# Regio - Climate - Project (REKLIP) GIS and Cartography

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## 1 Abstract

The „Regio-Climate-Project“ (REKLIP) is a trinational project (France, Swizerland, Germany) dealing with the analysis of climate development during the last 40 years in the area of the upper Rhine valley. The result will be a climatological atlas consisting of 80 maps produced by using methods of digital cartography within a geo-information-system (GIS).
For this purpose a digital database containing topographic and climatological data was established using a software combination of ARC/INFO as GIS and ORACLE as database.

The presented work shows the concept of the GIS-solution, especially the connection of ARC/INFO with PC-based systems for cartographic layout (ALDUS Freehand and ADOBE Photoshop). The map examples demonstrate the combination of digital topography (hill shading) with thematic information (overlayed raster matrices).
Based on these results further climate-modelling will be done with respect to the concerned Rhine valley region.

# 2 Introduction

The „Regio-Climate-Project“ (REKLIP) is a trinational project located in the upper Rhine valley. Its scientific research program began in 1989 with an expected duration of 8 years.

The principal aim of this project was to explore applications of climatic analysis which should illuminate the spatial and temporal distributions of the most important climatic parameters. Thereby the climatic effects on civilization have to be considered. Beside the climate the parameters “air quality” and “energy transport in the ground atmosphere”, the so called microclimate, will be included in the analysis process.

The most important aims of REKLIP are:

1. Creation of a climatic atlas in which climatic parameters (wind, temperature, cloud, fog, humidity, ...) are represented for the project area.

2. Providing criteria (climatic models) for the assessment of the hygenic air conditions after chemical or nuclear accidents

3. Analysis of the effects of human activities (urbanized regions, traffic, industry, agriculture, generation of energy, ...), on the air quality and the microclimate.

On the one side, the results should be supported by modern observation methods and, on the other side, on high developed numerical analysis. To fulfil these requests a GIS has been established based on the program ARC/INFO and the database system ORACLE.

FRANCE, SWIZERLAND and GERMANY - the countries which are located in the upper Rhine valley - are involved in REKLIP. The geographical unit of the upper Rhine valley is restricted by the Vosges mountains in the west, the Swiss Jura in the south and the German Black Forest in the east. But national boundaries devide the region in political units. Earlier research stopped at these political borders but, nevertheless, the climate do not take care of these artificial lines. REKLIP is the first attempt to pursue research activities in the upper Rhine valley as a climatic unit.

The institutions involved in REKLIP are several institutes of universities located in the project area as Strasbourg, Basel, Freiburg and Karlsruhe, some public organisations like national meteorologic services and other national or municipal facilities. Central point for the data collection and site of the GIS is the Department of Photogrammetry and Remote Sensing in Karlsruhe.

Some of the institutes use smaller subsystems at their disposal to control and prepare data for the transmission to the main system. Communication for data exchange occur at local and regional data networks. Simultaneously the institutes may work directly from their subsystems with the data in the central main system or exchange data with other participants.

# 3 Database

Task of the central database is to supply climatologic data for all participants. This data mainly consists of longtime observations of the national meteorologic services from 1951 up to 1980. With this information the different working groups will do statistical analysis to get maps for the climatic atlas for all meteorologic parameters.

The supply of additional information, like a digital terrain model, digital topographic maps and the results of three landuse classifications based on scenes of Landsat TM, serve for the computation of models, for the analyses with special thematic backgrounds and for producing maps for the climatological atlas.

## 3.1 Meteorological Data

Besides of the already mentioned continuous recordings of the national weather services for the period of 1951 - 1980, there are 36 permanently working meteorologic stations for the data capture. Those store different meteorologic parameters in a period of half an hour. For the take over of these data in the database - working with ORACLE - there exists a standardized data format for the measured parameters in which the owner of each station has to send his data to the central data base. Each station produces nearly 1 MB memory capacity per month (this is a total of 400 MB yearly). This permanently recorded data will be expanded by two intensive observation campaigns in spring and autumn of 1992. During this two weekly campaigns there has been a data capture at the meteorologic stations in a one minute cyclus at 5 selected days. Furthermore there were other mobile measurement systems (cars, balloons, airplanes). Starting from the database of the permanent meteorologic stations and the intensive observation campaigns in the following operational steps of the project, metereologic models for forecast and prediction should be created. These models should not only be used for meteorological forecasts, but also in case of chemical or nuclear accidents with effects on the atmosphere (see also aims of REKLIP).

