CARTOGRAPHIC PRESENTATION OF SPATIO-TEMPORAL INFORMATION RELATED TO PUNCTUAL DATA AS A USABLE TOOL FOR RIGHT MODELLING OF CONTINUOUS FEATURES

Bac–Bronowicz, J.

Agricultural University of Wroclaw, Department of Geodesy and Photogrammetry,
ul. Grunwaldzka 53, 50–357, Wroclaw, Poland. Association of Polish Cartographers.
Tel/Fax: (+48 71) 3205617. E-mail: bac–bronowicz@kgf.ar.wroc.pl

ABSTRACT

The paper presents the compound system of designations of temporal variety of data being in disposal for map makers. Each of signs determines certain period of data gathering. Suitable comparison of designation creates full information complex sign representing total period of measurement chosen characteristic. Signs on the maps connected with reliability of the parameters depends on taking into account suitably long periods of observation. Correctness and usefulness of process of cartographical modelling directly depend on truthfulness, adequacy and also representativeness of the data.

The paper is one of the first attempts to apply GIS to analysis of existing climatic data in the Lower Silesia. The method is presented using as an example the collection of characteristics connected with precipitation. Accessible data are the result of daily and weekly measurements. Sources of the data represent different levels of reliability with regard to their spatio-temporal representativity. Each of the meteorological stations provides information about the data of every registered features as well as its location.

Each of characteristic of precipitation has to be treated separately because the set of characteristics is not always constant during the whole period of station's activity. Applied graphical variables: value, shape, pattern – allow to recognise holistil spatial distribution of chosen group of terminal data and assess the level of their reliability in studied part of Lower Silesia region.

The example presented in the paper is a simplified form of the more detailed proposal. All characteristics have been elaborated and many may be used in practical case of different thematic studies.

In the next part author presents developed form of proposal on the part of studied territory. It can be noticed that adding the variable "colour" might have an influence on improving the reliability of the system. The next suggestion to navigate disseminate precipitation data in Lower Silesia region may be constructing multidimensional display. The 3D geoview can present time on the z-axis. 110 class is characterized by temporal rather than spatial factors. Events with this combination of characteristics are clustered temporally (several locations with similar attributes during the same year).

The isoline maps of reliability may be also constructed and presented. On the base of the spatial distribution determined groups of designation (using square grid) isolines of density of homogeneous data may be constructed. In this case not only comparison of data but also spatial distribution of measuring station should be considered.

For determined practical purposes different connections of characteristics have to be considered. But even separately treated characteristics of precipitation may not always be compared with suitable reliability. It is because of lack of homogeneous data on the whole studied territory. This statement is especially important in the age of fast development of spatial information systems which accelerated and simplified gathering and transferring of the data. Thanks to these systems, existing separate data files can be easily and quickly combined and integrated into the large data collection. Currently GIS endusers require detailed precipitation maps not only of mean annual values, but also information on expected deviations with probability of extreme events.

1. INTRODUCTION

The GIS usually includes basic topographic elements and information concerning landuse. The information system of terrain will be then supplemented with such area-based elements of natural conditions as: soil structure, geology, morphology and land cover.

Except for some elements of climate, all data mentioned above can be based on specially processed up-to-date cartographic and remote-sensing data each of them with a certain level of reliability. Now the GIS allow of combination of this information to relate to area-based elements with point information, for example median rainfall. Each of the meteorological stations provides information about the date of every registered feature as well as its location. These accessible data are the result of daily or weekly measurements. Sources of the data represent different levels of reliability with regard to their spatio-temporal representativity.

Measurements of the different periods from not firm numbers of points within the area are the base for continuous models. Reliability of climatic parameters for certain units is also connected with adopting adequately long measuring periods, their representation level, variation range and time lapse.

The paper is one of the first attempts to apply GIS to the analysis of existing climatic data in the Lower Silesia (Poland). In 2000 a project of Lower Silesia Spatial Information System was presented. Nowadays its basic levels concerning hydrology and environmental protection, are going to be gradually completed with soil structure, land cover and climate. Information will be assigned to geometric reference unit [1]. While evaluating correlations between precipitation data and land cover data we should take into account accuracy, probability and representativity values [2]. It is often disregarded in GIS but in correctly constructed GIS this should be taken into account to properly inform the decision-marker.

