

# DEVELOPING A WEB-BASED DEMOGRAPHIC ATLAS FOR CROATIA

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## Abstract

Demographic data play a central role in the development of any country. However basic and up-to-date information on the population, economy or environment is often not readily available to the scientific community as well as the wider public. This situation is also applicable to Croatia, a post-socialist reform state and candidate country to join the European Union where fundamental information on the structures, composition, distribution, natural and spatial developments and trends of the population is often not readily available. To help bridge this information gap a group of Croatian and German geoscientists are developing the Demographic Atlas of Croatia (DACIS) in a joint effort. DACIS is implemented as a web-based demographic atlas information system that provides the demographic fundamentals and regional developments of the Croatian population, since Croatia's independence from Yugoslavia in 1991. Targeted at the general public, educators as well as decision makers in politics and the economy, the electronic web atlas will be complemented by a conventional book volume.

**Keywords:** electronic atlas, atlas information system, demographic atlas, desktop mapping, web mapping, open source

## 1 INTRODUCTION

Croatia is one of those post-socialist reform states rooted in a rich and changeable history. Manifold geographic information on the past and present of its territory is available. Maps, atlases and alphanumerical data collections exist, both in analog and digital form. Recent products include the following atlases: Veliki Atlas Hrvatske (VAH), Zagreb 2002; Središnji registar prostornih jedinica Republike Hrvatske (SRPJ) = [Central register of spatial units of the Republic of Croatia], Zagreb, 2002; Zemljopisni atlas

Republike Hrvatske (ZARH) = [Geographic Atlas of the Republic of Croatia], Zagreb, 1992; A Concise Atlas of the Republic of Croatia & of the Republic of Bosnia and Herzegovina (CAC), Zagreb, 1993, etc. This information, however, is not always readily accessible to a wider public. A web-based demographic atlas information system (AIS) could help to bridge this information gap in at least one pivotal topic, the demographic situation. To provide fundamental information on the structure and dynamics of the Croatian population in one systematic collection Croatian and German geoscientists of Zagreb and Potsdam universities develop this AIS In a joint project. The Demographic Atlas of Croatia (DACIS) will provide this basic information about the population mainly since independence from Yugoslavia in 1991, complemented by regional case studies. To achieve the widest possible dissemination the electronic web atlas will be complemented by a conventional book volume. This paper deals with the development and prototype implementation of DACIS. It also discusses GIS-based data provision, data processing and high quality visualisation.

## **2 OBJECTIVES AND BACKGROUND**

DACIS is to provide fundamental information on the past and present structure, composition, distribution, natural and spatial developments and trends of the Croatian population. It aims at a wide audience in science, education, politics and economy at home and abroad. To reach the defined target group the atlas will be made available and disseminated in electronic form via Internet as well as in conventional book form. To communicate the information in map form professional visualisation is of key importance. Therefore the majority of maps are easy-to-comprehend 2D analytical maps supplemented by a selection of innovative 3D and multi-temporal map presentations.

For the development and implementation of the AIS concept the German partners could draw on expertise acquired during an earlier R&D project with university and academy partners from Albania and Kosovo. The main outcome of this project was the development and production of the Demographic Atlas of Albania (AGPS; *Bërxfholi et al. 2003*), a paper atlas based on a GIS software platform. Unlike DACIS, the Albanian demographic atlas has been conceptualised as a prototype for a multi-volume Albanian national atlas (*Asche 2009, Asche et al. 2005, Asche & Engemaier 2006*). The experience gained from the AGPS project provided valuable insight into theory and practical application of GIS-based atlas development which are of useful help to DACIS concept and design.