## 3.2 Topographic Data

Topographic informations of the surface are helpful for spatial analysis. On one side, they are useful for the maps in the climatic atlas, on the other side, they are important for some numerical calculations (emission of streets and urbanized regions, cascading, etc.). The capture of geometry was made by digitizing topographic maps in scale of 1 : 100000 and 1 : 200000. You can see a listing of the used maps in the appendix.
With the help of the ARC/INFO data structure the data was devided in the layers *highways*, *federal streets*, *roads*, *water*, *urbanized regions* and *railways*.

After digitizing it was necessary to carry out geometric corrections because of the resolution of the digitizer and the distortions of the maps. This is inevitable if you want to overlay different datalayers. In further work thematic completitions took place, for example a classification of hydrology and settlement.
At least all digitized layers have been transformed into the UTM coordinate system. This step made it possible to combine identical thematic layers of neighbouring maps into one datalayer for the whole project area.

The produced maps consist of topographic (geometric) information, digitized at the Department of Photogrammetry and Remote Sensing (IPF) and thematic information delivered by the other REKLIP–participants to the IPF.

# 4 Maps in the Climatological Atlas

Based on the digitized topographic data we produced a lot of maps (illustratiuons see appendix). The topography - here represented by cultural features, hydrological features and relief - constitutes the cartographic base map of the meteorological map. Just those features of culture and hydrology, which have close links with the thematic contents, were represented in the map. Thereby it should be avoided to overload the map with too much background information because otherwise the thematic contents loose their significance. Compulsory to all maps is the representation of the relief, either by contour lines, by hill-shading or in a combined form.
Most important in the REKLIP is the „base map“ with a scale of 1 : 500000 and the „general map“ with a scale of 1 : 1000000. They obtain their thematic contents by overlaying raster matrices whose resolution came from a sensible deduction of the measurements. Depending on the number and availability of the measurement points, grid cell sizes between 500 m (precipitation) and 5000 m (clouds, fog) resulted. Moreover selected parts can be illustrated in a detailed map at a scale of 1 : 200000. Because of the necessary high density of the measurements this scale is applied to smaller geographic parts of this project like the precipitation distribution in the basin of Freiburg.
These previously mentioned forms of expression matter the areal subjects (continua). For representation of point features there are diagram maps within the REKLIP- map- series in form of „base maps with diagrams“ at a scale of 1 : 500000 and as „general maps B“ at a scale of 1 : 1000000, where diagrams are directly positioned in the topographic background map. The „diagram sheet“ is available to greater local representations. In the center of this sheet there is a topographic map at a scale of 1 : 1500000 for purpose of orientation. Around this map the illustrations and diagrams are arranged. The geographic relation of the diagrams to the measurement points is realised by graphic characteristics.

The extension of the REKLIP area and the given paper size for printing fix the cutting of the map sheets. At a scale of 1 : 500000 by an extension of the project area from 180 km x 250 km a size of the mapsheet results from 36.0cm x 50.0cm. In this case it is possible to print the map in the DINA2 (42cm x 59.2cm) size. Maps at a scale 1 : 1 MIO are printed in thematical order at one paper sheet DINA2. Also the „Diagrammblatt“ map and the „Detail“ maps must be in DINA2 format.
The digitized topographical objects must be checked for geometric accurancy and completeness. After this check they can be used as map elements. For the REKLIP climatological atlas the aim was to plot the topographic elements much prettier than the official topographic maps. In case of this challenge the digitized streets have had a signature consisting of two lines. It was possible to create these two lines for every street in ARC/INFO. In case of the different scales in digitizing (1 : 200000 and 1 : 100000) and plotting (1 : 200000 and 1 : 500000) there arised different problems e.g. overlapping. These problems could only be solved by manual generalisation. You have to spend much time on this. At the plotting scale of 1 : 200000 we mostly have to displace the rivers from the streets. At a scale of 1 : 500000 it was necessary to reconstruct the automatically generated two line signature of the streets. Because of the geometric density of some digitized objects the generation of the double lines failed in some cases.
In the first plannings of the climatological atlas we wanted to create all maps out of one database. Due to the generalization we have one identical database for the maps at 1 : 200000 and 1 : 500000. For the other maps at 1 : 1 MIO and 1 : 1.5 MIO the manual generalization work was too comprehensive so that it was more convenient to digitize new ones. Therefore a

new database for 1 : 1 MIO and 1 : 1.5 MIO results on the base of the IWK (internat.World Map). The advantage of this work is a reduced database at these scales. We can handle the new database easier and quicker than the old one (1 : 200000) but on the other side, two different datasets are more difficult to handle: changes and completions have to be carried out in every scale, which turned out to be a time consuming work. Furthermore you must pay attention on pursuing all changes in each map.

