THE ATLAS CONSTRUCTION KIT: PROFESSIONAL AND COST-EFFECTIVE GIS-BASED PRODUCTION ENVIRONMENT?

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ABSTRACT

Atlases rank among the most common and wide-spread cartographic products. Since the formation of atlas cartography the cost-effective production of atlases has been an important issue in the business concept of atlas producers. One concept of particular relevance is that of the so called atlas construction kit. Using the modular principle this framework allows for the production of atlases by combination of technical or cartographic components and methods. This paper discusses the application, impact and opportunities of the atlas construction kit for professional and cost-effective production of modern atlases in the geoinformation age.

INTRODUCTION

Atlases rank among the most familiar and wide-spread cartographic products, whether in classic print form or, for now more than 30 years, in electronic form. An atlas is defined here as a systematic, application-specific, often thematically focused collection of maps with a uniform formal structure and design. Initially the term did not only refer to a specific content, a system of map models based on a common narrative, but also to the presentation medium, a map product in book form or paper maps assembled in a map case. The change to computer-assisted map construction has implemented the development and production of electronic atlases for on-screen use, thus extending the atlas definition to digital media (screen maps, web maps). Since the dawn of atlas cartography the production costs of atlases have dropped dramatically. Today a multitude of atlases, whether national, regional or thematic atlases is freely available on the internet anytime without any cost. Nevertheless, the conceptual development, technical production and distribution of conventional, digital or web-based atlases still remains costly and time-consuming. For this reason the cost-effectiveness of atlas production has always been an important issue in the business concept of atlas producers. Based on the respective state of technology concepts have been elaborated to reuse atlas or map components developed for one particular atlas in other products.

The atlas construction kit (ACK) or atlas toolbox is one practical solution to the continuing problem of cost-effective atlas production. The ACK is defined here as an applied production concept based on contemporary geoinformation technology (GIT) to assemble atlases (or atlas maps) cost-effectively from modules or components using the

modular principle. For that purpose the ACK includes methods and tools and to compose atlas maps as well as complete atlases from these building blocks (Asche, 2009). The main objectve of its application is first and foremost to organise the production of atlases in such a way that they have a payback period of one or a few print runs. To achieve this goal atlases are composed from map and atlas modules that can be isolated in the construction process. In this assimilation process considerations regarding content or cartography are not of prime importance. Nevertheless, intuitive map-based communication of geographic data is a basic postulate in atlas cartography. This, in turn, necessitates quality visualisation of the atlas maps that constitute the complete atlas. As a consequence, any application of the ACK will have to accommodate the contrasting issues of cartographic necessities, production-related options and economic requirements. This paper investigates the application, impact and potentials of the GIT ACK for the professional and cost-effective production of digital atlases. Particular attention is given to professional cartographic visualisation of atlas data.

2 THE GIS ACK: DATA-BASED ATLAS PRODUCTION

The spread of GIS in cartography has paved the way to link digital map graphics with the underlying geometry and attribute data in a space-related software system. Thus, maps generated from a digital (i.e. graphic-free) database can subsequently be visualised as analog map models for print or electronic media (Asche, 2001). Today, numerous atlas products ranging from national and regional to thematic atlases are based on GIS software (cf. Ormeling, 2009, Asche, 2007). GIS packages are generally available in the IT marketplace either as commercial software systems (like the market leader ArcGIS) or free and open-source software systems (like the open-source GRASS), respectively. Hence they can not only be employed by atlas producers, but also by atlas users. If GIS functionality is made available for atlas use, e.g. through a graphical user interface, GIS can also be used as a powerful tool of map and data exploration as well as spatial analysis. This use expands the classical static map-based documentation of geographic knowledge to a personalised, interactive atlas information system (AIS) (cf. Ormeling 1995, 2009, Sieber & Huber 2007, Asche, 2001, 2007).

A powerful GIS facilitating efficient graphic-free processing and storage of object-based atlas data is the core component of what can be designated as the GIS ACK. In addition, the GIS-based ACK contains geo-topographic base data as well as attribute datasets of varied geographic and thematic resolution. Depending on the application, existing atlas modules – digital datasets, complete atlas maps or chapters, thematically or technically separate – might also be included. All relevant components are assembled digitally in a wide range of combinations. If required, the resulting compilation can be supplemented individually by external geodata for specific application projects or at users' requests.

