Remote Sensing and Geographic Information Systems for Design and Operation of Water Resources Systems (Proceedings of Rabat Symposium S3, April 1997). IAHS Publ. no. 242, 1997

Access to hydrological data from GIS applications by graphical software tools — an example from the Hydrological Atlas of Germany (HAD)

RALF BUSSKAMP & HANS-JUERGEN LIEBSCHER
Federal Institute of Hydrology, Postfach 309, D-56003 Koblenz, Germany

Abstract Geographic information systems (GIS) are increasingly applied in hydrology. The necessary GIS software and the digital preparation of the data are usually very cost intensive. Moreover, the broad spectrum of GIS software can be utilized by specialists only, so that the data are accessible to a limited group of users. Here, simple graphic-oriented software tools are presented. These software applications preserve the spatial information while they provide interactive access to the thematic information assigned to the geometrical objects of the map. Theme-tailored user interfaces and consistent user prompting make digital data sets from GIS applications accessible to a much wider group of users.

INTRODUCTION

Many data in hydrology and water resources management are directly related to certain locations and interconnected by complex relations. The electronic processing of such data is increasingly made by means of geographic information systems (GIS). GIS applications allow to perform manipulations and analyses of spatial and non-spatial information, graphic output, and a standardized storage of data. GIS software poses high requirements on the operator's skill, and exhaustive GIS solutions are generally very expensive. Thus, the group of users of this information is strongly limited.

An easily operable, graphic-oriented software was developed to improve this situation. Individual user interfaces, tailored to specific thematic information, allow the access to the digitally stored GIS data even for the less skilled user. In the foreground of the consistent user prompting is the visualization in form of thematic maps. The attractive presentation of digital information aims to satisfy the needs of wide user groups at various levels. This may be the visualization of the available digitized data sets, and of thematic information coupled with digitized objects, or the graphical space-oriented access to the meta-database.

In Germany, similar GIS approaches are made in various fields. In the field of geodesy the important "ATKIS" Project (Amtliches Topographisch-Kartographisches Informationssystem - Official Topographic-cartographic Information System) is under development. The Federal Waterways and Shipping Administration has the lead in the project "DBWK" (Digitale Bundeswasserstrassenkarte — Digital Map of Federal Waterways). Another project in hydrology and water resources management is the revision of the Hydrological Atlas of the Federal Republic of Germany (Hydrologischer Atlas der Bundesrepublik Deutschland — HAD). First experiences from this project are reported in this paper.

THE PROJECT "HAD"

The reunification of Germany and the definition of a new standard period (1961-1990) for long comparable time series by the World Meteorological Organization (WMO) made a revision of the Hydrological Atlas of Germany (Keller, 1978) necessary.

In all its phases the work at the new Hydrological Atlas (HAD) has been computer based. Its concept is a parallel implementation of a conventional analogue atlas and a digital hydrological atlas (Leibundgut, 1994). The analogue (graphical) atlas provides the basic functions of overview, graphical representation as well as documentation. Thus, this graphical atlas represents the basis for the possibilities of spatial interpretations of selected themes. Map related explanations highlight aspects as quality of basic data, topicality and precision of maps, the methodology as well as the availability and the updating of the basic data sets. High-quality maps have been produced by computer-aided mapping, partially in generalized form, at a scale of 1:2 000 000. The functions of the analogue (graphical) atlas are supplemented by digital maps. These give detailed information like the original geometric precision and the possibility of a improved thematic resolution and accuracy, along with all advantages of digital storage. Finally, this digital component offers already the possibility to extract simple maps at scales from 1:500 000 to 1:2 000 000 without generalization from the digital model (Busskamp & Kern, 1995).

The significance of this new atlas is characterized by the fact that all thematic information is superimposed on a standardized base-map. The geometric basis chosen for HAD is the official network of water bodies in the Digital Landscape Model (DLM) 1000 at a scale of 1:500 000. It will be supplemented by an adapted elevation model with a 1 km^2 grid to have the possibility to derive elevation-related information by means of numerical models.

The first themes chosen for maps were the Hydrological Monitoring Network, soil, precipitation, flood-protection (retention areas and flood plains), water supply and wastewater disposal. So far, 80 proposals for maps have been submitted. Some important map themes, derived as well as analytical maps are listed in the Table 1.

Table 1 Selected themes of maps for the Hydrological Atlas of Germany (HAD).