Five different kinds of maps are developed for the climatological atlas. You can see some examples at the end of this article (Figures 2, 3, 4 and 5).

## 4.1 Map Production

First it was planned to produce all maps by using a single system namely ARC/INFO. In the course of time some different problems arised forcing us to think over. In ARC/INFO (at that time version 5.0.1) the following demands are difficult or not to realise (in the version 6.1.1 problems solved):

e.g. hill-shading
import of diagrams
lettering
cartographic symbols

It was planned to use the hill-shading as background information to the maps of kind 1, 2, 3 and 4. The production of hill-shading was not satisfactorily solvable in ARC/INFO (version 5.0.1). Other software programs like ADOBE Photoshop (for the hill-shading) and ALDUS Freehand (for the other points) give better results. Another important fact is the data import which can only be done indirectly. There are graphic systems which has solved this problem in an easier way. The third and most important point is the lettering task in ARC/INFO which do not provide the high quality that cartographic maps require. Special cartographic programs are better qualified for typography. Therefore, we have thought about how to produce maps for this climatological atlas. ARC/INFO (version 5.0.1) by itself cannot realize all the requirements. There are two possibilities to gain control of these problems:
Either you have to evolve your own program for best map production or you use commercial programs.
The first possibility was out of question due to time problems. Thus we decided to use the commercial programs Aldus Freehand and Adobe Photoshop.
Adobe Photoshop is a pixel based image processing program. It works on raster base. It is used to produce the hill-shading (as background information). The vector based program Aldus Freehand is wide spread in cartographic applications. Freehand is used to design the maps concerning cartographic aspects and for the output. Lettering, data-import and positioning the diagrams is realised by Freehand. Also the printing films are made by Freehand.
The realized steps are the following:

1. Digitizing the maps. Producing of thematic data by the meteorologists.
2. Export of the digitized maps out of ARC/INFO
3. Production of the hill-shading in Photoshop
4. Import of the digitized topographic data (the ARC/INFO export-files), the meteorological data and the hill-shading in Freehand.

5. Lettering the maps and arranging the diagrams (Freehand).

6. Map output (Freehand)

In the working flow shown above the maps are produced on digital way. The advantage is the digital existence of all features which on this way are available for further projects and calculations. All data can be get out of one databank and can be processed and updated.
The disadvantage is the use of three different systems (ARC/INFO, Aldus Freehand and Adobe Photoshop).
But if there are interfaces between different systems, why not using them to get the best result. And this is successfully realised in this way.
This stage of development is at the same time a new direction to the digital type of climatological atlasses. Therefore the thematic information layers have just to be updated so that they can be overlaid with the topographic data. Afterwards all layers can be together represented and processed. Beside this pure visualisation of data in a next step database queries and access to the databank can directly take place supported by special analysis functions. Besides of statistical results, analysis of time series can be done. The further result of the present climatological atlas in its traditional analog form will then be a complete "meteorological information system".

# 5 Conclusion

The use of geographic information systems with a variety of applications is steadily increasing. The common base of all applications is the cartographic data updating and output.
Unfortunately, the modern computer-aided means are opposite to the ideas of the classic cartography. This leads to unsatisfactory results which don't reach the quality of traditionally produced maps though a lot of techniques and material are available. This is probably caused by the fact that the costs of simple systems are decreasing so that an increasing number of people or firms have such systems to their disposal. The performance of these systems are impressive at first sight, but on closer examination or intensive use, it turns out that the one or the other component is missing. As a consequence, the users start looking for an additional system complying the missing tasks. The result is an amount of different systems in use, with whom the tasks can rarely be fulfilled in a correct and efficient way.
Not to speek of the problem of passing the data from one system to the other. The different systems can only correctly be used if the interface between the systems works without any problems. In this case an optimal and acceptable result can be achieved. As you can see, a system to produce maps completely on a digital way still is missing.

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