Based on this production concept the actual construction of atlas maps and compilation of complete atlases is performed by object-related combination of data stocks stored in the GIS database. The generation of analog map-like graphics from selected atlas datasets makes use of the standard presentation functionality of GIS. Any manipulation of the digital atlas datasets can be visualised, thus adding to the variants of GIS maps (fig. 1). A substantial number of digital atlases and AIS are based on the production concept of the GIS ACK (Asche, 2009). Among those are the national atlases of Canada (AOC) and Sweden (SNA), regional atlases, such as the atlases of Tirol (TAT), Austria, or South Australia (SAA), thematic atlases like the Dutch national health atlas (NAV) or the digital environmental atlas of Berlin (DUB), Germany, to name just a few. Such digital atlases or AIS provide the users with either basic or extensive resources to manipulate the analog map graphic as well as the underlying digital geodata. The scope of interaction options available ranges from cartometric queries to complete (re)visualisation of the existing map model (Asche, 2001, 2007). Access and use of GIS-based atlases and AIS is based on data media (DVD, CD-ROM) or the internet. The compilation of electronic (PC), web and regional atlases from the map and data stock of the printed Swedish national atlas is an illustrative example of current ACK use.

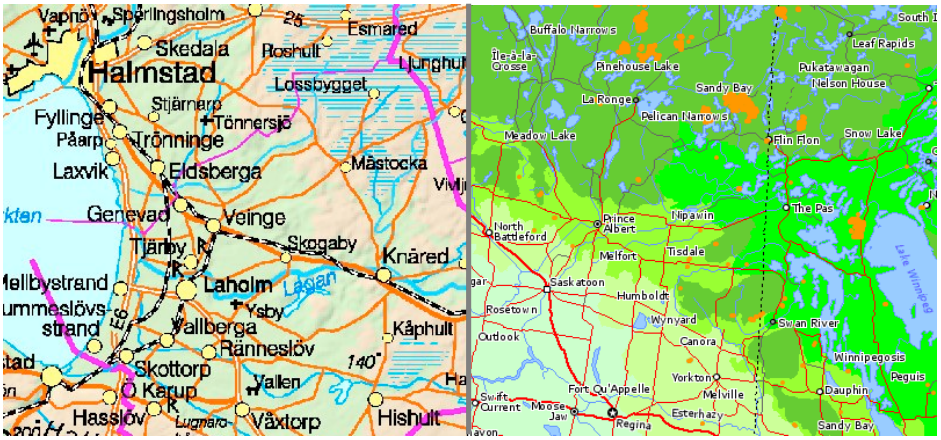

Figure 1: GIS maps in web atlases: Web Atlas of Sweden (left), Sverigekarta (general reference map), Atlas of Canada (right), Forest fire hotspots 2001-2008. Source: SNA (2005), AOC (2007).

In the course of GIS commercialisation the GIS-based ACK has established itself as a viable concept in atlas production, namely as a complement to the well-established graphic-based desktop mapping (DTM) ACK. The strengths of the GIS ACK can be highlighted as follows:

- Atlas data of the GIS ACK are graphic-free, seamless and seemingly scaleless in terms of continuous screen display. However, due to their acquisition scale, they are assigned to a specific scale range. Atlas stocks in the database can be updated without difficulty through the use of the relevant GIS functions.
- To compose and compile atlas products the ACK facilitates easy recourse to existing atlas components or modules. They can be combined in the GIS database in different ways for further customisation and subsequent professional cartographic visualisation. Additionally, the full range of GIS functions is available for the generation of new, additional atlas components.
- Digital linkage of GIS database and map graphics is the key feature of the GIS ACK. This substantially expands the use capacity of atlases in the sense of AIS. Atlas use now comprises classical map reading and analysis as well as data-based spatial analysis.

Opposed to these assets the following deficits of the GIS-based ACK are to be mentioned:

- Linkage of atlas database and visualised map objects is, by and large, not utilised to extend the use range of the analog map graphics.
- Professional as well as user-based application of the GIS ACK mainly results in suboptimal, inappropriate map graphics due to limited GIS visualisation functionalites.
- Map graphics generated with the GIS ACK largely lack the visualisation quality required by the princples of (thematic) cartography. In fact, most GIS map presentations do not comply with the classical map definition and thus would rather count among map-like representations.

An unsystematic and cursory analysis of the map graphics of GIS-based AIS (national, regional or thematic atlases) promptly confirms this finding (cf. Asche, 2007, 2009) which refers to a central issue of GIS: the graphic presentation of digital geo datasets frequently generates inadequate map graphics. In recent years this deficit – which is particularly relevant to proper geovisualisation – has found the attention of commercial GIS developers. A major breakthrough, however, supporting map generation in line with the principles of adequate map visualisiation has not yet been achieved. However, some progress can be identified in visualisation concepts like that of ”Cartographic representations“ by ESRI (Hardy, 2009).

