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REMARKS ON CARTOGRAPHIC METHODS IN THE RESEARCH
ON THE GEOGRAPHIC HABITAT CHANGES
/ BY MEANS OF LARGE SCALE TOPOGRAPHIC MAPS /

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Paper presented
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REMARKS ON CARTOGRAPHIC METHODS IN THE RESEARCH
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Up to the present the main task of cartographers, being engaged in topographic mapping at large scale / 1:10 000 - 1:100 000 /, has been the registration of geographical habitat elements in the moment of the day. The need of the terrain knowledge for military, administrative, economic and technical purposes was the beginning of all topographic works and of the development of this domain of cartography.

In result of this situation the definite model of procedure and of the map was formed. In respect of realization, these maps are elaborated directly on the ground of terrain survey. Considering the scope of the content, they represent all the geographic elements. Their content is characteristic because of high minuteness of details and of uniformity in the large sense of this word. Because of the large scale they are very accurate, and almost all the represented elements are measurable. The global test of this map value is the conformability with the current situation on the terrain. Maps out-of-date are considered to be unserviceable and are an object of interest of historians only.

The long lasting domination of this cartographic procedure and map model formed not only theoretical and technical problems of this domain of cartography but also opinions on subject and value of cartographic information.

Recently an essential change is observed in tasks of cartographers. Besides the traditional task of registration of the current state of geographical habitat, a new task of registration of the geographical habitat changes has appeared. The need of knowledge of these changes emerged together with natural resources deficit and the habitat devastation. Knowledge about direction and speed of changes is indispensable to control these changes and especially to exploit rationally and protect the natural resources. The fulfillment of these needs is possible thanks to the accumulation during the last two centuries of voluminous cartographic sources at large scale, based on the survey of vast territories in Central Europe in intervals of 30 - 50 years.

The mapping of the habitat changes becomes the topic of maps on different scales. Being of our interest the topographic large scale map is to accomplish here a particular function. It affords possibilities for a detailed information about changes and facilitates the examination of small changes. On large scale maps we can measure these changes with a great accuracy. On the other hand this map, considering its large scale, limits the scope of researches to the changes on small areas. Contrary to the small scale maps it seems to be a typical analytic map.

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In comparison with a map informing about the habitat in a given moment, the registration of changes in time requires different technology and map model and causes some new theoretical problems, connected with structural differences between four-dimensional reality and two-dimensional map. The main problem depends on the representation of time-dimension.

The changes, occurring in the habitat with the course of time are in general a continuous process, running with a variable speed. The examination of these changes by means of the map may de-

pend on the confrontation of a given phenomenon designated by the coordinates X, Y in some moments T , on examination of the speed of changes or on examination of its acceleration.

Information about the state of habitat in the definite moments is of basic value. It makes possible an immediate conclusion about changes by comparison of information from separate time points and conditions other forms of researches.

The representation of changes in time requires the elaboration of a series of maps. Every one of them informs about the state of habitat in moment $T_1, T_2 \dots T_n$. Let us call these moments "time-profiles" and the elaborated maps - "profile-maps". The content of these maps are the successive states: $/ X_1, Y_1 /$ in the profile T_1 , $/ X_2, Y_2 /$ in the profile T_2 , and $/ X_n, Y_n /$ in the profile T_n . The conclusions about changes of a given habitat element are made on the ground of differences between the following states: $/ \Delta X, \Delta Y /_{1-2}$, $/ \Delta X, \Delta Y /_{2-3}$, $/ \Delta X, \Delta Y /_{3 \dots n}$. On this basis only we may elaborate a map of the habitat changes during the whole examined period. This information ought to be transmitted by large scale maps because of its analytical character.

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The opportunity to formulate these remarks was given by works on the map of water-mill distribution changes in the Warta river basin at the scale of 1:100 000 and on the map of habitat changes in the Poznań region at the scale of 1:25 000. Both the maps concern the changes during two centuries, i. e. since the end of 18 th c. The changes of the water-mill number are examined as a symptom of water resource changes, whereas the other map is to bring data for the habitat protection and reconstruction in the urban agglomeration region.

