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## **GIS, CARTOGRAPHY AND SPACE-RELATED EVALUATIONS**

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CONTRIBUTED PAPER

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## **I. INTRODUCTION**

1. The present contribution describes the relation between computer-based cartography and the use of GIS in applications at the Federal Statistical Office. As there is no clear dividing line between cartography and GIS, one area may provide positive feedback for the other. Last year, experience has shown in German official statistics how the two areas complement and promote each other.

## **II. LAND USE/LAND COVER AND GIS**

2. GIS technology was introduced at the Federal Statistical Office more than ten years ago to meet the increasing demand for information on land use. Plans to compile a stock of land use data on a scale of 1 : 25,000 had to be shelved in the early nineties due to the related costs. From 1993 to 1997, work at the Federal Statistical Office focused on implementing the EU CORINE Land Cover project at national level, i.e. producing a digital land cover map on a scale of 1 : 100,000. Methods for checking the quality of digital land cover data and for integrating amounts of data into the seamless data stock were developed and used by the staff at the Federal Statistical Office. In cooperation with several companies, a homogeneous digital land cover data stock was produced. After completion of the raw data stock, a major activity in 1997 was preparing a CD ROM enabling the comfortable export of maps and providing a comprehensive metainformation system into which GIS functionality has partly been integrated.

3. The main objective of these GIS activities was preparing a basic land cover data base available to users in public administration and private businesses. Consequently, evaluating the data base for internal use has not been a priority so far. This is also due to the fact that relevant information can be obtained above all through combined analyses of the land cover data base and other digital data bases presently not available at the Federal Statistical Office. The data base was used for internal purposes when a sampling frame had to be determined for the "Ecological Area Sampling" pilot study. In the course of that study, detailed information was gathered on the flora and fauna of sampling areas, now managed by GIS and extrapolated with adequate mathematical methods.

4. The use of GIS in the applications outlined above has so far not made GIS technology a universal instrument in statistics or initiated the preparation of the respective concepts. This is partly due to the federal structure of official statistics in Germany. Consequently, GIS is in different stages of development in the various Länder. Whether or not GIS will be used as a universal and comprehensive infrastructure for official statistics in all of Germany depends on both methodological questions relating to the further development of statistics and the Land statistical offices' readiness to participate in the respective activities.

## **III. THEMATIC CARTOGRAPHY**

5. For a long time now, the results of statistical surveys have been presented also in the form of thematic maps. As regional data from the level of administrative districts (NUTS 3 level of the EU) have basically been the responsibility of the Land statistical offices, the preparation of maps has long played an important part in some Land statistical offices, while performing such tasks at the Federal Statistical Office is difficult. Nevertheless, there have regularly been cartographic publications also at the federal level, e.g. in the fields of population and agricultural statistics. For more than ten years, every staff member at the Federal Statistical Office has been able to prepare

simple thematic maps for administrative units to the level of administrative districts using STATIS-BUND, the mainframe-based Statistical Information System. Recently, cartographic presentations have increasingly been required for various publications, from information brochures to regularly published subject-matter series.

6. GIS applications on the subject of land use/land cover in Environmental-Economic Accounting and thematic cartography have developed rather separately for some time. In the following, two recent applications or projects will be outlined where cartography and GIS are closely related.

#### **IV. PREPARATION OF A STRUCTURE ATLAS FOR GERMANY**

7. In order to strengthen the cartographic component in the publications of official statistics, the Conference of Heads of the Statistical Offices, consisting of the Presidents of the Statistical Offices of the Federation and the Länder, has entrusted a working party with the preparation of a feasibility study for a structure atlas. The aim is to produce a publication largely consisting of maps and only little explanatory text, which can be updated without much effort when more recent figures become available. The publication is to cover all subject fields for which regional data exist, e.g. population, the health system, education, employment, the environment and national accounts. The unit of analysis will basically be the level of administrative districts (NUTS 3). As an introduction to each subject field, thematic maps at the level of Länder and administrative regions (NUTS 1 and 2) will be used. Although no final decision has been taken yet, the structure atlas will presumably be published at intervals of three years to supplement the publications consisting predominantly of tables.

8. Those divisions at the Federal Statistical Office which have so far used GIS for Environmental-Economic Accounting purposes were entrusted with the respective tasks. The Arc/Info system used so far to produce the digital land cover map contains also modules for generating thematic maps. The structure atlas will as far as possible be prepared with Arc/Info as the system provides a way to structure the basic data and offers comprehensive options for automatization.

9. It is intended to organize the specialized statistical data coming from different sources in data bank form. Some central pieces of meta-information on surveys and data availability will provide an overview of the data base state at any given time. The evaluation programs used to generate the maps are based on this data base. As experience has been gathered with GIS programming, it will be possible to develop an infrastructure for preparing the atlas so that the necessary work can be done efficiently. It is planned to produce the entire atlas as far as possible automatically in the form of postscript files and to send these files to a publishing house. It is obvious that this procedure will necessitate restrictions to the complexity of the maps. It seems, however, that GIS and GIS programming are adequate instruments for pursuing the objectives of this Office.

