for taxation purposes. In 1876 the cadastre in Prussia, the biggest province on German territory was completed. Although the main purpose for establishing these cadastres was taxation of land, the idea of using maps and records for further purposes of governmental activities was already implemented in the cadastral systems from the start.

After the German Reich was founded in 1871, the need for standardisation of the private law was evident. Since January, 1 1900 the common private law became operative for the entire country. This law regulates the major principles for buying and selling land and the rights to land and the introduction of the land registry (in German terms called „Grundbuch") for the entire nation. This land registration system contains all rights of ownership and other rights related to land and buildings, mortgages etc. The description of the land parcels in the cadastre (parcel identifier and cadastral maps) became the official and legal register of parcels.

The importance of good working cadastral systems grew very fast. Cadastre developed from a system for taxation of land to a register guaranteeing all rights on land in combination with the land register.

After 1934 the results of the official soil assessment were recorded in the cadastre. This was the first step into the direction of a multi-purposed cadastre.

Since 1949 with respect to the federal constitution of Germany the responsibility for legislation in the field of cadastre is in the hand of the states. The 16 states have passed various, basically uniform laws in the field of cadastre and state survey. The different tasks are not carried out by a central surveying authority responsible for the entire Federal Republic of Germany, but essentially by the Surveying and Mapping Administrations of the states. Tasks to be attended to at a federal level are partly performed by the Federal Office for Cartography and Geodesy (BKG), an agency under the authority of the Federal Ministry of the Interior, but BKG is not involved in cadastral activities. There is no federal institution responsible for cadastre supervising the authorities on a state level.

The state survey offices of the states cooperate within the "Arbeitsgemeinschaft der Vermessungsverwaltungen der Länder der Bundesrepublik Deutschland" (AdV) (Working Committee of the Surveying Authorities of the States of the Federal Republic of Germany) to discuss technical matters of fundamental and national importance with a view to finding uniform regulations. Among others a main task of AdV is co-operation in the development and application of technical procedures, especially in the field of basic surveying, of the topographic-cartographic information systems, as well as the automated Real Estate Cadastre. Therefore although cadastre in Germany is in the responsibility of the 16 states the systems and procedures are unique with only some small exceptions.

These days the cadastre fulfils almost all demands of administration and the private sector. It is a basic element for the Spatial Data Infrastructure in Germany and has many users in planning, environmental protection etc. Maps and cadastral records are kept in digital form since many years. These systems are the automated cadastral map (ALK) and the automated property register (ALB).

3. CADASTRE AS A PART OF THE GERMAN GEODATA INFRASTRUCTURE

Statement 1 on Cadastre 2014: "Cadastre 2014 will show the complete legal situation of land, including public rights and restrictions!" Cadastre shall be the information source for all facts on land.

Cadastre 2014 follows the model of a layer structure in one database containing all information related to land. It is quite unrealistic that this strategy will be successful in Germany even the design of an integrated real estate database developed from AdV dates back some 30 years. The technology available at that time didn't allow this sophisticated approach and there was not the right political support for these ideas.

The technology available now opens other strategies to come to the same result. Not a layer structure in one database will be the final solution. Geo-portals which allow the access to distributed databases and individual combination of the contents of these databases will be the solution. So now it is more an organisational than a technical task to introduce such an information network in a SDI like the German GDI-DE project.

Governmental authorities in Germany are busy establishing E-government programs and services on all levels of the administration (international, federal, regional, local). Geodata play a key role in a lot of these E-government projects. The establishment of geodata portals and metadata catalogues in SDI-projects like GDI-DE (German Geodata infrastructure) are therefore necessary prerequisites for operating cadastral data in E-Land Administration.

Through GDI-DE it will be possible to meet user requirements and to tackle the major problems which can be mainly found in data structures not following international standards, insufficient and inhomogeneous documentation, inconsistent licensing and pricing policy of public data providers. The metadata system of GDI-DE is called GeoMIS.Bund. This metadata system will be part of the GeoPortal.Bund which will be the main entrance for GDI-DE and which can become part of the European SDI. With regard to the European INSPIRE-geoportal the GeoPortal.Bund will be able to act as a node of it.