By using mentioned above designation one can determine the precision of object, for example in obtained median rainfall monthly basis and others value precipitation data. Metadata show the probability with which these object have been correctly classified. Recognition of the distribution of characteristics of precipitation makes it possible to assess the correctness in each point in the whole area.

2. DATA AND METHODS

2.1 Data

In 1891 the regular measurements of precipitation in Lower Silesia region began. From 1889 to 1981 there were 400 sites of data gathering in certain period. Nowadays there are about 50 observation points.

In this area Institute of Meteorology and Water Management collects and disposes the meteorological measurements. Some of the data are available only on maps and tables. Maps are made according to 4 different coordinate system with different data collection.

Polish network of measuring stations does not represent most of units, which are separated by topoclimatic conditions. This study proposes a selection of precipitation data series received from a measurement net: precipitation sums on monthly and annual basis; precipitation sums on daily basis; the number of precipitation days; maximal snow depth; downpours and rainfall of high density; hail, snow and thunderstorm data; snow cover water equivalent; “totalizator” (“lottery”) type of rain gauge. Information concerning an above-mentioned meteorological stations consists of a list of data related to different climatic periods.

2.2 Method

Each of characteristic of precipitation has to be treated separately because the set of characteristics is not always constant during the whole period of station’s activity. Application of graphical variables: value, shape, pattern – allow to recognise the holistic spatial distribution of the chosen group of final data and assessing the level of their reliability in studied part of Lower Silesia region.

On this maps point data represent the location of each station. Point symbols represent many important features. After many trials of comparison multi-circle compound symbols has been proposed. Signs were constructed as hierarchy and succession system of circles showing the consecutive periods of observations. Circle symbols have been chosen because of very small area being in disposal (Figs. 1 and 2).

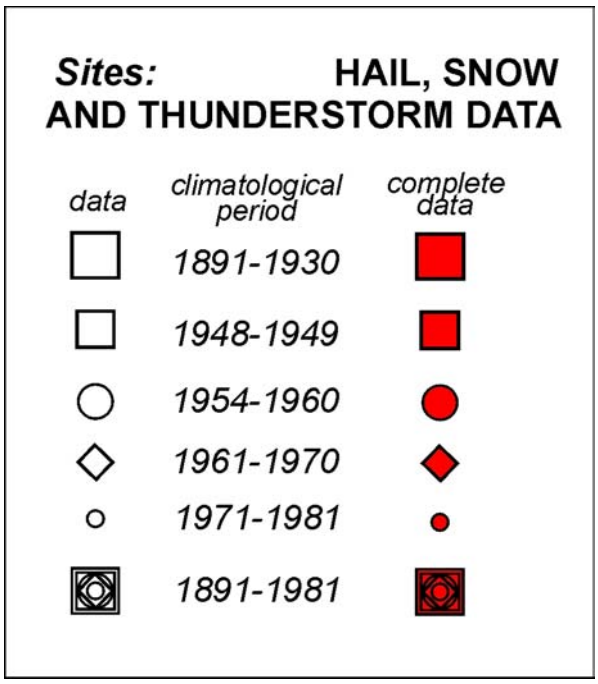

Figure 1. Legend – Multi-shape point symbols represent precipitation events at climatic periods and places