## **3 DACIS CONCEPT**

DACIS is based on state-of-the-art science and technology of the geoinformation age. In this manner it makes extensive use of the internet as the primary and most important platform of disseminating geographic information (*Lechthaler et al. 2005*). In this early stage the development and implementation of DACIS is based on commercial GIS software (ArcGIS). This GIS environment provides for powerful and flexible base data

storage and processing. It does not, however, support map visualisation in accordance with the quality standards of thematic cartography. To facilitate professional map construction the GIS is complemented with a visualisation system (VIS) supporting the full range of graphic composition and design (*Wolff & Asche 2008*). In the final implementation stage open source software will be used to mainly complement or fully substitute the commercial software systems in DACIS. To face potential challenges of unequal access to digital information a paper atlas is also developed from the DACIS platform complementing the web atlas. The paper atlas will be produced in collaboration with a Croatian publishing house.

The development of DACIS aims to meet the following objectives which subsequently can be broken down into work packages:

- Development and implementation based on a GIS-VIS software platform linked by adaptive workflow
- Problem-oriented atlas compilation based on narrative
- Thematic focus on current demographic structures and dynamics in a post-socialist transformation context
- Professional, easy-to-comprehend and visually attractive map models
- Short explanatory texts to accompany main atlas topics
- All-embracing graphic design for web and print atlas.

The development as well as the implementation of DACIS is based on a collaborative approach. Therefore work packages are executed either in Croatia or Germany. Both partners assess work progress in regularly scheduled project workshops.

### **3.1 THEMES AND DATABASE**

In Croatia, most data on the population geography are available past and prior to independence after disintegration of Yugoslavia following the political turnaround of 1989-91. Demographic data covering, in particular, this transformation phase and present developments are frequently not readily accessible to the scientific community as well as a wider public. The continuation of this situation will increase the disproportion between existing data and their unrestricted access as a consequence. By the provision of fundamental, up-to-date and selected historic information on the following demographic subjects DACIS is contributing to narrow this divide:

- Spatial distribution of population: population density, settlement size, etc.
- Natural development of population: natural growth, natality, mortality, etc.
- Spatial mobility: internal/external migration, commuting, refugees, etc.
- Population structure: age and sex structure, education, rural and urban, etc.
- Households and dwellings: features of housing, housing quality, etc.
- Zagreb population: structure and dynamics, etc.
- Population Projections: development until 2025, etc.

In DACIS, all map themes are based on official data collected by the National Bureau of Statistics and on additional information gathered in the Department of Geography of Zagreb University (e.g. *Nejašmić* 1996, 2003, *Nejašmić & Mišetić* 2004, *Nejašmić et. al.* 2008). All themes refer to the current demographic situation according to the administrative divisions used in the 2001 census. These data have been supplemented with intra-census data (1991-2001) and older archive data. They have carefully been checked for quality and consistency before included in the DACIS database. The focused multi-temporal map sequences required all data to be referred to identical administrative divisions. Since the country has seen frequent changes in its administrative divisions historic data have been converted to the administrative units of the 2001 census.

The definition and implementation of a consistent, up-to-date dataset of the Croatian administrative divisions and their nomenclature is of fundamental importance in the development of DACIS. Such dataset did not exist. What was available was the administrative database and nomenclature from the National Bureau of Statistics. Due to different data sources and changes of administrative boundaries over the past decade the geometry of administrative units had to be corrected from existing datasets, updated and unified. A new administrative unit nomenclature has been defined according to clear geographic criteria: ID numbers assigned for each division level. To necessarily complement the administrative units database a generic attribute database has been set up integrating all relevant demographic and related information. In combination both databases are base elements for map construction and visual as well as data-oriented exploration and analysis. This GIS database is the core component of the GIS system powering DACIS.

### **3.2 VISUALISATION AND MAP TYPES**

To target the DACIS objectives map visualisation of demographic data is the most pivotal component. In generally atlas and map design is aimed at producing attractive, easy-to-comprehend maps to facilitate intuitive visual exploration and analysis. Cartographic visualisation thus includes the full range of classical demographic 2D map types complemented by experimental 3D maps. Visualisation and map design is based on the well-established principles of thematic cartography. This approach helps to safeguard that the map models developed fully comply with the professional standards of up-to-date thematic mapping. Quality map visualisations, in turn, facilitate intuitive map reading, exploration and comprehension essential to communicate demographic information and the resulting geographic structures.