The use of international standards is a key element in the development and establishment of SDI-projects. AdV started 1997 with the description of the AFIS®-ALKIS®-ATKIS® model based on international standards. The description of this model is completed. It covers the information about control points (AFIS), cadastre (ALKIS®) and topographical data (ATKIS®) in one database and will replace the current systems.

It will be possible to realise statement 1 of Cadastre 2014 in a dynamically growing GDI-DE environment. It seems to be more a political and organisational task than a technical one.

4. CADASTRE AND LAND REGISTRY

Statement 2 on Cadastre 2014: “The separation between 'maps' and 'registers' will be abolished!”

Already in the first decade of the 20th century the description of the land parcels in the cadastre (parcel identifier and cadastral maps) became the official and legal register of parcels as supplement to the land register. Since then only both systems land register and cadastre in combination show the complete legal and de facto status of the land and the private rights related to land.

The split system of land registration (Grundbuch) and cadastre seems to remain in Germany even if some political activities are coming up from time to time. The motion which is now on the way through the Parliament wants to give the responsibility for organisational tasks around the land registration into the hands of the states. They shall then have the right to pool

both organisations. The 16 states have agreed on this motion but chances for passing the Federal Parliament are estimated as quite low.

Chances for a technical solution are far more realistic. The Federal and the state Ministries of Justice have established a commission for a re-design of the digital land register. The technical concept will be ready by the end of next year. The interface for Land register and cadastre will be described on the ALKIS®-standard. This guarantees at least the electronic data transfer in order to update redundant data sets in both systems. The realistic vision for 2014 is a land register and the cadastre as an internet-based information system where data from both systems will be presented with one single user interface without storing redundant data in each of the two systems.

Germany, like many other developed countries, introduced digital cadastral records (ALB) in the late 70s and maps (ALK) in the 80s of the last century. An integrated approach was not possible, because the limited capacities of the data processing equipment of that time did not allow an efficient processing of data. Therefore ALB and ALK were developed as independent software solutions.

This statement of Cadastre 2014 will be realised in cadastre when ALKIS® will replace the old systems ALK and ALB in the near future.

5. ALKIS® - THE NEW STANDARD IN GERMAN CADASTRE

Statement 3 on Cadastre 2014: “The Cadastral mapping will be dead! Long live modelling!”

5.1 Current situation

As mentioned above ALB and ALK were developed as independent software solutions. These factors did not allow an integrated approach. Two independent databases without mutual object structures cause some problems in data maintenance, exchange and data consistency. The result was frequent inefficient checks of both databases.

Beside these developments the Official Topographic and Cartographic Information System ATKIS® was established throughout the entire country. Both systems ALK and ATKIS® do not have the same object structures which makes a straight data exchange between both information systems almost impossible even if features in the cadastral data may be useful for the topographic data and vice versa.

Despite these facts ALB, ALK and ATKIS® became the most important geoinformation data in Germany used for a wide range of applications in the private and public sector. Increasing demands come from the real estate market, banks, navigation companies etc. The interface to the customers’ databases is represented through the Unique Database Interface (EDBS) for ALK if not DXF or TIFF format are required. Digital ALB data can be distributed with an interface called WLDG which produces ASCII data. Both interfaces were developed by the

Surveying Authorities, not following international standards (they did not exist in that time) but accepted by most users of cadastral records in Germany.

5.2 Reasons for re-design and decision of the AdV

The development of standards in the IT sector and especially for geoinformation by ISO and OGC played an important role in the decision making process in AdV about the future development of the information systems. ALB, ALK and ATKIS® are not able to meet these modern technical requirements. When ALB and ALK were developed standards for databases did not exist. ALB was not designed for using a commercial relational database management system.

