The interactive alpine information system GALPIS

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Introduction

The availability of detailed information facilitates decision-making or arguing a scientific point. It can also mean power in the hands of those who possess that information. A wealth of data exists on the Alps but this resource is not without its drawbacks. The data is dispersed across several countries. Differing methods of gathering the data used in the different censuses and other instances of data capture make the results impossible to compare. With expert knowledge required to pool, harmonize and chart them, it becomes inaccessible for bottom-up decision-making processes. GALPIS-Web (http://www.galpis.at) provides an instrument based on a harmonized data set that contains a large amount of data (1 375 in total, 1 173 of them accessible in GALPIS) to be presented in user-defined form. The RAUMALP consortium, led by the working group Mountain Research at the Institute of Urban and Regional Research of the Austrian Academy of Sciences (in 2006 transformed into the Institute of Mountain Research: Man and Environment, IGF), created this instrument (www.oeaw.ac.at/isr/raumalp.at) and has since developed and fine-tuned it further at the IGF. All data were recalculated on the scale of the municipality (NUTS 5) (Bender & Pindur 2003). In addition to the information system itself, GALPIS provides a help function and is available in German and English.

GALPIS-Web offers a range of options for use in teaching situations, from presenting digital maps to independent learning and research using scientific analyses to creating meaningful cartographical visualizations.

Levels of data capture and analysis

The RAUMALP project was carried out as multi-level analyses (Fig. 1) to make the differing methods of the working groups compatible. These levels included the "grid space", the administrative space (or "statistical space") and the "real space". Comprehensive data capture was carried out at all three levels.

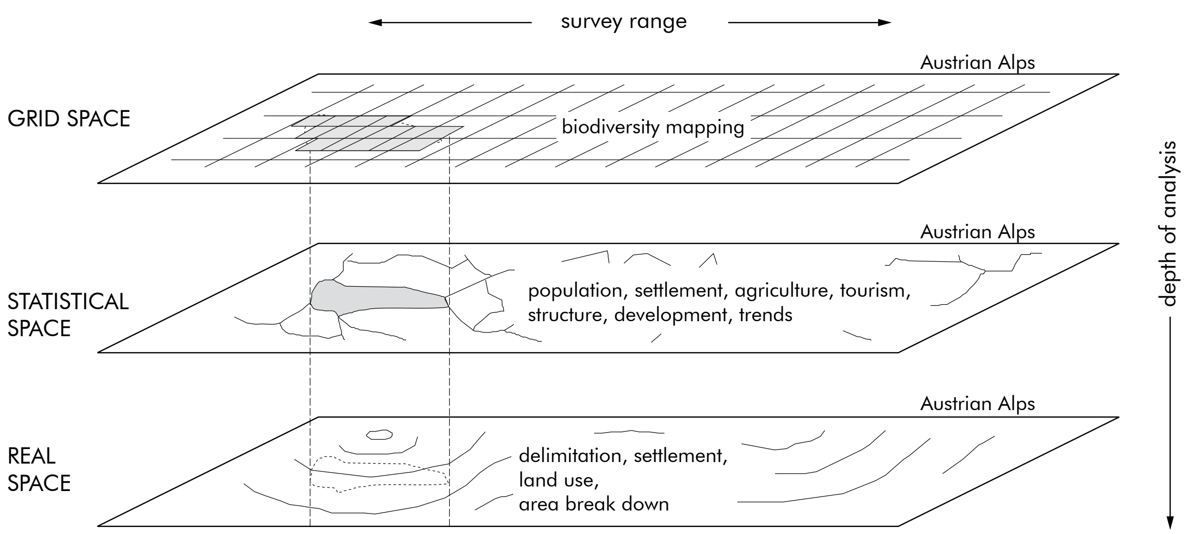

Fig. 1: Multi-level design in RAUMALP.

- The grid space is made up of grid cells (3' x 5', equivalent to ca. 4 km x 4 km) inserted into the net of geographical coordinates. Data on biodiversity, esp. flora mapping carried out by the University of Vienna (Niklfeld 1997) are mapped on to these grid cells.
- The statistical space is formed by the system of municipalities (1 145 in the Austrian Alps, 2 359 in the whole of Austria). Data from the ten-yearly censuses on population, settlements, agriculture and tourism were used here, plus data from other sources that relate to the municipalities, e. g. telephone surveys on the level of local provision with daily necessities.
- The capture patterns for ecology and land use relate to the real space. Data was captured via map analyses and remote sensing, e. g. in the Realraumanalyse Österreich (Seger 2000), produced at the University of Klagenfurt, and in several ecology projects at the University of Vienna (e. g. Grabherr et al. 1998).