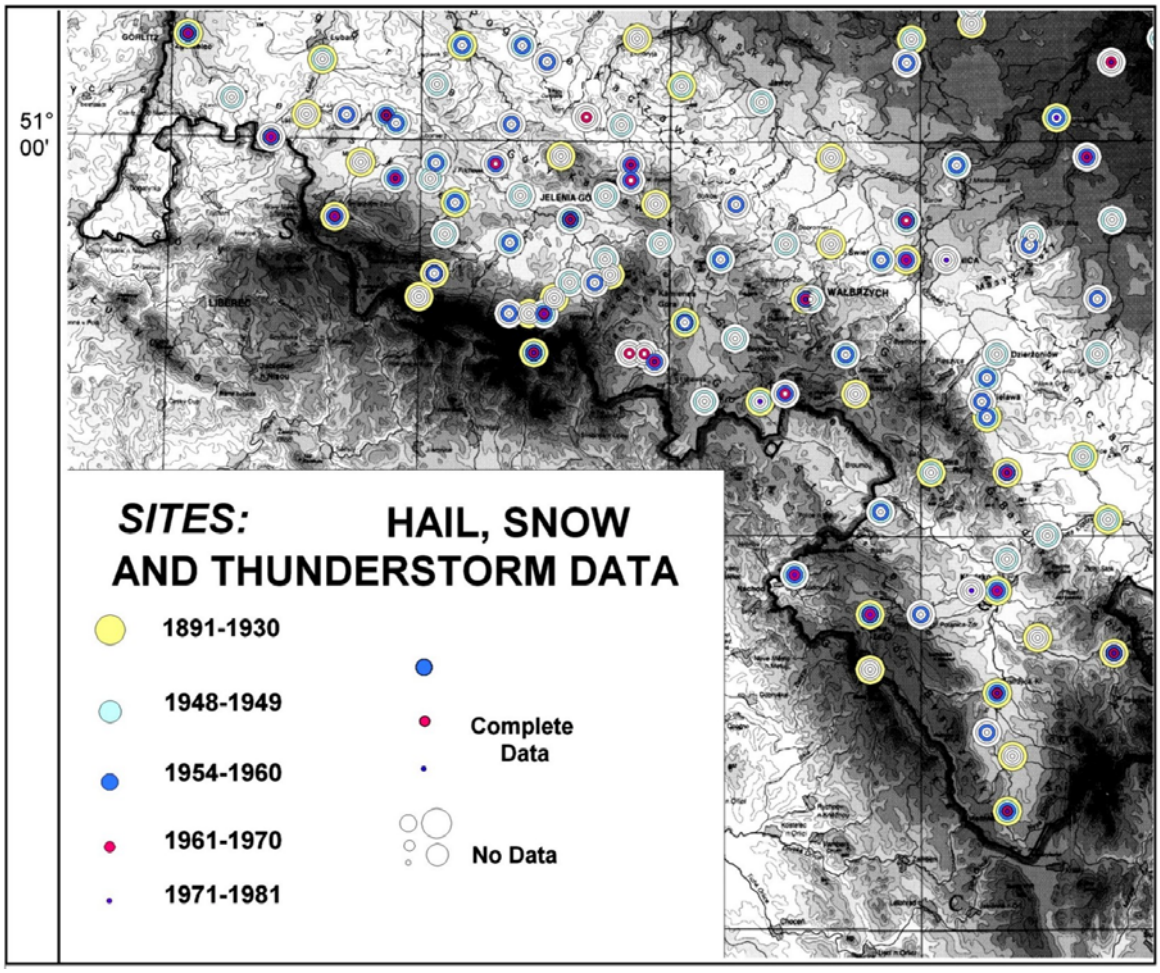

Figure 2. A geoview is a "three – dimension" window in which geographic space is mapped in two dimensions. The "third dimension" represents data related to different climatic periods. Exterior circle represent pre-war period. The topographic basis [4].

The complete data in each of the presented measurement's periods are the basis for further geoview constructed. It can be noticed that adding the variable "colour" might have an influence on improving the reliability of the system. These symbols can be easily varied in size [3]. The example (Fig. 3) presented in the paper is a simplified form of the more detailed proposal.

Based on the available meteorological data, spatial distributions models of climate's characteristics were created, connected in various ways, and adjusted to the specified needs of the users. The identification of precipitation regions in the tested area typical for Lower Silesia region is an important part of a research project, being sponsored by the State Committee for Scientific Research for the years 2001- 2004 (The modelling spatial climate data in GIS no. 8 T12E 042 21).

