CHOICE OF ACCEPTABLE INTERVALS OF TYPES AND VALUES OF TOPOGRAPHIC FACTORS AS THE POSSIBILITIES TO DETEMINE THE RELIABILITY ZONES OF TRANSFERRED INFORMATION OF CONTINUOUS FEATURES MEASURED IN POINT

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ABSTRACT

In this paper there is a proposition of different ways of construction of distribution model of phenomenon, than the ones in which it is assumed that the spatial distribution of parameters is described by the same function of distribution in each place of the area. It was assumed that the closer the measurement point is, the probability that information transfer in the neighborhood is correct, is greater. Secondly, it was assumed that in the areas of similar topographic conditions, information transfer of the value of parameter measured in point to its surroundings is more probable than when other factors change e.g. land cover, height above the sea level etc. Present proposition is aggregate geometric basic units of the system in adequate areas on the grounds of their affiliation to certain regions. Such areas will have similar topographic conditions. They can also be a basis for the analysis of distribution of other environment-dependent phenomena, such as different types of pollution, soil erosion, climate, vegetation and so on. Classification can be used to evaluate the usability of areas for different purposes, forecasting the outcome of investments and the like. Selection of the reference unit, which fulfill the needs, details' level and accuracy of the compilation scale are a very important point of the construction of the spatial information system.

1. INTRODUCTION

Accuracy of information accepted from the model which was constructed on the grounds of point data base of spatial information system will also depend on the size of the reference unit (natural or geometric) on the basis of which it was created. If we have earlier accepted function or interpolate model of distribution of information in geometrical basic units then the construction of model is not very difficult. Those constructions are more complicated when network of measured points does not represent majority of units, which were separated by factors' distribution, for example topographic condi-

tions. Surroundings of a survey point has got a great influence on the value of measured characteristic, especially in environmental research where attributes depend on environmental conditions. For example phenomena connected with the climate highly depend on the relief and absolute height. Precipitation has got a low variation rate within lowland. Values of precipitation' parameters can significantly vary in places of high land's variability, especially in case of existing morphological barriers. Common obstacles for the airflow are river valleys, elevations and mountain ridges. For example in the city of Wroclaw (around 300 sq. km.) it is not surprising to find specific parts of the city where changeable weather conditions occur. Rivers and high buildings in the city centre are sufficient barriers to change the distribution significantly.

Specific topoclimate (river valley, meadows, slope with certain exposition) is created on the basis of the influence of the closest surroundings of survey point depending on: buildings, type of the vegetation, relief. Location of the measurement station also can highly influence survey results, especially in case of the northern or the southern slope. Stations should be placed when technical and environmental conditions are steady. The information about the type of landscape for the specific station has been placed in the reports. Especially the following can be mentioned: residual ridges and inselbergs of foreland, watershed uplands, rounded and flat-topped elevations, low terrace plains, wide river valley. It means that certain measured values are valid only for the same landscape unit and further "spreading out of information" should be conditioned by the analysis of the surroundings. Such characteristics as a shape of the area near the station, and convex or concave also have a great influence on the data. Conditions of the roughness of the neighbourhood, as well as the conditions of the moving air masses transformation, the frequency of calms and light winds etc. should be taken into account during the analysis of the representation level of the stations' location.

2. INTERVALS OF TYPES AND VALUES OF TOPOGRAPHIC FACTORS

Selection of the reference unit, which is accommodated to the needs, detailing level and accuracy of the compilation scale are very important points of the construction of the spatial information system for the phenomenon. 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'. Then the field is divided into 9 rows and 12 columns. In elaborated area units are about 1 km square and fluctuate between 0,981 and 1,022 km square. Further division is possible using quadruple system.

For each of the basic fields, there have been quality and quantity indices established adequate with topographic factors which have impact on spatial distribution of environment-dependent phenomena. In literature, the relief and land cover have been perceived as factors which have great influence on distribution of climate, while positions adequate with equator as well as both factors mentioned earlier are responsible for distribution of phenomenon (Bac-Bronowicz 2001, 2005). As the basic factors which influence on the distribution of climatic phenomena, the following have been chosen:

1) Affiliation to physico-geographic units (Kondracki, 1994): microregions, macroregions, subprovinces and provinces.
2) Absolute average heights in basic fields.
3) Land usage on three levels of generalization from CORINE Land Cover (Image, 2000).