Map content	Map type: Basic	derived/analytical
Spatial distribution of heavy precipitation		×
Mean actual evapotranspiration		×
Aquifer capacity	×	
Groundwater retention time		×
Mean annual groundwater recharge		×
Acidification tendency in groundwater		×
Hydrogeology	×	
Runoff balance of Germany		×
Mean annual high-flow and low-flow		×
Extreme high-flow and low-flow		×
Influences of runoff regulation on water bodies		×
Water protection zones	×	

Standardization and development of the graphic software tool

For the necessary standardization of the digital database existing GIS software solutions by potential map authors were reviewed. After comparing the pros and contras of available software systems and there acceptance, the GIS software "ARC-INFO" made by ESRI was chosen for the preparation of the draft maps of the project.

The development of the user interface was also based on a software product available on the market. In order to meet the requirements of the visualization interface as described above, the following list of minimum requirements had to be satisfied by this product:

(a) The software must run on various hardware systems.
(b) The data interface to the ARC-INFO data model must ensure maximum compatibility for graphical data and thematic attributes.
(c) It must be possible to modify the user interface according to the needs of the various themes.
(d) The software must be available at a reasonable price.

These requirements are met by another product of the ESRI Company. The software ArcView 2.× is offered as a desktop mapping program. By using the

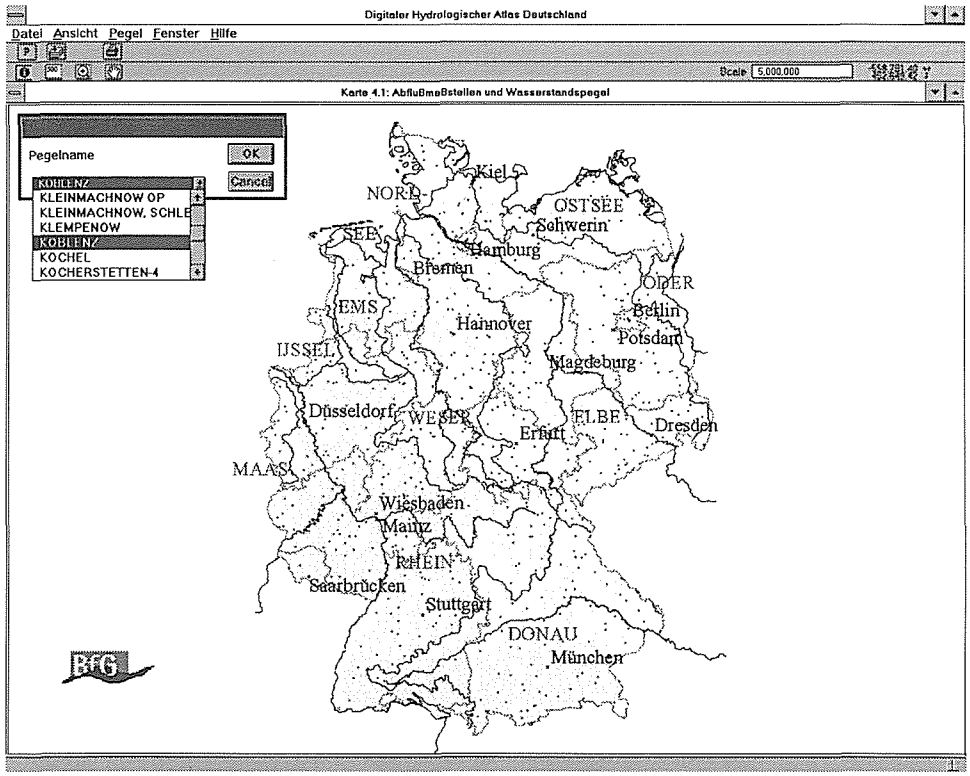

Fig. 1 Survey map, digital version of the Hydrological Atlas of Germany (HAD) represented in the graphic-thematic interface of the map "Hydrological Monitoring Network".

object-oriented programming language AVENUE an adapted user interface can be easily generated from the functional features of ArcView.

The graphic-thematic interface

The main idea in developing the graphic software tool (graphic-thematic interface) for providing users with hydrological data was to create an easy-to-operate tool while offering the user a maximum of functionality. Only this approach ensures the wide application of the product. Using this software should be possible without special knowledge; within a few minutes the operator should be familiar with the interface.

The example of the thematic map "Hydrological Monitoring Network" is taken to demonstrate the functionality of such a graphical software tool. The map theme is loaded by mouse click on an ICON (thematic symbol) under Windows. The user is guided directly into the specific thematic interface. In the case of the "Hydrological Monitoring Network", it is a survey map of Germany which needs no further explanation (Fig. 1).

