TOPOGRAPHIC FACTORS AS A USABLE TOOL FOR CORRECT MODELLING OF CONTINUOUS FEATURES INDICATED IN POINTS

Joanna Bac–Bronowicz

Department of Geodesy and Photogrammetry, Agricultural University of Wroclaw,
Association of Polish Cartographers, Poland

Abstract:

In models, connected with values measured in discrete point, truthfulness, adequacy as well as representativnes of information are very difficult to characterize. It concerns particularly measuring parameters in points which spatialization of values is dependent on topographic conditions, for instance, spreading of air pollution is important especially in mountains and hills, because of very strong influence of relief. What is proposed is the division of the area around the station into the regions of homogenous conditions containing the same type of information. Geometric basic units of the system can be aggregated in adequate areas on the grounds of their belonging to suitable regions. Each region consists of elementary fields, which will be assigned to determine the type of conditions with adequate degree of risk which is the product of probabilities of information transfer. It has been shown on the example of precipitation.

INTRODUCTION

The precise determination of zones, for which the value of natural parameters has been found with height probability, is of great importance particularly in interdisciplinary research where specialists from different scientific fields cooperate very closely.

Nowadays we have more and more data and information about phenomena. Choosing data from such a wide range of geographic databases requires establishing the needs and the aim of creating the model of those data as well as information we want to obtain from such a model. Professional knowledge about researched phenomenon, predicting possible solutions and usage of created model are crucial. Making geographical analyses, which do not have clear aim, without awareness of their limited possibilities may lead to meaningless results but may as well reveal the unconventional solutions to the problem. The new approach to geographical data analyses and syntheses, out of which we obtain information about the world, is responding to many changes in the contemporary world, especially in human thinking, the collection of data leading to geo-information which is shared through knowledge (Konecny, 2004). On the basis of data and information we can create models of high probability of different phenomena, on the condition that we will consciously cover the way to wisdom through knowledge gained on the basis of experience attained from information taken from purposely chosen data of the highest quality. In some cases, the knowledge of the phenomenon should be detailed (Bac-Bronowicz; Dancewicz, 2005) but should be also accompanied by knowledge about factors which have an influence on values' distribution of that phenomena (Bac-Bronowicz, 2004). The influence of area's shape, technical devices' durability and soil capacity on the flood borders is the obvious example. In such a case, the relationships are possible to predict, especially if we have historical knowledge about floods in given region. Due to the knowledge and experience about the phenomenon we can protect many areas from flood, which causes costly loses, or at least assess the risk and minimize the results of disaster. Lack of knowledge on that fact may lead to drawing wrong conclusions when it comes to phenomenon distribution and to elaborating incorrect forecasts.

Another example of phenomena, which spatial distribution of values is connected to topographical factors, are various climatologic characteristics. They are measured in points. The best solution is to place a measurement point in each unit separated by different topographic conditions, so as to make the data representative for the whole area. Existing measurement's networks usually do not meet those conditions. Final construction of the spatial model probably will depend on the accepted collection of interpolation criteria (Bihari Z.,2000)

Depending on the interpolation method (two-stage – distance-weighted and correlational; surface-raster; carry propagation) the outcome may vary.
Corrections of regions' borders and reliability zones are introduced as a part of geographic research. We can differentiate areas which have similar group of accompanying and affecting the phenomenon distribution factors. For example: distance, height above the sea level and land use/ land cover. Values of parameters can vary significantly in places of high land variability, especially where morphological barriers are present. It is obvious that the categorization in inherently complex spatial phenomenon into classes is bound to involve subjectivity to such areas as class description (Zhang J., Goodchild M. 2002). In this elaboration "the same type of information" represent discrete points belonging to suitable classes and localization of these points is similar when it comes to topographic conditions. In considerations included in this paper, the probability of transfer of information of uncertainty in categorical variables is not introduced into calculations. Accepted in this paper categorization has been considered certain, but in the later elaborations, the probability of ambiguity in categorical variables is planned to be introduced.