2.1 Affiliation to PHYSICO-GEOGRAPHIC UNITS: microregions, macroregions, subprovinces and provinces

In the frame of this system, four basic sets have been established on the basis of the map "Physico-Geographic Units" elaborated by J. Kondracki and W.Walczak included in the "Atlas of Lower and Opole Silesia" presenting the ranges of microregions, macroregions, subprovinces and provinces. The initial base with frame about 1km square in has been created. It consists of the following columns:
Number of square
Area of square
Name of microregion of the surface from 100% to 50% inclusive -(Mikrore_100_50)
Share of area of microregion over-(Udz_Mikro_100_50)
Name of microregion of the surface from 50% to 30% inclusive – (Mikrore_50_30)
Share of area of microregion over-(– (Udz_Mikro_50_30)
Name of microregion of the surface from 30% to 10% inclusive – (Mikrore_30_10)
Share of area of microregion over–– (Udz_Mikro_30_10)
Name of macroregion of the surface from 100% to 50% inclusive – (Makroreg_100_50)
Share of area of macroregion over – (Udz_Makro_100_50)
Name of macroregion of the surface from 50% to 30% inclusive – (Makroreg_50_30)
Share of area of macroregion over – (Udz_Makro_50_30)
name of makroregion of the surface from 30% to 10% inclusive – (Makroreg_30_10)
Share of area of macroregion over – (Udz_Makro_30_10)
Name of subprovince of the surface from 100% to 50% inclusive - (Podprow_100_50)
Share of area of subprovince over – (Udz_Podpr_100_50)
Name of subprovince of the surface from 50% to 30% inclusive – (Podprow_50_30)
Share of area of subprovince over – (Udz_Podpr_50_30)
Name of subprovince of the surface from 30% to 10% inclusiv – (Podprow_30_10)
Share of area of subprovince over – (Udz_Podpr_30_10)
Name of province of the surface from 100% to 50% inclusive - (Prow_100_50)
Share of area of province over – (Udz_Prow_100_50)
Name of province of the surface from 50% to 30% inclusive - (Prow_50_30)
Share of area of province over – (Udz_Prow_50_30)
Name of subprovince of the surface from 30% to 10% inclusiv - (Prow_30_10)
Share of area of province over – (Udz_Prow_30_10)
If there are more than one area of the share from accepted ranges (100% - 50%; 50% - 30%; 30% - 10%) then additional columns have been created. They include letters "a" or "b", for example: Mikro_50_30a; Udz_Makro_30_10a. There have been 54 columns in the table created.
Then, 4. basic sets were created. They have identical structure of columns but separately for microregions, macroregions, subprovinces and provinces. Individual columns of these sets have been updated on the basis of division and updating using the sets of ranges of microregions, macroregions, subprovinces and provinces.
On the basis of the base created in that way, generalized picture of each level of physico-geographic division can be elaborated. The base has been created in such a way as to provide a possibility of qualification of units in basic field on three levels. The brackets of feature qualification (physico-geographic unit) have been adjusted to commonly accepted rules for such elaborations (agriculture usability of soil, land use, land cover etc).

2.2 Absolute average height in basic field

Basing on the created base of average heights in elementary fields, obtained on the basis of numerical model of terrain, it is necessary to determine intervals of height differences to enable further analyses. It seems obvious that intervals would be different for lowlands, uplands and mountainous areas. To verify whether the intervals have been correctly determined, the borders of physico-geographic units by Kondracki will be placed on the distribution of average heights. These units are similar when it comes to relief, absolute height, slope and selected landscapes. The example of height distribution of various intervals has been presented in pictures 1.