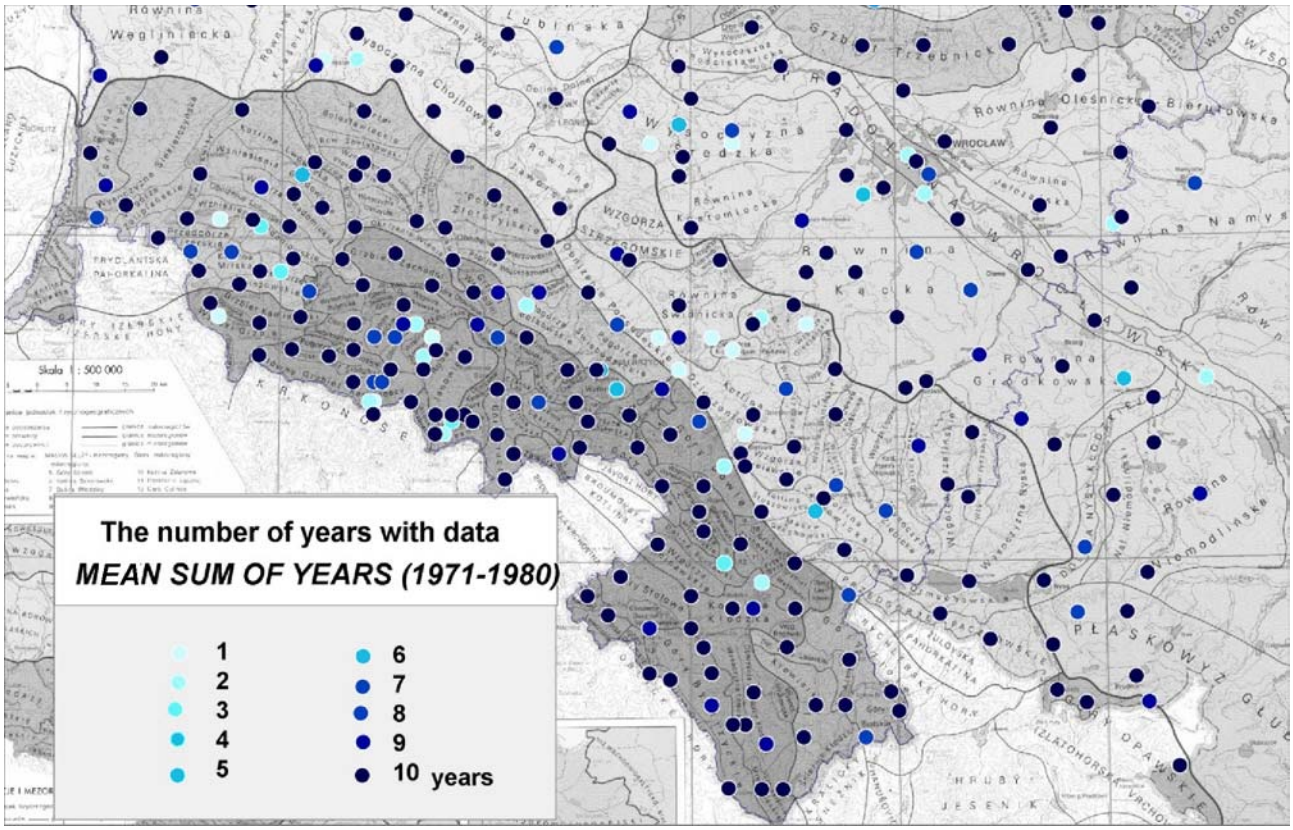

Figure 3. The complete measurements during the period of ten years.

3. METHODOLOGICAL REMARKS FOR THE APPLICABLE ELABORATION OF CONTINUOUS FORM OF CARTOGRAPHIC PRESENTATION OF THE POINT DATA (EXAMPLE OF PRECIPITATION)

All characteristics have been elaborated and many may be used in practical case of different thematic studies. Reliable maps which show distribution of factors of climate should be created only basing on the results from the same periods. Collected annual precipitations sums show the lowest variation in comparison with other precipitation parameters.

The only many years' averages of precipitation that can be used in the detailed comparisons should derive from the same period obtained from continuous observation from at least thirty and better forty years. For a certain number of stations in Lower Silesia the results from 110-year-long precipitation time series concerning years from 1891 to 2001 are published. Average values of precipitation from 30 year long periods (for example: 1931-60, 1951-80) are placed in particular series of 110 years' duration. Even 30-years-long period can be unrepresentative because of uneven distribution of precipitation in longer perspective (for all 110-year period).Proposed symbols may play a role in the geospatial infrastructure needed to search for disseminate climate data (Figs. 1 and 2).

In case of shorter period of observations analyses of data should be more detailed. In extreme cases maximal daily precipitations measurement can be used. To show continuous data, the graphic variable "colour" has been used. Variable "colour" to smoothly graduated tints has been indicated (Fig. 3).

The isoline maps of reliability may be also constructed and presented. On the base of the spatial distribution determined groups of designation (using square grid) isolines of density of homogeneous data may be constructed. In this case not only comparison of data but also spatial distribution of measuring station should be considered.