COMBINATED MODELING OF VALUES OF PHENOMENA INCLUDING TOPOGRAPHIC DATA CONSIDERED TO BE THE FACTORS

What is proposed is the division of the area around the indicating point into the regions of homogenous conditions containing the same type of information.
Geometric basic units of the system (Bac-Bronowicz, 2001) can be aggregated in adequate areas on the grounds of their belonging to certain regions. Each region consists of elementary fields of climatic groundwork, which will be assigned to determine the type of conditions with certain degree of risk which is the product of probabilities of information transfer.
After the analyses for elaboration of parameters' distribution, the basic fields in elaborations of the size of 1 km square were chosen. In Poland one of the basic systems is the TEMKART (Podlacha, 1999). The initial unit is a trapezium with sides that correspond with one degree in geographic reference system, divided into fields with sides 10' and 5'. Basing on the model of probability's distribution together with the increase in distance between meteorological stations, it was assumed that probability of the transfer of the values of for example precipitation sums diminishes together with the distance (Fig.1).

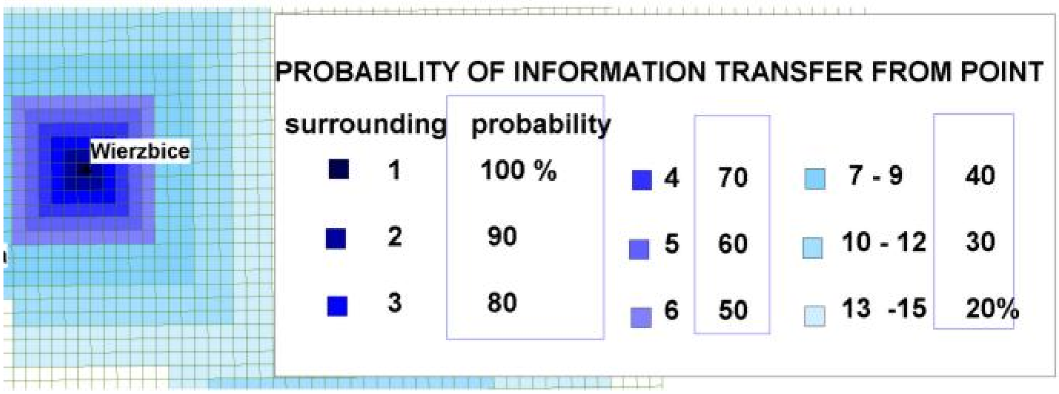

Figure 1. Assigning point information about adequate attributes to elementary fields in spatial information groundwork

Sums of precipitation were estimated earlier - the fact that different data represent different level of reliability as far as their spatio-temporal representation was taken into account (Bac-Bronowicz, 2003).
Such an assumption of information transfer results in the fact that some of elementary fields are included in two or even 3 indicating points' surroundings. (Fig.2).
First of the author's accepted ideas of defining the superiority of probability of alternative belonging to the area was a proposition of applying the units by Kondracki to the borders resulting from shape and morphology of terrain (Fig.3). Using the Kondracki units (Kondracki, 2000) it is possible to distinguish morphological barriers, which are the main factor of climatic characteristics' distribution. Adopting those units as basic ones in climatic modelling raises the reliability of the received results.
Such an idea of using spatialization of those units was proposed by climatologic specialists dealing with this issue long before GIS was introduced. Instead of using GIS they made geographical analyses according to their geographical and car-

tographical knowledge. (Bac, 1977).
Another considered factor, important for the distribution of natural phenomena which are dependant on other natural processes, was the height of measurement station above the sea level.