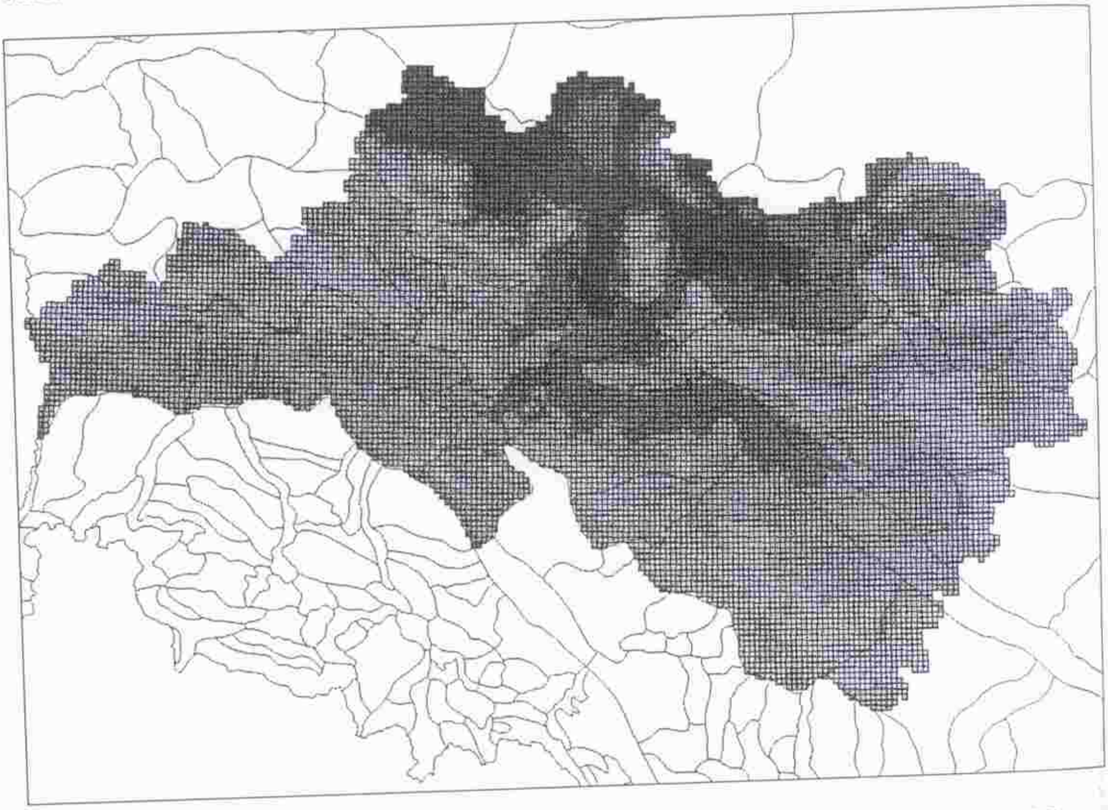

Fig. 1. Lowland. Interval 25m. Bracket absolute height above sea level: 75 – 425 m

Although it is not possible to establish one interval for a given area, it seems that for lowlands the distribution of the interval 15 m seems to picture the terrain relief in the best way and it covers well with the physico-geographic units. In lowlands the differences in height are the smallest and that is why the interval pictures these differences better. In uplands the differences are greater and the change of interval form 40m to 60m does not influence significantly on visualisation of relief. Mountainous areas are the most differentiated when it comes to height so the interval is the greatest.

Comparing the number of fields (while considering the intervals) with patterns of numbers of fields included in the interior border of physico-geographic units it can be assumed that for the interval for which the differences are the smallest, the visualisation of terrain is the most precise. However the fact that for one unit the distribution is the most favourable does not mean that this method can be applied to the whole area. However, for this elaboration I assume that this hypothesis is precise enough.

For example in the tables below there is numerical distribution of basic fields describing given physico- geographic unit using different intervals. In lowlands, in the chosen unit there are 175 basic fields, on the basis of the table it is visible that to obtain the most similar value we should use the interval smaller or even 20m, with 25m the value seems to differ greatly from the pattern.