The topic of the first map is the change of one punctual object only, whereas the other map refers to all the main elements repre-

sented on topographic maps. The methodical purpose of the first elaboration is the initial recognition of the changes mapping on a simple example. All the problems of the changes mapping will come to light in the other elaboration. That is the reason why the research on the first topic overtakes the map elaboration of the habitat changes in Poznań region. Namely, the first fascicle of the maps of water-mill distribution changes is prepared for printing, while the works on the map of changes in Poznań region are at the stage of the profile-map elaboration. Therefore, these remarks are based on relatively narrow experience and can not be taken for final conclusions.

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Generally, the proper representation of change process by means of profile-maps depends on the number and distribution of the profiles. The greater the number of profiles, the more exact is the information about process of changes in the course of time. To simplify the elaboration we can manage with the representation of the habitat state in some moments, in which the changes achieved characteristic quantities. The fidelity of information and the possibility of determination of the phenomenon state in a medial point of time depends finally on the proper choice of these moments. There exists an analogy of representations of the time dimension and of the height dimension on the map.

In practice the cartographer has no great choice, but he is subjected to the set of sources. The distribution of the time-profiles corresponds to the terms of realisation of new topographic maps. The evaluation of the correctness of this distribution depends on how far the dates of source-maps execution coincide with the characteristic moments in the habitat evolution.

In the elaboration of the maps of water-mills changes and of habitat changes in the Poznań region all the maps, executed directly on the ground survey were used. The oldest data were supplied by

the maps 1:50 000 of Gilly and Cron and by the maps 1:25 000 of Schmettau from the end of the 18 th c. For the proceeding periods no maps are found but descriptions only. Because of the essential differences between the structures of a description and a map, the problems of map elaboration on the ground of descriptions are quite different and are not taken into consideration in this paper.

Successive data were brought by maps worked out on the ground of surveys 1:25 000: about 1830, 1890, immediately before the second world war and after this war.

These periods correspond generally with the characteristic moments in social life and in the development of geographic habitat. The cartographic sources from the end of 18 th c. inform about the habitat state towards the close of the feudal system. The profile 1830 is characterised by the land reform after the enfranchisement of peasants. Maps elaborated about 1830 inform about the habitat state after the propagation of capitalistic system of economy. The following profiles fall on the end of capitalism and on the socialist economy.

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With the distribution of time-profiles the question of the accuracy determination of the mentioned profiles is connected. The above given dates, for instance $T = 1890$, serve as a catchword only and one can not conclude, that the map information refers only to this one moment. Topographical survey and map elaboration take usually several years; this period is the longer, the larger is a territory and the scale of a cartographic elaboration. During the whole period from surveying to printing the content of the map may be progressively completed.

Finally each part of course-map represents the habitat state in different time-point. Profile-maps made on this basis enable to compare the states not in time-points $T_1, T_2 \dots T_n$, but in certain time-

intervals $dT_1, dT_2 \dots dT_n$. If we use also the derived map, the time-interval dT may enlarge considerably.

The value dT may be determined as the error of information dating on profile-map. This error exerts an influence on the results of changes comparison. If it achieves a quantity approximated to the time between two adjoining profiles, the comparison is nonsensical. Hence, the time-intervals dT must not surpass a certain value, depending upon the space of time between the profiles / they must be relatively small in comparison with this space of time /.

The main source for researches concerning the habitat changes are the maps, where the content may be exactly dated and these derived maps, which were elaborated on the original maps in not distant moment. The maps published in time between surveys are generally partly completed, that is why the dating of their content is either encumbered with a great error, or impossible. When source-maps were made during long-lasting survey of a vast territory, the data can not be related to one profile, but the analysis of changes is to be carried out separately on each part of territory.