In consideration of these facts and trends AdV decided in 1995 not to invest in the old software solutions any more, only to guarantee sustainability of the systems until 2005 and to develop a new integrated approach for cadastral and topographical data. The existing information systems ALK and ALB will be replaced by a new development with an integrated approach called ALKIS® (Official Real Estate Cadastre Information System). A harmonisation process in respect of the data model, the content and the semantics has also been carried out in line with ATKIS®.

ALKIS® in combination with the new ATKIS® is designed to

- process all necessary cadastral and topographical data for a parcel based map and register of land owners, land use and more unified basic data for the entire Republic,
- control the use and maintenance of the system and to
- enable the use of the entire geographical data of the surveying authorities for all users via a metadata system including quality information for all data and a standardised data interface for ALKIS® and ATKIS®. Of course links of the users' specific data they already linked to ALK, ALB or ATKIS® still have to be possible in the new environment without reasonable new investments on the customers' side. They shall trust in the sustainability of their investment in data.

The object catalogues and data of ALKIS® and ATKIS® will be harmonised in order to allow a vertical data flow avoiding data redundancy and double work in data acquisition and data processing.

AdV followed the idea only to design and to describe the database model. The GIS industry carries out the software solutions. The new ALKIS® standard therefore has to guarantee sustainability for the GIS industry in order to protect their long-term investment in the future software development. Essential for this approach is the use of a standardised database description language with graphical and lexical features.

Of course one major claim is the option for a complete automated migration of the ALB, ALK and ATKIS® data into the new target systems.

The access to ALKIS® data is restricted respecting the regulations to protect against the misuse of personal data. The access to ALKIS® by individual users is manifested in user profiles. ALKIS® produces access protocols to allow the observation of correct use by the data protection commissioners.

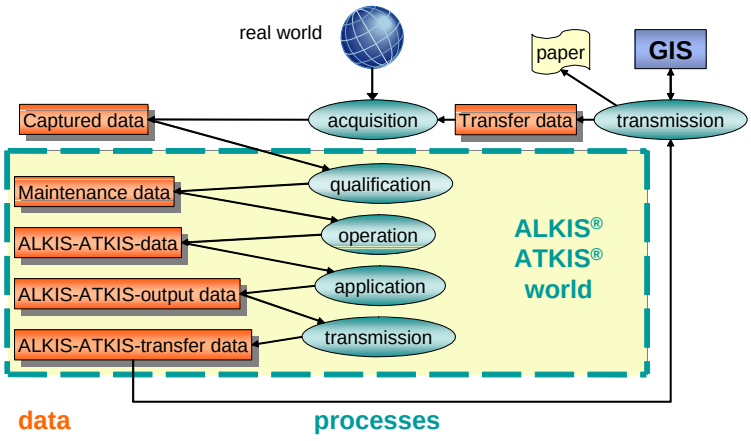
5.3 Principles of the ALKIS® modelling

The description of the AFIS®-ALKIS®-ATKIS®-model, in short the AAA-model, is documented in the GeoInfoDok (AdV 2006) and available on the web. The main document is as well available in English on the website of AdV (www.adv-online.de).

Besides developing a conceptual data model it is essential for a comprehensive description of an application to develop a model of methods and a model of processes which allows setting the data into a functional interdependence and defining the dynamic behaviour of the application.

Initially ALKIS® was modelled by using the draft documents of the database description language EXPRESS (EXPRESS-L for the lexical and EXPRESS-G for the graphical part) developed by the European Standards Body CEN. New developments on the fields of international standards forced AdV to reshape the description on the ISO standard Unified Modelling Language (UML) for describing the application schema and the feature catalogue. This language is also used by ISO/TC 211 in the field of geoinformation standardisation. A universal and system-independent data exchange and/or file format is automatically generated in conjunction with so-called encoding rules. These encoding rules are created in accordance with ISO standard 19118 Encoding and the GML specification of the OpenGIS Consortium (OGC). The language XML (Extensible Markup Language) of the World-Wide-Web-Consortium (W3C) is used as the format.

