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**SELECTED REPORTS ON RESEARCH
INTO PHYSICAL DEVELOPMENT OF POLAND**

**Edited by
KAZIMIERZ DZIEWOŃSKI**

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RESEARCH FOR PHYSICAL PLANNING IN POLAND 1944-1974

KAZIMIERZ DZIEWOŃSKI

The organization of research for physical planning in Poland has had a long tradition reaching back to the inter-war period of later twenties. However, its full development has taken place only after the war. In the last thirty years in Poland such applied research has played an important role in the progress of physical planning on all three basic, i.e.: national, regional and local levels, as well as in the development of various sciences, in particular: of geography. Nevertheless, the subject and the scope of such research were constantly changing. Such changes were connected on one hand with the arising needs of planning and planners, and on the other with readiness and possibilities of undertaking the proposed themes by scientific institutions and scientists. Their effectiveness was always rather closely connected with organizational forms prevailing at the given moment and current methodology of scientific research planning. For these reasons a more detailed description of research carried out in these years, its character and achievements to be presented here should be divided into several parts, each connected with successive stages in organizational transformations of physical planning and scientific research. The following phases shall be taken into account: years 1944-1953, the time when the integrated institutions of physical planning were organized, and when their relations to the institutions of economic planning were defined and developed, and when the research institutions at the universities were being reestablished after war destruction; years 1954-1958, when the national and regional planning was included in the long-term or "perspective" economic planning and the central research institutes of the Polish Academy of Sciences were founded; years 1959-1970, when the long-term research was organized and coordinated by the Committee for Space Economy and Regional Planning of the Polish Academy of Sciences; and, finally years since 1971 when the first draft of the national plan for physical development till 1990 was being prepared and most of the research studies were concentrated within the framework of a very ambitious programme of the so-called "nodal" problem: scientific bases for the physical development of the country. To introduce the whole process a short information on the research carried out earlier, in the thirties, i.e., before the Second World War is given. Without this information the post-war situation cannot be understood fully.

I. PIONEERING RESEARCH FOR PHYSICAL PLANNING OF THE INTER-WAR PERIOD (UP TILL 1939)

The crucial moment for the development of pre-war physical planning was year 1928 when the master-plan of Warsaw was formally approved for the first time, the new Act covering city planning and building by-laws was promulgated and the first proposals in the field of regional planning formulated.

With a wider programme of planning activities the need for more detailed information became evident and even acute. The compilation of information was an obvious first step in the preparation of the planning scheme. It usually carried the name of a "survey". Such a survey was at the beginning a simple collection of available and accessible data and maps; sometimes some more exhaustive existing studies were added. If these turned out to be insufficient, the efforts were made to extend them and cover the missing information. The participation in such inventories of individual geographers and other scientists became possible, advisable or even necessary. Such work, originally performed *ad hoc* by single persons, led to the permanent employment of scientists as members of the staffs both in urban and regional offices. Some studies were undertaken also in and by the scientific institutions at the universities. There, under the direction of older and more experienced professors, work was carried on by younger assistants or even students. The next step in the growth of such studies was the integration of single studies into a monographic description leading in turn to deeper analysis of specific problems. All these studies differed in scope and depth as far as particular areas were concerned. The most developed programme was prepared and studies carried out for the region of Cracow (under the direction of J. Smoleński and S. Leszczycki). Already in 1939 a large number of scientific workers well-trained for making of regional and urban inventories and survey were available. During a training course for city planners, organized in February 1939, even a systematization of all such studies was attempted by S. Leszczycki and K. Dziewoński. Further growth was however interrupted by the War.

II. RESEARCH DURING THE YEARS OF RECONSTRUCTION AND FORMATION OF NEW PHYSICAL STRUCTURE OF THE WHOLE COUNTRY (1944-1953)

The years immediately after the end of the war were characterized by some specific and unique organizational conditions. On one side a new, very ambitious, completely integrated and strong state organization of physical planning at three levels: national, regional and local was quickly established under the aegis of the Ministry of Reconstruction although without a corresponding partner in form of a fully developed institutional set-up of economic planning. On the other hand, however, the organizational reconstruction and development of research institutions were rather slow. At that time the main stress here was laid on the formation of new cadres and new properly educated staffs within the framework of reconstructed and newly created universities and other higher schools. One of the results of such a situation was the concentration of almost all fully qualified and experienced in the field of physical planning scientific workers in the planning offices even if they had been university professors before. In face of the enormous tasks of reconstruction, the scarcity of scientific workers (consciously decimated by Nazis in war-time) and the lack of organized laboratories, workshops, and libraries, the parallel, double employment in schools and offices was advantageous.

About year 1949 this situation began to change rather quickly. Physical planning was split between two branches of state administration. National and regional physical planning offices were included into the strongly established organization of economic planning. The local planning was however, transferred to the building authorities formed on basis of the former Ministry of Reconstruction. At the same time progress in the reestablishment of scientific institutes at the universities brought back there all the fully qualified workers as

well as allowed them to carry the research independently within their own schools. Finally, after the First Congress of the Polish Science which took place in 1950, the Polish Academy of Sciences was formed, and begun to organize a network of its own institutes of fundamental research, concentrating on the so-called basic scientific problems. Among those the Institute of Geography was established by the end of 1953.

At the beginning, i.e., after the end of the war, all efforts in the field of research were concentrated on documentary work. The need for just such studies was outstanding. Documentation and information pertaining to all problems in which the physical planning was interested had been dispersed and destroyed by the invaders and had to be organized and amassed anew. With changed conditions practically all the pre-war materials were also out-of-date, specifically in the economic field. At the same time the deep social and economic transformation linked to the changes in the state territory and large transfers of population have broken the continuity of already identified and observed phenomena making preserved and accessible materials of earlier research work at least partly inadequate. An additional complication was created by the need of unification and integration of information pertaining to the geographical, in particular to the natural environment; the information which had been previously amassed by two sides: Polish and German, each using different concepts and methods. This created great divergences in the classification of phenomena and in resulting synthetic studies. All these difficulties were specially evident in planning on the national level, where the interregional comparisons were of great importance.

In the result of efforts and diligent work of numerous workers, scientific (mainly geographers) and technical, largely employed in the planning offices but also outside, in few years (up to 1949) the main needs in the field of synthetic, cartographical materials were satisfied. The best maps were published in two volumes entitled *Studia do Planu Krajowego* (Studies for the National Plan); a part of the materials prepared for the third volume remained unpublished. Moreover, it may generally be stated that the possibilities of more valuable synthetic studies at that stage of knowledge and development were exhausted. In relation to the implemented studies their new, improved and extended versions involved collection of—at least,—additional, often completely new observations and data, more detailed analyses, new theoretical and methodological approaches.

The surveys and collection of information for individual regions were carried on simultaneously, alongside the editing of materials for the whole country. Here, however, in spite of many efforts, significant disproportions have developed due to unequal research potential of various voivodeships. As a rule those voivodeships which, within their boundaries contained a university (usually in the capital city of the region) were able to satisfy their needs for research better than the others. For instance the Cracow region, a traditionally strong center of science and higher education was the best documented one. It possessed a large number of analytical studies and inventories amassed over a period of over-sixty years. By good luck even all pre-war planning surveys were preserved and available. These were the only valuable planning archives, which survived the war in an undiminished form.

An important task in this field was the recovery, classification and putting in order of all data, maps and studies gathered by Germans for physical planning purposes in the western and northern voivodships in pre-war times and during the war years.

One of the more important stages in the preparation of such inventories was connected with making of the so-called "simplified" schemes of development for all cities and towns in the territories recovered as the result of the Second World War. This action was necessary for the resettlement of population and for establishing deeds of land ownership.