Table 1. Numerical distribution of basic fields lowlands

	In unit	interval 13 m	interval 15 m	interval 20 m	interval 25 m
Number of fields	175	159	135	159	113

2.3. Land usage on three levels of generalization (from CORINE Land Cover)

Database for basic field has been filled with data describing land cover. The source data for attributes connected with the structure of land cover were "Land Cover in Poland. Database CORINE Land Cover", elaborated by Institute of Geodesy and Cartography in Warsaw, on three levels.
Content of database of CORINE Land Cover includes:
1. Artificial surfaces such as: urban fabric, industrial, commercial, mines, dumps and construction, artificial non-agricultural.
2. Agricultural areas: arable land, permanent crops, pastures.
3. Forest and semi natural eco systems: forests, scrub and/or herbaceous, open spaces with little.
4. Wetlands: inland wetlands, coastal wetlands.
5. Water bodies: continental waters, marine waters.

Information about land cover has been coded; the construction of three-number-code enables its aggregation and reclassification.
Separation at the levels 2 and 1 as well as their analyses are elaborated for the needs of the project. What was also made was attributing the types of usage compatible with cadastral data – done on the basis of separation from level 3, basing on the commentary to definition of individual separations. For the surface of separation of grounds on the level 3, the basic statistics characterizing spatial phenomena structure, have been calculated.
The analysis of the relative entropy index for fields' distribution was made. On the basis of the value of that index it can be noticed that the fields' distribution in the separated classes for agricultural areas and forests is similar to maximally differentiated, while for the wetlands and water bodies it is concentrated in class 1. Artificial surfaces aim at concentrated system. The value of index describes the phenomena structure without taking into consideration its spatial distribution. The possibility to evaluate the spatial structure is made by dazimetric cartograms which can be elaborated using data included in the database of the system. Such a way of presentation, possible due to elaborated base and module of thematic maps available in GIS programs, enables to evaluate spatial distribution of fields of different intensity of phenomena. On the basis of the maps we can notice mutual regularities in their distribution in dolnośląskie voivodship and neighbourhood of individual class categories.
Joining two pieces of information, that is the structure of land usage and slopes, makes the analysis of relation between these phenomena possible. Mutual relations can be presented in the form of cartographic models.

As additional complement to this system, there is the elaboration of the occurrence ranges of individual separations classified as level 1. 5 categories of land use have been distinguished: artificial surfaces, agricultural areas, forest and semi natural eco systems, wetlands and water bodies. Using this elaboration we can carry out geographical analyses in the basic fields.
In the dolnośląskie voivodship, each category of separated grounds of level 1 includes: Artificial surfaces (1040 objects distributed on the area of 751,369 km^2), agricultural areas (380 objects distributed on the area of 12 982, 471 km^2, - the biggest object has the area of 11 910 km^2), forests and semi natural eco systems (1 586 objects distributed on the area of 5 957, 383 km^2), wetlands: (25 objects distributed on the area of 27,875 km^2), water bodies: (178 objects distributed on the area of 154,252 km^2).
Elaborated databases give the possibilities for many geographic analyses, statistical estimation and visualisation of spatial distribution of the phenomena.

3. ASCRIBING THE PROBABILITY OF INFORMATION TRANSFER TO SEPARATE ZONES

The main assumption of this elaboration is to prepare a system in which user would get information about data reliability gathered in measurement points and referring to the area around the station. The proposition of rule of information transfer from measurement point is presented in figure 2.