Map types have been determined in accordance with the objectives targeted with DACIS and the statistic source data available. In keeping with the aim to provide easy-to-read map models demographic data relating to administrative units have been visualised in analytical 2D choropleth maps or cartograms. Based on the statistical method these single-layer maps are the most common and familiar and at the same time easy-to-comprehend visualisations of demographic phenomena. DACIS includes choropleth

maps for topics like population distribution, natural growth of population, mortality, etc. (cf. fig. 1, left).

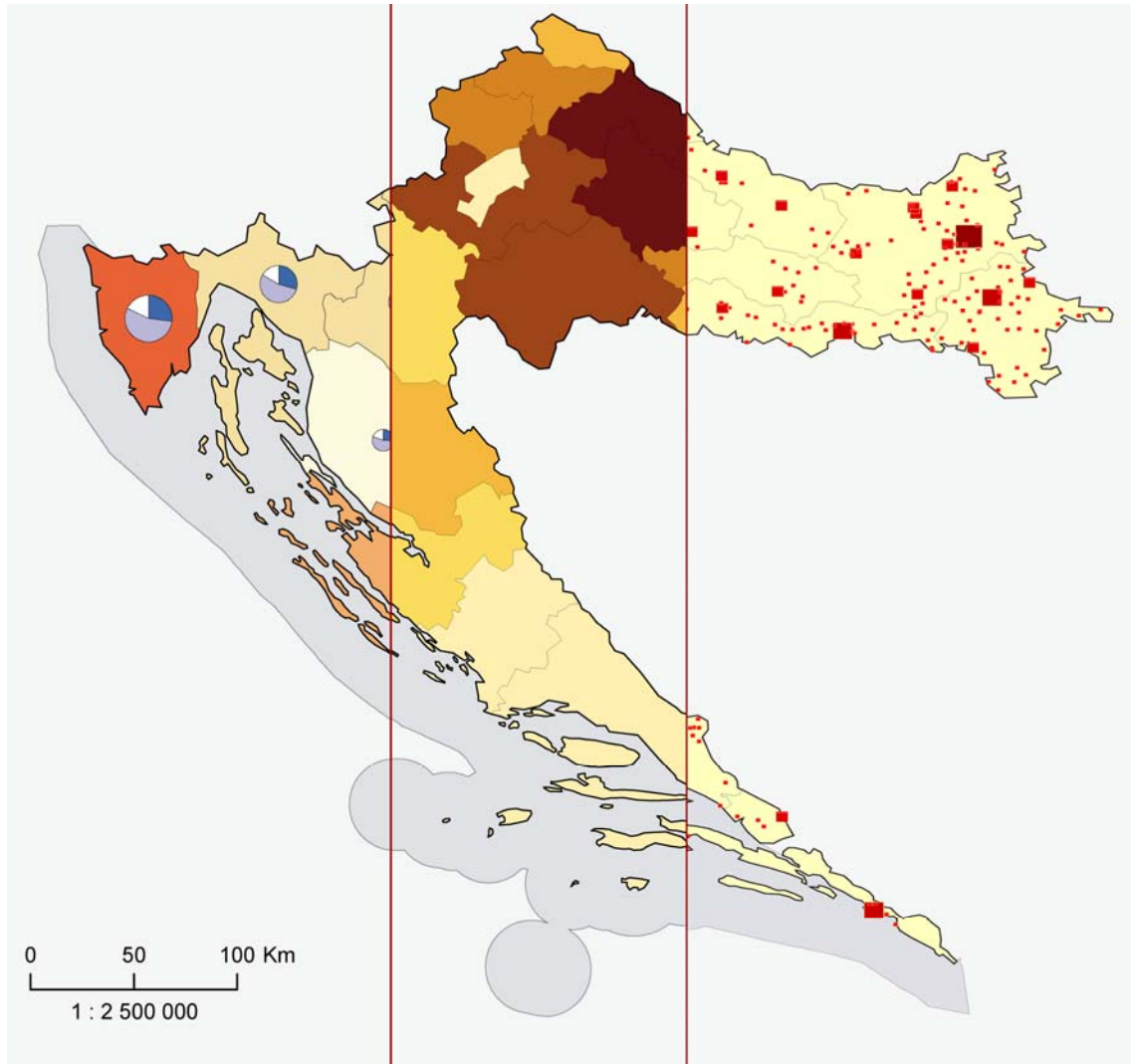


Figure 1: DACIS map types: choropleth map (left), diagram map (centre), dot map (right) from print atlas prototype