The National Census of 1950 formed a new basis for analytical studies, pertaining to the demographical structure of all regions, based on unified and integrated methods, earlier agreed on and accepted by all. These studies led to the preparation of the so-called "characteristics" i.e. descriptions of all voivodships. They were the last of synthetical documentary studies carried out completely within the framework of regional planning offices.

In the beginning of the fifties the organizational forms of statistical, topographical and geodesic, geological, soil and meteorological services, whose task is to collect basic data and to present synthetic descriptions, was finally crystallized and formally established. In the result basic information necessary for planning purposed could be obtained directly from these institutions. However, their activities did not cover all elements which such information should include. Hence the efforts to provide more detailed systematical description of geomorphological, hydrographic, climatic and biogeographical conditions as well as of land utilization, were undertaken by geographical scientific institutions. After a period of experimental work the experience obtained has shown, that in a rather short period of time, let us say in ten or fifteen years, the preparation of the full inventory, covering the whole national territory is practically impossible without an organization in form and character of a service possessing a large staff of field workers. Thus the burden of scientific research began to shift towards deeper monographic studies pertaining either to a specific problem or to a specific area, often rather small in extent. The comparative studies have developed only later, in the sixties. Some monographic studies, rather limited in scope but deeper both in methodological approach and theoretical concept had already been undertaken immediately after the end of the war; now, in the fifties they grew in number and importance.

Among the first pioneering works sociological studies pertaining to the urban development and life should be mentioned, for instance, a series of studies for the city of Łódź, executed under the direction of J. Szczepański, and the monograph of a rather small town of Garwolin prepared by W. Lipińska-Mrazek. Among geographical work the last larger studies of E. Romer have to be placed first—a rather paradoxical fact, considering his personal dislike of planned research. They presented a new approach to climatic regionalization of Poland as well as to climatically defined agro-economic areas. Another climatic study of Poland, although based on different scientific assumptions, was completed by R. Gumiński. In the field of human geography studies on the industrial location and concentration (K. Dziewoński, S. Herman, E. Ziolkowski), on the transport network and the accessibility of cities (K. Bromek, F. Uhorzak) and on economic regionalization (J. Kostrowicki, later S. Berezowski) should be mentioned here.

Studies of the settlement network and functional structure of cities were very popular and strongly developed. They led to new organizational forms of scientific research and to the revision of old and the formulation of new concepts, both methodical and theoretical. The first impulse came from the acquaintance with Christaller's central place theory. There were specific studies on the similarities between Polish urban network and some of Christaller's network models (K. Bromek). At the same time a study based on the Soviet concepts (V. S. Davidovitch, P. Levchenko) of the functional structure of cities, in partic-

ular of Warsaw (S. Herman and J. Wilska) were prepared. This approach was fully developed in the doctoral dissertation of J. Kostrowicki on the elements of settlement network and functional structure of cities in Poland. Statistical studies, based on 1950 census materials were continued later by L. Kosiński. Problems of the urban network were at that time connected with the delimitation of the administrative territorial divisions. A very ambitious programme of research in this field was prepared to define the sphere of influence of the largest cities. It was to be carried out by all geographical institutes existing at the time in the universities under the direction of the Research Section of the Polish Geographical Society but it was completed only in one part and the results were neither published nor utilized. The programme was based too strongly on the new organizational approach which was appreciated only much later and could not be implemented with the financial instructions and bureaucratic procedures existing at that time. Even so, the establishment in 1950 of three new voivodships Koszalin, Opole and Zielonogóra and very radical changes in boundaries of the remaining ones were based on information collected at that time.

In 1951 new models and rules for organization of research were crystallized in the result of preparatory work before, and the discussions during the First Congress of Polish Science. At the same time an effort was made to prepare and to implement a complex and integrated national plan research. The part of the plan concerned with the geographical sciences and physical planning at the national and regional levels was formulated in the Section of Earth Sciences during the Congress. In this field the main postulate was the preparation of maps and studies which jointly were to establish a detailed description of the geographical environment in Poland. Alongside the cartographical presentation of geological and soil conditions, the compilation of which by proper state services had been already begun, corresponding maps for geomorphology, hydrography, climate and biogeography were needed. In the field of human economic geography studies of land utilization were to be their corollary.

The organization measures followed the formulation of the research programme. At the end of 1953 the Institute of Geography of the Polish Academy of Sciences was established as the central and leading body for organization and implementation of basic research in the field of geographical sciences. Practically at the same time in all the then seven existing universities the organization of research alongside the teaching tasks was successfully achieved. The Research Section of the Polish Geographical Society was temporarily abolished (later on it was reconstituted to initiate and popularize research studies in the regional and local communities — in particular among the school teachers) and its research functions were taken over by the newly founded central Institute or, as the overall coordination was concerned, by the Committee of Geographical Sciences of the Polish Academy of Sciences. However, the activities of all these bodies belong already to the next phase of the assumed periodization.

III. BEGINNINGS OF INTEGRATION OF PHYSICAL PLANNING WITH LONG-TERM PLANNING AND OF RESEARCH CARRIED OUT ON BASIS OF CENTRALLY FORMULATED PLANS (1954–1958)

The establishment of a fully developed organization network of research bodies formed the basis for implementation of the already mentioned, indeed very ambitious, research programme. Almost at the same time, already in 1955, the planning bodies were again reorganized. The clear distinction between the short-time or operative and the long-term or perspective planning formed the

basis of introduced changes. Physical planning on the national and regional level was included into the long-term planning. This created propitious conditions for a new development of large-scale physical planning, which after its integration with economic planning, had suffered from its concentration on short-term tasks and the following lack of any greater flexibility. The increased planning activities with their aim of establishing of a national plan of physical development, together with similar, more detailed plans for all regions, brought back the demand for extended research for planning needs and purposes.

At the beginning when the introduced changes in the organization of planning had not yet been fully completed the coordination between planning and research was limited to the selection by agreement those among the proposed themes which were to be include into the research programmes. When the agreement pertained to an area comparatively small results were relatively good and the procedure satisfactory. Studies carried out by the Polish Academy of Sciences in the fifties for the regional plan of the Upper Silesian Industrial District may serve as an example. But in cases where research was directed towards specific problems no outstanding results were obtained by way of such agreements. They led to evident disappointments both among planners and among scientists. The main reason was that in such agreements the factor of time, needed for fruitful research was not taken into account.

Research into a specific problem, which was not to be limited to pure description and expert judgement involved in practice more time than planners wanted and could concede. As the result, in the moment when study had been finally completed planners were already occupied with other schemes, with different problems in need of research. The situation may be summed up as follows: in most cases neither did planners obtain research results when they were needed, nor did scientists have the satisfaction of seeing their work fully appreciated and utilised. The popular saying at that time was that the research was done "to be put into the storeroom".

However, the results of that phase should not be considered as totally ineffective and lost. It may even be stated that although they did not find direct application in practice they formed a lasting contribution into the development of physical planning. As far as the preparation of the detailed geomorphological, hydrographic and land utilization maps is concerned valuable methodological concepts evolved and were tested in making of such maps for specific regions. In this way the standard procedures were established. In fact these methods found a large appreciation abroad both in the socialist states and among the developing countries of the "Third World". In Poland maps were prepared and partly printed for large parts of the country. The extent of actual work on such maps was later strongly limited but this was only because to cover the whole country with such maps in a comparatively short (10-to-15 year) time was obviously more than the staff possibilities of scientific institutions allowed for, especially with scientific attractiveness of such work sharply diminishing. Independently from the development and verification of methods and from the making of maps for selected, important from the planning point of view areas, the field experience and knowledge gained in their preparation led to a series of scientifically important monographic studies. For instance, in the field of physical geography a large majority of doctoral dissertations presented at the Institute of Geography of the Polish Academy of Sciences and of studies published in the series *Prace Geograficzne* (Geographical Studies) of that Institute were based on the materials gathered during the preparation of these maps. Out of the detailed surveys and maps of land utilization has grown not only the

concept of more generalized maps of land utilization in Poland as well as in some foreign countries, but also the whole cycle of studies on complex typology of agricultural production and economy prepared under the direction of J. Kosiński. These studies cover Poland and other countries — the whole work being carried out under the auspices of the Commission on Agricultural Typology of the International Geographical Union. They are also utilized by the Food and Agricultural Organization of the United Nations.

