NATIONAL REPORT

ON THE GERMAN CARTOGRAPHIC ACTIVITIES

Deutsche Gesellschaft für Kartographie DGfK
(German Society of Cartography)
Report Period 2011 – 2015

Compilation:
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1 Activities of the Deutsche Gesellschaft für Kartographie DGfK (German Society of Cartography)

1.1 Society Organisation and Activities

The *Deutsche Gesellschaft für Kartographie DGfK* is the national professional organisation of the cartographers of the Federal Republic of Germany and of those persons who have an interest in cartography.

The aims of the society are:

- to promote cartography in research, training and practice
- to support all involved in the field of cartography with apprenticeships and further training, especially for entrants
- to cultivate national and international co-operation in cartography and with other specialist fields
- to promote knowledge of cartographic science for geospatial planning and pro-jects
- to support and nurture the cartographic culture in Germany

Executive bodies of the DGfK are the Vorstand (Executive Committee) the Vorstandsrat (Executive Council) and the Mitgliederversammlung (General Assembly). The Society is regionally organised in Regional Branches (Sections), professionally in Commissions. The Sections and Commissions organise professional and social meetings, lectures, seminars, and excursions for their members and guests. At present the Society has about 2000 members.

The DGfK holds an annual "Deutscher Kartographentag" (German Cartographic Conference). The annual general assembly of the society also takes place during this event.

Also, within this conference the “Ravenstein Förderpreis” will be awarded, a prise to honour young talented cartographic students and professionals for their qualified work.

The "Kartographischen Nachrichten", the only cartographic periodical in German, is also published by the DGfK. Six issues per year are delivered to the DGfK members free of charge. In articles, reports, reviews, and much other information, also job advertisements, this periodical mirrors cartographic news in Germany and abroad (especially Switzerland and Austria).

Apart from the "Kartographischen Nachrichten" members of the DGfK also receive, every couple of years, the "Kartographisches Taschenbuch" (Cartographic Paperback) which contains an extensive list of addresses in the field of cartography. Together with the "Staatsbibliothek Preußischer Kulturbesitz, Kartenabteilung" the "Bibliographia Cartographica" is published annually. It is the only regular documentation of international cartographic literature.

DGfK is a member of the International Cartographic Association (ICA). On a European level DGfK is, since 1999, a founding member of the European Cartographic Union (ECU). Nationally, DGfK contributes to the Deutsche Gesellschaft für Geoinformation “DDGI” (German Society for Geoinformation) and the German GeoUnion. In this way our society is engaged on an international and national level and is involved in the development of cartography.

Annual Meetings "Deutscher Kartographentag" (German Cartographic Conference)

2011 Nuremberg: Joint Conference with INTERGEO, the Conference of the Gesellschaft für Geodaesie, Geoinformation und Landmanagement “DVW” (Society of Geodesy, Geoinformation and Land Mangement). Conference theme: “Cartography all over – Ubiquitous Cartography”.

2012 Hannover: Joint Conference with INTERGEO, the Conference of the Gesellschaft für Geodaesie, Geoinformation und Landmanagement “DVW” (Society of Geodesy, Geoinformation and Land Mangement). Conference theme: “Cartographic Solutions for Big and Open Data”.

2013 Dresden: Within the scope of the 26th International Cartographic Conference ICC2013 organised by the German Society of Cartography. Conference theme: „From Pole to Pole“.

2014 Hamburg: Joint Conference with “Geomatik 2014”. Conference theme: “Geoinformation open the Gate into the World”.

2015 Stuttgart: Joint Conference with INTERGEO, the Conference of the Gesellschaft für Geodaesie, Geoinformation und Landmanagement “DVW” (Society of Geodesy, Geoinformation and Land Mangement). Conference theme: “Cartographic Solutions for Big and Open Data”.

1.2 Commissions

1.2.1 Applied Cartography – Geovisualisation

Chair
Dr. Erik Theile

Terms of Reference
The Commission has for many years been involved in advanced cartographic visualisation in the filed of the earth sciences. Its major task is characterised by the early identification of technological developments in all relevant application areas.
Subsequently technologically leading and application-oriented developments are communicated into the community of the German Cartographic Society and beyond by offering appropriate information. High-end-Workshops as well as a biannual Symposium in the German town of Königslutter convey transdisciplinary know-how based on findings of the Commission.

Members
The Commission comprehends members who are, in their professional predominantly dealing with cartographic themes and activities (private enterprises, public administration, authorities, self-employees universities). Currently the Commission on Applied Cartography – Geovisualisation counts 11 members.

Projects/Activities
Continuously new findings of members deliver input for Commissions discussions and for the identification of ne topics of interest.
Current activities of the Commission focus arround the following items:

- positioning and navigation
- open data, e-government
- geo statistics
- geo analyses
- mobile media
- Apps
- OpenStreet Map
- German AFIS-ALKIS-ATKIS (AAA) geodata
- generalisation
- 3D models and simulation
- social mapping
- geomatics education.

The above mentioned catch words continuously mold the work of the Commission. During regular meetings they are depend and updated towards new technological developments.
The Königslutter Symposium, for the last times organised in 2013 and 2015, featured under the motto "Reality – Perception – Knowledge". This symposium continuous a tradition to identify current and future trends in Cartography. It offers possibilities for an intensive exchange of information and experience between representatives of industries, small and medium companies, authorities as well as science.
In May 2012 a workshop focussing on mobile media under the title "Maps4Apps Cartography" was organised.

Publications

Averdung, C. (2012): Aktuelle Trends und marktrelevante Entwicklungen der Geoinformationswirtschaft. Aus der Arbeit der DGfK-Kommission Angewandte Kartographie-Geovisualisierung Kartographische Nachrichten, 6, 323-326.

Theile, E. (2014): Geomatiker werden und bleiben – ein Beruf mit Zukunft/Becoming and remaining Geomatiker – a career for future. Kartographische Nachrichten, 6, 331-334.

Preview

Currently the transfer of cartographic knowledge into various problems of geodata visualisation draws a lot of interest among the Commission members. The Königslutter Symposium planned for 22-24 May 2017 will attraced a great number of interested cartographers.

1.2.2 Education and Further Training

Chair

Frank Dickmann

Terms of Reference

The aim of the Commission "Cartographic Communication" of DGfK is to offer an opportunity to discuss and spread new findings on the efficient transfer of map information. The idea is to promote a dialogue of cartographic researchers and practical cartographers. In this way, modern developments shall be taken up to support theory formation in cartography.

Members

The Commission currently consists of some 10 active members working at different universities of Bochum, Berlin, Halle-Wittenberg or at educational authorities in Germany.

Activities

The work of the commission comprised workshops (e.g. in Berlin 2014, Bochum 2013, Magdeburg 2012) and publications, such as teaching materials. Here, the focus was on the exploration of map-

based visualisation techniques using "SMART Board". In cooperation with Diercke / Westermann, audio-visual maps were created for their use in geography classes.

Publications

Lammert-Siepmann, N., Edler, D., Dickmann, F. (2014): Die Effekte audiovisueller Informationsvermittlung in Topographischen Karten auf die Behaltensleistung – Das Beispiel geographische Namen, in: Kartographische Nachrichten, 64 (6), S. 308-316.

Diekmann-Boubaker, N. (Ed.) (2014): Diercke – Methoden und Präsentationen für interaktive Lerneinheiten. Braunschweig

Edler, D., Lammert-Siepmann, N., Diekmann-Boubaker N. und Dickmann F. (2014): Audio-visuelle Karten auf dem Weg in die Schulkartographie?, in: Seyfert, E., Gülch, E., Heipke, C., Schiewe, J., Sester, M. (Eds.): Geoinformationen öffnen das Tor zur Welt, = Publikationen der Deutschen Gesellschaft für Photogrammetrie, Fernerkundung und Geoinformation e.V., Bd. 23, 8 S. [DVD-Rom]

Diekmann-Boubaker, N., Edler, D., Lammert-Siepmann, N.: (2014): Dürregefahr in der Sahelzone, in: Diekmann-Boubaker , N. (Ed.): Diercke – Methoden und Präsentationen für interaktive Lerneinheiten. Braunschweig, S. 24-30.

Diekmann-Boubaker, N., Edler, D. (2014): Megastädte und Global Cities. In: Diekmann-Boubaker , N.(Ed.): Diercke – Methoden und Präsentationen für interaktive Lerneinheiten. Braunschweig, S. 126-130.

Dickmann, F., Bröhmer, K., Buchroithner, M., Knust, C. (2012): Möglichkeiten und Grenzen lentikularer Mehrbildmodelle im Vermittlungsprozess raumbezogener Informationen. In: Diekmann-Boubaker, N., Dickmann, F. (Eds.): Innovatives Lernen mit kartographischen Medien, (= Kartographische Schriften, Bd. 15,. Bonn, S. 129-144.

Diekmann, N., Dickmann, F. (Eds.) (2012): Innovatives Lernen mit kartographischen Medien, Bonn, Kartographischen Schriften, Vol. 15, Bonn.

Edler, D., Lammert-Siepmann, N. (2012): Audio-visuelle Karten in der Fremdsprachenvermittlung - Beispiele für den Englischunterricht an Grundschulen. In: Diekmann-Boubaker, N., Dickmann, F. (Eds.): Innovatives Lernen mit kartographischen Medien, = Kartographische Schriften, Bd. 15, Bonn, S. 73-82.

Edler, D., Lammert-Siepmann, N. (2012): Audio-visuelle Karten für den Englischunterricht an Grundschulen, =Materialien zur Raumordnung (MzR), Bd. 75., Bochum.

1.2.3 High Mountain Cartography

Chair D, A, CH
Karel Kriz

Chair Germany
Manfred Buchroithner

Terms of Reference
Further define the topics of Mountain Cartography and promote the methods and knowledge of mountain cartography among scientists and professionals in cartography and related fields.

1. Provide an updated, attractive web-site with information about Commission activities, links to other events and theme-specific knowledge.
2. Provide an updated web-portal with links to related web-sites and bibliographic information.
3. Emphasize cartographic design issues and map related representations in large scale topographic mapping.
4. Continue the well-established workshop series.
5. Promote publication activities (proceedings, web-proceedings, journal articles and special issues) and common research activities.

Members

In Germany, the Commission currently only comprehends less than 10 members who are active. They come from TU München, TU Dresden and the German Alpine Club (Deutscher Alpenverein).

Activities

With active participation from the group of TU Dresden, the following workshops and meetings have been attended:

12th meeting of the ICA Commission on Mountain Cartography, 5 July 2011, Paris, France

13th meeting of the ICA Commission on Mountain Cartography, 4 September 2012, Mt. Ruapehu, New Zealand

14th meeting of the ICA Commission on Mountain Cartography, 29 August 2013, Dresden, Germany

15th meeting of the ICA Commission on Mountain Cartography, 25 April 2014, Banff, Canada

8th ICA Mountain Cartography Workshop, 1st-5th September 2012, Taurewa, New Zealand

9th ICA Mountain Cartography Workshop, 22-26 April 2014, Banff, Canada

Publications

Maps:

Buchroithner, M.F., Himpel, T. & Uffmann, J. (2013): Shorong / Hinku Trekking Map 5 (Nepal, 1:15 000). Institute for Cartography, Dresden University of Technology. 59 x 84 cm.

Buchroithner, M.F., Himpel, T. & Künkel, H. (2013): Khumbu Himal Trekking Map 2 (Nepal, 1:50 000). Institute for Cartography, Dresden University of Technology. 112 x 80 cm.

Buchroithner, M.F., Kropacek, J., Trültzsch, J., Himpel, T., Hovden, A., Holzer, N., Pieczonka, T., Rosenau, R., Schöley, S. & Schröter, B. (2014): Kailash / Gurla Mandhata Trekking Map 11 (Tibet / Nepal 1:100.000), Insitute for Cartography, Dresden University of Technology.

Wünsche, S., Buchroithner, M.F., Erfert, A. & Schröter, B. (2014): Trekking Map Rio Los Cipreses (Chile, 1:100.000 / 1:25.000), Institute for Cartography, Dresden University of Technology.

Herr, C., Buchroithner, M.F. & Schröter, B. (2015): Travel & Trekking Map San Pedro de Atacama (Chile, 1:350.000 / 1:50.000), 7th edition, Institute for Cartography, Dresden University of Technology.

Herr, C., Buchroithner, M.F. & Schröter, B. (2015): Trekking Map Altos de Teno (Chile, 1:50.000), Institute for Cartography, Dresden University of Technology.

Krüger, R., Buchroithner, M.F. & Schröter, B. (2015) Adventure Map Central Chile & Argentina (1:500.000), Institute for Cartography, Dresden University of Technology.

Krüger, R., Buchroithner, M.F., Pippig, K. & Schröter, B. (2015): Trekking Map Hornopiren / Pumalin / Palena (Chile, 1:350.000 / 1:100.000 / 1:50.000). Institute for Cartography, Dresden University of Technology.

Krüger, R. & Buchroithner M.F. (2015): Trekking Map Huilo Huilo (Chile, 1:50.000). Institute for Cartography, Dresden University of Technology.