3 THE GIS-VIS ACK: MAP-BASED ATLAS PRODUCTION

As a consequence the shortcomings of the GIS-based ACK – which are critical for cartographic communication of geographic information – cannot be properly eliminated. In fact, a professional solution would require automatic derivation of a scalable graphic model from the digital GIS data model. For the time being, this

fundamental cartographic modelling and visualisation problem has not been solved. That is why, at this stage, the GIS ACK is supplemented by a powerful visualisation system (VIS) outside the GIS for professional cartographic map modelling and visualisation (Buckley et al., 2005). GIS and VIS modules are linked by an inserted data filter (MaPublisher). Its function is to ensure that geodata stored in the GIS database in separate layers can be imported into the VIS component in the existing configuration thus allowing for map visualisation based on the layer principle.

The addition of the VIS module extends the GIS base to a two-level production system termed the GIS-VIS ACK. Interaction of the GIS and VIS components including the data filter is organised in a generic process chain (Wolff & Asche, 2008). In this workflow the GIS and VIS modules act as the system back- and frontend. The GIS backend allows for the graphic-free processing, storage and management of the atlas stock. In contrast, the VIS frontend facilitates a graphic-oriented analog visualisation of the selected atlas datasets in line with cartographic quality requirements. The current edition of the Swiss national atlas (ADS-2, fig. 2) can be considered an exemplary exponent of the GIS-VIS component solution (Sieber & Huber, 2007).

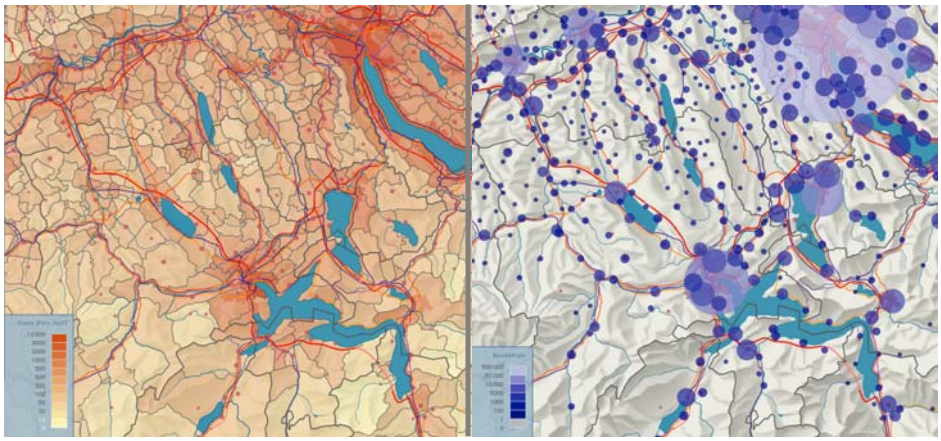

Figure 2: Quality cartographic visualisation with the GIS-VIS atlas construction kit: Atlas of Switzerland 2, population density 2002, jobs in the tertiary sector 2001. Source: ADS-2, 2004

As presented here, the GIS-VIS ACK – basically a GIS construction kit enhanced by cartographic visualisation methods – combines modular methods of data-based and graphic-oriented map modelling according to the current state-the-art of technology in geographic data processing. The GIS-VIS core consists of the two-tier information system explained above. According to the application or visualisation requirements its VIS frontend can either be a vector-oriented 2D graphic arts system or a complex 3D

visualisation system (Wolff & Asche, 2008, 2009). Currently tried and tested commercial software systems are used as GIS and VIS components, respectively (GIS packages, such as ArcGIS; visualisation systems, such as Illustrator or LandXplorer). However, the GIS-VIS ACK concept allows for substitution by comparable free and open-source software components (GIS packages, such as GRASS; visualisation systems, such as Inkscape or VTS). In the case of AIS visualisation is focused on the generation of high-quality thematic map models. This requires a high-performance 2D visualisation module that is time-tested in DTM and available in the IT software mass market (graphic arts packages such as Illustrator or Freehand). Map models professionally visualised from GIS data using DTM software are subsequently reprocessed for the designated distribution channels (web, data media, print) and tailored to the targeted user interaction.