Another theme widely treated with some good results in the fifties was the analysis of economic base of towns and small cities. The starting point for the development of scientific and social interest was the fact that this form of urban settlement, very numerous (about 800 units) in the Polish lands, was undergoing some very significant evolution. These towns and cities had suffered very great population (mainly through the Nazi liquidation of the Jews) and material (war destruction) losses. The post-war nationalization, first of industry and few years later of commerce, was connected with the nationalization and concentration in one common network of plants, stores and shops — a process which has involved radical changes in the functional bases of the existence and development of such cities. Hence the problem of the so-called "activation of small towns". To construct a positive programme for such action a great deal of information and data were needed pertaining to the state of their economy, reserves and possibilities of their development, investment needs and so on. Within the framework of the undertaken research, monographs of a large number of such towns were prepared as well as several synthetic studies. The completed research, published partly in form of a large volume, was followed later by similar studies in the Soviet Union. Studies of individual towns which were at first based on the detailed description of their functions, were quickly transformed into analyses of the existing reserves and possibilities of their utilization for further development. This in turn led to the research of interrelations between such towns and their spheres of influence and then to the study of local settlement networks. When the scope of analysis was enlarged to cover the regional scale, larger cities had to be included prompting the researcher away from the subject of small towns.

Experiences gained in these studies have shown the importance of interdisciplinary research. Hence the creation of the Committee for Space Economy and Regional Planning (*Komitet Przestrzennego Zagospodarowania Kraju*) of the Polish Academy of Sciences was welcomed by all with a hope for increased possibilities of research and complex analyses.

IV. FORMATION OF THE COMMITTEE FOR SPACE ECONOMY AND REGIONAL PLANNING OF THE POLISH ACADEMY OF SCIENCES AND EFFORTS TO PLAN RESEARCH FOR NEEDS OF PHYSICAL PLANNING 1959–1970

At the end of 1958 the Praesidium of the Polish Academy of Sciences accepted the proposal of the Chairman of the Planning Commission of the Council of Ministers to establish the Committee for Space Economy and Regional Planning. Its task was to initiate, to organize and to coordinate research for needs of the physical planning. Its organization was modelled on a similar committee already working for years within the USSR Academy of Sciences. The decisive motive of its creation lay in the consciousness that in order to satisfy the demands of physical planning as a long-range form of planning, research has to precede it by several years and that the implementation of such research is impossible within the framework of planning organization.

The Committee (under the direction of S. Leszczycki) has decided to carry its programme of work in four directions: first — to sum up and to estimate critically the state of knowledge of the geographical environment and of the spatial economy of Poland; second — to improve the cartographical presentation of the basic problems involved in the national space economy and physical planning; third — to develop further theoretical concepts and methods pertaining to the location analysis together with economic and social regionalization; fourth — to study the possibilities of improving and advancing methods of planning on the national and regional level.

This programme, in its basic assumptions an interdisciplinary one, was functioning mainly during the years of the second five-year plan (i.e. from 1961 till 1965). Although never fully completed, it had nevertheless obtained some important scientific results. As far as the geographical sciences are concerned, their participation in the interdisciplinary research led to new concepts as well as new interests. At the same time, by spreading information among other sciences of the concepts, methods and achievements specific for geography, it strengthened its position and authority.

The effort to sum up the existing knowledge of the geographical environment and of spatial economy has spent its impetus first. Cartographical bibliographies and inventories were prepared for several (but not all) elements of geographical environment and one was published. Out of bibliographies concerned with spatial economy the ones on demography and on industrial location were also published.

In the field of research into the structure of spatial economy some very valuable results were obtained. The methods for regional disaggregation of national income (created, and consumed), were discussed and identified. This research initiated by M. Kaczorowski was carried out by a team of scientists from the Central Statistical Office under the direction of Mrs. E. Krzeczowska and W. Zienkowski. The estimates for several successive year were prepared and these have led S. Leszczycki to an analysis of the spatial structure of national economy in terms of the aggregated, complex economic indices such as: national income, value of fixed assets, size of annual investments and others. Among other interesting studies those on the changes in the distribution of population in the 19th and 20th centuries in Poland together with an analysis of trends and patterns of urbanization should be mentioned. Also an atlas of industry, based on a special census carried out in 1956 was edited and the concept and first maps for the National Atlas of Poland were prepared.

Among theoretical studies the most valuable were those concerned with regional economy as well as with the theory of economic regions and economic regionalization. Some studies of the development of planning methods in Poland were also undertaken and several published.

In the following phase, i.e. in the period of the third five-year plan (1966-1970), the studies undertaken under the auspices of the Committee for Space Economy and Regional Planning were limited in scope in comparison with those undertaken in the first stage. This was the direct result of an effort to concentrate on a smaller number of select topics considered to be both most important for the development of physical planning and most promising scientifically. The main achievements of that period were studies of the structure and typology of agricultural production and economy, of the coordination of various means of transport and corresponding networks, of the social and economic role and the growth of large urban agglomerations. Discussions on the methodological problems of planning on the national level were started and continued.

In discussion of the work of the Committee mention of its publications should be made. Two series were edited: Bulletin and Studies. Their task was to circulate information of research undertaken and completed. It is difficult to overestimate their importance and role in improving the qualifications of the planning staff all over the country. The publications aroused their interest, introduced them to new methods of analysis and planning, and spread the information about the most important features of the spatial economy of the whole country.

During this whole period the organization of research bodies did not change very much although their staff were growing both in numbers and in quality. This allowed for the complete liquidation of double employment among the scientific workers. However, after 1969 the organizational set-up of universities and colleges became very fluent which impeded the implementation of planned research.

In the Institute of Geography of the Polish Academy of Sciences research was based on the continuation of programme established in the fifties when the Institute was founded. It was modified when the Committee for Space Economy and Regional Planning started to initiate and to coordinate the research for physical planning. The obtained results and experience also influenced deeply the direction of studies.

For instance detailed geomorphological surveys led to a series of monographical studies, usually connected with an analysis of Holocen morphological processes; often research into the contemporary processes changed into paleogeographic analysis. The studies of changes in the geographical environment under the impact of construction of large dams and reservoirs and of soil movement and circulation of water in mountain river valleys have grown out of materials and observations obtained in hydrographic surveys. First efforts to chart local climates inspired analyses of heat balance and of evaporation from active surface.

The transition from land utilization mapping to typological studies of agricultural production and economies was already mentioned. In the field of settlement geography the passage involved replacement of small towns by middle cities and urban agglomerations as the main object of study. Then the comparative analysis and theoretical studies have gained in importance. The concepts of urban economic base and functional structure of cities have served as the starting point. The problems of standard and specialized urban functions were studied first theoretically and then practically as monographic studies of several countries.

A separate place in the work carried out in this phase was taken by theoretical and methodical studies of economic regions and economic regionalization. These studies were organized in the international cooperation within the framework of the International Geographical Union (Commission on Methods of Regionalization) and led to close relations with the Regional Science Association.