Whenever quantitative data subdivided into designated groups are available relating to administrative divisions they are visualised in diagram maps. These combine range-graded symbols or diagrams with area information of the cartogram type. On the one hand the resulting double-layer maps raise the explanatory power of the map graphic, facilitating, e.g., comparison of contextually related absolute and relative quantitative data. On the other hand their greater visual complexity might impede intuitive perception of the map content. That is why the use of diagram maps has been limited to topics like population dynamics, rural and urban population, age structure, etc. (cf. fig. 1, centre).

Locational data on population distribution require a map type presenting the geographic position of absolute values. To serve this purpose dot maps are used to visualise, e.g. settlements and their size or the distribution of population. These analytical maps use range-graded dot symbols to represent the exact locations and values of quantitative information (cf. fig. 1, right).

#### **4 IMPLEMENTATION**

A two-step approach has been decided for the web implementation of DACIS. In the initial phase of prototyping the offline maps are directly transferred into the web atlas prototype. At this stage, the maps provide allow for limited user interaction of the view-only type. In a second extension phase the offline-production platform will be ported to a web-based client-server environment which facilitates the dissemination of data and client or user-centred map compilation. This transfer necessitates a web-based spatial database (such as commercial Arc-IMS or open-source UMN Map Server at least SQL-data-base) as a prerequisite. Such web GIS-VIS platform will permit the use of DACIS map models as templates for vector-based web maps. Interaction with the database is through a graphical user interface (GUI). User interaction with the data-base via the GUI will be interpreted and performed by an interface script language, such as PHP.

GUI development and design has focused on the integration of basic interaction tools in the initial phase. Priority has been given, however, to screen map design. Although the size of computer screens is steadily increasing the space available for the display of map, legend, menus and toolbars is still limited. As a consequence, efforts are required to provide intelligent solutions for efficient and intuitive use of the navigation and manipulation elements. In the prototype stage of a web-based DACIS user interaction includes selection of

- language (Croatian, English, German),
- map themes,
- base map elements,
- administrative divisions,
- zoom and pan function within a predefined range of map scale,
- textual information on map theme selected
- map data and classification
- map print and export functions.

In addition, help and background information on tools and map themes can be accessed (cf. fig. 2). More advanced GUI-based exploration and analysis functions, such as measuring of area and distance, flagging of areas or themes of interest, object selection for comparison of attribute values, manipulation of graphical map appearance by modifying map symbols and data classification, import of personal map symbols, etc. will be implemented in the extension phase.

Until now a GUI prototype relevant for the web environment has been created that allows for further study and experimentation on the DACIS architecture and workflow. The Scalable Vector Graphics Format is one of the tested technologies for GUI implementation. It has the potential to fit the needs of interaction and graphic quality of web atlases (Förster 2003, Engemaier 2005). The prototype includes file-based data storage, Java script-based interaction functionality and DHTML/SVG graphic output (Ernst 2008).