Lademann, J. & Buchroithner, M.F. (2015): Laguna del Maule Winter Trails (1:50.000). Institute for Cartography, Dresden University of Technology.

Reisser, K., Buchroithner, M.F., Pieczonka, T. & Schröter, B. (2015): Trekking / Orthophotokarte Nevado Chimborazo (Ecuador, 1:20.000). 2nd Ed., Institute for Cartography, Dresden University of Technology.

Reisser, K. & Buchroithner, M.F. (2015): Trekking / Orthophoto Map Nevado Cotopaxi (Ecuador, 1:20.000). Institute for Cartography, Dresden University of Technology.

Paper:

Neckel, N., Kropacek, J., Bolch, T., Hochschild, V. (2014): Glacier elevation changes on the Tibetan Plateau between 2003 – 2009 derived from ICESat measurements In: Environmental Research Letters 9, Nr. 014009

Pieczonka, T., Bolch, T., Liu, S., Wei, J. (2013): Heterogeneous mass loss of glaciers in the Aksu-Tarim Catchment (Central Tien Shan) revealed by 1976 KH-9 Hexagon and 2009 SPOT-5 stereo imagery In: Remote Sensing of Environment, Nr. 130, S. 233-244

Osmonov, A., Bolch, T., Xi, C., Kurban, A., Guo, W. (2013): Glacier characteristics and changes in the Sary-Jaz River Basin (Central Tien Shan, Kyrgyzstan) – 1990–2010 In: Remote Sensing Letters, S. 725-734

Gardner, A. S., Moholdt, G., Cogley, J. G., Wouters, B., Arendt, A. A., Wahr, J., Berthier, E., Hock, R., Pfeffer, W., Kaser, G., Ligtenberg, S. R. M., Bolch, T., Sharp, M. J., Hagen, J. O., Broeke, M. R. van den, Paul, F. (2013): A Reconciled Estimate of Glacier Contributions to Sea Level Rise: 2003 to 2009 In: Science, Nr. 340, 6134, S. 852-857

Bolch, T., Moholdt, G., Gardner, A., Neckel, N., Pieczonka, T., Holzer, N., Kropacek, J., Berthier, E., Kääb, A. (2013): Variable glacier mass changes in High Mountain Asia 1975 - 2010 In: Proceedings International Symposium on Changes in Glaciers and Ice Sheets: Observations, modelling and environmental interactions, International Glaciological Society (IGS), 28.07-02.08.2013, Beijing, China

Bhambri, R., Bolch, T., Khawishwar, P., Dobhal, D. P., Srivastava, D., Pratap, B. (2013): Heterogeneity in glacier response in the upper Shyok valley, northeast Karakoram In: The Cryosphere, Nr. 7, S. 1385-1398

Basnett, S., Kulkarni, A. V., Bolch, T. (2013): The influence of debris cover and glacial lakes on the recession of glaciers in Sikkim Himalaya, India In: Journal of Glaciology, Nr. 59, S. 1035-1046

Pieczonka, T., Bolch, T., Junfeng, W., Shiyin, L. (2013): Heterogeneous mass loss of glaciers in the Aksu-Tarim Catchment (Central Tien Shan) revealed by 1976 KH-9 Hexagon and 2009 SPOT-5 stereo imagery In: Remote Sensing of Environment 130, S. 233-244.

1.2.4 Law and Geodata

Chair
Dietrich Dietz

Terms of Reference
The Commission on Law and Geodata discusses and publishes legal aspects relevant for the processing and use of geodata. Of high priority are copyright issues, rights of database producers, licence models, competition law, data protection/obligation of privacy, spatial infrastructure and surveying law, internet contract law.
Taking up current developments of legislation or jurisdiction, questions from cartographic institutions or topics from the business of its members the Commission holds discussion and suggests solutions.
The Commission on Law and Geodata is a common Commission of DGfK, DGPF and DVW.

Members
Currently the Commission comprehends 8 members from business, science and public sector.

Projects
The following topics are in the centre of the Commission's activities:
- Which works or geodata are protected either by copyright or by right of database producer?
- Which actions may injure these rights? Which actions are allowed by law (esp. for purpose of education and science)? Preparing and publishing a short guide "Urheberrecht leicht gemacht" for users.
- What are the characteristics of the different licence models?
- What happens if one's own geodata are inserted into open geodata bases (e.g. OpenStreetMap) or if OpenStreetMap data are used for one's own products?
- What are the effects of European regulations (e.g. INSPIRE, PSI) for provision, access and re-use of geodata on the national legislation and practice?
- Which geodata have to be considered as private thus protected by the obligation of privacy?
- In which cases may the obligation of privacy be infringed during the processing and provision of geodata?
- What has to be considered when putting geodata into the internet?
- What has to be considered when providing and selling geodata via the internet?

Publications

Rösler-Goy, M.: Rechtliche Aspekte von Geoinformationen – Harzer GIS-Report 2012/2013.
Rösler-Goy, M.: Eine Landkarte ist eine Datenbank. KN 2013, 1: 33-36.
Diez, D., McCutcheon, E., Rösler-Goy, M.: Geodaten für alle – scheitert dies am Datenschutz? KN 2012, 2: 74-78.
Diez, D.: Urheberrecht und Open Government Data – passt das zusammen? KN 2013, 2/3: 97-99.
Diez, D.: Zum Stand der Rechtsprechung im Recht der Geodaten. KN 2013, 5: 285-286.
Rösler-Goy, M.: Datenschutz und Nutzungsrechte – Leitfaden Mobiles GIS und standortbezogene Dienste, RTGIS 2013.
DGfK (ed.): Urheberrecht leicht gemacht. 2014, 2015, www.dgfk.net/download/Urheberrecht.pdf.

1.2.5 Map Curators

Chair

Wolfgang Crom

Terms of Reference

The Commission of Map Curators is a forum for the exchange of ideas between staff members in map collections of different institutions like archives, libraries, institutes, and museums. It is an open body without a rigid member structure. This means the Commission holds annual meetings at various places. On the one hand, meetings are an information forum for questions about current issues, on the other hand a meeting always has a main topic and according the subject, external speakers are sometimes invited to join the conference. Thus, the meetings often are continuing professional education events.

Members

Currently the Commission comprehends 20 German members plus a number of colleagues from Austria and Switzerland.

Projects

Introduction of the international guidelines Resource Description and Access (RDA), drafting of national standards and training examples for the implementation of the new cataloging instructions.
Further development of the Bibliographia Cartographica towards a better online presentation and visibility, especially regarding electronically available publications. Strengthening of international relations with the aim to improve the data for documenting cartographical literature. A form for external contributors has been put online. The creation of a repository for cartographic material is in preparation.
Improvement of catalogues and search capabilities in map collections. Further standardisation of procedures for the work with cartographic materials, inclusion of geographic coordinates in title information and subject authority files as a basis for graphical search tools.
Exchange of experiences regarding digitisation projects (digitisation, storage, presentation), which frequently are joint projects.

Spreading of Results

- Publication of the results in journals of the library and archive sectors as well as in the KN (Kartographische Nachrichten).
- Participatoin in congresses (national and international) with oral presentations and/or posters.
- Organising of meetings and events.
- Internal working papers.

Publications

Bibliographia Cartographica online: http://bc.staatsbibliothek-berlin.de
Crom, W. (2011): DGfK-Kommission Kartenkuratoren mit der Arbeitsgruppe Bibliographie des kartographischen Schrifttums. Ein Beitrag zu „60 Jahre DGfK “. In: Kartographische Nachrichten, 61, 5, 289 – 291.

1.2.6 Cartography and Research

Chair
Jochen Schiewe

History
Since 2010 the Commission on "Cartography and Research" provides a platform within DGfK for persons from universities, public authorities and companies, who are active in cartographic research and want to make this visible to an international community. In order to express the desired networking aspect in German speaking countries, members from Austria and Switzerland are explicitly invited to participate in this Commission..

Terms of Reference
General goal of the Commission on „Cartography and Research" is to monitor and to foster cartographic research on an international level, in particular by the following actions:

- Propagating and promoting the scientific positioning of Cartography and its self-conception to be the responsible discipline for the communication of spatial data;
- Promoting the exchange over a huge bandwidth of current research topics and initializing research co-operations;
- Developing and promoting networks with other disciplines;
- Strengthening of international networking and improving the international visibility of Cartography in German speaking countries.

Board
The activities of this Commission is guided by a group which consists of Prof. Dr. Doris Dransch (Potsdam), Prof. Dr. Sara Fabrikant (Zurich), Prof. Dr. Georg Gartner (Vienna), Dr. Ernst Jäger (Hannover), Prof. Dr. Jochen Schiewe (Hamburg) and Prof. Dr. Monika Sester (Hannover). Prof. Schiewe acts as chair of the Commission.

Activities since ICC 2013
In October 2012 the Commission organized the Workshop "Map creation from user generated data" in Hannover. As a follow-up, a round table talk (funded by the German Research Foundation, DFG) developed this topic in more detail. Finally, these activities led to a proposal for the DFG Priority Programm "Volunteered Geographic Information: Interpretation, Visualization and Social Computing". In the meantime this proposal has been accepted so that this bundle project (with about 15 single sub-projects) will start in 2016.
In March 2014 the Commission organized the Young Scientists Workshop "Application of empirical methods in Cartography" in Hamburg where six in-depth presentations were given and discussed.
Finally, in January 2015 the Commission was involved in the Workshop „2015 GeoViz_Hamburg – Supporting Decision making through geovisualization: A view from different perspectives". In a small auditorium interesting talks given by Jochen Schiewe, Alexander Klippel, Alan MacEachren, Sara Fabrikant, Liqiu Meng and André Skupin were intensively discussed.

Further information: www.visualisierung.dgfk.net

1.2.7 3D City Models

Chair
Ekkehard Matthias and Bettina Petzold (for DGPF)

Terms of Reference
The Commission represents the first common Commission of DGfK together with the German Society for Photogrammetry, Remote Sensing and Geoinformation (DGPF). It is devoted to the methods for acquisition, storage, presentation and usage of three-dimensional geographic objects and the applied techniques and conveys those to interested individuals by means of workshops and lectures.

Members
Members from industry, commerce, authorities and science make sure that a wide range of topics with a relation to 3D city models is represented. Currently the Commission comprehends 22 members including one Swiss. The regional distribution of the members reflects the German „3D landscape" very well.

Projects / Activities
In November 2014 the 6th international workshop held in German language dealt with exemplary cases employing different acquisition and up-dating methods for 3d objects, the retaining and description of the quality of 3D city models, application examples, clarification and advertising of the use of 3D city models, database techniques for storage and management incl. the CityGML standard as well as existing services.
Commission Members participated in various events and spread and fostered the topic of 3D city models.
The Commission holds a meeting at least once a year, in June 2015 e.g. at the Technical University of Munich in Bavaria, and arranged a competition for students in 3D applications.

Publication
In 2014 the Commission launched a brochure about the possibilities of usage of 3D City Models together with InGeoForum.

Preview
For 4/5 November 2015 currently a workshop at the University of Bonn is in preparation. It will, again, include topics concerning other Central European countries.

Further Information: www.3d-Stadtmodelle.org

1.2.8 History of Cartography

No report submitted.

2 Cartographic Activities of Authorities

2.1 Bundesamt für Kartographie und Geodäsie (Federal Agency for Cartography and Geodesy)

The Federal Agency for Cartography and Geodesy deals with the authoritative Topographic Cartography of Germany.
The creation and management of geotopographical data for Germany including the topographic map series in Germany is traditionally the responsibility of the 16 Laender of the Federal Republic of Germany and is part of official surveying and mapping. The authorities provide the government, industry and private users with the topographic georeference data for the national territory based on an official spatial reference system in a standardised and platform-neutral way. While the surveying authorities / agencies of the Laender are responsible for managing the topographic georeference data in the Laender, the provision of corresponding analogue and digital topographic data at the federal level is within the responsibilities of the Federal Agency for Cartography and Geodesy (BKG) under the Federal Ministry of the Interior.
Printed topographic maps have been the primary product of official topographic cartography but became less important with the introduction of digital communication. Nowadays the demands of the information society have changed almost totally to spatial data in digital formats as a component of a national spatial database. The Working Committee of the Surveying and Mapping Authorities of the Laender of the Federal Republic of Germany (AdV) has reacted in good time to this development with the setting up and management of the **A**mtliches **T**opographisch-**K**artographisches **I**nformations-**s**ystem (Authoritative Topographic-Cartographic Information System) (ATKIS®, Figure 1) and is

providing standardised topographic georeference data nationally for establishing the national spatial database in the Spatial Data Infrastructure in Germany.