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The profile-maps are useful for researches on the habitat changes, if they are directly comparable. Generally the source-maps do not fulfill this condition. They differ one from another in methods of survey, scale, projection and in editing. This is followed by the differences in the scope of content, way of representation and in map accuracy. The divergences are the greater, the longer is the time period between the moments of maps execution.

The above mentioned differences influence the method of profile-maps elaboration. During this elaboration one should first of all resolve all the data to one system of reference and one should eliminate the deformations occurring especially on the older source-maps.

For this purpose as the basic material the contemporary map is

taken, which may be considered practically errorless, and on this basis the first profile-map is executed. The following older profile-maps are elaborated by method of retrogression, t. e. by working out the map of succeeding profile T_2 on the ground of map made already for the profile T_1 / the copy of the first profile-map is used as the basis for the next profile-map /. In this manner we come gradually to the elaboration of the map informing about the oldest state of habitat.

The transfer of content from source-map on base-map begins with the identification of stable points on both of the maps. We also indentify the directions, for instance of these roads, rivers and limits, which can be considered as invariable. As the identification concerns localization, we have in regard both the objects, which keep their character and the relicts of these objects / for instance the remains of buldings, waters and roads /.

The comparison of the mutual localization of identified elements on both of the maps allows us to estimate the accuracy of source-map and to indicate the points mapped faultlessly. These points serve afterwards as a basis for transfer on the base-map of these details, which are only on source-map, or which are not identified with certitude. By this transfer we use all the geometric constructions known in topographic surveying. The best results are achieved by traverse lines based on identified points and directions.

In case of the oldest source-maps the detaile are transfered in smaller sets, which form aby wholes of survey and are encumbered with the same deformation of directions. The detailed base of old topographic surveying was as a rule imperfect and especially the directions were determined with greater error.

The comparability of the habitat states on the profile-maps depends on the accuracy of the details localization on these maps. This accuracy is before all conditioned by the precision of the source-map and it is the lower, the older ist the source. We may assume that, in spite of careful correction of deformations, the mean errors

of points transferred from the maps of the end of 18 th c. are about 3 times greater in comparison with the accuracy of contemporary map.

The error of the point situation on profile-map evidently imposes restrictions on the comparability of the habitat state. If the difference in the situation of an element on two profile-maps is contained in limits of this error, or if this difference only slightly surpasses these limits, we can not consider it as an evidence of the habitat changes. The progressive increase of this error on older profile-maps restricts gradually the comparability of these maps. Moreover, there exists probability that certain number of gross errors will not be discovered and will enter from source-maps on profile-maps. That induces us to be careful in interpretation of all the differences between maps as habitat changes.

The most important reduction of comparability comes from lower detail minuteness of the old topographic surveys in result of smaller scale and bigger generalization, then certain number of little and secondary details were omitted and the broad lines of big objects were simplified. In a consistent way, together with retrogression, the number of comparable objects diminishes gradually.

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Finally I should like to compile the main features of the map of changes in time. Contrary to the topographic map, the map of changes is not so uniform, because it is based on differentiated sources. As we pass to the information from older periods, the scope of content and the minuteness of detail diminishes. At the same time the accuracy of the object localization gradually decreases, what makes difficult the measures on the map.

The possibility of the information value improvement of this kind of maps - in comparison with the classical topographic map - is much limited. The main way of this improvement is careful collection and

analysis of source materials, which - in case of older periods - were not published in originals and were not yet found. On the ground of the knowledge of surveying methods we can determine a method of elaboration, which affords possibilities for elimination to the highest degree of the deformations of old source-maps. The works on the habitat change map ought to be preceded by researches on the history of topographical surveying and by a search after old maps.

At the same time at the reconstruction of old habitat states on a map we must take into consideration the regularity of synchronous and especially diachronous relations between particular elements of geographical habitat. For the purpose we ought to complete the static model of reality, dominating at present in cartography, by a dynamic one. New way of looking at the terrain should be formed during the education of cartographers by conveying knowledge not only on descriptive, but also on historical topography.