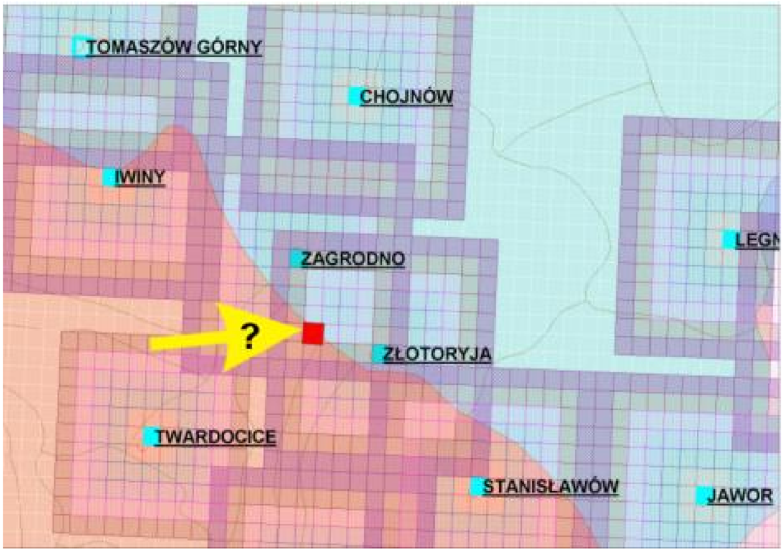

Figure 2. Some of elementary fields are included in two or even 3 indicating points' surroundings

Figure 3. Grid of about 1 km sq.; measured points and physiogeographic units by Kondracki

The height of the station is very often an additional usable information in modeling spatial distribution of phenomena.
Values measured in such stations are the basis for calculating different kinds of climatic characteristics: sums of precipitation in different periods, probability of the risk of thunderstorm or extreme minimum temperature.
The division of the area around the indicating point into the regions of homogenous conditions containing the same type of information is the aim of the elaboration.
The applied way of indicating similar regions assumes calculating a few values of that area's features at the same time. (multi-features division). Such data should relate to the elements of the same space dimension. (0,1,2 or more). Considered in this work data, the most often are related to the surface, so a possibility of substituting the value of height of measurement station for average height above the sea level in elementary field including this station is being considered.

Before beginning works over the construction of borders of regions of similar factors, indicated spatial distribution of topographic-dependent phenomena's average height above sea level was evaluated Fig. 4.

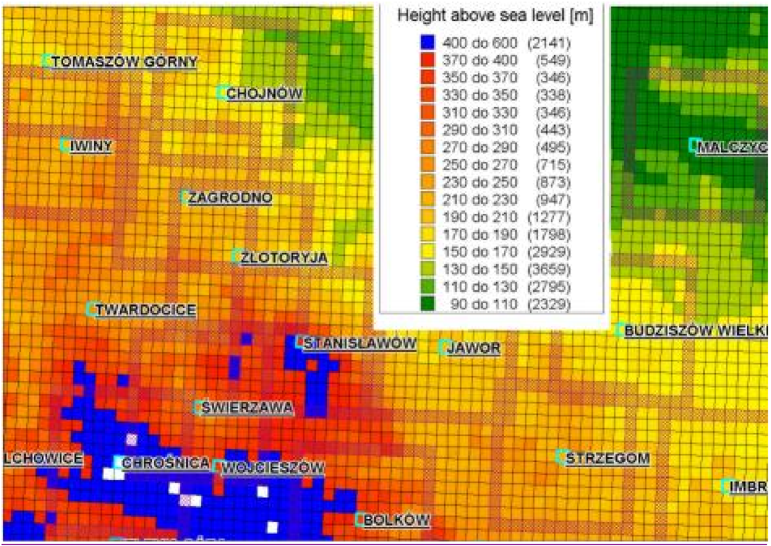

Figure 4. Cartographic presentation of height above the sea level

This problem is being tested and as a result, some digital cartographic models presented in Fig. 5 have been obtained. In the picture choropletic map with classes of differentiation of height, contour lines and isolines of absolute differences can be seen. Values of accepted height differences- brackets of classes' borders were accepted on the basis of previous elaborations of factors accompanying the precipitation.