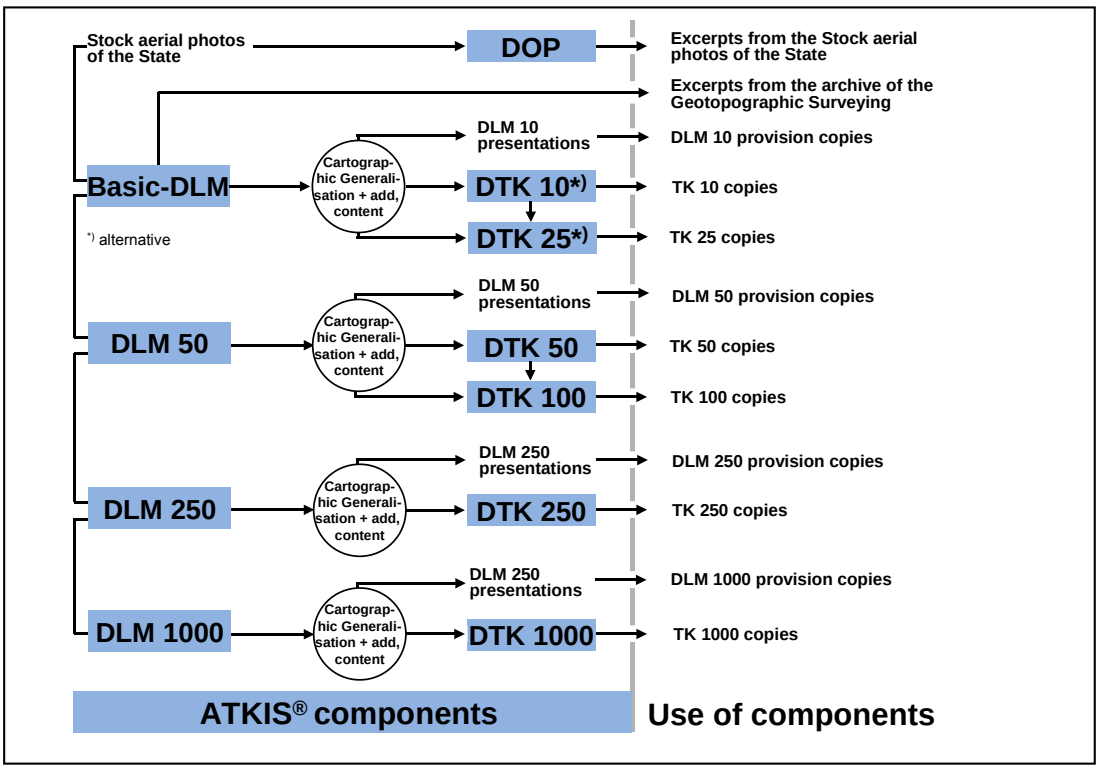


Figure 1: ATKIS® components

2.1.1 Spatial Data Infrastructure in Germany

The Spatial Data Infrastructure Germany (GDI-DE) is a joint project of the Federal government, Laender and local authorities.
Decisions in administration, economy and politics are more efficient using the network of spatial data conveying by the GDI-DE. Tasks of the GDI-DE are the inspection of national developments as well as integrating the developments in a European (INSPIRE) and global scope (GSDI, GEOSS).
In order to ensure the collaboration of the Federal government, the Laender and the local authorities, a Steering Committee (LG), composed of representatives from the Federal government, Laender and local authorities, has been set up as a strategic decision committee. The activities of GDI-DE are supported by a permanent coordination office (KSt). The Coordination Office cooperates within a network with the contact points established at the Federal Government and the Laender. The LG GDI-DE reports to the IT Planning Board (***IT-Planungsrat***), the control body for federal cooperation in the field of information technology.
The tasks of the GDI-DE include the recommendation and evaluation of standards, the operation of central components such as the Geoportal.de, and the coordination of activities related with the INSPIRE Directive in Germany.

2.1.2 ATKIS® Digital Landscape Models Components (DLM)

The basic DLM is the geotopographical basis for the derivation of the DLM50, DLM250 and DLM1000 small scale digital landscape models and for the derivation of the digital topographic maps to be created with new map graphics. The basic DLM has been introduced gradually. In 2010 it was finalized for the entire country with more than 120 topographic feature types. Now frequent update cycles ranging between a few months and one year are established for important topographic data such as transport network and administrative units in particular, to ensure provision of up-to-date

information. For topographic features with a high demand on spatial accuracy the quality of position is achieved at +/- 3 m in the base DLM, +/- 15 m in DLM50, +/-100 m in DLM250 and +/- 250 m in DLM1000.
In the course of the "**ATKIS®** Generalisation" project, under the control of the Surveying Authorities of yet 12 Laender supporting the project, the prerequisites have been created for being able to derive the DLM50 in an automated way from the basic DLM using model generalisation. With this geotopographical database a widely available digital landscape model standardised for Germany is ready, which shows a more simple structure and a lower amount of data as compared with the basic DLM, so that it is particularly suitable as basis for computer supported analyses and for location based services (LBS) or for the calculation of routes and for applications at the federal administrations level. Over the recent years major progress has been achieved with the introduction of automated map generalisation procedures for the production of an intermediate data set to serve as data source for the DTK50 with minimized manual interaction. The tools are now almost fully operational.
The DLM250 and the DLM1000 processed in the BKG are available for the entire country and updated annually. They serve as a data source for the EuroGeographics products EuroRegionalMap and EuroGlobalMap. The contents are continually extended to allow for linking the DLM with other data such as gazetteer and hydrological data.
The digital landscape models can only meet the requirements if a high up-to-dateness of information can be ensured. The surveying authorities of the Laender and the BKG constantly endeavour to improve the currency of the topographic data. In doing so, they are primarily setting up a close co-operation with the parties responsible for the topographical changes using advanced methods of information technology and also using photogrammetric and computer-controlled terrestrial reconnaissance systems. Furthermore the satellite imagery are evaluated for their potential in updating the topographic data.

2.1.3 Digital Terrain Model (DTM)

The Laender are establishing DTMs in parallel with the DLMs and are providing these with different degrees of accuracy and abstraction. Initial production of the data sets is based on laser scanning. Update of the data sets is performed as required using photogrammetric methods. As well as regularly distributed geodetic points, the DTMs usually contain vector structure elements in the form of terrain form lines and particular terrain points. As a result of the automated harmonisation of the currently available DTMs in the Laender with the BKG, a homogeneous DTM with a terrain-type dependant height accuracy of at least 2 m and a grid width of 10 m is available for the Federal Republic of Germany which is distributed by the Zentrale Stelle Geotopographie (ZSGT) at BKG. Since 2014 a Digital Terrain Model at high accuracy with a grid of 5 m (DGM5) is available at all Laender. Most Laender provide even better data with a DGM2 or DGM1, or are about to create such data.

2.1.4 Digital Topographic Maps (DTK)

On the basis of the already available digital landscape and terrain models, the surveying authorities of the Laender produce the official topographic map series with new map graphics, documented in the ATKIS® portrayal catalogues. Digital topographic maps (DTK) at scales of 1:10 000 and 1:25 000 are already achieving a high profile in the product range of the surveying authorities of the Laender. For the map products at scales 1:50 000 and 1:100 000 (DTK50 and DTK100) the Laender and the Federal Armed Forces have agreed on a joint civil-military map series to avoid duplication of work. The DTK50 has been produced according to the ATKIS® portrayal catalogue in most Laender. Great importance is attached to a high degree of automatisation in production and revision processes, with manual interaction being minimized. This applies to the DTK100 as well. For the DTK100 the full coverage of Germany was achieved by the year 2012. The map series DTK250 and DTK1000 are produced at the BKG. The DTK250 has been finalized for the German territory in 2014 and replaces the former map series 1:200 000 which is now discontinued

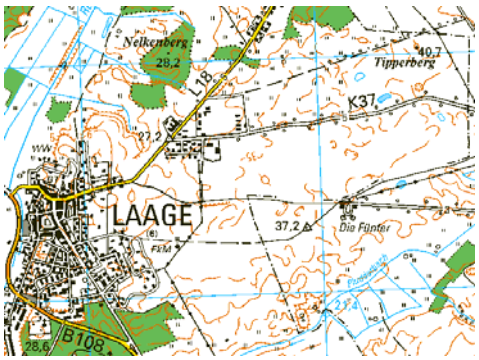
As long as some topographic map series are not fully available at the map graphics defined by the ATKIS® portrayal catalogues, the previous scanned maps may remain at offer. The update of the traditional maps will be discontinued with the introduction of the new DTK. Figure 2 shows a direct comparison of the previous and current topographic map series.

topographic map at scale 1:10 000

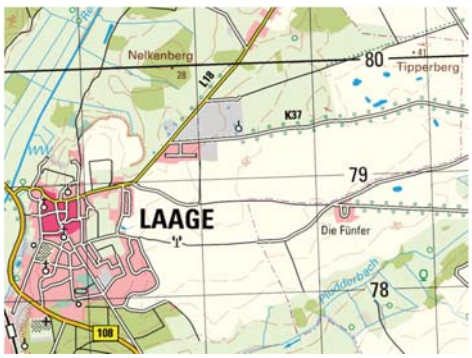
digital topographic map at scale 1:10 000

topographic map at scale 1:25 000

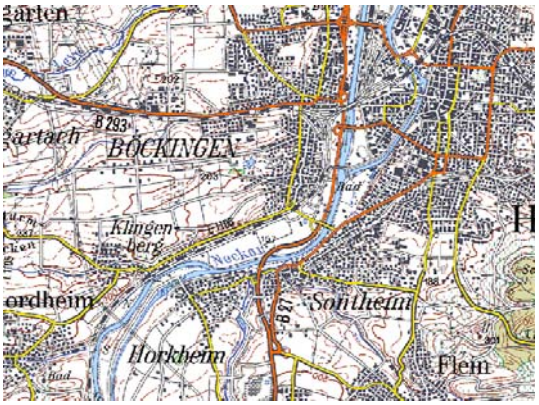
digital topographic map at scale 1:25 000



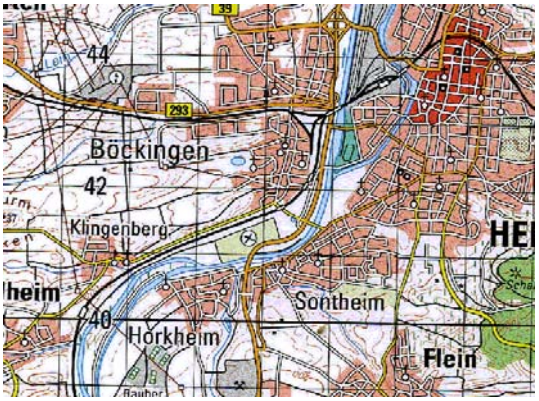
topographic map at scale 1:50 000



digital topographic map at scale 1:50 000



topographic map at scale 1:100 000

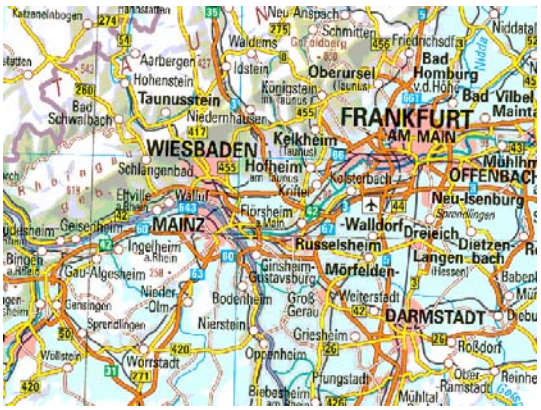


digital topographic map at scale 1:100 000

topographic map at scale 1:200 000

digital topographic map at scale 1:250 000

topographic map at scale 1:1 000 000



digital topographic map at scale 1:1 000 000

Figure 2: Map graphics of the previous and future topographic map series

2.1.5 AFIS®-ALKIS®-ATKIS® Project

Starting from an analysis of the developments on the geodata market and the future requirements for official spatial databases resulting from this, the AdV has achieved a standardised modelling of its real estate cadastres' databases, the geodetic spatial reference and the geotopography. It has developed the common AFIS®-ALKIS®-ATKIS® (AAA®-)data model for this. AFIS® stands for **A**mtliches **F**estpunkt-**i**nformation**s**ystem (Authoritative Fixed Point Information System) and ALKIS® for **A**mtliches **L**iegen-schafts**k**ataster**i**nformations**s**ystem (Authoritative Real Estate Cadastre Information System). The complete project is documented in GeoInfoDok and is available at www.adv-online.de. The migration of the available databases to the AAA® data model has been started, and is already completed in some Laender. For the ATKIS®-DLM full coverage was achieved by mid 2013. For AFIS® and ALKIS® the migration is expected to be completed by end of 2015 or early in 2016. Then all georeference data of Germany will be available in a uniform model according to standardized rules for the first time. The implementation of the ETRS89 location reference system in combination with the UTM mapping is intended in direct connection with the implementation of the AAA data model.

2.1.6 WebAtlasDE

The need for official map services among various kinds of user has risen dramatically in recent years. In addition to good performance, “continuous” zooming, high availability, provision in the viewer and as a service, font and signature adjustment at every scale level, a simple, standardised map style and a provision throughout Germany and across the Laender are expected.
DLM and DTK were unable to fully meet these requirements. Based on the activities of some member administrations, in 2012 a common web-based map service was implemented by the Federal government and the Laender under the name “WebAtlasDE” which was already been linked in the Federal and Laender geoportals. From the digital landscape models, grid map tiles of various scales are created and provisioned via a Web Map Tile Service (WMTS) with good performance and high reliability.
In particular, the complete representation of all buildings available in the real estate cadastre, including their house numbers and periodic comprehensive update of geotopographic data similar to the DLM updating are unique features of the WebAtlasDE.