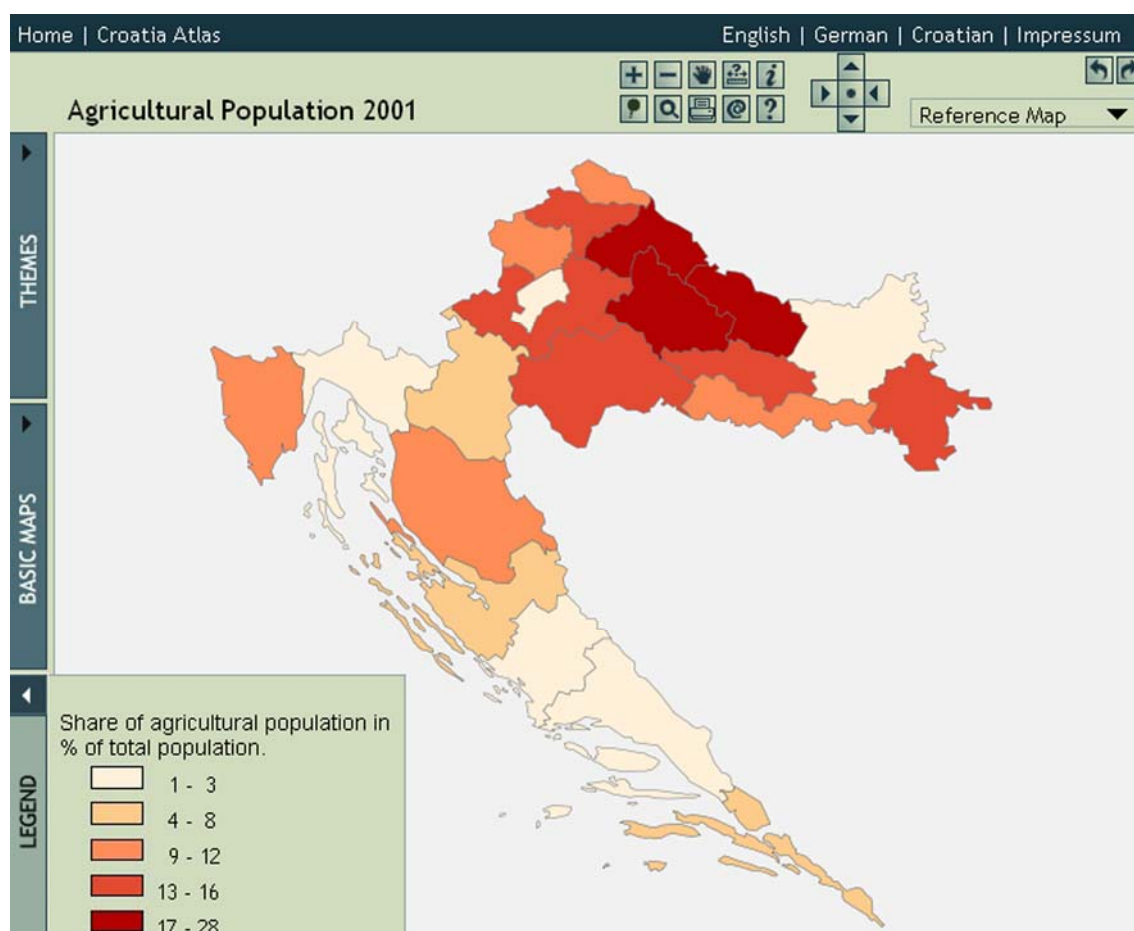


Figure 2: DACIS web atlas prototype – user interface (screenshot)

## 5 CONCLUSION

This paper presents and discusses the conception, development and implementation of a demographic atlas information system for Croatia (DACIS) in the framework of a bi-national R&D project. First results of the initial phase of prototyping show that the combined GIS-VIS environment has proved to be an adequate, stable and efficient software platform to generate the database as well as the map visualisations relating to the demographic themes selected. The GIS and VIS components are combined in a ge-

neric workflow that allows for flexible adaptation to related applications outside DACIS. The cartographic maps generated as well as the database created conform to professional standards in current geoinformation science and technology. To date the existing DACIS prototype is available on the intranet only. Web prototype and prototype map products have thoroughly been analysed and discussed with population geographers and geoinformation scientists in Croatia, Germany and abroad. The feedback received has been positive and encouraging stressing the importance of map-based dissemination of demographic information on Croatia on the web and in book form. As collaborative work of the Croatian and German project partners on the AIS commences an executable version will be published. Among the work packages to be executed the porting of DACIS from the present commercial software system to an open-source environment is a major priority. First tests in this future-oriented direction have been promising. Another important task is the revision and improvement of the user interface. For that purpose competent partners have been included in the project.

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