The great majority of these studies could have been and was utilized in physical planning. However, the full integration between research and planning depended to a large extent on close running collaboration with the proper planning bodies — in the field of national and regional physical planning, first of all with the State Planning Commission of the Council of Ministers. Such close collaboration existed organizationally and personally practically all the time, but at the end of the sixties the mutual understanding about the most important and decisive topics was somewhat weakened. The planners' inability to define clearly and well ahead on time the research needs of planning and the scientists' lack of interest and understanding of characteristic themes and difficul-

ties existing in planning processes seriously limited the intensity and effectiveness of the undertaken research. The situation has changed again when simultaneously the new plan of research for the period of the next, fourth five-year plan (from 1971 till 1975) was being prepared, and the new forms of organization and financing of all research were defined and introduced.

V. NEW ORGANIZATIONAL FORMS OF RESEARCH PLANNING AND FINANCING AND THE RESULTS OF RESEARCH OBTAINED IN YEARS 1971-1974

In the preparation and implementation of the national research plan for the fourth five-year plan, i.e., for 1971-1975 the programme of research and the necessary financial means were for the first time fully correlated. To introduce such an important decision serious changes were necessary in the rules and forms of financing of the scientific institutions. A large majority of them received the status of independent (autonomous) budget establishments obtaining most of their financial means by contracts for execution of specific research tasks. In particular all research activities were decided into three parts: plan A — the state plan, covering problems of special importance for the economic and social development of the whole nation (country), and financed from the national fund set aside for such purpose; plan B — comprising plans of individual ministries, covering problems of special importance for the given ministry representing a specific branch of national economy and financed from the funds in possession of those ministries; the Academy of Sciences was included here, being treated as a separate ministry responsible for the development of science as a whole; finally, plan C — covering the research considered to be of importance by the given scientific institutions and financed from their own incomes or from the budget subsidies. The costs of research executed on the basis of contracts (plan A and B) include the individual or real costs of research so-called general over-head costs and the earnings of the institution (calculated on percentage basis, with rate being defined each year by supervisory authorities). Each institution possesses an open account in the Polish National Bank with open credit up to the 90% value of the signed contracts. The contracted funds are transferred and the credit repaid only when the given research is finished and accepted or approved. In addition, with the assumption that problems included in plans A and B involve interdisciplinary research, for each problem in plan A the coordinating institution is designated. Such institution, within the terms of reference of the given problems, prepares detailed coordination plans for approval, organises (makes contracts) and coordinates research, accepts or rejects the contracted studies and work, prepares the transitory and final reports.

In the present plan of research in plan A there is included a problem concerned with research for planning at the national level, called "Bases for the physical development of the country" (*Podstawy przestrzennego zagospodarowania kraju*).

The proposal for the inclusion into this plan of such problem was made in 1969 jointly by the Academy of Sciences and the Planning Commission of the Council of Ministers. The Institute of Geography of the Polish Academy of Sciences was empowered to prepare the research programme and later was designated as the coordinating institution. Originally the problem was named "Transformation of spatial structure and of urban and rural settlement network" (*Przekształcanie struktury przestrzennej oraz sieci osiedli miejskich i wiejskich*),

but during the preparation of the plan in July 1970 its name was changed into "Bases for the physical development of the country". The plan had several successive, each time more detailed versions. The greatest constructional changes and additions were made during the critical review of the project by the Presidium of the Committee for Space Economy and Regional Planning, acting on behalf of J. Kaczmarek, the Chairman of the Committee of Sciences and Technology, at that time the highest ministerial body (later it was transformed into the Ministry of Sciences, Higher Education and Technology). In 1973, in view of obtained results and experience and by order of the Secretary General of the Academy, the whole plan was revised and corrected. The new present version was finally approved in July 1973. It should be stressed that the whole plan and its implementation are under constant supervision of the Committee for Space Economy and Regional Planning which in this way preserves its role as the initiating, organizing and coordinating body in the whole field of research for physical planning, in spite of the fact that the large majority of studies and financial means set aside by the state for this purpose is included in the problem just described.

The whole plan is divided into 4 parts, 19 thematical groups and about 100 themes. In particular part A "Physical development of the country and regions" includes 10 thematical groups and 54 themes; part B "Physical development of urban and rural settlements" — 3 thematical groups and 17 themes; part C "General and synthetic reports" — 2 thematical groups and 10 themes, and part D "Theoretical and methodological studies" — 4 thematical groups and 17 themes. The financial plan defines the total costs in years 1971–1975 at the level of 230 million zlotys; out of which 66 millions are provided for the research institutes of the Academy, 81 millions the research bodies at the universities and colleges and 73 millions for the research institutions belonging to various other ministries.

Two hundred and fifty five fully employed scientific workers were taking part in the implementation of this programme in 1973, among them about fifty professors. The coordination plan provided for three hundred people at the beginning with the figure rising sharply during the whole period from 1971 till 1975. The reduction in numbers is at least partly explained by the growth of wages of scientific workers which has taken place without the parallel increase of the funds set aside for the implementation of planned research.

The results so-far obtained should and can be discussed from four different points: improvements achieved in the organization and planning of research; the formation and education of qualified research staffs; the progress in scientific knowledge and theories; the applicability of results in social and economic life, in particular for the planning practice. Analysing the situation in 1974 from those points of view it is possible to state that the results are real and important although they are no always easily observable.

In the tumult of everyday events and difficulties — generally speaking — it is easy to forget that for the first time in the history of Polish science not only the ambitious programmes and plans are formulated (which in the past has happened several times not only in the framework of planned socialist economy but also earlier) but that they are based on a solid financial basis and are — for several years already — consciously and rythmically carried out towards completion. In the field of research for physical planning this is an achievement without many precedences not only in Poland.

The financing system of research through contracts for the execution of partial tasks, functioning within the framework of an integrated complex coordination plan possesses two main advantages. On the one side the effective-

ness and social control of research carried out in various scientific institutions which had so far functioned on the basis of budget grants and subsidies were improved. On the other the means — financial and others necessary for enlarging the research front became available. The so-much-needed collaboration between different research institutions found solid foundations and has strongly developed. It is possible at present to speak of wide and serious interdisciplinary research which was always desired but only rarely achieved in the past.

Another achievement of the same kind lies in the participation in the research programme of the numerous academic (i.e. university) research institutions. Whoever has taken part in their activities knows how difficult it is to organize concentrated and common research of these scientists whose first duty is the highly responsible and absorbing educational and didactic work. Hence the research achievements, sometimes quite outstanding of this group were often haphazard, characterized by thematic dispersion and extreme individualism. If there is any doubt about this it is possible to look in the archives into to-day already historical documentation of research plans and programmes compiled in the fifties and sixties, which give a fantastic picture of dispersion or even of serious mis-conceptions in the choice of subjects for research. If to-day we do sometimes speak of the lack of discipline or of the unsatisfactory level in research carried out at the universities, we should not forget that these research institutions have willingly accepted the proposed research tasks and in spite of all difficulties and heavy didactic burdens, consciously and on the whole well implement their assumed duties. We should add to that the parallel although still relative concentration in themes of research which often involved resignation of personal interests. I am sure that the achieved selection and crystallization of research subjects already forms a large step forward in the organization of science, an achievement which should be strengthened and widened in the next five-year plan. In all circumstances the initiating and leading role of the problems included in the state plan (plan A) is now quite clear, indeed obvious.