The surveying authorities' tasks are data acquisition, qualification, operation (setting up and maintenance of data), application and data transfer. Each of these tasks may be defined as a process. Relations between data and processes in AdV-terminology are shown in the diagram. By definition through AdV the data acquisition process and the captured data shall not be modelled by ALKIS® because these processes are and may be designed individually by each state depending on different survey methods or data sources.



5.4 Status and future development of the project

AdV's activities in modelling ALKIS® and ATKIS®, the definition of standard output products based on a XML interface, the metadata catalogue based on UML and the NAS interface are completed. The member states in AdV agreed upon the basic contents of ALKIS® to guarantee a unique standard for the system and data in ALKIS® for the entire country.

All necessary documents describing AFIS®, ALKIS® and ATKIS® are published under www.adv-online.de and are free accessible. The leading GIS software producers have adopted these documents and developed or are developing the necessary software tools for migration of data and processing the new system. All states committed themselves to start with the implementation of ALKIS® not later than 2005. The migration process is on its way in the cadastral world in Germany. Some states will migrate to the new system in late 2006 or early 2007.

Both the public sector and the GIS companies have successfully designed and developed a future oriented cadastral information system. Statement 3 of Cadastre 2014 is no longer science fiction in Germany!

6. WORKFLOW IN CADASTRE

Statement 4 on Cadastre 2014: "Paper and pencil cadastre will have gone!"

ALB and ALK are available throughout the entire Republic. Paper and pencil cadastre is a thing of the past regarding the registration part of the cadastral business. Data capture, submission of survey acts from private licensed surveyors to the cadastral authorities and the production of extracts out of the cadastral maps and textual data is still not completely free of paper and pencils.

The introduction of ALKIS® will allow the establishment of modern communication technologies and distribution channels. As mentioned above ALKIS® is one of the pillars of GDI-DE, the national SDI-project in Germany. All states are establishing geo-portals in their administrations. AdV plans to link these state portals on a federal level by an AdV-portal. This is not yet carried out but plans are already on the table. E-government projects will increase the workflow in the public sector and between the public and the private sector on all levels of governmental activities, so as well in cadastre.

A major prerequisite to reach this goal is that all cadastral data are available in electronic form. Cadastral maps and textual information will be available through ALKIS®.

In addition to that a lot of cadastral authorities have digitized their archives including analogue field books, survey results and other documents related to the parcels by scanning the documents and updating the necessary retrieval systems with the information where to find the digital documents related to a specific parcel. These data will be accessible not only

for the public cadastral organisations but as well for the private licensed surveyors. The next step is that new survey results can be submitted in electronic form in the standardised NAS format, so that the ALKIS® update procedure will run nearly automatically as long as the qualification process shows green light. This service can be carried out by the states under their ongoing E-government projects.

Field survey procedures have changed dramatically due to the new developments on the survey instruments sector. Some years ago AdV established a service for real time and post-processing differential GPS (DGPS) applications called SAPOS®. A network of 250 permanent GPS reference stations have been established throughout the entire Republic with distances of 40 to 70 km. SAPOS offers different services on different levels of accuracy. For cadastral purposes the High Precision Real Time Positioning Service HEPS is most relevant. HEPS allows Real Time Kinematik applications (RTK) with an accuracy from 1 to 5 cm which is recognised as sufficient for cadastral surveys. AdV agreed on a protocol containing the relevant data for updating the cadastre in an electronic workflow.

Earning the entire benefits of RTK survey methods is only possible when the coordinates of the cadastral boundaries are based on an appropriate reference system. AdV decided in 1991 to introduce the European reference system ETRS89 for all sectors in state survey and real estate cadastre. In 1995 it confirmed this decision and established the Universal Transversal Mercator projection (UTM) as projection system for all cadastral and topographical mapping systems.

Some states are now processing the establishment of ETRS89 in cadastre. During this process tensions inside old control point networks can be identified and compensated (Hawerk 2002). After compensating these tensions maintenance of the existing control points is dispensable. This strategy allows best cost benefit relations for the establishment of the SAPOS® service. The implementation of ETRS89/UTM in cadastre will be co-ordinated with the implementation of ALKIS® to avoid stress on the customers' side.