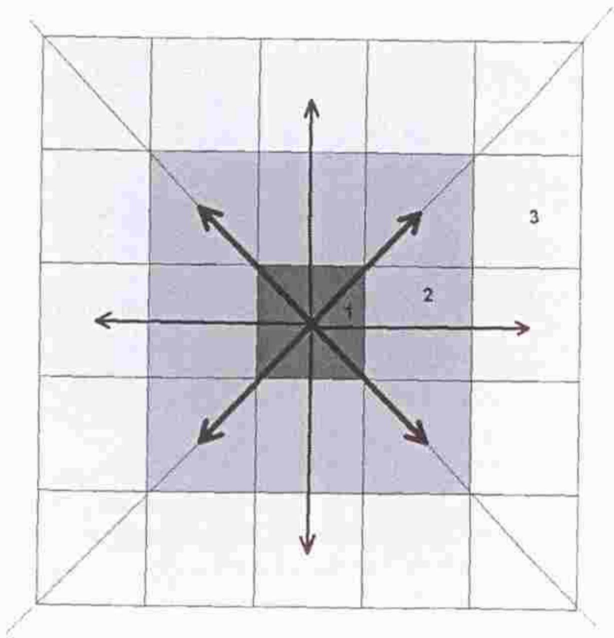

Fig. 2. Transfers of information - the zones are 1 km in width.
1. - 1st zone - MEASUREMENT STATION, 2. - 2nd zone, 3. - 3rd zone

Because we deal with point data referring to spatial phenomena, this reliability would differ depending on the distance from the station and terrain topography. Correct determination of probability distribution is significant in that case.
The most useful parameter to determine similarities in the surroundings of measurement station (apart from distance of the field from the station) is difference of height

between measurement station and basic fields, which are placed in the zones of information transfer of the given station. It was assumed that the influence of height difference on spatial information transfer is the same as the influence of the distance from the station. The proposition is that probability has linear distribution up to 6^{th} zone inclusive. In the 1^{st} zone of information transfer the probability is 100% so probability is 1. in the second zone it diminishes to 0,9 in 3^{rd} to 0,8, in 4^{th} – 0,7, in 5^{th} – 0,6 and in 6^{th} – 0,5. From 7^{th} to 9^{th} it is 0,4. If we wanted to cover the whole area with the next zones of information transfer, it could be accepted that from 10^{th} to 11^{th} zone it would be 0,3, from 12^{th} to 15^{th} – 0,2, from 16^{th} to 20^{th} – 0,1 while in the 30^{th} zone the probability would be 0. Obviously, many other possibilities of ascribing different probability levels to different factors can be accepted.

If we have acceptable differences of height for information transfer then, from the tables as in picture 3, we can choose these fields which answer the accepted variances.

For example, we allow for the differences of information transfer in the zones 1 and 2 to be of more or less 20m between the station and elementary field; in 3 and 4 to 30m and in 5,6 and 7 to 40m.

In the presented example, only 19 elementary fields will be excluded from qualification of information transfer from the measurement station.

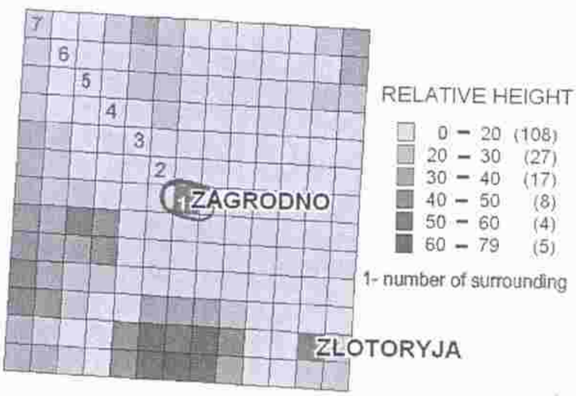

Figure 3. Relative height can be a basis for decisions about transfer of information from measurement point

In the similar way we can compile and differentiate probabilities of information transfer because of other topographic factors.

Cartographic models show the possibilities of transfer of information of rainfall from climatic stations and they were made for different periods of observation. In picture no 4. the localization zones for one of those periods can be seen.

In similar way, the comparable areas, when it comes to land cover and the like, have been separated. The similarity of terrain cover can also be used in considerations over probability of information transfer.

In picture 4. there are print screens presented, with the possibility for the user to choose correct range zones of information transfer in the system's fields (applying qualification of information transfer from the measurement station mentioned above).