This role is reflected also in number and themes of doctoral dissertations prepared within the framework of the plan i.e. in the education and formation of the scientific workers. It is possible to state that these dissertations — necessary for the obtainment of scientific degrees — are now characterized by the better choice of the subject, fuller documentation, modern methodical approach, bolder theoretical constructions and interpretations and wider (in this case obviously necessary) practical applicability. These studies are not limited to strict descriptions, they explore the genesis of the observed phenomena and as a rule try to predict logically some future consequences which involves the identification of specific regularities and of the constraints conditioning their existence. In addition these dissertations are prepared within specific limits of time, so-far a rare phenomenon in their preparation, which makes the quicker professional advance of young scientists possible. In the conditions of increased social demand for qualified scientists this is an important factor. All these advantages and achievements may be ascribed to the fact that these dissertations are prepared and discussed in an interdisciplinary and interregional scientific environment, fermenting and innovatory in the field of theoretical concepts and analytical methods. From that point of view the numerous symposia, seminars and, other scientific gatherings, organized for discussion of common methodological and theoretical problems arising during the implementation of various specific research themes and tasks are of special importance. They make possible an easy flow of scientific information and serve as the ideal mean in spreading of an integrated and unified set of concepts and terms of a common

scientific language. To give instances of such meetings-conferences on the concept of urban agglomerations, regional growth centers, territorial division of the country, integrated networks of transport for the whole country, on technical and economic infrastructure in urban agglomerations, complex mapping of the natural resources and values as well as on revalorisation of geographical environment and many others should be mentioned.

In so far as the scientific results are concerned, the first to be obtained were rather accidental and disjointed, coming as first signals out of separate themes. Their detailed description is out of question. It would be too long and rather tedious. However, with time some larger issues started to come forth. They began to coalesce, allowing some unification and integration of the obtained partial results. It should be stressed that only where a certain new, innovating concept or result had come to the fore, defining and integrating research in the whole thematic group (or at least in one theme) only there the whole complex of studies reached a higher scientific level and the effectiveness of undertaken research was better. Several such achievements are worth of being described in detail.

The concept of socio-economic space and its structure allows the integration of well developed studies of the regional and functional structure of global product and national income as created and consumed, of the structure and regional models of consumption as well as of the spatial distribution of fixed assets and new investments. At the same time the population potential turned out to be in the first approximation a good representation of such space. The maps of this potential for years 1950, 1960, 1970 based on the network of standardized basic squares (with area of 100 sq km) were prepared with the use of computers both for the calculation of the values of potential and for drawing of maps giving an extremely interesting and true picture of Polish post-war achievements in the development of space economy.

The valorization of natural environment as the framework and basis for the social and economic activities was faced with some extremely difficult questions both of methodological and theoretical nature even in compiling the inventories of resources and values of this environment. Although these difficulties have not been so far fully overcome nevertheless certain progress had been achieved. The concepts of review (or general) maps of such resources and values as well as of the spatial economy based on these resources and of their conservation had been worked out and first, exemplary sheets prepared.

The verification of the physico-geographical regionalization (as previously worked out by J. Kondracki) based on the analysis of climatic diversification and of circulation of heat and water is under way. Moreover, the review geomorphological and hydrographic maps of Poland are already prepared for publication.

The leading factor in the implement of ambitious research into the spatial organization of agricultural and food problems lies in the concept of dynamic typology of agricultural economy (not limited to the elements of production only). This concept supported by specific cartographic studies made possible the elaboration of a series of maps demonstrating changes which have taken place in the past and are foreseen for the future. This approach was several times described in detail by J. Kostrowicki in separate publications.

In the field of forestry the concept of multifunctional character of forests forms the methodological novelty by which the present studies of regionalization in forestry differ from the former ones.

The research into the location of industry and the processes of industrialization was only partially successful. The documentary analysis of the industrial

censuses was carried out together with a series of interesting monographs of specific branches of industry and of some industrial regions. However, the impasse, existing for a number of years in the theoretical concepts and methodological approaches has not been so far overcome. This fact is disturbing, especially when compared with new very promising developments in this field abroad. These include the study of location in condition of uncertainty and the use in the locational analysis of the graph theory. The development of theoretical studies belongs therefore to the most important tasks for research in the coming years.

Important progress was obtained in studies of the spatial economy of technical and economic infrastructure. This became possible thanks to the concept worked out by M. Madeyski of the integrated transport economy involving close coordination and collaboration between networks of various transport means. The question which has lately become of special interest is the size of employment in transport as a constraint in the growth of passenger and goods transport volume. To overcome it more mechanization becomes necessary which in turn increases to unbearable limits the necessary investments.

As far as the social infrastructure is concerned, after a number of organizational difficulties had been overcome studies are developing at a very wide, perhaps even too wide front. However, with the critical estimate of achievements we have to wait. The work was started late and the incoming results are only fragmentary.

A similar situation prevails in studies of tourism and recreation. After the initial organizational reverses the undertaken studies are — it is true — complex and exploring the whole field of touristic phenomena, but often they are nothing more than inventories, registrations of basic data and analyses of concepts and proposed models. Experience gained in other more advanced fields indicates that after the first preliminary phase, others have to follow in which the selection of themes to be studied and the concentration of efforts are necessary. With unsufficient and unexperienced staff of research workers a very wide front of research may be a mistake.

The study of settlement structure and network has a very long tradition, interesting achievements and a great number of efficient scientific workers — not only among geographers but also in other branches of social sciences. The fact that in this field some significant progress has been achieved is not therefore very unusual.

First of all, the new concept and term of a “settlement system” was introduced. In this way new methods of analysis and better understanding of the arising questions became possible. The advantages are already visible although the full exploration of its possibilities will be possible only in the next planning period, i.e. in years 1976–1980 (the fifth five-year plan).

The analysis of the distribution of population and migrational mechanisms brought up number of so far unknown or sufficiently unappreciated interrelated phenomena, indicating clearly the necessity of integrated approach to problems of population and settlement within the whole country. Only on the basis of such approach the choice of proper, regionally differentiated policies in the field of population, urban and rural growth and physical development is possible. The obtained results support the view that the concept of settlement system is useful and advantageous both in research and in planning on the national and regional level. Another assumption, the working hypothesis that within the national settlement of Poland there exist — at present — three main subsystems: on the national level — of urban agglomerations with regional networks

of subsidiary centers and of local rural-urban settlement complexes was also fully verified.

The studies of urban agglomeration were very successfully and widely developed. Their development in time and in space was reviewed and preliminary theory of their growth formulated. It differentiates between the phases of growth of mono-centric metropolitan areas, policentric industrial and mining conurbations and recreational conurbations (although this last type of urban agglomeration in Poland just begins to emerge). It seems that in spite or rather because of the reversed direction in their spatial transformations there are great similarities in the final outcome: patterns of urban agglomerations show metropolitan areas becoming policentric and industrial conurbations evolving the capital, the main center. With growing interest of the national, political authorities in the proper, rational development of urban agglomerations as the leading elements in the physical structure of the country, i.e., in the socio-economic space, the problem of research as a basis of their physical plans and planning becomes unusually important. In result the study of urban agglomerations in form of an applied research is to become in the next plan an independent problem (either in plan A or in plan B). However, in the framework of the present more general problem one theme will remain — the role and functions of agglomerations in the whole settlement system and the typical regularities in their growth and development.

The study of regional centers led to the definition of their fourfold function: of administrative and organizational centers, of service centers for specific smaller regions, of diffusion centers of modern civilization and technology and of concentrations points for diversified industries. This significantly modifies the classical theory of growth poles.

Unfinished studies of local settlement complexes have shown large regional differentiation in types and structure and the important role played there by the historically developed locational and spatial patterns. However, collected materials are unsufficient for even hypothetically formulating their typology and theory of growth.