Digital archives together with ETRS89 and boundary coordinates free of tensions in addition to well defined cadastral processes and data interfaces will allow a workflow without media breaks from the office into the field and back into the office. The survey results can be produced according to the ALKIS® regulations as ALKIS® objects. These results will be checked in a defined qualification process and will be used automatically to update the original database. The survey records will be stored in the digital archive carrying the digital signature of the person who is responsible for this update.

These standardised processes will allow new forms of cooperation between the private licensed surveyors and the public authorities responsible for the maintenance of the cadastral database. The survey methods will be changed into hybrid methods by using RTK equipment together with total stations controlled by GIS software which uses the survey equipment only as a sensor for measuring positions. The results from data capturing come out in digital form as coordinates and objects as XML-files according to the ALKIS® definitions.

The requirements on the cadastral data for establishing a modern workflow are clear but not yet realised completely, but in some regions, especially in urban areas where boundary co-ordinates are available these benefits can be earned already now.

7. COST RECOVERY

Statement 5 on Cadastre 2014: “Cadastre 2014 will be highly privatized! Public and private sector are working closely together!” and Statement 6 on Cadastre 2014: “Cadastre 2014 will be cost recovering!”

The private sector is strongly involved in the cadastral procedures. Except in Bavaria private licensed surveyors (Öffentlich bestellte Vermessungsingenieure ÖbVI) are established in all states in Germany. The licence allows the surveyors only to practice in one state. Their role is restricted only to carry out the field work. They are the interface to the customers who want to subdivide their land or to reconstruct the parcel boundaries. Registration in maps and records and archiving of field records as well as the distribution of data is the tasks of the public cadastral authorities. The private sector is highly involved in cadastral procedures. Cadastral surveys may be carried out as well by the public sector. The share of the public sector on cadastral surveys is a matter of political decisions and may be different from state to state. The trend is that more and more tasks go to the private sector.

ÖbVI and the cadastral authorities calculate their prices on the same pricing list. These tasks shall be cost recovering, because this is the essential income of the private surveyors. The receipts the cadastral authorities are able to get for updating the records, data capturing, maintenance, selling data etc. is not able to recover all costs in the public sector for running the entire system. Cost recovery in this field is a political issue discussed on national as well as on European level.

8. CONCLUSION

One of the major tasks for all stakeholders in the field of cadastre is to meet future requirements properly. The technological problems are more or less solved. One of the more important tasks for the near future will be looking for new organisational structures not only in the public sector but as well in the working process together with the private sector in order to create an electronically processed cadastral service for the private and public customers.

During the next few years a lot of effort has to be put into the migration process from the digital cadastral maps and registers to the new ALKIS® standard. It is the big chance for the German cadastre to introduce a common standard not only in software and interfaces but as well in the core data sets.

Digital archiving systems were introduced in most cadastral authorities. The entire benefits can be only earned completely when all relevant documents can be accessed in digital form.

The archives shall be opened for professionals via internet technology, so that transfer of data between the cadastral offices and the private surveyors can be improved.

The complete introduction of ETRS89 in cadastre in combination with boundary coordinates free of tensions is one of the big tasks in the near future.

These activities will enable the establishment of a smooth workflow from the office to the field and back and are an important factor for a better customer service for both the private and the public sector and are good for reaching a better cost-benefit-rate.

Cadastral data are fundamental data for legal, administrative and technological structures for the entire public administration if the authorities responsible for cadastre in Germany are able to meet future requirements. But these data will only be of this importance in an E-government environment when they follow well defined standards and are available throughout the entire country via internet technology. The introduction of ALKIS® is the entrance key for the cadastre to GDI-DE. The acceptance will improve as well when the different pricing systems will be harmonised.

This paper tried to describe necessary improvements of data and services in German cadastre during the next years. It is not an easy task due to the constitutional circumstances in Germany but we are optimistic to reach these goals in near future.

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BIOGRAPHICAL NOTES

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