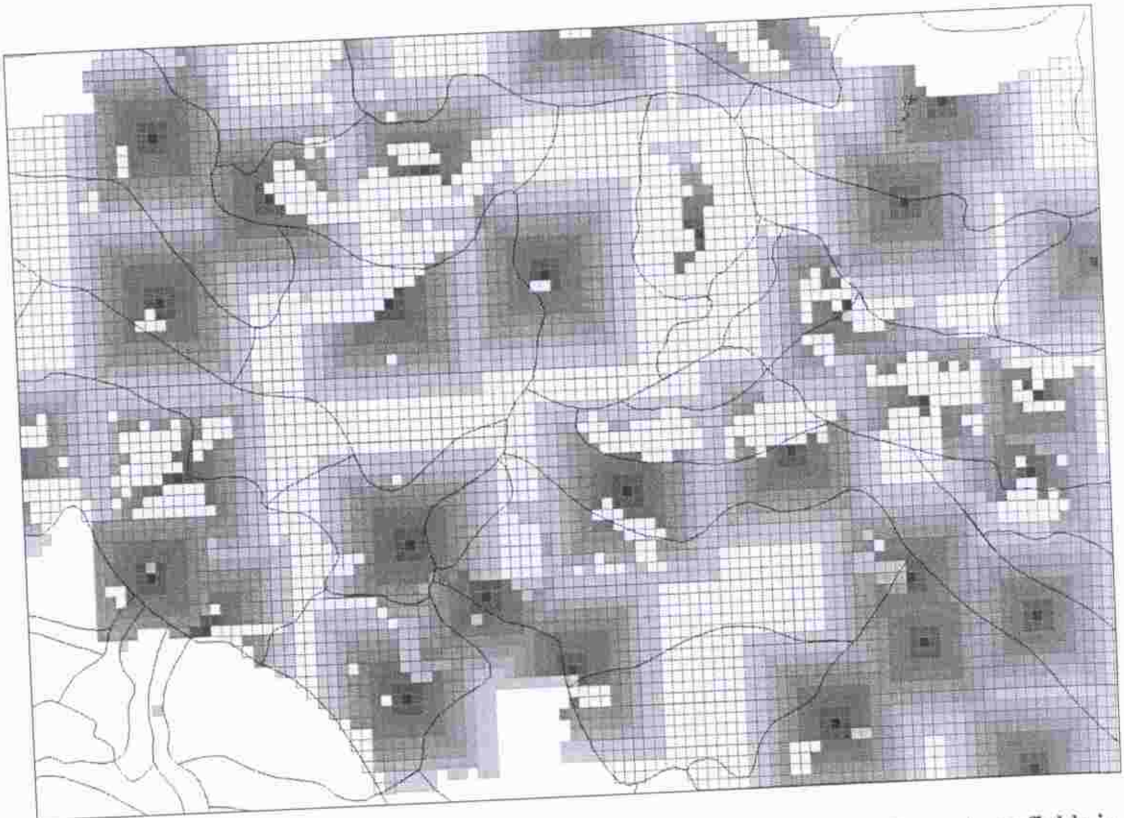

Figure 4. Assigning point information about adequate attributes to elementary fields in spatial information groundwork, connected with acceptable difference of average height above sea level between elementary fields including point and fields in surrounding (stations active 1960-1980)

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 carry on these 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 subregions are compatible in 85% with the borders of physico-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. The precise determination of zones, for which the value of natural parameters has been found with high probability, is of great importance particularly in interdisciplinary research, where specialists from different scientific fields cooperate very closely.

Final construction of the spatial model probably will depend on the accepted collection of interpolation criteria. Lack of knowledge on that fact may lead to drawing wrong conclusions when it comes to phenomenon distribution and to elaborating incorrect forecasts (In Elements.., 1995).

Basing on the available meteorological data, spatial distribution 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 a part of a research project, being sponsored by the State Committee for Scientific Research for the years 2001- 2004.

The Geographical Information System presented in the paper is considered as a solution that could facilitate the acquisition and application of knowledge about environment. While making decision on spatial planning and strategy of agriculture development at the central and regional level, it is required to perform research and analysis of many phenomena and data. In order to increase the role of GIS as the tool for analysis, communication and data depiction, it is essential to have up-to-date and simple in use bases of spatial data, which are available for a wide range of users in the whole country, voivodship, county or commune.

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