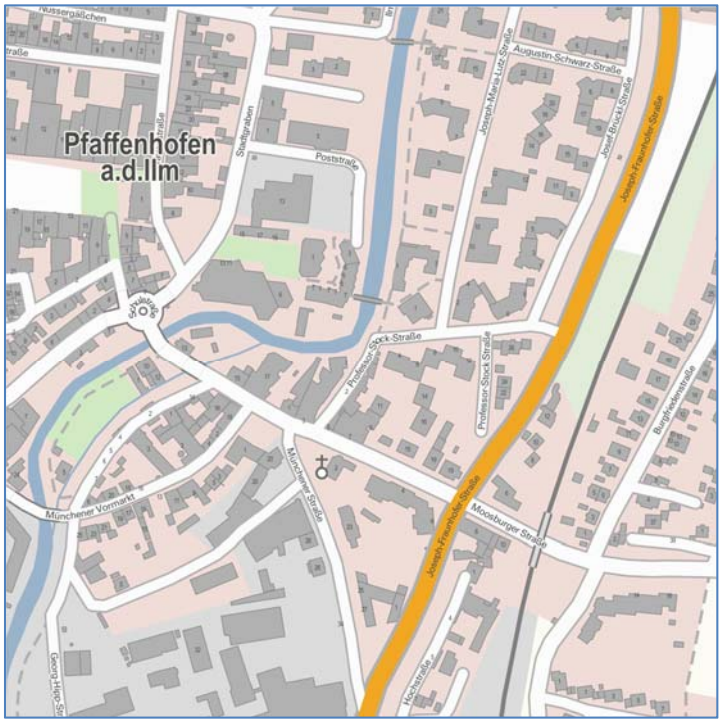


Figure 3: WebAtlasDE at zoom level 10

2.1.7 Toponymy

The „**St**ändiger **A**usschuss für **g**eographische **N**amen“ (StAGN) (Permanent Committee on Geographical Names) is the independent scientific body responsible for the standardization of geographical names in the German-speaking area. The office of the StAGN is located at the Federal Agency for Cartography and Geodesy (BKG) in Frankfurt am Main. Of great importance is international cooperation, especially with the United Nations Group of Experts on Geographical Names (UNGEGN), which comprises a Dutch- and German-speaking Division (DGSD). Information about the StAGN and a link to UNGEGN are available at www.stagn.de.

2.1.8 Data Utilisation

Together with the traditional provision of official geotopographical information via printed media, the use of digital topographical data has established itself in administration and the economy. Modification of the data and sales structure in the surveying authorities of the Laender has also been set up. As well as the provision of geotopographical data on data carriers, Web based applications are achieving a higher profile and geodata, metadata and geoservices are being provided via Web portals and Web shops of the Laender.
Based on the knowledge of necessary harmonisation also in the provision of geospatial reference data via Web technologies and building on the Web profiles for representation and download services created technically neutral by the AdV in the area of geotopography, in a similar manner to developments in the real estate cadastre, designs for product specifications on ATKIS®-DLM-WMTS (Web Map Tile Service), ATKIS®-DLM-WMS (Web Map Service) and ATKIS®-DLM-WFS (Web Feature Service) have been created.
The ATKIS® digital landscape and terrain models and the digital topographic maps are provided throughout Germany in a harmonised form via the Zentrale Stelle Geotopographie (ZSGT) established in the BKG in collaboration with the Laender. The Web portal of this geodata centre, www.geodatenzentrum.de, presents interactive maps for direct access to the database, standardised map services, online coordinate transformations, testing data for download as well as technical information and aids. Linked with the Web portals and Web shops of the Laender, the meta information system gives information about the availability, features and contact persons of the products. The system is established and maintained in conformance with the international standard ISO 19115. Data research and networking of different meta information systems using international data exchange standards and services will thus be even better supported.

2.1.9 European Collaboration

EuroGeographics (EG), the association of the European national mapping, land registry and cadastral agencies has set itself the primary objective of setting up the reference data (geodetic reference networks and geobasis data) for a European Spatial Data infrastructure, with a focus on the interoperability of reference data.
The AdV is sustainably supporting this objective, in particular via contributions from the BKG. The BKG has been active in the framework of EuroGeographics for more than 15 years as project co-ordinator for the EuroBoundaryMap product, a pan-European data set of administrative boundaries at the municipality level, produced from contributions of the European mapping agencies. For EuroGeographics’ topographic reference data sets at medium scale (EuroRegionalMap, 1:250 000) and small scale (EuroGlobalMap, 1:1 000 000), the BKG is contributing the data of the German national territory and is involved in harmonisation of the data.
Further to the contributions from German authorities to EuroGeographics, there is active participation in numerous European activities such as, for example, INSPIRE and Copernicus. The primary goal for this collaboration of the national authorities in Europe is the creation of harmonised specifications for European geodata.

Further information: www.adv-online.de; www.bkg.bund.de

2.2 The Bundeswehr Geoinformation Office (Federal Armed Forces Geoinformation Office)

When meeting the requirements for GeoInfo data and products relating to the German territory, the Bundeswehr Geoinformation Centre relies almost completely on the data of state and federal authorities. The interests of the Bundeswehr are represented in the Working Committee of the Surveying Authorities of the States of the Federal Republic of Germany (German abbreviation: AdV). AdV membership allowed publication of the 1:50,000 and 1:100,000 joint civil-military map series, among others. There is no proprietary map production for the Federal territory but for training area and special-purpose maps.
For the international sphere and mission-relevant areas, products are generated in accordance with international standards harmonised with nations from NATO (North Atlantic Treaty Organisation) and the EU (European Union).

2.3 Bundesamt für Seeschifffahrt und Hydrographie, BSH (Federal Maritime and Hydrographic Agency)

2.3.1 Cartographic Responsibilities and Activities of BSH

BSH is responsible for the production and issuing of official nautical charts. It presently produces about 66 charts covering the German waters of the North and Baltic Sea. The production is based on the cooperation of national hydrographic services under the umbrella of the International Hydrographic Organisation (IHO) and takes advantage of the system of International Charts coordinated by IHO.
In addition, BSH is responsible for producing the so called Electronic Navigational Charts (ENCs) for German waters (155 cells), using the IHO Transfer Standard for Digital Hydrographic Data, referred to as S-57. These official ENCs, and their regular electronic updates, are for the onboard use on an Electronic Chart Display and Information System (ECDIS). They are Germany's contribution to the World-wide ENC Database (WEND) coordinated by IHO and distributed by Service Providers appointed to the International Centre for ENCs (IC-ENC) based in United Kingdom. Printed nautical charts and ENCs are produced by BSH and other hydrographic services worldwide to satisfy the carriage requirement for ships according to the International Convention "Safety of Life at Sea" (SOLAS) of the International Maritime Organisation (IMO) and are part of a comprehensive nautical information system comprising charts, nautical books and the regular update services "Notice to Mariners".
BSH licenses its cartographic products for commercial reuse by private companies.

2.3.2 Important cartographic products and projects

Products (see above):

- Official nautical charts for professional shipping and small craft
- Notice to mariners, a printed weekly bulletin for keeping nautical charts and publications up-to-date
- Official Electronic Navigational Charts (ENCs) including weekly electronic up-dates
- Vessel Traffic Services Guide North Sea and Baltic Sea
- WMS chart services based on ENCs as part of the national geodata infrastructure (GDI) accessible via www.geoseaportal.de

Projects:

- Electronic Sailing Directions
- Three charts of Antarctic waters according the commitment of Germany within the framework of the international Antarctic Treaty.

2.3.3 New Developments

The "Hydrographic Production Database" (HPD) is currently being introduced into the BSH production environment is based on the IHO S-57/S-100 standard (see below) and forms the core element of a fully integrated digital work flow from processing of survey data and other relevant sources down to final cartographic products in either printed or digital form..

2.3.4 International Cooperation

All hydrographic services cooperate under the International Hydrographic Organisation and its Regional Hydrographic Commissions (RHCs). Relevant for BSH are the North Sea Hydrographic Commission and the Baltic Sea Hydrographic Commission. BSH has also observer status in other RHCs, depending on varying requirements, such as bilateral projects. BSH cooperates also, within the framework of IHO, in the development of standards related to hydrography. A particularly important one is the development of the IHO Universal Hydrographic Data Model, referred to as S-100. S-100 came into force on 1 January 2010. S-100 is the document that explains how the IHO will use and extend the ISO 1900 series of geographic standards for hydrographic, maritime and related issues. S-100 extends the scope of the existing S-57 Hydrographic Transfer standard. Unlike S-57, S-100 is inherently more flexible and makes provision for such things as the use of imagery and gridded data types, enhanced metadata and multiple encoding formats. It also provides a more flexible and dynamic maintenance regime via a dedicated on-line registry.
S-100 provides the data framework for the development of the next generation of ENC products, as well as other related digital products required by the hydrographic, maritime and GIS communities.

2.4 Bundesanstalt für Geowissenschaften und Rohstoffe (Federal Institute for Geosciences and Natural Resources)

2.4.1 Activities of BGR and its cartographic responsibilities

The Federal Institute for Geosciences and Natural Resources (BGR) is the central geoscientific authority providing advice to the German Federal Government in all geo-relevant questions. It is subordinate to the Federal Ministry for Economic Affairs and Energy (BMWi).
As a federal institution the BGR is responsible for maps and map products at a scale of 1:200,000 to 1:5,000,000 and smaller. The maps are available in printed or plotted form or as digital data sets. Large-scale maps and information can be found at the state geological surveys (SGD) of the respective federal states.
Geological information made available by the BGR includes a wide range of both national and international geological maps and spatial data. In addition to general geological maps (Germany, Europe, etc.) also specialized thematic maps and map series are available. BGR publishes official German maps (on-line, digital and on paper) on geology, mineral resources, groundwater and soils mainly in the scales 1:200,000 and 1:1,000,000. Thematic maps covering Europe and produced in European cooperation are published at scales of 1:1,5, 1:2,5 and 1:5 Million and smaller.
Also in projects of technical cooperation (TZ) thematic maps are produced at different scales, financed by the Federal Ministry for Economic Cooperation and Development (BMZ). Also in geoscience research projects BGR participates in producing thematic maps of various scales and subjects.

2.4.2 Important official national maps

2.4.2.1 Maps at a scale of 1:200,000

The geological (GÜK200), hydrogeological (HÜK200), soil (BÜK200) and mineral resources (KOR200) maps at a scale of 1:200,000 are compiled in close cooperation with the German State Geological Surveys (SGD). Each map series consists of > 50 map sheets covering an area of 357.022 square kilometres.

- *Geological Overview Map of Germany, Scale 1:200,000*
  The map series “Geological Map of Germany 1:200,000” (GÜK200) presents the result a of long cooperation (since 1964) between the German State Geological Surveys (SGD), neighbouring countries and the Federal Institute for Geosciences and Natural Resources (BGR). The GÜK200 represents the near-surface geology of Germany and provides information on stratigraphy, genesis and petrography of the individual geological units. As part of the ongoing work at BGR, semantic and geometric disharmonies between the map sheets are in the process of being dissolved. As a result, at a later stage each geological unit will be described and portrayed consistently for the whole of Germany and the current 55 individual map sheets will be available as one seamless map.

Also, the harmonized GÜK200 data are going to be transformed according to the Data Specifications of the European INSPIRE Directive INSPIRE-Guidelines so that INSPIRE-compliant datasets can be downloaded.
For the time being the 55 map sheets of the GÜK200 are digitally accessible via the BGR Geoviewer (http://geoviewer.bgr.de) and available as WMS (Web Map Service) and in various download formats (e.g. ESRI Shape) via the "BGR Produktcenter" (http://produktcenter.bgr.de).

- *General Hydrogeological Map of Germany, Scale 1:200,000*
  Since the middle of 2001 and in order to implement the guidelines of the European Parliament and Council of the European Union for the creation of an administration framework for Community action in the field of water policy (EU – Water Framework Directive/EU-WFD), the German State Geological Surveys (SGD) and BGR have agreed to produce a digital general hydrogeological map at a scale of 1:200,000 (HÜK200) that encompasses all German federal states. The aim is to record the hydrogeological characteristics of rocks in the upper aquifers and to provide a modern hydrogeological survey of the groundwater bodies in Germany.
  For this it was agreed to capture a series of hydrogeologically relevant characteristics such as consolidation, type of porosity, permeability, type of rock, type of aquifer and geochemical classification. This information is based on the mapping units of the Geological Overview Map (GÜK200) and is derived by assigning hydrogeological attributes to geological units as delineated by the SGD1 offices. In this way the uppermost aquifers are characterised. The data are stored in a geographic information system (GIS) and are being processed with the GIS software ArcInfo. BGR, in agreement with the German states, has set up a coordination and data centre. At present version 3 providing a seamless dataset is processed. An online visualisation is available; as are data of the individual map sheets.