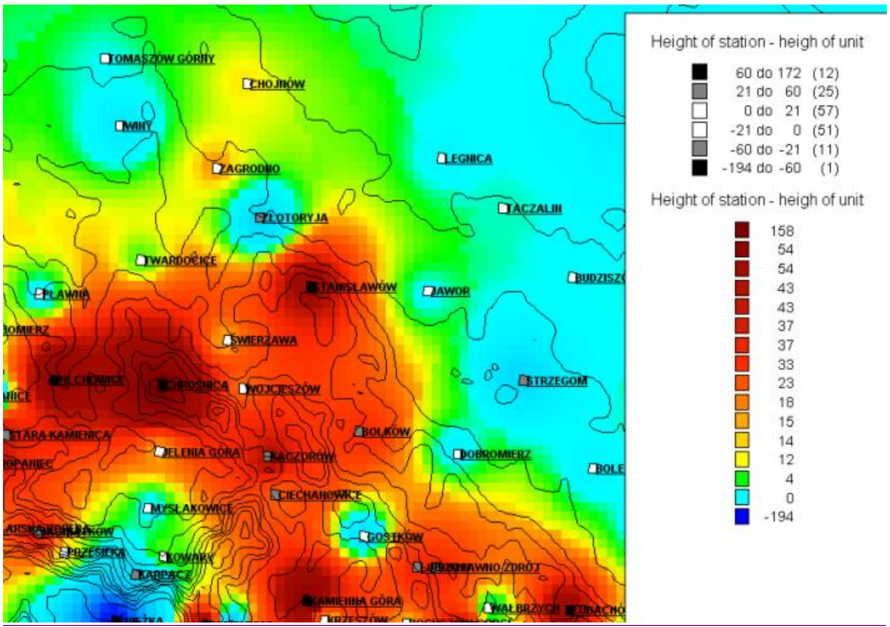

Figure 5. Possibility of substituting data of height of measurement station with average height above the sea level of elementary field including this station

This geography analyses show that only the station in lowland can be represented by the unit including station.
Basing on the model of probability's distribution together with the increase in distance between meteorological stations, it

was assumed that probability of the transfer of the values of precipitation sums diminishes. Sums of precipitation were estimated earlier- the fact that different data represent different level of reliability as far as their spatio-temporal representation was taken into account (Bac-Bronowicz, 2003).
Apart from that distance from the measurement point, also the height of measurement point's surroundings was taken into account. Then, the height of the station above the sea level and the class of probability of transferring information were analyzed. The condition of surface continuance in surroundings was preserved while defining probability of height. This condition excluded transferring information in mountainous terrains in the area of 3km, or even less, around the station. 2 groups of height were distinguished and acceptable differences of height for the field with measurement station were classified. The above mentioned assumptions have been determined for the studies area (Fig. 6).

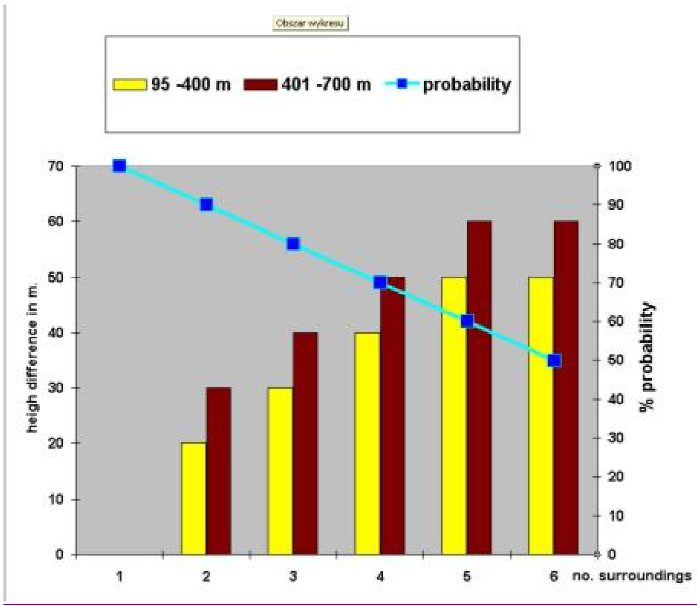

Figure 6. Acceptable difference of average height above the sea level between the elementary fields including point and fields in surrounding