4. CONCLUSION

Correctness and usefulness of cartographical modelling process depend on truthfulness, adequacy and also representativity of the data.For the determined practical purposes different connections of characteristics should be considered. But even separately treated characteristics of precipitation may not always be compared with suitable reliability. It is because of the lack of homogeneous data on the whole studied territory. This statement is especially important in the age of fast development of spatial information systems, which accelerated and simplified gathering and transferring of the data. Thanks to these systems existing separate data files can be easily and quickly combined and integrated into the large data collections. For complete inference, only data from stations with similar geographic location (relatively close distance, morphological and roughness conditions) can be taken into account.

Creating adequate multivariate maps of climatological conditions using GIS system requires full information about both climatic data and their accuracy based on metadata. Currently GIS end users require detailed precipitation maps not only of mean annual values but also information about expected deviations with probability of extreme events. Such models enable unbiased assessments of climate conditions with detailed spatial resolution. It seems to be the current issue because several research programmes on the construction of climatic databases in medium scales have been just started.

Methodology of creating climatic data is based on the regional spatial information systems, which are still under development. Because of that the development of studies about the interpretation of correctness of climatological characteristics is very important.

Environmental data sets usually have both: temporal and spatial components. There are two purposes: the first is to extend GIS with the analysis of spatial and visualisation methods into a spatiotemporal sphere the second is to integrate geographic information science in order to produce new methods that facilitate environmental science and environmental policy decision.

The next suggestion to navigate disseminate precipitation data in Lower Silesia region may be constructing multidimensional display. The 3D geoview can present time on the z-axis [5]. 110 class is characterized by temporal rather than spatial factors. Events with this combination of characteristics are clustered temporally (several locations with similar attributes during the same year). The form of presentation has to be precisely planned to eliminate dependent topographical elements. They should be easy to understand and not complicated.

Based on the available meteorologil data, constructed as mentioned above, spatial distribution models of climate characteristics will be created, connected in various ways and adjusted to the specified needs of the users [6].

5. REFERENCES

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ul. Grunwaldzka 53, 50–357, Wroclaw, Poland. Association of Polish Cartographers.
Tel/Fax: (+48 71) 3205617. E-mail: bac–bronowicz@kgf.ar.wroc.pl

Biography

Dr. Joanna Bac-Bronowicz holds a Diploma of Geodesy (Geodetic and Photogrammetric Determination of Tree-dimensional Form of Cavern) from the Agricultural University of Wroclaw and in 1991 got PhD in Geodesy (The Method of Construction of Multi-feature's Thematic Maps for Example Maps of Spatial Distribution of Precipitation of Lower Silesia).

She started to work in the Agricultural University of Wroclaw as an assistant in the Department of Geodesy Photogrammetry at Agricultural University of Wroclaw. Nowadays she is an academic worker in GIS Laboratory. Several years ago (1993–2002) she taught computer cartography in the University of Wroclaw, Institute of Geography.

She is an author of 40 published works. She dealt with elaborating maps for atlases – e.g. in Atlas of Lower and Opole Silesia. Nowadays she deals with elaborating modeling and visualization of spatio-temporal data and for 10 years she has been constructing maps as a basis for GIS and thematic base for environment (Wroclaw and Lower Silesia).

Apart from that, she deals with teaching children new methods of cartography and between 1997 – 2001 she actively took part, working in the Children and Cartography commission of ICA. She also works with Lower Silesia Spatial System lead by Department of Geodesy and Cartography Office of the Marshal of Lower Silesian Voivodship and she was a computer editor of Romer Polish Cartographical Publishing House (3 years).

For eight years Mrs. Bac–Bronowicz was a chairwomen of Cartographic Section of the Association of Polish Surveyors and for four years she is a member of National Committee of ICA and a member of State Committee of Geodesy and Cartography of Surveyor General of Poland.She belonged to the group of people who founded Association of Polish Cartographers and from 1999 she is a president of that association. Association of Polish Cartographers was scattered in different organizations and institutions, and divided into groups of "large- and small-scale" cartographers, publishers and scientists, civil, military and navigational cartographers. The main goals of APC are following: gathering the originators and specialists that actively work as cartographers to represent our trade in Poland and abroad, co-operating with proper institutions to develop different new techniques and also cartographic production, implementing our research achievements in the field of cartography and publishing, protecting our profession and copyrights, raising the level of knowledge and qualification of the members and moreover developing a high level of professional ethics, popularization in the society the issues of science, technology and economy in the field of cartography.

Mrs. Bac – Bronowicz is married and has two daughters. Her husband is a doctor of medicine and both daughters study at University School of Physical Education in Wroclaw. Her biggest hobby is sailing.