- *The 1:200,000 Soil Map of Germany*
  The 1:200,000 Soil Map of Germany (BÜK200) is a seamless, harmonised dataset for the whole of Germany, compiled by BGR and the sixteen SGD. The coverage is about 90 % by July 2015, and completion is under way. The sheet-wise explanations are amalgamated to a general legend. A database with representative soil profiles comes along with the soil map, and both together represent the most important data component of the Soil Information System of the Federal Institutes for Geosciences and Natural Resources (FISBo BGR).
  In addition to the digital and currently updated version, 50 map sheets have been printed after their completion.. Although the dataset does not yet cover the whole country, first derived maps will be published in 2016, e.g. about thermal conductivity of the soil.

- *Map of the Near-Surface Mineral Resources of Germany, Scale 1:200,000*
  Since 1986 the "Map of the Near-Surface Mineral Resources of the Federal Republic of Germany, Scale 1 : 200 000 (KOR200)" has been published sheet by sheet. The objective was and is to provide a nationwide documentation, presentation and description of deposits and occurrences of mineral resources according to standard criteria. By now 46 map sheets are available as printed edition. The maps are showing those mineral resources that are predominantly extracted from open-pit mines or from near-surface underground workings. These resources include industrial minerals, construction materials, peat, lignite, oil shale and brine. Each map sheet is accompanied by comprehensive explanatory notes.

2.4.2.2 Maps at a scale of 1:1,000,000

- *Geological Map of Germany, Scale 1:1,000,000*
  The Geological Map of Germany at the scale of 1:1,000,000 (GK1000) presents the geology of Germany and its adjacent countries on a single map sheet. The geological units are shown as mainly stratigraphical units with additional information on lithology and genesis.
  The GK1000 map was first published in 1973; in 1993 the fourth edition, compiled using a GeoInformation System (GIS), was published as a paper map and also included the area covered by

the former German Democratic Republic. Together with the General Soil Map of Germany, Scale 1:1,000,000 (BK1000) and the Map of Mineral Resources of Germany, Scale 1 : 1,000,000 (BSK1000), the GK1000 presents the BGR map series at the scale 1 : 1,000,000.
The geological information of the GK 1000 is the basis for the German contribution to the EU project OneGeology-Europe and the global OneGeology project.

- *General Soil Map of Germany, Scale 1:1,000,000 (BK1000)*
  The national soil map 1:1,000,000 (BÜK1000) has been produced shortly after the reunification of the two German states and thus represents the only complete nation-wide soil map. It was compiled on the basis of published soil maps of the former German Democratic Republic and the pre-1990 federal states of Germany. The map contains 72 soil mapping units in 12 soil regions, described in a detailed legend on the basis of the German and FAO soil classification systems. The legend contains typical soil profiles and selected attribute data for the dominating soils of each mapping unit. The map was published in 1995. Its digital version is part of the spatial database integrated into the FISBo BGR Soil Information System. The digital version is also provided through the web mapping service (WMS) of BGR. In 2014, the following maps were published that were derived from BÜK1000:
  - Potential soil erosion risk of water erosion on arable soils in Germany, 1:1,000,000
  - Potential soil erosion risk of wind erosion on arable soils in Germany, 1:1,000,000
  - Yield potential of arable land in Germany according to the Müncheberg Soil Quality Rating, 1:1,000,000.

- *The Map of Mineral Resources of Germany, Scale 1:1,000,000 (BSK1000)*
  The Map of Mineral Resources of Germany 1:1,000,000 (BSK 1000) provides the basic information about the spatial distribution of these commodities all over the country. The mineral resources are summarized in commodity groups, represented as different colored units. They range from energy commodities via "stones and earth" - these are especially mineral raw construction materials - up to the industrial minerals and ores.
  The back of the map also contains information about the definition, development, important resources, use and economic importance of all commodities shown.
  The map was compiled by BGR in cooperation with the German State Geologial Surveys (SGD).

2.4.2.3 Maps at other scales

- *Soil map of Germany, Scale 1:2,000,000*
  The soil map 1:2,000,000 of Germany (BÜK2000) is based on the General Soil Map of the Federal Republic of Germany 1:1,000,000 (BÜK1000). The map contains 61 soil mapping units which are derived based on aggregation principles. This map is published in the Hydrogeological Atlas of Germany (HAD). Based on BÜK2000, a comprehensive soil atlas of Germany with maps at a scale of 1:3,000,000 and smaller on soil forming factors, soil properties, potentials and threats will be published by the end of 2015 as a printed version with 48 maps and a digital version on the web with more than 100 maps (www.bodenatlas.de).

- *Map of Mining Industries, Storage and Deposition Sites, Scale 1:2,000,000*
  Since 1967 BGR in cooperation with the mining authorities of the states of Germany the Map of Mining Industries, Storage and Deposition Sites, Scale 1:2,000,000 is released annually. The map contains information to the extracted material, amount, and number of sites in operation. Since 2002 the map is released exclusively via Internet.

- *Maps for the Hydrological Atlas of Germany*
  The Hydrological Atlas of Germany (HAD) is the work of cooperation between the major German institutions in the fields of hydrology, meteorology, geoscience and environmental protection and the German Federal States. BGR is contributing to this project since 1995 and provides geological, hydrogeological and soil maps and expertise. The atlas is published both as a conventional graphic atlas and as a digital version.

The following thematic maps at the scale of 1:2,000,000 have already been realised by BGR:
- Soils
- Lithology
- Hydrogeology
- Depth of the Effective Root Zone
- Field Capacity up to 1 m Soil Profile Depth
- Available Water Capacity in the Effective Root Zone
- Air Capacity in the Effective Root Zone
- Mean Annual Rate of Percolation from the Soil
- Hydrogeological Regions
- Groundwater Yields
- Mean Annual Groundwater Recharge
- Geogenic Groundwater Quality
- Mineral Water, Thermal Water and Medical Water

- *Map of Soil Regions and Great Soilscapes of Germany 1:5,000,000*
  The map of Soil Regions and Great Soilscapes of Germany 1:5,000,000 (BGL5000) has been collated during the preparation of the Soil map of Germany 1 : 200 000. Soil regions were defined based on geology and relief, while great soilscapes were delineated using soil material information, water regime, relief and macroclimate.

- *Map of Soil Parent Material of Germany 1:5,000,000*
  The map Soil Parent Material of Germany 1:5,000,000 (BAG5000) provides the basis for maps on heavy metal background values (natural and diffuse contamination). It has been derived from the General Soil Map 1:1,000,000 (BÜK1000) and statistical analyses based on analytical values from soil profiles from the whole country.

2.4.3 Maps in European and international cooperation

- *International Geological Map of Europe and the Mediterranean Regions, Scale 1:1,500,000*
  The International Geological Map of Europe and the Mediterranean Regions, scale 1:1,500,000 (IGK1500) consist of 45 map sheets covering Europe and neighbouring countries in Africa and Asia. The map was published partially as 2nd and 3rd edition and was completed in the period between 1964 and 2000. The map is the product of close cooperation between BGR and the Geological Surveys of the concerned countries with support by UNESCO. The decision to compile this map was done on the occasion of the 2nd International Geological Congress in 1881 in Bologna (Italy).

- *International Hydrogeological Map of Europe, Scale 1:1,500,000*
  The International Hydrogeological Map of Europe, scale 1:1,500,000 (IHME1500) consists of 27 map sheets including explanatory notes covering the European and parts of the Asian continent. The national contributions are compiled under the aegis of the International Association of Hydrogeologists (IAH) with the commission for hyrogeological maps (COHYM). The project is supported by the Commision of the Geo-logical Map of the world (CGMW). The edition of the map is supported by BGR and UNESCO. The map and digital dataset have been completed in 2014.

- *International Quaternary Map of Europe, Scale 1:2,500,000*
  The International Quaternary Map of Europe, scale 1:2,500,000 (IQuK2500), was published on paper during the period 1967 to 1995 by BGR in cooperation with the UNESCO, Paris and International Union for Quaternary Research (INQUA). The map shows the Quaternary landform features, including end moraines, ground-moraine hillocks, kames, drumlins, eskers and ice limits, and also those resulting from ice movement, limits of marine transgressions and tectonic faults. Important key localities for Quaternary research, bathymetric lines and sea-floor deposits, are also indicated. The Quaternary geological units are represented by a combination of age, genesis and lithology. The map consists of 14 map sheets that cover Europe, together with a special legend sheet (explanation given in German, English, French and Russian).

- *Review, digitization and new edition (IQUAME 2500)- International Quaternary Map of Europe 1:2,500,000*
  BGR began reviewing, reworking and digitising the paper map in order to build a geographic information system (GIS) of the Quaternary geology of Europe in 2011, through international cooperation, and under the umbrella of the Commission of the Geological Map of the World (CGMW) and supported by INQUA. The Quaternary information is planned to be compatible with the already existing GIS of the 1 : 5 million International (pre-Quaternary) Geological Map of Europe and Adjacent Areas (IGME 5000, see below) so that the information in each layer can be combined, selected and cross-referenced.
  The IQUAME 2500 GIS and map will contain digital information concerning:
  - the geological boundaries and classifications of the Quaternary rocks, both unconsolidated sediments and bedrock, including young volcanic extrusions,
  - the extension and boundaries of permafrost,
  - the last glacial maxima,
  - active faults,
  - submarine exhalations (this is not English - reject!) of gas hydrates (cold seeps),
  - geomorphology/landforms,
  - submarine currents and their impact on the ocean floor etc.
  - Key localities of significance.

  To facilitate the review, all contributors will receive the same base material and guidelines with complete instructions on how to undertake the review, add new information and how to convey the information to BGR. The work is carried out in cooperation with by over 25 geological surveys and similar organizations throughout Europe, with support of an advisory board of leading international scientists. The complete map is planned to be presented at the 15th INQUA Congress to be held in Dublin in 2019.

- *The 1:5 Million International Geological Map of Europe and Adjacent Areas (IGME 5000)*
  The International Geological Map of Europe and Adjacent Areas was published 2006 as paper map and web mapping application. It is a result of the IGME5000-GIS-project of the BGR under the umbrella of the Commission of the Geological Map of the World (CGMW). Its aims were to build up a Geographic Information System (GIS) on Europe's pre-Quaternary geology, to print a map in consideration of high standards in scientific and cartographical aspects, and to implement a web mapping application.
  In this project 48 active European and non-European geological services have been involved. It was supported by a network of academic advisors from European and northern American universities and scientific institutes. Special scientific research
  The IGME 5000 displays the pre-Quaternary geology of Europe onshore and –for the first time at this scale- also offshore.
  In addition to the geology – attributed by age, petrography and genesis – also magnetic anomalies, tectonic structures, the continent-ocean boundary, metamorphism, oceanic crust information and bathymetric lines are being provided. The GIS IGME5000 as well as its web map application allows manifold cross-national queries over whole Europe.

- Soil Regions Map of the European Union and Adjacent Countries 1:5,000,000 (EU SR5000 *Version 2.0)*
  The "Soil Regions Map of the European Union and Adjacent Countries" is a joint project of the European Soil Bureau Network (ESBN) and the Joint Research Centre (Ispra, Italy), coordinated and realized by the Federal Institute for Geosciences and Natural Resources (BGR). As a basic component of the project "Georeferenced Soil Database for Europe" it is part of the Manual of Procedures intended to support better harmonized soil mapping at the scale 1:250,000.
  Existing maps as well as soil information provided by the European partners were interpreted by using uniform delineation criteria (WRB classification). In the map 285 soil regions and 35 climate areas are distinguished, as well as undifferentiated Fluvisols, Anthrosols and urban soils. The map

units are stratified using combinations of about 120 different soil associations and eighteen different parent material associations. Whereas in the map legend only dominant soil and parent material is presented, an explanatory text offers more information also about the co-dominant and associated soils.

To enhance the geomorphographic aspects, e.g. the mountainous climate areas, a shaded relief is drawn in the background of the map. It is based on the GTOPO30 global digital elevation model (DEM) with a horizontal grid spacing of 30 arc seconds (approximately 1 kilometre), provided by the U.S. Geological Survey (USGS).

Additionally to the map and the explanatory text an auxiliary database has been de-veloped which contains information about all relevant parameters (climate, soil type, parent material, elevation, slope, land use, geographical position etc.) in query mode.