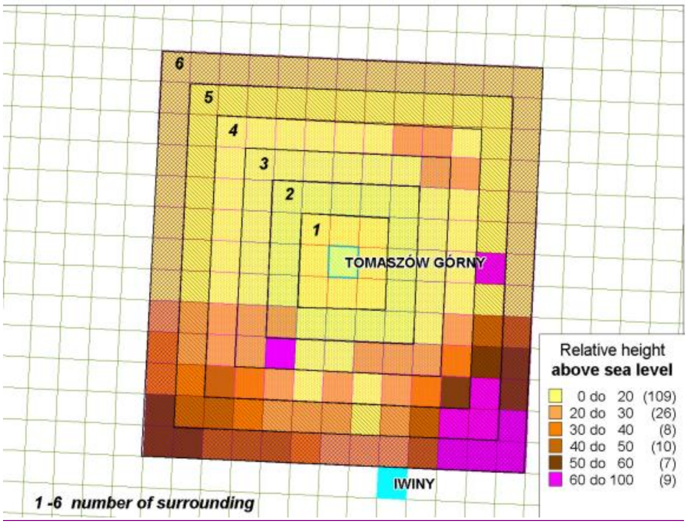

Figure 7. Relative height can be a basis for decisions about transfer of information from measurement point

On the basis of those calculations, the differences between height in the points' surroundings were estimated (Fig. 7). Cartographic models show the possibilities of transfer of information and they were made for different periods of observation. In picture no 8. the localization zones for one of those periods can be seen.

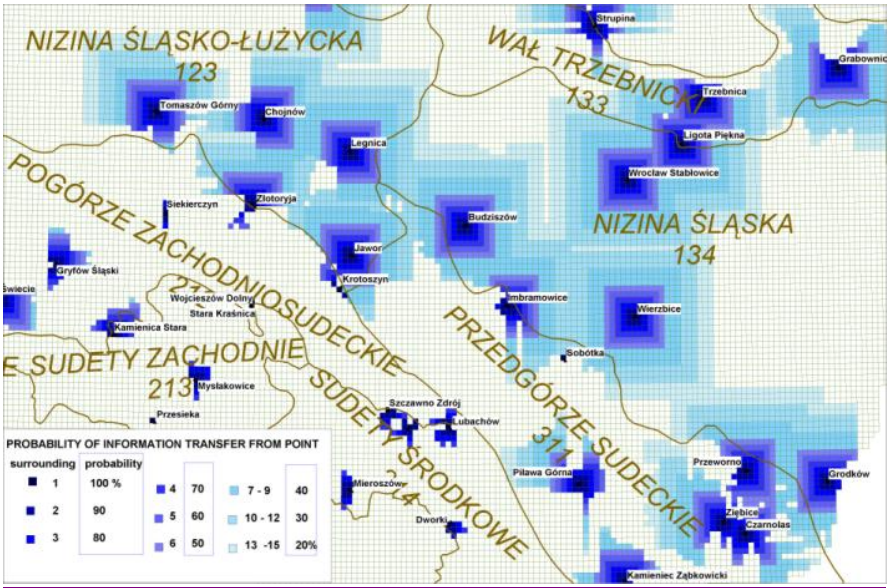

Figure 8. Assigning point information about adequate attributes to elementary fields in spatial information groundwork, connected with acceptable difference of average height above sea level between elementary fields including point and fields in surrounding (stations active 1960-1980)

The next step is the division of the area of sub-regions on the basis of classification values of parameters indicated in points. In picture 9 the division into precipitation regions is shown. The terrains with similar topographical factors were included in the similar regions.