Interesting results were also obtained in the field of research and testing of new methodological approaches and possibilities of their wider, practical applications in practice of physical planning. The studies were mainly concerned with simulation models, certain forms of econometric accounting, construction of prognoses for needs of physical planning and others.

Some synthetic studies and reports have been already started, but it is too early to discuss their results and value. This will become possible only at the end of year 1975 when they shall be well advanced or almost completed. For the time being we have only rough reports for the thematic groups and for the whole problem. In such preparatory work the value of synthetic approach have been proven and their feedback effect for the analytical studies was clearly visible. However the dummy of final report was not the first synthetic approach and approximation. Such an approximation was inherent already in the coordination plan itself — a result of extensive discussions between scientists participating in the research. In addition, in 1971 the coordinating committee prepared a set of proposals pertaining to the physical development of the country for the VIth Congress of the Polish Unified Party of Workers. At the end of year 1972 and in the beginning of 1973, an assessment of the present state of development and proposals based on achieved research to the Plan of Physical Development of the Country till 1990 (prepared at that time in the Planning Commission of the Council of Ministers), were formulated and transmitted to

proper authorities. The preparation of these materials played an important role in the integration of studies carried out in different thematical groups.

The presentation of the research results to the authorities and planning institutions is directly connected with their practical utilization and application. Taking into account the nature of planning proper, the application of the research obviously means the spread or diffusion of information about the obtained results. Those were transmitted currently and continually to the central and regional planning bodies as well as to the interested ministries and their regional subordinates. However, the full utilization of obtained results implies much wider distribution and better diffusion of information.

In this field some successes should be acknowledged which although still insufficient promise well for the future. First of all the publication of source materials has begun. The first part of the National Atlas of Poland is already published and there is some hope that by the end of 1975 the whole atlas shall be in hands of the public. The Atlas of Industry is to be published in a restricted circulation. Similarly, the geomorphological and hydrographic maps (in several sheets) should be published soon. The Central Statistical Office has already published — prepared within the framework of the problem — estimates of global product and of national income as created and consumed by regions (voivodships) in 1970.

The recently edited bibliography for years 1971–1973 of published and unpublished studies, executed within the problem contains about 600 positions. There are over 180 publications (in 1973 only — 53 positions). The real difficulty is not the number of positions but the length of time taken in editing and publishing of material after the research itself is finished. If we omit the editing as done by the author, which lasts often during one whole year or longer, and look at the technical editing and printing only — it takes in case of books between one and half and two years, in case of articles published in scientific journals six to twelve months and in case of duplicated materials from two to six months depending on the amount of editing work and current capacity of duplicating machines. This is the next, perhaps final, obstacle which has to be overcome in the implementation of the research plan.

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This review of research and changes shows very clearly the long road behind us. In the chaos of everyday duties one has sometimes an impression that nothing changes and when new obstacles and difficulties arise the feeling of depression and disappointment grows still further. Looking back over the last post-war thirty years one sees continuous progress in the organization of research, strong growth in number of scientific workers and large increase in material means set aside by the community for research. Yet the themes to be studies grow even quicker. This is unavoidable. Only in conditions of total lack of knowledge it is possible to imagine that there is a definite end to the growth of scientific knowledge. The reality is different. As we improve our analytical tools, as we grow in knowledge of the phenomena surrounding us; as we widen and deepen our theories and hypotheses, integrating and unifying them, we observe an increasing number of additional themes for research and in result we have to extend our work and our organization.

The last thirty years have taught us that there is no significant opposition or contradiction between the pure and the applied science and research. The truth is quite different. Between science and practical problems of life there are very important interactions and feedbacks. Practical life and application of research

results pose before scientists new problems for study. The growth of theories and scientific knowledge leads in turn to the improvement in individual and social life.

The achievements of the past years should not make us blind to the fact that the demands of the future are and shall be even greater and more important.

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THE CONCEPT AND ASSUMPTIONS ON SOCIO-ECONOMIC SPACE ANALYSIS

ZBYSZKO CHOJNICKI

The purpose of this report is to present the concept and foundations of research into the changes in the differentiation of socio-economic space. The study is to provide a synthetic picture of the changes in Poland's socio-economic space on the ground of the basic socio-economic indices and to consider its links to the geographical environment.

What has been completed up to now, i.e., in the first phase, is primarily of methodological and preparatory purpose. Empirical analyses consisted mainly in testing the methods and models.

The notion of socio-economic space is the fundamental underlying concept of the whole research project. It is a generalization of the spatial characteristics of different patterns constituting the spatial socio-economic system. The notion of socio-economic space has many theoretical implications if it is interpreted not only in terms of the role fulfilled by physical space in the socio-economic system covering physical distance but also in the more general terms deriving from the mathematical concept of space, i.e., of space treated as a set of elements fulfilling definite postulates.

Thus conceived, socio-economic space is to be interpreted as a category of the relational description of systems that are sets or subsets of socio-economic phenomena and which are considered in terms of their differences (space of properties), neighbourhood (topological space), distance (metric or physical space). So far, such a concept has not been extensively employed in this analysis. In space-economic studies this notion is often used in a more restricted sense, in its substantive meaning of area or its dimensions or capacity. The relational notion of space is more comprehensive and permits to comprise both what F. Perroux calls banal or geonomic space and economic space.¹

The relational concept of space can also be referred to the geographical environment as the system which is the foundation for the socio-economic system. Geographical environment is an external system but it fulfills a significant role in the spatial differentiation of the socio-economic system. Analogously, this system can also be described in spatial terms, calling it geographical space.

Poland's socio-economic system comprises today several interrelated subsystems and spheres of activity each of which is the resultant of different historical processes.

The basic elements of differentiation and complexity of the system are the distribution of population and of the durable, or fixed products including the

¹ F. Perroux, Economic space: theory and applications, in: Regional Development and Planning, J. Friedmann and W. Alonso (Eds.), Cambridge, Mass. 1964, pp. 21-36.

infrastructure in the broad sense, that is the settlement network, productive and nonproductive facilities. They form patterns of relatively high spatial stability, closely interrelated with each other which, if they are locationally ill-adjusted, account for many significant spatial processes, such as migrations or commuting.

These patterns determine the distribution spheres of production processes, of services and of the production of nonmaterial goods. The differentiation of these patterns and spheres results in the spatial differentiation of the distribution of national income and of living conditions.²

The relations between these patterns and spheres are not of a simple direct causal nature which would produce direct vertical links between them in a given area. What does result is a comprehensive process of spatial interaction. Thus the system of spatial development comprises the mutual relations between the patterns and spheres both as regards spatial differentiation and spatial links.

The characteristics of the individual patterns and spheres can be regarded as the particular socio-economic subspaces, and the socio-economic space is their overall synthesis. The socio-economic space can therefore be interpreted as the synthesis of the nation's spatial economy, though not as a simple adding-up of the particular socio-economic subspaces but as a definite resultant of their mutual relations.

The notion of socio-economic space is used to reconstruct a definite state of the socio-economic system, which is dependent and conditioned by the processes of development governing it.

The spatial properties of the system must not be treated in a purely structural manner, in isolation from the process of development, that is as if they concerned the extra-temporal inner links of the system in which time has been engrossed in the spatial structure.

In practical research there occurs a sharp distinction, that of space vs. development, which is a difficult dilemma to solve.

When solving this dilemma it is necessary to remember that the developmental approach need not include a meticulous study of the origin of the spatial system; in particular, what is dispensable is a reconstruction of its historical development, but instead emphasis must be put on the changes in stability, resistance, the formation of new and the decline of old elements — all of which leads to a transformation of both the spatial system itself and of its intrinsic interactions.