2.4.3.1 Maps at the scale 1:25,000,000

- *Groundwater Resources Map of the World, Scale 1:25,000,000*
  The World-wide Hydrogeological Mapping and Assessment Programme (WHYMAP)is a joint activity of the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Commission for the Geological Map of the World (CGMW), the International Association of Hydrogeologists (IAH), the International Atomic Energy Agency (IAEA) and the German Federal Institute for Geo-sciences and Natural Resources (BGR). It aims at collecting, collating and visualising hydrogeological information at the global scale, to convey groundwater related information in an appropriate way for global discussion on water issues and to give recognition to invisible underground water resources. WHYMAP brings together the huge efforts in hydrogeological mapping, at regional, national and continental levels. BGR has built up a geo-information system (WHYMAP GIS) in which the groundwater data are managed and visualised.
  An important milestone of the WHYMAP Programme has been the publication of the Groundwater Resources Map of the World at the scale of 1:25,000,000 in 2008. As a first result two special editions of the global map at the scale of 1:50,000,000 have been issued in 2004 and 2006. In the meantime, two additional global maps have been compiled and published:
  - Map 'River and Groundwater Basins of the World 1:50,000,000' (special edition for the 6th World Water Forum, Marseille/France, March 2012)
  - Map 'Global Groundwater Vulnerability to Floods and Droughts 1:40,000,000' (special edition for the 7th World Water Forum, Daegu & Gyeongbuk/Republic of Korea, April 2015).

2.4.4 Maps in Projects of Technical Cooperation for Development in Partner Countries

Via the German Ministry of Economic Cooperation and Development (BMZ) the German government commissions a number of executing agencies for Technical Co-operation projects – including BGR in the geology and mining sector – to plan and implement Technical Cooperation projects and programmes (TZ) in Latin America, Africa and Asia. In addition, support is also given to transform countries in the former Soviet Union and the reform processes in Eastern European countries (South-East Europe Stability Pact). Key elements are combating poverty and protecting natural resources. BGR supports state institutions, e.g. Geological Surveys and other public sector organisations in developing countries in the following areas:

- management and resource-optimised utilisation of water and soil
- mineral and energy resources (exploration and evaluation of deposits, oil geology, renewable sources: geothermal energy)
- environmental and resource protection / mining environment
- geological principles of regional planning and policy (e.g. for the location of suitable sites for landfills)
- geo-risks, climate and disaster protection.

In order to the mission geological and thematic derivate maps are produced in scale to be used as overview maps or detailed for specific purpose like regional and urban planning and also as base map

for further geological research. Most of the maps are based on GIS-techniques and are disseminated as digital maps using the Internet or CD.

2.4.5 The BGR "Produktcenter"

All maps are also digitally available (mostly for free) within the BGR product centre (Produktcenter) which provides an overview about editorial and technical information: http://produktcenter.bgr.de. Here all maps are referenced in a meta database and can be researched based on regional and technical aspects. They are available in a variety of resolutions and formats (PDF, TIFF, JPG, PNG and as ESRI shape and e00 files). The research results are provided as detailed information for the map/map series' including coordinates, technical descriptions, contact persons and ordering options (online or through bookshops).The maps is also included in the Geoviewer (see below).

2.4.6 Open GeoViewer (http://geoviewer.bgr.de)

The BGR GeoViewer allows the user to visualize and to combine BGR's web map services (WMS) based on data of various disciplines. The information for every map contains a link to the "Produktcenter" where the relevant geodata are available for download. The offered map data cover whole Germany and are generalized for different scale intervals between 1:200,000 and 1:5,000,000. Thus, some of the map services are displayed only for fixed scale ranges depending on data sources.

The layout will automatically adjust itself for display on smartphones and tablets.

2.5 Bundesamt für Bauwesen und Raumordnung (Federal Office for Building and Regional Planning)

No report submitted.

3 Cartographic Activities of Private Enterprises

No report submitted.

4 Cartographic Training and Research at Institutions of Higher Education

4.1 Beuth Hochschule für Technik Berlin (Beuth University of Applied Sciences Berlin)

Research

Research activities mainly focus on applied sciences, e.g. the application of Geoinformation Systems (GIS), advanced analysis of remote sensing data, the perception, compilation and interactive usage of cartographic representations and geovisualisation. That includes the important topics: internet cartography, health mapping, atlas research and 3D landscapes.

Research Topics and Projects:

- One aspect is the usage of GIS methods in health services research. This includes studies in Germany as well as in countries in Eastern Africa. The focus is to monitor systems for decision makers to ensure a most ideal usage of available healthcare resources.
- Beuth University traditionally has tight cooperation with various partners in African countries. Applied GIS techniques and GIS analysis methods were used for mapping purposes on different scale levels and spatial resolutions in these regions. Since more than ten years a strong connecting to Universities in Ethiopia, Sudan, South-Sudan, Ruanda and DR Congo has been established.
- Navigation strategies and wayfinding behavior are relevant research topics for spatial sciences and cartography. By using mobile Eye Tracking Technologies, innovative analysis methods are

applied to investigate cartographic visualizations. Mental representations of the spatial environment in a cognitive map are investigated to study the perception of space from the perspective of map users.

- A cooperation project with the University of Leida (Spain) and the Mannheimer Zentrum für Europäische Sozialforschung (MZES) is focusing on the development of an administrative map of Europe to show continuity and changes of administrative units between 1871 and 2000.
- GIS experts and professional cartographers are working on the Qatar Sudan Archaeological Project. That project is administrated by the Orient Department of the German Archaeological Institute (DAI). DAI's research is focused on the reconstruction of urban life at the Nile during the Meroitic period. The archeological excavation close to Hamadab village in Sudan is supported by Beuth University with field mapping campaigns, photogrammetry and geodesy methods for the surveying part and high resolution remote sensing image data analysis. Finally we are integrating all the spatial data in a GIS and perform a detailed 3D reconstruction and visualization of the historic site.
- The development of advanced cartographic visualization is a major research topic. Mobile devices have become very popular and cartographic information ("where I am?") is an important driver of the mobile information. We are developing interactive, user oriented smart mobile maps and we enhance and overlay those maps with Augmented and Virtual Reality (AR, VR) features.

Education

Starting fall 2015/2016, the Beuth University of Applied Sciences Berlin offers a consecutive two-step study program in cartography. With the beginning of the fall semester, a new degree program will replace the existing structure, consisting of the courses Surveying, Geoinformation and Cartography. The general study program "Geoinformation" will start with a common base for all students. In a later study phase the students may focus on one specialized study program: Geodesy, Geoinformation or Cartography. The new BA study program is equipped with up to 132 study places. A Master study program in Geodesy and Geoinformatics and Cartography is designed as a consecutive follow up.
The international networking of Beuth University has been significantly extended within recent years. The University of Bahir Dar, Ethiopia, El Neelain University, Khartoum, Juba University, Sudan, University of Dar es Salam and Ardhi University Tanzania, Université Evangélique en Afrique, Bukavu / Democratic Republic of Congo (DRC), Polytechnic of Namibia (PoN) are sharing our expertise in geospatial sciences.

4.2 Hochschule für Technik und Wirtschaft Dresden (Dresden University of Applied Sciences), Faculty of Spatial Information

Research

The Faculty of Spatial Information is a competent partner for government, administration and economy. The research activities are mainly focused on the development of Web-GIS components and GIS applications, multimedia applications and information systems for the public and private sector. In projects and theses research was conducted to make historical maps and data available on the internet. 3D subsurface city models were developed. Further fields of research are 3D laser scanning and 3D modelling, atlas cartography and also unmanned aerial system (UAS) and aerial photography.

Selected international projects

- NascaGIS: Digital conservation of the world heritage geoglyphs in Nasca and Palpa, Peru
- UAS for the documentation of archaeological finding spots and for fresh water ecology in Mongolia (partner: Mongolian Academy of Sciences)
- Road maps of Namibia for tourists developed in collaboration with the Namibian authorities (Roads Authority of Namibia, TASA)
- Photogrammetric 3D-reconstruction of Tayma in Saudi-Arabia using aerial images (in collaboration with German Archaeological Institute (DAI))

- Historical Atlas of the Lusatian Highlands “Oberlausitz-Atlas” (partners: Oberlausitzische Gesellschaft der Wissenschaften e. V., Stowarzyszenie Milosników Górnych Luzyc w Lubaniu)

Selected national and regional projects and products

- WMS/WMTS “Berliner Meilenblätter”: georeferencing and edge adjustment of all the 370 map sheets for an online publication (URL: http://geoportal.sachsen.de/cps/karte.html?show-map=true)
- Atlas of the Reformation, venture project of the Leipzig University, the state of Saxony and the Eastern German Bank Foundation (Ostdeutsche Sparkassenstiftung) to mark the Luther Decade
- Atlas of History and regional Geography of Saxony (Atlas zur Geschichte und Landeskunde von Sachsen) in cooperation with the Saxon Academy of Sciences (Sächsische Akademie der Wissenschaften) and Staatsbetrieb Geobasisinformation und Vermessung Sachsen (governmental organisation)
- Other regional atlases: “Vogtlandatlas”, “Kursächsischer Ämteratlas”
- Cartography for museums: 2D and 3D items for exhibitions and multimedia applications (partners: Militärhistorisches Museum der Bundeswehr in Dresden, Technische Sammlungen Dresden, Europäisches Kultur- und Informationszentrum Via Regia e.V., Archaeological Heritage Office in Saxony)
- Taking part in private publishing projects (“Sächsische Heimatblätter”, “afrikapost”, travel guide “Wandern in der Vogtländischen Schweiz”).

Education

In 2007 the course of studies Diplomingenieur (FH) was successfully converted to bachelor programme “Spatial Information and Cartography” (Geoinformation und Kartographie) and master programme “Geoinformation and Management”. To better meet the future requirements in working practice all existing programmes of study were drafted in 2014. With the winter semester 2014/2015 the following new study programmes were offered at the Faculty of Spatial Information.

Programme	Degree	Duration	Numbers of students per year	Accredited
Cartography/Geoinformatics (Kartographie/Geoinfomatik)	**Bachelor**	**7 semesters [1)]**	**40**	**yes**
Surveying/ Geoinformatics (Vermessung/Geoinfomatik)	Bachelor	7 semesters [1)]	40	yes
Geoinformatics/Management (Geoinformatik/Management)	Master	3 semesters (consecutive) [2)]	30 [3)]	Yes
Geoinformatics/Management (Geoinformatik/Management)	Master	4 semesters (not consecutive) [2)]		yes
Surveying (Vermessungswesen)	Diplomingenieur (FH)	10 semesters (correspondence course)	35	no

[1)] beginning: every winter semester
[2)] beginning: every winter semester and summer semester
[3)] numerus clausus

The new course programme “Cartography/Geoinformatics” is focused on

- natural sciences/applied sciences: mathematics, computer science, geography, geodesy;
- theoretical cartography: map projections and coordinate reference systems (CRS), communications technology and design, printing and media technology, thematic cartography;
- practical cartography: geoprocessing and computer graphics, geographic information systems and spatial database systems, photogrammetry and remote sensing;
- softskills: language and rhetoric skills, skills of scientific working, knowledge of law and copyright.

In the 5th semester an external work placement takes place for at least 18 weeks. The 6th and 7th semester is to improve, e.g., building information modeling, 3D city models, application development for geomatics and web design. At the same time each student works on a complex cartographic project.

Series of the Faculty of Spatial Information:

- "Dresdner Kartographische Schriften" (since 1998, eight booklets)

Further Information: http://www.htw-dresden.de/fakultaet-geoinformation.html

4.3 Hochschule Karlsruhe – Technik und Wirtschaft (Karlsruhe University of Applied Sciences) Faculty of Information Management and Media

Research

For the 300-year anniversary of Karlsruhe in 2015, many students helped to generate 3D-city models of its development for five time steps. These reveal the origin as a palace at the centre of fan-shaped streets as early as 1739 and the evolving of today's inner city around this unique plan up to today. The animated fly-throughs along prominent streets form part of the city's official exhibition for the festivities. To make the visualizations more lively figures of people in the streets are included for which students dressed in costumes of former times. The model of 1945 shows the heavily destroyed town. Today's situation is based on the official representation as used by the city council of Karlsruhe.

Since 2012 DAAD (German Academic Exchange Service) supports a subject-related partnership with Masinde Muliro University of Science and Technology (MMUST, Kakamega) in western Kenya and Makerere University (MAK, Kampala) in Uganda. The aim of the UnivGisKoop project is to streamline up-to-date GIS teaching into existing curricula structures across various departments by preparing lecturing materials and exercises for students based on regional geodata. As map reading skills cannot be taken for granted, the partners work not only on two GIS modules but also on an additional module on geodata use aiming to create true map reading literacy which is needed to gain full potential from today's geospatial technologies. The project allowed MMUST to also apply for funding of a much-needed GIS lab from DAAD. Besides it made it possible for German students to spent time in Eastern Africa. One student's stay at MMUST was particularly beneficial, as various map-based environmental education tools could be developed together with the local stakeholders..

Education

The new Bachelor degree programme "Geo-Information Management" (GIM), which started in 2009 proved to be a direct competitor for beginner students who would have otherwise opted for our "Cartography and Geomatics" Bachelor program. In consequence, in 2012 cartography as a degree program was inserted into the former as the third option of specialization, named Cartography and Geomedia, this besides the other options of Geobusiness and Environment. 60 students are admitted per year, the start of studies is always with the winter semester. After two basic modules in cartography and visualizations for all students, from the third semester onwards the students gain specialized training within six further modules dedicated to map making: covering map design and geomedia, map compilation, thematic cartography, atlas cartography, interactive cartography as well as realtime cartography. With another module on 3D-visualization, again for all, thus 25% of the credits are dedicated to specific cartographic knowledge.