The concept of the modular GIS-VIS ACK provides a substantial contribution to professional cartographic modelling and visualisation of atlas data stocks. The VIS component, in particular, allows for significant progress in atlas visualisation towards the established standards of professional high-quality, easy-to-use map graphics. In addition, the GIS-VIS concept provides for the combination of graphic-based communication of geographic structures with the manifold options of graphic-free geodata analysis.

4 THE DEMOGRAPHIC ATLAS OF ALBANIA: A REAL WORLD GIS-VIS ACK APPLICATION

Taking the Demographic Atlas of Albania (AGPS) as an example (Bërxholi et al., 2003), potentials and limitations of the GIS-VIS ACK in practical use are briefly discusssed in the following. This atlas is one result of a R&D project in which geoscientists from the geography departments of the universities of Potsdam (Germany; coordination), Tirana (Albania), Prishtina (Kosova) and the cartography group of Karlsruhe university of applied sciences (Germany) have cooperated within the framework of the Stability Pact for South East Europe (Asche et al., 2005, Asche & Engemaier, 2006). The concept of the GIS-VIS ACK presented above has been developed during the conceptualisation phase of the AGPS and tested in the real-world production of the atlas. The atlas production is based on a commercial GIS backend (ArcGIS/ArcView). All atlas data are digitally processed and managed in the GIS module. To make full use of the GIS database for a wide variety of applications a generic data model has been developed for data acquisition, storage and analysis. In line with the categories of this data model the atlas data are stored in the database. Hence GIS functionalities can be used for graphic presentation or further processing of selected atlas datasets. Due to the GIS presentation shortcomings explained above, the resulting maps, however, are largely not compatible with the standards of professional, high-quality geovisualisation.

As a consequence, professional visualisation of the atlas data is performed in a separate VIS frontend (Illustrator/Freehand). Both components are coupled via a data filter (MaPublisher) that facilitates the transfer of the GIS layer structure to the VIS module. The import of layer-spearated data into the VIS frontend ensures professional map modelling constistent with the principles of thematic cartography. Depending on the map purpose, e.g. line elements (such as watercourses or administrative boundaries) are generalised for the presentation scale of the respective map type. Map symbol construction and colouring also complies with the rules of thematic cartography. The atlas maps generated this way are subsequently processed for the distribution medium selected (fig. 3), e.g. paper map/print atlas; screen map/web atlas (Asche & Engemaier, 2006).

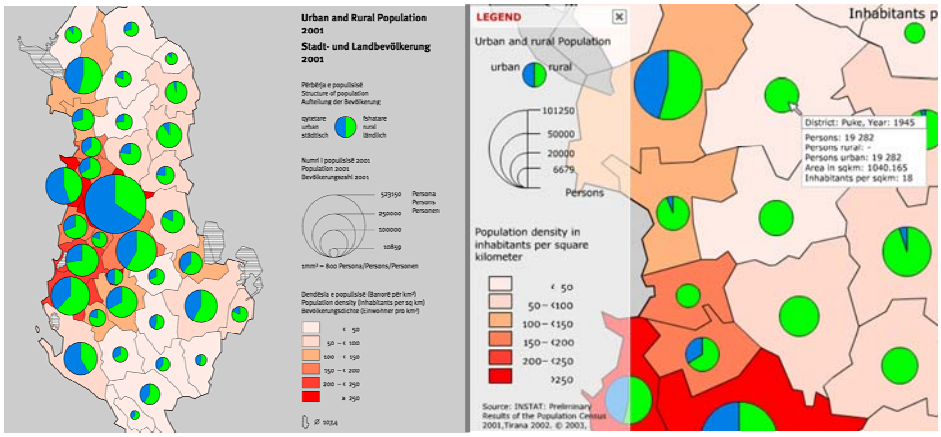

Figure 3: The GIS-VIS atlas construction kit in practical use: Professional thematic map visualisiation (urban and rural population 2001) by VIS frontend from GIS-based atlas stock for print map (left) und web map (right). Source: AGPS (2003), Engemaier (2005).

In the production process presented above the GIS backend serves as the platform for the generation of media-specific AGPS products: web atlas and paper atlas. The dissemination medium produced from the digital atlas stock is partly determined by a number of influencing factors to be assessed according to a specific application or region. Relevant parameters include:

- Product-specific: production costs and financing or access of potential user groups to potential dissemination media,
- Audience-/region-specific: user access to information, information and communication technology (computer systems, data networks), stable electricity supply, etc. Unequal access to digital information and communication infrastructure

in terms of spatial and social participation (digital gap or digital divide, respectively) results in a knowledge gap that eventually leads to differential development opportunities in the information society.