The concept of time-space seems to be promising as a conceptual tool integrating the socio-economic space with the process of its development. The possibility of using this concept in our field of study was pointed out by H. Greniewski, who drew an analogy to relativistic physics as regards this concept. He wrote "Two contradictory phenomena may occur in one place (space) but at different times. For instance, a road crossing must be pulled down before a new two-level crossing is built in the same place. If phenomena are contradictory in time and occur in the same space an important question arises: how to assess the social advantages and the adverse effects of all transformations..."³

The methodology of studying the socio-economic system realizing the above assumptions in terms of socio-economic space, geographic space and time-space comprises two approaches: one analytical and one synthetic.

The analytical approach is based on the assumption that the socio-economic system is one whole defined by the set of its socio-economic properties. The

² Z. Zajda and S. M. Zawadzki, *Prognozy rozwojowe badań nad przestrzennym zagospodarowaniem kraju*.

³ *Biuletyn KPZK PAN* 1968, 46, pp. 35–36.

spatial interpretation of this system is comprised in the category of the overall socio-economic space. This space can be described by a three-dimensional principal components model.

The above method identifies the latent structure of the overall space. The components are significant spatial patterns, that is the particular subspaces together with the dimension of time integrated into them. These patterns do not exhaust the whole set of subspaces but they are of basic importance both as regards the respective weights of the phenomena they represent and their persistence (or variation) in time.

In conclusion, these patterns may thus be identified as the carriers of changes in forming the inner structure of the overall space or as stabilized patterns which condition the crystallization of that structure.

The latter of the two approaches assumes that the particular spatial patterns constitute the socio-economic system which belongs to the category of metapatterns. The set of subspaces is, despite the multiplicity of its elements, a finite set, but its elements remain interdependent.

Thus the overall socio-economic space is a resultant of the particular subspaces which constitute its structure. This concept of overall space assumes that the properties of the socio-economic space are defined through the integration of the subspaces.

Regression analysis is the basic technique of linking the subspaces with one another from the standpoint of spatial differentiation. In this manner it is possible not only to define the types of mutual relations of the patterns but also to find out which of these relations are intrinsic. Another version of regression analysis, is the trend surface analysis of the potential of manpower, fixed capital, market demand and national income produced, and this analysis fulfills primarily a descriptive-explanatory function in the study of spatial links between patterns.

To sum up, the methodological idea of the integrated description of socio-economic time-space can ultimately be brought down to solving two research tasks: a) the macrostudy of the particular subspaces, b) the formulation of generalized statements about the variation of phenomena in the system as a whole such that have not been detected in the elementary patterns.

The study of subspaces can be reduced to analysing the spatial differentiation of specific socio-economic phenomena. Within the set of these subspaces, the population distribution pattern plays a dominant role.

A highly generalized description of the particular pattern of population is made using the trend surface method. As the point of departure, the population potentials created in given control points by the individual population masses of each unit belonging to the set of basic squares are established.

The population potential as a measure of differentiation and spatial links of the population serves as the foundation for the description of the particular socio-economic spaces; this description, which is strongly representative for the whole system, comprises also the effect of distance on the mutual interaction of socio-economic phenomena.

In order to generalize the spatial variation the trend surface method is employed. The trend surface method has the form of a multiple regression equation (an n -th degree polynomial) which defines the dependence of the population potential on the orthogonal geographic coordinates. This model permits a simplified description of highly complex population distribution patterns by separating the trend, i.e. systematic large-scale spatial changes called regional changes, from local or chance fluctuations. Maps of the trend can disclose spatial re-

gularities and constitute the point of departure for the interpretation of the spatial distribution of the population.

The generalized description of the spatial distribution of population by the trend surface method is repeated for several time points. The sequence of the estimated comparable multiple regression coefficients is viewed as a time series and this is followed by a study of the space-time trend in order to obtain a generalization of the spatial distribution of population in time. Each parameter of the function of spatial trend for a definite state of population distribution describes a definite spatial form, and the changes in the coefficients identify the time-related changes in the spatial forms of population distribution. These changes coincide with the phase of Poland's socio-economic development. Thus the value of this methodological concept consists in studying the relations between spatial structure and processes.

Poland's geographical environment is a system differentiating the socio-economic system's spatial structure. It has a different organization and the regularities governing it are of different character. As the ground structure for the socio-economic system, it has a definite level of utilization intensity. Diagnoses in this respect are possible if the input-output analysis is applied on the ground of the types of relief and land use in the pattern of delimited territorial units of economic activity.

The "geographic environment vs. society" relation provides the foundation of the concept of complex metasystem considered in terms of a unique synthesis of geographic space and a general synthesis of the socio-economic space.

The analysis of this metasystem must employ the principal components method. This method starts with a description of the statistical links between the variability of properties of the geographical environment and the spatial properties of the socio-economic system. As metafeatures underlying the correlations within a given set of properties, the components can be interpreted as essential properties of the geographical space integrated with the socio-economic space, properties on which are based the regularities observable in the spaces and which therefore are of great importance for the measurement, description and explanation of the variation of the metasystem.

The knowledge of variation in the spatial differentiation of the socio-economic system in the form of development trends may prove helpful in the task of forecasting and controlling the transformation of spatial structure.

Efficient forecasting is best served by a model of structure development. Unless such a model is at hand, the forecasting of future spatial structures may not be entirely unequivocal. In forecasting various research tools can be employed, both tools based on the knowledge of the evolution of spatial structures, which results from the knowledge of the mechanism of their development, and tools based on more general considerations concerning the direction in which the socio-economic system may be developing. In practice there are no solutions that would meet scientific requirements, though some research tools, as, e.g., extrapolation and developmental trends, can reinforce the scientific foundation of a forecast.

AN ATTEMPT AT THE DETERMINATION OF TRANSFORMATION TRENDS IN THE SPATIAL ORGANIZATION OF AGRICULTURE IN POLAND BETWEEN 1960 AND 1990

JERZY KOSTROWICKI

Transformations in the spatial organization of Polish agriculture and the determination of their trends are subject of comprehensive research, carried out within the national-scale priority project called "Bases for the country's spatial development". The Department of Agricultural Geography of the Institute of Geography, Polish Academy of Sciences, was made co-ordinator of this research.

These problems, and in particular the methods of the synthetic studies of agriculture were a subject of research carried out by the Department for quite a long time; therefore, in 1971, the Planning Commission entrusted the Department with a task to prepare a prognosis, or to be more precise, a program of transformations of Polish agriculture between 1970 and 1990. The study which followed contained 85 pages of the text and over 50 maps or diagrams¹; it was completed in December 1972 and presented to the State Planning Commission at the beginning of 1973, in the form of a duplicated manuscript. Various versions of certain parts of the study were subsequently discussed on such occasions, as the annual session of the Commission on Spatial Problems of Agriculture of the Committee of Space Economy and Regional Planning, Polish Academy of Sciences; the Annual Meeting of the Institute of Geography, Polish Academy of Sciences; the Session of Section III of the Polish Academy of Sciences; a special meeting of agricultural economists and planners; as well as during the IV Polish-French Seminar and the VI Meeting of the IGU Commission on Agricultural Typology, held in Verona, Italy, in 1974. By necessity problems presented each time for discussion were selected in such a way as to comply with the principal topic of each meeting. For example, the application of typological methods for the investigation of dynamics in the transformations of the spatial structure of agriculture was discussed during the previous Annual Meeting, while at present, because of the character of the session, I would like to concentrate upon methods applicable to prognosing and programming transformations in the spatial organization of agriculture, as well as upon the results that can be obtained by using such methods.