Another proposal has been handed in to continue the Bachelor PLUS study offer. While extending their studies by one semester, students can spend a full year abroad sponsored by a DAAD scholarship. Here we cooperate with Edinburgh Napier University (Scotland, UK), Universidad Politécnica de Valencia (UPV, Spain), and Minnesota State University (Mankato, USA).

The Master program in Geomatics is well established. Since its major revision in 2007 only smaller changes were realized, now including modules on open source GIS and navigation/mobile applications. While our graduates of Geodesy and Navigation often opt for electives related to applied geodesy, for the GIM graduates the option to focus on geoinformatics and visualization modules is often preferred. A unique study environment is offered, as almost all courses are taught in English and students mix

from diverse backgrounds and cultures. When from abroad or having spent a semester abroad, the degree of an International Master is awarded. All variants, consecutive students (studying 3 semesters), non-consecutive students (4 semesters, including a first conversion semester) as well as the double degree with UPV are now handled via a common set of study and examination regulations.
Although the former Faculty of Geomatics was integrated into the new Faculty of Information Management and Media (IMM) in 2012, the geodata processing-related study programmes remain to have a strong standing. In particular teaching of cartography can benefit from the other media-related study programs and their teaching staff.

4.4 Hochschule für Angewandte Wissenschaften München (Munich University of Applied Sciences)

No report submitted.

4.5 Technische Universität Dresden (Dresden University of Technology)

Research
Like within the previous reporting period, Theoretical Cartography (i.a. Cartosemiotics), High-Mountain Cartography (primarily Multitemporal Glacier Cartography), 3D Cave Mapping/Speleological Cartography, Mobile Cartography, True-3D Cartography and – for a couple of years – Generalisation were the strongholds of research. Here, a series of national and international cooperation projects funded by various funding entities – mainly the German Research Council (DFG), the Federal Ministry of Education and Research (BMBF) and the German Academic Exchange Service (DAAD) – have been carried out and are still ongoing for several years.

Geographically, the mapping activities are covering parts of Antarctica, the whole Andes, Western Greenland, the Austrian Alps, Tian Shan, the Himalayan Range, Tibet as well as the Malaysian Peninsula and Borneo.

Education

Beginning with 2011/12 the first batch of Master students in Geo-Information Technology have been pursuing their studies.

Since fall 2011 the globally unique *International Master Course Cartography*, together with the Munich University of Technology and the Vienna University of Technology, has been operational. The highly competitive application process has so far every year resulted in a group of 15 – 25 highly motivated students from all over the world.

Organised Symposia
- Honorary colloquium on the occasion of the 60th Birthday of Prof. Dr. Manfred F. Buchroithner, 21 Jan. 2011
- Scientific colloquium on the occasion of the centenary of Prof. Dr. Wolfgang Pillewizer's birth, 13 Sept. 2011
- Relief representation yesterday and today – Colloquium on the occasion of the bicentenary of Johann Georg Lehmann's death (1765-1811), 14 Oct. 2011
- On behalf of German Society of Cartography: 26th International Cartographic Conference 2013, 25 – 30 Aug. 2013.

4.6 Leibniz University Hannover

Research
The research projects at the Institute of Cartography and Geoinformatics (ikg), generally deal with questions of automation of spatial data processing. Major focus lies on the automation of generalization, data integration and harmonization, interpretation of landscape models, visualization of Point Cloud Data, analysis of spatio-temporal data (especially trajectories), VGI, as well as geosensor networks.

A current focus lies on the interpretation of trajectories, e.g. for behavior recognition (individual behavior, group behavior) and network extraction.
3D-data acquisition and interpretation is investigated with respect 3D-city modelling and navigation using Mobile Mapping Systems, especially using LIDAR. The research group of Prof. Dr. Brenner focuses on applications in car assistance and robotics. One major aspect is the development of a dynamic map to represent the needed environmental information.
The research projects are funded by German Science Foundation, German Ministry of Science, as well as by cooperation with federal authorities and industry in Germany.
At the institute software products for cartographic generalisation have been developed, namely for building simplification, aggregation and typification (CHANGE, TYPIFY), and for object displacement (PUSH). These products are being used by several National Mapping Agencies in Germany and in Europe. Ongoing developments deal with the problem of scaling the approaches to proceeding large data sets.

On-going research projects (selection):
- Decentralized ride sharing using autonomous cars
- Development of a dynamic map (DFG)
- Using cars as moving rain gauges for precise estimation of rainfall (DFG)
- Interpretation of trajectories for behavior recognition (Industry)
- Semantic and geometric intergration of cadastral and topographic data (NMA Niedersachsen and Schleswig-Holstein)
- Landmark based positioning for driver assistance using Lidar data (Volkswagen).

Together with Prof. Burghardt (Dresden), Prof. Schiewe (Hamburg) and Prof. Nejdl (Hannover), Prof. Sester was successful in acquiring a priorty project funded by the German Research Foundation (DFG) dealing the the interpretation and visualization of VGI data.

Education
The ikg is responsible for the education in *Geoinformatics and Cartography* at Leibniz University Hannover. Basic, as well as advanced courses in GIS are taught to students both from Geodesy and Geoinformatics, and to students from Geography, Computer Science and landscape architecture. In 2011 a new master course was introduced, entitled “Navigation and Field Robotics”, offered together with Mechanical Engineering and Computer Science.

Service for Scientific Organisations
The ikg is active in ISPRS by chairing a Working group on Mobility: Tracking, Analysis and Communication. This working group has organised workshops, and contributed to ISPRS symposia. One major activity is the organization of the ISPRS Tracking and Imaging Challenge 2014, aiming at creating a stronger connection between imaging and GIS researchers. The ikg is organizing an annual workshop on automation in spatial data processing (AgA) since 15 years.

4.7 Technische Universität München (Munich University of Technology)

Research
Research fields of the Department of Cartography are map-matching with emphasis on the updating and enrichment of road networks, landmark-based routing visualization, non-photorealistic visualization, spatio-temporal data modeling for visualization, attention-guiding image mapping, event-detection from VGI, visual analytics of lightning data for nowcasting, data mining from GPS-trajectories of floating cars. Main collaboration partners and sponsors are: German Natural Science Foundation (DFG), BMW, Graduate School of TU Munich, China Scholarship Council.
On-going research projects:
- Road network conflation for car navigation
- Reconstruction of road network from sparse GPS trajectories
- Detection of driver’s behavior from floating cars
- Event detection from Volunteered Geographic Information

- Indoor landmark modeling for navigation
- Sensemaking image mapping from remotely sensed Global Land Cover Accomplished projects since 2012
- Non-photorealistic visualization for 3D city models on mobile display
- Intercultural comparison of map icons
- Attention-guiding design of concise image maps
- Enrichment of routing and visualization for multimodal navigation
- Spatial data conflation of imagery and vector road database
- Visual analytical approach to movements of lightning clusters.

Education
The International Master's Program "Cartography" jointly run with TU Vienna, TU Dresden and University of Twente was granted with Erasmus+ in 2014 for five intakes from 2015.
In addition, cartography is one of the essential components in the bachelor / master program of "Geodesy and Geoinformation" at TU Munich. The Department of Cartography is also involved in the following international master courses:

(1) Land tenure and land management
(2) Earth-oriented space science and technology
(3) Transportation systems
(4) Environmental engineering

Organised Academic Event
The international conference on "LBS 2012", Oct.16-18, 2012.

4.9 Ruhr-Universität Bochum (Ruhr University Bochum)

Cartography is part of the Geomatics Group within the Institute of Geography at the Ruhr-University Bochum. The Geomatics Group teaches in various geography study programmes (more than 1400 students) available in Bochum. In these programmes cartography, remote sensing, GIS and modelling are integral parts in the teaching. A specific M.Sc. programme offers students to specialise in geomatics (www.geographie.ruhr-uni-bochum.de/ag/geomatik/).

Research
During the report period the research topics included digital cartography, geo-information systems, web mapping, 3D cartography, satellite cartography and user-oriented cartography. In addition to research, relevant aspects of practical cartography were also considered. The main topics in cartographic research are summarised as follows:
- efficiency analysis of thematic maps (empiric cartography)
- 3D-Geovisualisation / photorealistic 3D-modelling of buildings
- 2D and 3D visualization
- multimedia representation and communication
- web mapping / web gis
- thermal mapping
- lenticular foil techniques for thematic cartography
- cognitive mapping.

Education
In addition to the regular teaching, the geomatics group offers courses for professionals to update and supplement their professional skills. These courses focus on the following topics:
- geographic information systems
- Visual programming languages
- 3D-data capture from aerial photographs
- map updating techniques from aerial photographs
- cartographic presentation with GIS.

Further information:
http://www.geographie.ruhr-uni-bochum.de/arbeitsbereiche/geomatik/forschung

4.10 HafenCity University Hamburg

Research
Cartography at the HafenCity University Hamburg is conducted at the Lab for Geoinformatics and Geovisualization (g^2lab), headed by Prof. Dr. Jochen Schiewe. The lab focuses on the development of methods and applications which are positioned at the interface between Geovisualization, Remote Sensing and Geoinformatics. Main projects in the report period were concerned with

- developing Visual Analytics methods and workflows for improving the interpretation with special consideration of uncertainty information;
- developing new methods for modeling and visualizing uncertainty information of Volunteered Geographic Information (VGI);
- improving noise maps for presentation and public participation purposes by enhancing cartographic design and interactive tools;
- developing new algorithms for data classification and aggregation considering the spatial context;
- developing web-based cartographic visualizations for presenting and exploring data and information in the context of a "Geographical Heat Information and Simulation System".

Besides this research work g^2lab was responsible for organizing a couple of national and international Workshops, for instance the workshops *GeoViz_Hamburg* in 2013 and 2015 in close co-operation with the ICA Commission on "Geovisualization".

Education
Education in Cartography at HafenCity University Hamburg is embedded in the study programs on "Geomatics". While there is only little consideration in the Bachelor of Science course (with only one larger unit on Cartography, besides other lectures in GIS, Remote Sensing, etc.), the Master of Science program offers a specialization area in "Geoinformation Technologies" with a strong emphasis on (geo-)visualization topics which are taught in various formats (lectures, seminars, projects).

Further information: www.g2lab.net

4.11 Helmholtz Centre Potsdam German Research Centre for Geosciences

Research
Research activities at GFZ, Section Geoinformatics, focus on the development of Visual Analytics technologies to analyze and interpret geoscientific data. The research takes place in the context of data intensive science, a novel research paradigm that postulates knowledge generation by fusion and mining of existing data bases. Visual Analytics is regarded as powerful method for information extraction from large and heterogeneous data sets.
Several prototypes of Visual Analytics technologies have been developed at GFZ. They enable geoscientists to

a) compare large data sets form simulation models and observations to validate geoscientific simulation models
b) detect patterns in large geoscientific time series
c) create good mental models form multidimensional data space
d) visually synthesize heterogeneous data form various sources
e) use information from social media for disaster management

Detailed information about the prototypes can be found in the following literature:

Sips, M., Unger, A., Rawald, T., Sasgen, I. (2015 online): Exploring mass variations in the Earth system. - Cartography and Geographic Information Science, 1-13.

Köthur, P., Sips, M., Unger, A., Kuhlmann, J., Dransch, D. (2014): Interactive visual summaries for detection and assessment of spatiotemporal patterns in geospatial time series. - Information Visualization, 13, 3, 283-298.

Köthur, P., Sips, M., Dobslaw, H., Dransch, D. (2014): Visual Analytics for Comparison of Ocean Model Output with Reference Data: Detecting and Analyzing Geophysical Processes Using Clustering Ensembles. - IEEE Transactions on Visualization and Computer Graphics, 20, 12, 1893-1902.

Dransch, D., Poser, K., Fohringer, J., Lucas, C. (2013): Volunteered Geographic Information for Disaster Management. - In: Silva, C. N. (Ed.), Citizen E-Participation in Urban Governance: Crowdsourcing and Collaborative Creativity, (Advances in electronic government, digital divide, and regional development (AEGDDRD) book series), Hershey, Pa.: Information Science Reference, 98-118.

Sips, M., Koethur, P., Unger, A., Hege, H.-C., Dransch, D. (2012): A Visual Analytics Approach to Multiscale Exploration of Environmental Time Series. - IEEE Transactions on Visualization and Computer Graphics, 18, 12, 2899-2907.

Unger, A., Schulte, S., Klemann, V., Dransch, D. (2012): A Visual Analytics Concept for the Validation of Geoscientific Simulation Models. - IEEE Transactions on Visualization and Computer Graphics, 18, 12, 2216-2225.

4.12 Leibniz Institute for Regional Geography Leipzig

The Leibniz Institute for Regional Geography (IfL) is the only non-university research institute for geography in Germany with one department that focuses on cartography, atlas production and visual communication.

Research

The IfL research on cartography has focused on the understanding and using of web-based mapping by experts and prosumers, interactivity, animation and the visualization of mass flow data e.g. for commuters or migration and cutting edge concepts and techniques for atlas compilation and production. Our research and publications are supported by a newly developed database for base map cartography, that will also be important for future products. This connects research on visualization with the main research objectives of the institute.