A two-line caption contains only a few buttons which enable the user to control the program. Besides the purely graphically oriented selection of gauging stations, zooming — free or by pre-set factors — and the map shifting function, the user has

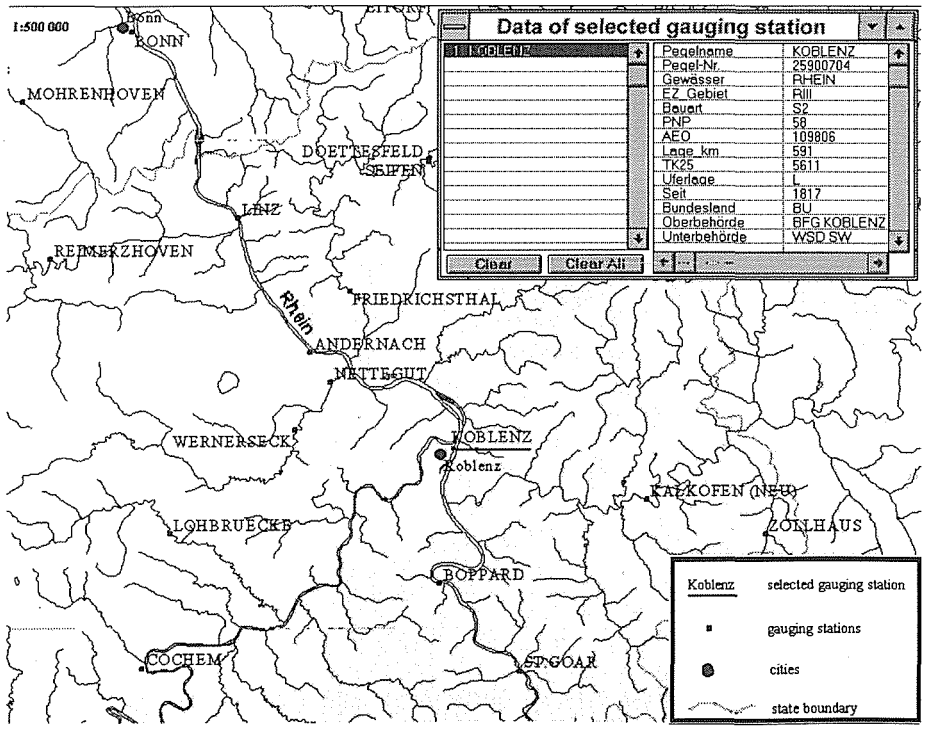

Fig. 2 Zoomed map "Hydrological Monitoring Network" showing a table of data of a selected gauging station.

also an alpha-numerical option for data retrieval at his/her disposal (see Fig. 1, top, left-hand side). After the selection of a gauging station the map is zoomed to a scale of 1:500 000 and the selected station is placed into the centre of the display by default.

Generally, a mouse click at one of the objects (gauging stations) generates a table of all data available describing this object. The vector graphics output can be locally varied in scale by several zoom factors. The density of information in the map increases with the scale. For instance, the network of water bodies is automatically shown in higher density, and the object symbols are adapted (Fig. 2). The content of the respective map section is arranged in such a way that a hard copy can be provided in acceptable quality without any further action of the operator.

In order to optimize the response time, only names and labels which are really necessary are displayed on the monitor. The paper print, however, can contain more description, such as names of water bodies. Moreover, the paper print includes a legend, so that it can be read and understood by anyone without any additional information.

CONCLUSION

GIS applications gain wider fields of application. GIS data which used to require cost-intensive treatment now become accessible to a completely new group of users through the use of the above-described graphical software tool. This will certainly have a positive effect on the general acceptance of GIS solutions.

Acknowledgement The authors thank the Federal Ministry for the Environment and Nuclear Safety for funding the project.

REFERENCES

Busskamp, R. & Kern, F.-J. (1995) Neuer Hydrologischer Atlas von Deutschland in der Pilotphase (The New Hydrological Atlas of Germany, a draft study) (in German). *Deutsche Gewaesserkundliche Mitteilungen* **39**(3), 108-109.

Keller, R. (1978) *Hydrologischer Atlas der Bundesrepublik Deutschland* (Hydrological Atlas of Germany) (68 maps incl. commentary in German and English). Harald Boldt Verlag, Boppard, Germany.

Leibundgut, Ch. (1994) Machbarkeitsstudie — Konzept eines Hydrologischen Atlas der Bundesrepublik Deutschland (Feasibility-study for the conception of a Hydrological Atlas of Germany) (in German). *Bericht der Professur für Hydrologie der Albert-Ludwigs-Univ. Freiburg i. Br., Germany.*