#### **V. SUPPORTING THE REDEFINITION OF CONSTITUENCIES FOR THE 2002 ELECTIONS TO THE GERMAN BUNDESTAG**

10. The number of constituencies will be reduced from presently 328 to 299 for the 2002 elections to the German Bundestag. For a redefinition of constituencies, the following principles have, among others, to be observed:

- ù The population of a constituency should not differ in number by more than 15 % from the average number of inhabitants of all constituencies; the deviation may by no means exceed 25 %.
- ù The boundaries of communities, administrative districts and towns not attached to an administrative district should, where possible, be retained.
- ù A constituency should consist of one single territory.

11. The constituencies to be defined have to be composed of communities, in the case of larger cities consisting of several constituencies, they are composed of districts. To support the coordination process in the Länder, a GIS-based program was developed which meanwhile has all the components of an integrated Geographical Information System.

12. The System contains a data import component by means of which a proposal for a constituency is entered in the form of a sequential "main election record", together with further files containing additional information. For each proposal, a community map supplemented by the relevant city district constituencies is used as a basic digital map. From the data entered, the input program generates a constituency map and the files required later for purposes of evaluation.

13. The evaluation system includes a component for comfortably visualising proposals for constituencies and another component for an interactive development of new proposals. While working with the system, one can at any time generate any extracts, have the designations of the administrative territorial units and the respective population figures displayed, or colour the map so as to show the electoral behaviour at community level.

14. Supplementing the visualization, comparative tables can be called up for the various constituency proposals. When new constituency proposals are generated interactively, communities can be shifted from one constituency to a neighbouring one by clicking on the screen. The System calculates comparative tables for the proposals thus generated, so that the quality of a variant can be judged immediately. The System contains a comprehensive printing component. With this component, large-size maps can be generated for instance in the computing centre of the Federal Statistical Office.

15. From mid-1997, the System developed was used at various meetings. It turned out to be an efficient instrument for supporting the process of coordination. At the Federal Statistical Office, the Federal Ministry of the Interior and on the part of the Members of the German Bundestag involved it was realized through this application that much additional information can be drawn upon if space-related criteria are also considered by using modern GIS technology.

16. The basic functionality for this application is generally provided also by PC-based desktop GIS systems. Nevertheless, the project could not have been carried out satisfactorily with such a system. During both the program development and application phases, the system had to be supplemented and modified quite frequently. It turned out that flexible and efficient responses to such requirements are possible with a system such as Arc/Info.

## **VI. APPROACHES FOR SPACE-RELATED EVALUATIONS**

17. The two applications outlined basically aim at a presentation of statistical data related to fixed units, e.g. administrative districts, communities, or fixed parts of communities in the case of the constituency application. Visualization and aggregation are of major interest, i.e. the analytical

potential of GIS is not used to the full. As, however, the data are thus available within a Geographical Information System, applications would be possible using a more comprehensive GIS functionality. Here, too, the relation of neighbouring units could be analysed, e.g. to identify outliers with regard to space or to create units that are homogeneous in respect of several variables. More thought should be given to this sector in order to derive more information indispensable for GIS and GIS procedures from the space-related statistical data available.

18. In the subject field "use of area and space" of Environmental-Economic Accounting, some thought has been given to the question of how the digital CORINE Land Cover map could be used to describe urban structures. A radial spatial reference model is used to describe the spatial distribution pattern within an agglomeration. For this purpose, an urban agglomeration is overlaid with any number of concentric circles of equal distance and analysed in tabular form after overlay with the land cover data stock. With regard to the subject of "regional urbanization", the settlement area share, the expansion of highly urbanized sectors (Diameter of the first ring zone with a settlement share < 40 %), the degree of fragmentation (Proportion of the settlement circumference to the square root of the total size of the settlement area), and the share of distant non-built-up areas (Share of non-built-up areas at a distance > 1 km to the settlement boundary in the total area of the distance bracket) are analysed in the ring zones. Moreover, some indicators of the occurrence of non-built-up areas and accessibility were calculated. These indicators are based on the work of the Institut für ökologische Raumentwicklung e.V. (Institute for Ecological Regional Planning) [1], [2] and have partly been modified at the Federal Statistical Office by the Environmental-Economic Accounting Division [3]. Initial results are available and now have to be discussed with the competent experts. From the viewpoint of the Federal Statistical Office, obtaining relevant environmental data from basic data available with the help of GIS procedures is a promising approach. Further indicators are being considered, in particular for assessing the state of the environment.

## **VII. PROSPECTS**

19. The cartographic applications outlined have helped, for the time being, to increase once more the interest in the dimension of space in German official statistics. Now an official digital data base containing the administrative boundaries is needed for various applications. In connection with related Eurostat activities, the Federal Statistical Office aims to have the Bundesamt für Kartographie und Geodäsie (Federal Office for Cartography and Geodesy) compile such a data stock.

20. At the same time, activities for using GIS in Environmental-Economic Accounting continue. Presently, a study is prepared which examines the methodology for updating the land cover data stock. Updating will presumably start in 1999. Now that the pilot study on "Ecological Area Sampling" has been completed successfully, that project, too, has good prospects of being implemented in the entire Federal Republic within the next few years.

**LITERATURE**

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