Products

In addition to many maps produced for in-house publications, journals and research partners the institute is specialized in atlas production and different forms of animated and interactive maps. In continuation with the National Atlas of Germany (NAD) – published between 2000 and 2007 – the institute has prepared the following products either as print atlases or as CD, DVD and online products:

- **Wissenschaftsatlas Heidelberg** (2011- print in German, 2012 – print in English and Spanish), as a new form of a jubilee book that presents the universities history and status with the spatial perspective and is produced in co-operation with the Geographical Institute of the University of Heidelberg,
- **Elbe Atlas des Globalen Wandels** (2011, print) as a cartographic result of the research project “Global Change Impacts on the Hydrological Cycle in the Elbe River Basin” co-ordinated by the Potsdam Institute for Climate Impact Research (PIK).
- **www.nationalatlas.de** (started in 2011) is a new atlas portal, an information platform and archive on regional, national and thematic atlases. The portal also provides the user the opportunity to connect with other IfL-visualizations like “Europe in Maps” or “Kleiner Atlas der Siedlungsnamen”.
- **Nationalatlas aktuell** (launched in 2007) is an online journal that brings a new theme of current interest every month such as natural hazards, the education situation, health or demographic development in continuation of NAD.
- **Mobility Studies.** A database with information about migration (Wanderungsdatenbank) has been developed to support regional planners and communities gain a better understanding of mobility in urban and rural communities of Eastern Germany.

– **Landschaften in Deutschland online** (started in 2015) extends a rich print regional geography series of over 70 monographs, through an online portal to supplemental information and excursions.

5 Major Map Collections in Libraries

5.1 State Library Berlin, Map Department

http://staatsbibliothek-berlin.de/en/about-the-library/abteilungen/karten/
The map department holds the largest map collection in the German speaking area. With around 1.150,000 maps, 155,000 views, 34,000 atlases, 35,500 volumes of cartographic literature, 2,900 CD-ROMs / DVDs and 620 globes the collection covers a very broad spectrum. The focus is on the acquisition of topographic map series. In the last two years – and particularly in the subject field Topographic maps – it was possible to complement our collections by numerous additions, as the selection of large scale map series clearly shows:

Algeria: 1:100,000
Botswana: 1:50,000
China, Tibet: 1:100,000
Colombia: 1:100,000
Cuba: 1:100,000
Cyprus: 1:50,000
Czech Republic: 1:50,000
Finland: 1:25,000
Ghana: 1:50,000
Hungary: 1:100,000
Iran: 1:250,000
Macedonia (Republic): 1:25,000
Morocco: 1:50,000
New Zealand: 1:50,000
Norway: 1:50,000
Suriname: 1:40,000
Thailand: 1:50,000
Vietnam: 1:100,000
Yemen: 1:100,000

A synopsis of modern topographic map series in the holdings of the map department is accessible online, countries are arranged in an alphabetical list. The listing contains nearly 1,750 map series. A number of entries provide additional information like, e.g., index sheets: http://staatsbibliothek-berlin.de/en/about-the-library/abteilungen/karten/recherche-und-ressourcen/topo-liste/. The acquired cartographic literature is systematically catalogued in the Bibliographia Cartographica. There is a print edition of this bibliography and publications published from 1989 onwards are accessible online free of charge: http://bc.staatsbibliothek-berlin.de/index.php?lang=en. At the end of 2015, the Deutsche Forschungsgemeinschaft will put an end to the funding of the acquisition of cartographic literature and topographic map series in the framework of the special collections programme. The library will fund the acquisition. The international journal exchange of the journal Kartographische Nachrichten which is organised on behalf of the German Cartographic Society (DGfK) provides a major support for the collection of data for this international bibliography. Bibliographic details for all titles (maps, atlases, cartographic literature) published from 1940 onwards are searchable online in the electronic catalogue (StaBiKat) of the Staatsbibliothek zu Berlin. Old printed maps and atlases published before 1851 are listed in the IKAR-Database of old maps: http://ikar.staatsbibliothek-berlin.de/. It is an online database free of charge which records the holdings of twelve map collections. Antiquarian acquisitions especially those of the 19th century are made in the framework of the Collection of German Prints. Digitised

maps are made available via the digital collections portal of the Staatsbibliothek as well as via the World Digital Library and similar projects. Various exhibitions will be supplied and reprints are produced. The map department closely cooperates with various scientific partners. Special emphasis is put on the georeferencing and transformation of old land surveys for their integration into WebMapServices.

Publications:

Crom, W.: Digitalisation of maps – only a colourful picture or a value added service? In: e-perimetron Vol. 9, No. 3, 2015 [97-104] http://www.e-perimetron.org/Vol_9_3/Crom.pdf

Atlas Sive Cosmographicae Meditationes De Fabrica Mundi Et Fabricati Figura / Gerardo Mercatore Autore - Faks.-Ed. nach der Ed. principissima nach dem Exemplar der Staatsbibliothek zu Berlin - Preußischer Kulturbesitz. - Duisburgi Clivorum//Duisburg, 2012 = 1595 [273] Bl.: zahlr. Kt. + Begleitbd u.d.T.: Atlas Gerardi Mercatoris 1595 : der Mercatoratlas / von Thomas Horst. Mit einem Vorwort von Wolfgang Crom

Crom, W.: Begutachtung der Sammlungen Scharnhorst und Klöden und der frühe Sammlungsaufbau der Kartenabteilung der Staatsbibliothek zu Berlin. – In: Brunner, Kurt und Thomas Horst (Hrsg.): 15. Kartographiehistorisches Colloquium München. Vorträge, Berichte, Posterbeiträge 2.-4.9.2010. Bonn: Kirschbaum, 2012, 27-32.

5.2 State and University Library Goettingen, Map Collection

Goettingen State and University Library intensively collects and catalogues maps and atlases. This includes Germany as well all other regions in the world and all topic areas. In addition to the important historical holdings amounting to some 65,000 sheets, the collection possesses approximately 320,000 recent maps and 11,000 atlases. Until 2014 the collection has continuously been extended focusing on thematic maps by funding of the German Research Foundation (DFG).

Important Projects:

- The portal www.geo-leo.org combines subject-specific holdings, information and services of the main libraries, for the nationwide supply of literature. Topic areas include Geology, Mineralogy, Petrology, Soil Science, Mining, Geophysics, Geography and Thematic Maps. The portal was developed in cooperation with several institutions in Earth Sciences and Cartography. Geo-Leo is being expanded to incorporate several new functions and contents, particularly in the area of digital documents.
- The „Kulturerbe Niedersachsen“ (Cultural Heritage Lower Saxony) website offers a central hub for digital reproductions of unique objects of cultural heritage including maps. It is currently maintained by several institutions from different fields, ranging from archives and libraries to museums on a partnership basis. It is coordinated by the Goettingen State and University Library, Map Collection. The amount of high quality digital reproductions of the cultural assets of lower saxon memory institutions is constantly being expanded and increased.
- The University of Goettingen is home to many nationally - and internationally - renowned collections in the fields of natural science, humanities and medicine. To highlight the tremendous potential of these academic collections, the University prepared a special exhibition as part of its 275th anniversary celebrations in 2012. The exhibition ‘Objects of Knowledge’ offered an overview of the richness and variety of the 30 collections - including the map collection. (See also other publication The Collections, Museums and Gardens of Goettingen University)

5.3 Saxon State- and University Library, Map Collection

Between 2011 and 2015 the digital collection of the Map Forum (http://www.slub-dresden.de/sammlungen/karten/) had grown to over 26,000 images and maps. In 2012, the Map Forum was redesigned and extended with a timeline and references to place names. Now the user has the opportunity to explore the map collection grouped by 18 themes, perform temporal search queries as

well as search queries based on place names. For map types like plane survey sheets or topographic maps of the German Reich, overview maps were added for an easier access to the single map sheets.
Since 2013, the SLUB hosts a spatial data infrastructure (SDI) for searching, accessing and visualizing georeferenced map collections. The SDI was developed and implemented within the project – Virtual Map Forum 2.0 – which was funded by the German Research Foundation (DFG). As part of the SDI, tools for crowdsourced and automatic georeferencing of plane survey sheets as well as a portal for the searching and visualizing of the georeferenced maps were developed.
Since 2015 the SDI provides access to more than 5.700 historic plane survey sheets, dated between 1868 and 1945, at a scale 1:25,.000. The maps mainly describe the area of historic Germany. Using a portal (see Figure 4 - http://kartenforum.slub-dresden.de) users can search historic maps by their spatial and temporal extent. Further, they can visualize the georeferenced maps on top of an Open Street Map base layer or on top of other georeferenced historic maps. Additionally, the portal allows viewing the original maps and gives registered users the opportunity to georeference maps or to improve an existing georeferencing of a map.

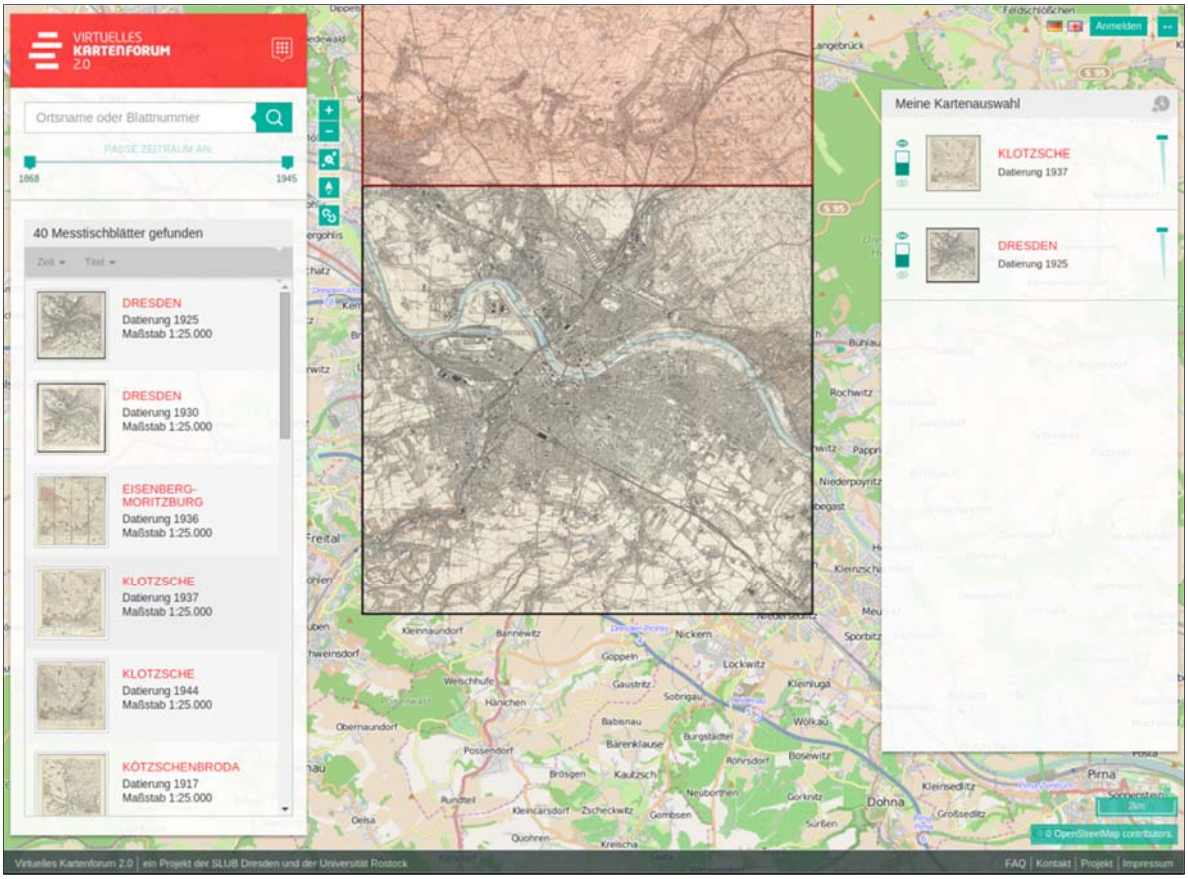


Figure 4: Portal of the Virtual Map Forum 2.0

The portal uses the standardized services of the Virtual Map Forum SDI. These services rely on standards of the Open Geospatial Consortium (OGC) and the International organization for Standardization (ISO) and they foster the integration of the georeferenced map data in external mapping applications. The georeferenced maps can be accessed via Web Map Service (WMS) and the ones dated before 1900 via Web Coverage Service (WCS). Also, georeferenced maps are accessible via a Tile Map Service (TMS). A Catalogue Service for the Web (CSW) publishes a metadata record complaint to ISO 19115 / 19139 for every map sheet. All map data is published under a Creative Commons license (https://creativecommons.org/licenses/by-sa/4.0/).

Next steps are the integration of further historic maps, e.g. maps of the German Reich with a scale 1:100,000 and geological maps of Saxony, into the SDI. Also, the toolset of the portal should be further improved, especially for a better and free reuse in other use cases.