In a post-socialist transformation country like Albania both influencing factors constrain the dissemination of the atlas information. To provide potential users with broad access which is independent of the country's technical infrastructure (connectivity), a conventional atlas book has been compiled, produced and published in Albania from the GIS-based atlas data stock (Bërxholi et al., 2003). To this end the atlas map graphics and colouring of the maps generated in the VIS component were customised for optimal map printing. The print atlas is accessible via the classical distribution channels (bookshops, libraries, mail-order map stores) at home and abroad. In fact, sales figures and an evaluation of the atlas show that the atlas does reach its audience and meet the qualitiy requirements of current thematic atlases. In addition to the atlas book a prototype of an AGPS web atlas has been developed as a proof of concept (Engemaier, 2005).

5 CONCLUSION: THE GIS-VIS ACK – PRODUCTION ENVIRONMENT FOR QUALITY ATLASES?

This paper discusses the opportunities and limitations of atlas production using the modular principle from a GIS-based atlas data stock. For a long time modular compilation of of atlases and atlas maps from an atlas stock has been a production concept of commercial atlas producers. With respect to its techncial components the ACK concept has always been closely linked with the relevant status of production technologies. That is why the available tools (methods, procedures, software systems) and components (digital geodata, graphic geodata) are crucial for the graphic quality required to produce atlas maps and atlases in accordance with the principles of cartographic geovisualisation. As has been demonstrated GIS maps frequently do not conform to the quality standards of thematic cartography. Any GIS ACK use is thus affected by the dilemma of up-to-date data use accompanied by nonprofessional map graphics.

One way of overcoming this conflict is the extension of the GIS ACK by a high-performance visualisation component for production. The resulting GIS-VIS ACK is designed as a two-level production system for digital geodata processing (GIS backend) and professional map construction (VIS frontend). Through the interaction of both system components the professional cartographic quality required of atlas maps can be combined with the manifold options of digital geodata manipulation. At the same time the object-oriented, granular definition of the atlas building blocks provides commercial as well as institutional atlas producers with a flexible and versatile atlas compilation framework in line with the principles of (thematic) cartography. By addition or

substitution of the 2D visualisation component by a 3D visualisation system the VIS component can be fine-tuned to extend or focus the spectrum of cartographic visualisations.

The sustainabilty of the GIS-VIS concept presented here is currently investigated in further R&D projects of the geoinformation research group of Potsdam university. Among those we mention the binational project „Demographic atlas of Croatia information system (DACIS; Asche et al., 2009) as well as – outside the atlas domain – the implementation of GIS-VIS modules for spatial analysis in the R&D project „3D geoinformation“ within the scope of the „InnoProfile“ programme of the federal German Ministry for Education and Research (cf. Wolff & Asche, 2008, 2009). Our own R&D activities as well as the analysis of current digital atlases demonstrate that the concept of the GIS-VIS ACK allows for the professional generation of quality atlas products which is cartographically correct, technically viable and economically sustainable.

REFERENCES

ADS-2 (2004): Atlas der Schweiz/Atlas de la Suisse/Atlante della Svizzera/Atlas of Switzerland 2 [DVD/2 CD-ROM]. Eidgenössische Landestopographie, Wabern.

AOC (1994-2007). The Atlas of Canada/L'atlas du Canada [Online]. National Resources Council, Earth Sciences Sector, http://atlas.gc.ca/site/index.html (last visited: 02/2009)

ASA (2002-). Atlas South Australia [Online]. Government of South Autralia, http://www.atlas.sa.gov.au (last visited: 02/2009).

ASCHE, H. (2009). Der Atlasbaukasten: nachhaltiges Produktionskonzept im Geoinformationszeitalter? Eine Bestandsaufnahme. Kartographische Nachrichten 59(1), pp.3-12.

ASCHE, H. (2007). Stand und Zukunftstendenzen der Atlaskartographie im Spiegel digitaler Atlanten. Kartographische Nachrichten 57(4), pp.183-191.

ASCHE, H. (2001). Auf dem Weg zum virtuellen Atlas – Stand und Perspektiven der Atlasnutzung im Medienzeitalter. In Buzin R. & T. Wintges, eds., Kartographie 2001 - multidisziplinär, multimedial. Beiträge zum 50. Deutschen Kartographentag. Heidelberg, pp.22-32.