In order to visualize the data, the statistical space was set as main reference and the data from the real space and the grid space recalculated for the municipal by intersection in the GIS. A probability of error remains, however. In the statistical space, area changes over time presented a major problem when analysing time series. In the period from 1971 to 2001 alone, nearly 10% of municipalities experienced changes to their area. In GALPIS, we developed a method of recalculating all data related to municipalities for the current dimensions of the municipal area. Depending on the theme to which the variable was allocated, it was recalculated either by the percentage change in municipal area or in population (Bender & Pindur 2003).

What users want from GALPIS-Web

If a large amount of geodata such as the municipality database is to be made available to the public at large in visual, i. e. map, format, an obvious path is to do it via the internet using client-server technology. The basic assumption here is that of providing a so-called "thin client", i. e. a user needing nothing but a browser and internet access, with access to space-related data that are maintained on a server on the web using a proprietary GIS. This means a total departure from the classic image of GIS as an expert information system. How interactive and open a "web-GIS" can be in the end depends on the intentions of the data providers and on the programming. Based on these considerations, we drew up a list of specifications for GALPIS-Web. The user should be able to:

- access selected attributes interactively of the geo-objects municipality;
- visualize these data interactively in thematic maps and be offered presentation options;
- generate new attributes interactively from existing ones as needed and use them for his / her own analyses.

Technical implementation

GALPIS-Web was implemented as an interactive map server. The user interactively controls the data he or she wants to visualize, i. e. within the user interface he or she selects the data that the map server will use to generate the map (cf. Asche 2003, Bill 1999, Dickmann 2001). Given the large number of attributes and to ensure the system remained open for extension, the approach chosen for GALPIS-Web is not layer-oriented as commonly used in existing systems, where each GIS layer carries the thematic information for a particular theme. Instead, a database-oriented concept was implemented in GALPIS-Web (Borsdorf & Moser 2004). There are only few layers and these carry only topographical information. The attribute data for the municipality polygons are maintained in an Access database, integrated via Macromedia ColdFusion software. The data requested by the user are allocated to the spatial objects (the municipalities in GALPIS) via an XML interface and graphically represented using ESRI internet