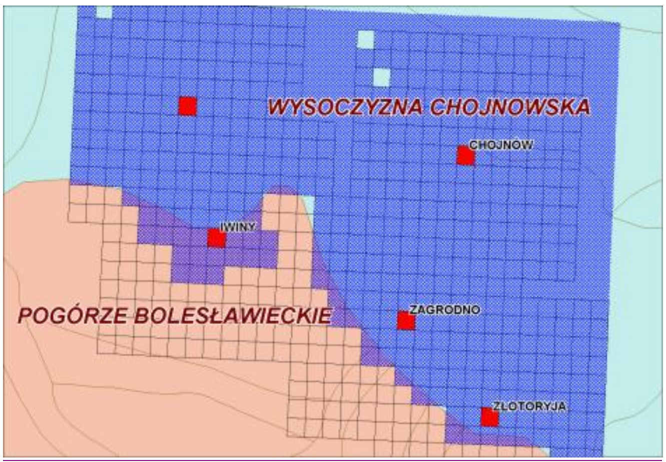

Figure 9. Sub-regions with similar value of precipitation in March 1970 -2001

CONCLUSION

The reliability of the model of phenomena distribution can be increased due to the additional factors connected with conditions in the place of measurement of parameters. This reliability can be precisely calculated. To make this calculations, we need metadata about indicated factors of distributions. In data base, the values of probability connected with the distance between the station and elementary fields in its surroundings, as well as the probability connected with height differences above the sea level were calculated. The above mentioned method can be used as well while applying different methods of indicating probability of information, not only such factors as height or distance.

After many geographic analyses, made on the basis of complicated DMT and multi- dimensional analyses, it turned out that the borders connected with environmental factors of sub-regions are compatible in 85% with the borders of physio-geographic units indicated by Kondracki*. It turned out that it is useful to find cartographic elaborations made by the professionals and then it became clear that we do not have to do everything once again from the very beginning using digital methods.

The next problem to be solved in the nearest feature, connected with the issue discussed above, will be a presentation of the errors of the information's value. Elaborating such a visualization of those errors is significant for decision - making.

---

* This famous Polish professor of geography made his geographic analyses many years ago.
Professor Jerzy Kondracki (1908 –1998) worked in ICA Commission on National and Regional Atlases in 70'.

REFERENCES:

Bac S. 1977. Warunki agrometeorologiczne Dolnego Slaska jako podstawa gospodarki wodnej [Agro – meteorological conditions of Lower Silesia as a basis of hydro economy]. Komisja Nauk o Ziemi PAN [Polish Academy of Science] [in Polish]

Bac-Bronowicz J. 2001. Possibilities of Environmental Data Interpretation in Groundwork with Elementary Geometric Fields; an Example of Precipitation. Proc. 20th ICC nr 386, Beijgin.

Bac-Bronowicz J. 2003. Cartographic presentation of spatiotemporal information related to punctual data as a usable tool for right modelling of continuous features. Mat. 21th ICC, ICA. 2028. Durban,.

Bac-Bronowicz J. 2004. Technique for constructing continuous meteorological fields from point measurements using incorporated effects of topography. 10th EC-GI&GIS Workshop. Warszawa.

Bac-Bronowicz J., Dancewicz A. 2005.The density of precipitation net of urban areas as a base for evaluating the interpretation of spatial differentiation of precipitation with the example of Wroclaw agglomeration. GIS –Ostrava 2005.

Bihari Z.(2000). Mapping of climatological elements in Hungary. In: 3rd European Conference on Applied Climatology, Pisa, CD. ISBN 88-900502-0-9.

Kondracki J.(2000). Geografia regionalna Polski [Polish Regional Geography] . Wyd. Nauk. PWN, Warszawa. [in Polish]

Konecny M. 2004. Quo Vadis Cartography? Yearly Focus 2004/5 GIS, GPS and Mapping. Geoinformatics.

Zhang J., Goodchild M. 2002. Uncertainly in Geographical Information. Research Monographs in GIS. Taylor&Francis Group. New York.

BIOGRAPHICAL SKETCH OF DR. JOANNA BAC-BRONOWICZ

Dr. Joanna Bac-Bronowicz holds a Diploma of Geodesy (Geodetic and Photogrammetric Determination of Three-dimensional Form of Cavern) from the Agricultural University of Wroclaw and in 1991 got PhD (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 led 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 six years Mrs. Bac–Bronowicz was a chairwomen of Cartographic Section of the Association of Polish Surveyors and for eight years she has been 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 has been 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.

Address:
Agricultural University of Wrocław
GIS Laboratory
ul. Grunwaldzka 53, 50–357 Wrocław, Poland
e–mail: bac-bronowicz@kgf.ar.wroc.pl
phone/fax: (+48 71) 3205617