ASCHE, H., BËRXHOLI, A., SIEMER, J. & D. DOKA (2005). Demographic of Albania: Pilot project for a National Atlas Information System in a South East European transformation country. *Mapping approaches into a changing world. Proc. 22nd Intern. Cartogr. Conference A Coruna* [CD-ROM], Jul. 9-16, International Cartographic Association, A Coruna.

ASCHE, H. & R. ENGEMAIER (2006). Vom Themenatlas zum Atlasinformationssystem: Medienspezifische Visualisierung statistischer Zeitreihen des Bevölkerungsgeographischen Atlas von Albanien. In Kriz, K. Cartwright, W. Pucher., A. & M. Kirnberger, eds. Kartographie als Kommunikationsmedium. Wien, pp.23-31.

ASCHE, H., TOSKIĆ, A., SPEVEC, D. & R. ENGEMAIER (2009). The Demographic Atlas of Croatia - a web based atlas information system. In Gartner, G & F. Ortag, eds., *Proc. First ICA Symposium for Central and Eastern Europe 2009* [CD-ROM], Feb. 16-17, Viena University of Technology/International Cartographic Association, Wien.

BËRXHOLI, A., DOKA, D. & H. ASCHE, eds. (2003). Atlasi Gjeografik i Popullsisë së Shqipërisë/Demographic Atlas of Albania/Bevölkerungegeographischer Atlas von Albanien. Tirana.

BUCKLEY, A., FRYE, C. & B. BUTTENFIELD (2005). An information model for maps: towards cartographic production from GIS databases. *Mapping approaches into a changing world. Proc. 22nd Intern. Cartogr. Conference A Coruna* [CD-ROM], Jul. 9-16, International Cartographic Association, A Coruna.

DUB (1995-2009). Digitaler Umweltatlas Berlin [Online]. Senatsverwaltung für Stadtentwicklung, http://www.stadtentwicklung.berlin.de/umwelt/umweltatlas (last visi–ted: 02/2009).

ENGEMAIER, R. (2005). *Medienspezifische Visualisierungs- und Nutzungsstrategien in Internetatlanten: Konzeption eines internetbasierten „Bevölkerungsgeographischen Atlas von Albanien“*. Dipl., Potsdam: Universität Potsdam.

HARDY, P. (2009). High-Quality Cartography in a Commodity GIS: Experiences in Development and Deployment. In Gartner, G & F. Ortag, eds., *Proc. First ICA Symposium for Central and Eastern Europe 2009* [CD-ROM], Feb. 16-17, Vienna University of Technology/International Cartographic Association, Wien.

NAV (2000-2008). Nationale Atlas Volksgezondheid [Online, v.3.16]. Rijksinstituut voor Volksgezondheid en Milieu, http://www.rivm.nl/vtv/object_document/o4235n21143.html (last visited: 02/2009).

ORMELING, F. (2009), Moderne Atlaskartographie im Spiegel von National- und Regionalatlanten – Bestandsaufnahme und Entwicklungslinien. Kartographische Nachrichten 59(1), pp.12-17.

ORMELING, F. (1995), Atlas information systems. *Cartography crossing borders. Proc. 17th International Cartographic Conference Barcelona*, September 3-9, International Cartographic Association, Barcelona, 2, pp.2127-2133.

SIEBER, R., HUBER, S. (2007). Atlas of Switzerland 2 – A highly interactive thematic national atlas. In Cartwright, W., Peterson, M. & G. Gartner, eds., Multimedia Cartography, Berlin-Heidelberg, pp.161-182.

SNA (1990-2005): Sveriges Nationalatlas/National atlas of Sweden. Landmäteriet, http://www.sna.se (last visited: 02/2009).

TAT (2001-07): Tirol Atlas [Online]. Institut für Geographie, Universität Innsbruck, http://tirolatlas.uibk.ac.at (last visited: 02/2009).

WOLFF, M. & H. ASCHE (2009). Mapping crime using geovirtual urban environments – a 3D geovisualization approach. In Gartner, G & F. Ortag, eds., *Proc. First ICA Symposium for Central and Eastern Europe 2009* [CD-ROM], Feb. 16-17, Vienna University of Technology/International Cartographic Association, Wien.

WOLFF, M. & H. ASCHE (2008). Designing 3D Geovirtual Environments by linking GIS and 3D-VIS via GIS-Programming. *Proc. 5th international symposium on LBS & telecartography*, Nov. 26. - 28, Salzburg Research/Vienna University of Technology,

Salzburg.