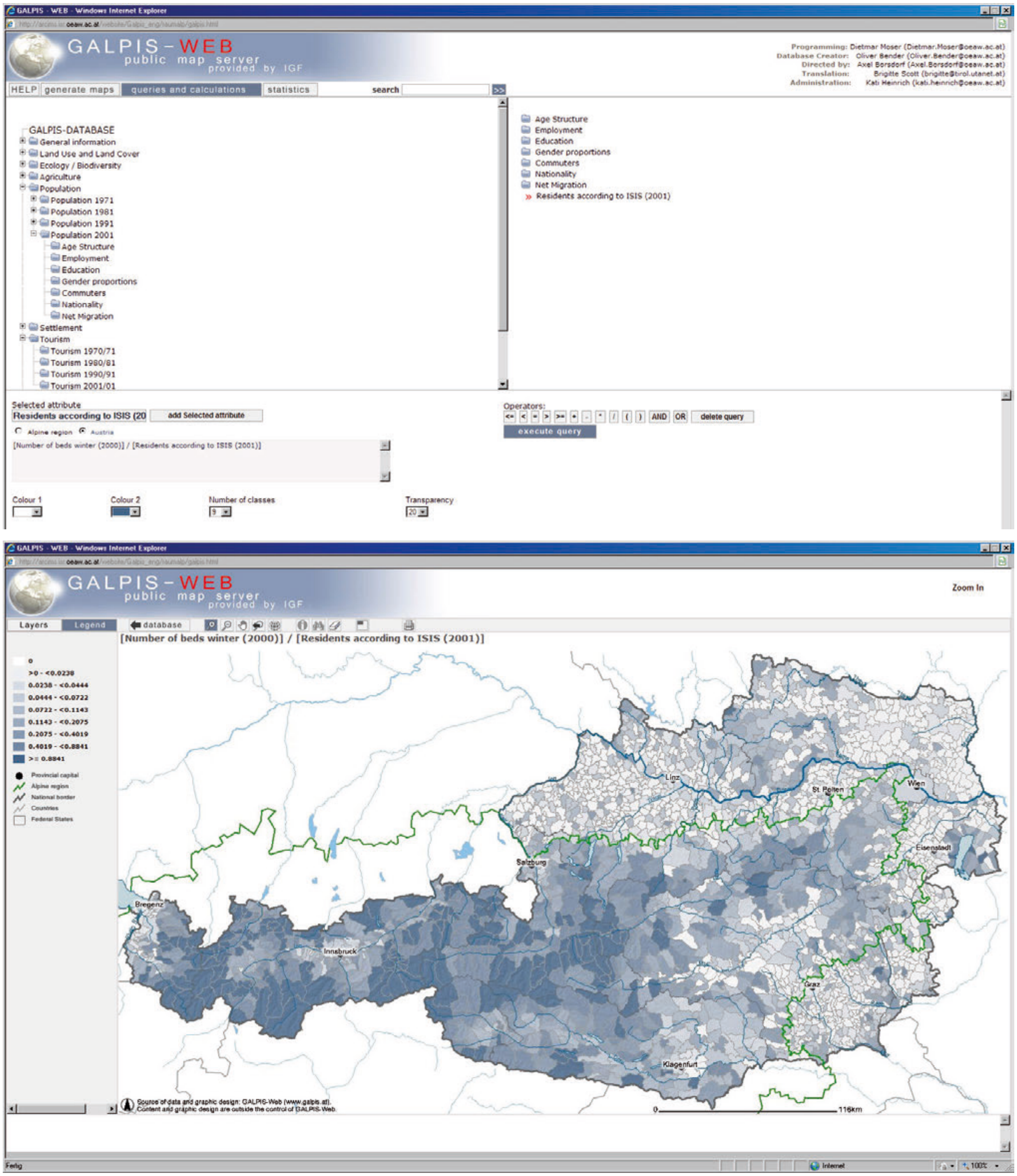

Fig. 2: Selecting primary data in the GALPIS database and creating a calculation formula. Visualizing "new" data using the calculation tool; in this case, tourist intensity as the relation of beds to inhabitants.

mapping software ARC-IMS. The vector map with the thematic representation of the municipality polygons is then transformed into a GIF grid image and sent out via the internet.

Cartographical functionality

The graphical user interface (Fig. 2) contains the range of interactive options for the user as well as the cartographical functionality of GALPIS. The cartographical setup includes a series of predefined map layers for geographical orientation (altitudinal model as shaded relief, rivers, borders, settlements, legends, mapped for the whole of Austria or only for the alpine part, etc.). These layers can be switched on or off as needed. The main layer is the object type municipality with a choice of mapping the whole of the municipal area or just the permanent settlement area, which is often more meaningful. The main information of the map is contained in the attributes related to the municipality. The user has a range of options for selecting both the number and type of attributes as well as how they will be represented. The attributes are selected via a browser. There is a choice of two types of representation: a spatial representation using various normalization rules (related to size of municipality, number of inhabitants, etc.), or proportional symbols, the size of which is determined by several transformation rules. The user can freely determine the range of colours and the number of classes or use the default settings. All data are also provided as figures for double-checking. A meta-database holds the exact definition of the data.

Analytical functionality

The real significance of GALPIS-Web is its analytical functionality which makes it particularly interesting for geographical applications. In addition to performing statistical calculations and classification of the records, the system allows creating thematic maps, especially in the form of harmonized series of maps. The multi-temporal database also enables a comparison of temporal section maps and the mapping of change. Real interdisciplinary cooperation and multi-themed use is facilitated by the free combination of all variables (Fig. 2). The user can, for instance, combine data from the official statistics with ecologic data derived from remote sensing or observations in the field. This increases the number of potential maps from over 1 000 primary records to a limitless number of individually calculated maps. Essentially the performance matches that of traditional cartography, even if the primary output medium is the screen rather than paper, but the user can, of course, print out all generated maps. The step up from a mere data viewer to an interactive analysis tool provides much greater functionality. The only potential drawback, as with any user-defined web GIS, is the fact that it is also possible to generate thematic maps that make no sense.

Here are a few application examples. The free calculation operators of GALPIS-Web enable the user to define indicators that aggregate a situation. The system offers some suggestions, e.g. mapping a *Sustainable Development Index* (SDI), which shows the degree of sustainable development of each municipality. Scientists may use the system to generate highly complex maps. Bender et al. (2002), for instance, presented an urbanization index of Austria, which not only displayed the degree of urbanization (proportion of the urban population in the total population, this can also be mapped) but also the degree of transformation of areas as a result of urban lifestyles. In this case, they used the indicators housing density, proportion of people with university entrance qualification and the proportion of economically active females. The system also facilitates decision-making when choosing a location for new businesses. A supermarket operator wanting to make sure that the shop will have enough business can quickly find out which municipalities do not yet have a supermarket in their own area or in the neighbouring village and the proportion of the population with limited mobility (the young, the old).

Technological trends

For the future, a key objective would be the transition from the current commercially marketed software to open-source products, both for the map server itself and its integration with the database behind it. The independence from proprietary formats and specifications could reduce the running costs currently payable for the services of these companies. Considerable expansion of the analytical options are desirable and well within reach. This would mean expanding the database, i. e. including – harmonized – data from the next census on 31/10/2011 as well as attributes of accessibility (e. g. from Tele Atlas data) and implementing risk and natural landscape data such as danger zones, permafrost cadastre, etc. Another aspect worth looking at would be to design access in such a way that data can be used for analysis and mapping but direct download remains barred. In addition, one could consider options to create an interface for users to deliver data into the web GIS and to download data within the scope of the authorizations and licensing regulations.

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