In the study, which has served as the basis for this paper, tendencies in transformations in the spatial organization of agriculture were investigated by

¹ J. Kostrowicki et al., *Próba zarysowania przemian w strukturze przestrzennej rolnictwa Polski w latach 1960–1967 oraz hipoteza dalszych przemian w latach 1970–1990* (An attempt at outlining transformations in the spatial structure of Polish agriculture between 1960 and 1967, and a hypothesis of further changes between 1970 and 1990), Warszawa 1972, Inst. Geogr. PAN (a duplicated manuscript).

means of typological methods. Directions of the further transformations were established by means of the method of extrapolation of the past tendencies and the rate of development. The results of the extrapolation were then revised on the basis of information as to the tasks set before Polish agriculture for the decades 1970–1980 and 1980–1990 and means to be allotted for their implementation by the State Planning Commission. The trends of transformation in the spatial organization of agriculture were also determined by the use of the analogy method, i.e., by drawing conclusions from experiences gathered by other countries or regions where the level of agricultural development is higher, whereas the conditions of development are comparable.

The application of typological methods seems to be justified by the fact that while separate elements in agriculture can be planned and subsequently combined together (or not) in centralized planning by the use of balance sheets, the making of a prognosis or program of spatial systems of agriculture should be of a complex character.

For agriculture is not a simple sum of processes or elements, but a set of elements or components, highly interconnected and interrelated, developing in definite external natural or other exogenous conditions, in which the change of one element or component induces a change of the remaining elements. Such a concept of agriculture should therefore be understood as a system in terms of the systems theory.²

Individual farms or agricultures, understood as systems, can be compared with each other and grouped into types based on similarities of their components or characteristic properties. Farms or agricultures, possessing a great number of similar features, can be considered as being of the same type.

I do not want to talk again on the subject of theoretical premises and the use of typological methods in agriculture. As a result of the activity of the IGU Commission on Agricultural Typology and of the Department of Agricultural Geography,³ this subject has been dealt with in many publications, in the Polish and other languages. To avoid any possible misunderstanding I would only like to emphasize that typology and regionalization are two different notions and should not be confused. Typology is a systematic or taxonomic concept, whereas regionalization is a territorial one, even if it may be based upon typology.⁴

The two most important methodological problems in agricultural typology are as follows: (1) the selection and expression, in an adequate form, of variables, representing each agricultural characteristic feature; the variables, if com-

² Cf. for example J. W. Birch, Farming systems as resource systems, in: *Agricultural typology and land utilization*, Verona 1972, pp. 13–22; C. W. Olmstead, The phenomena, functioning units and systems of agriculture, *Geogr. Pol.*, 19, 1970, pp. 31–41.

³ For more details cf. J. Kostrowicki, *Typologia rolnictwa. Założenia, kryteria, metody* (Sum.: Agricultural typology. Principles, criteria, methods and techniques), *Przegl. Geogr.*, 41, 1969, 4, pp. 599–621. A study referring to Poland: J. Kostrowicki, R. Szczęsny, *Rolnictwo* (Agriculture), in: *Struktura przestrzenna gospodarki narodowej Polski*, Warszawa 1971, PWE, pp. 17–102. Regional studies: W. Stola, *Próba typologii rolnictwa Pomorza* (Sum.: An attempt at an agricultural typology of Pomorzanie, Central Poland), *Prace Geogr. IG PAN*, 81, 1970, 143 pp.; W. Biegajło, *Próba typologii rolnictwa na przykładzie województwa białostockiego* (Sum.: Agricultural typology. A study made on the example of the Białystok voivodship), *Prace Geogr. IG PAN*, 100, 1973, 163 pp.; M. Matusik, *Próba typologii i regionalizacji rolnictwa na obszarze Dolnego Powiśla* (Sum.: An attempt at an agricultural typology and regionalization of Lower Powiśle, Northern Poland), *Prace Geogr. IG PAN*, 102, 1973, 152 pp.

⁴ Cf. J. Kostrowicki, R. Szczęsny, *Rolnictwo* (Agriculture), op. cit., pp. 99–101, and J. Kostrowicki, *Zarys geografii rolnictwa* (An outline of agricultural geography), Warszawa 1973, 590 pp.



Fig. 1. Changes in the commercial production per 1 ha of agricultural land in 1960-1967
1 — no changes, 2 — slight increase, 3 — increase, 4 — great increase

bined together, should fill in the aggregation, which agriculture is, to a maximal degree; (2) the selection of methods by means of which multi-featured units, which each farm or other research unit is, can be compared.

The study of agricultural typology of Poland was based upon the following variables, representing individual agricultural properties:

I. Social and ownership characteristics

- (1) Percentage rate of socialized farming in the total agricultural land;
- (2) Average size of individual holdings.

II. Organizational and technical (operational) characteristics

- (3) Inputs of mechanical power measured by the number of tractors per 100 ha of arable land;
- (4) Chemical fertilizing measured by the use of fertilizers in pure content NPK in kilograms per 1 ha of arable land;
- (5) Organic manuring measured by the number of livestock in conventional (large animal) units per 100 ha of agricultural land;































Fig. 2. Types of agriculture in Poland in 1960

Types of agriculture (codes and legend)

Niveau de traits de production ↓

→ Ensembles des traits sociaux

	I(11)	II(21)	III(12)	IV(22)	V(31, 32, 33, 41, 42)
1					B 31 21223 1221 U 41 33222 1221
2	K 11 12443 2122	S 21 22323 2221	E 12 11333 2221		
3	C 11 23433 2222				P 32 31323 1232
4			F 12 12333 2223 M 12 22333 2232		
5	L 11 12444 2233	J 21 21333 2332			Z 32 33323 2332
6	T 11 33433 2333 D 11 34434 3233		H 12 23323 2243	W 22 32333 2333	
7		V 21 33334 3333	(G 12 23432 3333) N 12 23333 3333		Z 31 34323 2343
8				R 22 34433 3344	(I 33 33411 2443)
9				X 22 33323 3344	
10	O 11 34333 3254				Y 32 44423 3345
11	(Q 11 34341 4355)				(A 33 54211 3553) (L 32 45422 4444)

	I(11)	II(21)	III(12)	IV(22)	V(31, 32, 33, 41, 42)
1					 B  U
2	 K	 S	 E		
3	 C				 P
4			 F  M		
5	 L	 J			 Z
6	 T  D		 H	 W	
7		 V	 G  N		 Z
8				 R	 I
9				 X	
10	 O				 Y
11	 Q				 A  L

Explanations to the Figures 2, 3, 4 and 5

- (6) Inputs of labour measured by the density of agricultural population per 100 ha of agricultural land;
- (7) Inputs of animal power measured by the density of horses per 100 ha of agricultural land.

III. Production characteristics

- (8) Land productivity expressed by gross agricultural production per 1 ha of agricultural land;
- (9) Labour productivity expressed by gross agricultural production per 1 person of agricultural population;
- (10) Degree of commercialization expressed as the percentage rate of commercial to gross production;
- (11) Level of commercialization expressed as commercial agricultural production per 1 ha of agricultural land.

Many critical comments can be made of most indices expressing the variables. Their selection, however, and particularly the way of expressing them, was largely handicapped by lack of respective statistical data. Moreover, this fact did not make it possible to treat separately individual and socialized farming. As indices characterizing both forms of agriculture differ greatly, which is a clear sign that these constitute two different types of agriculture, this is a great shortcoming.

Because of that the significance of the completed study lies primarily in its methodological concept, whereas all the conclusions drawn from it are only approximate. It is hoped that in future all necessary data will be available and a new, improved version of the study will be prepared then, in which changes occurring after 1970 will also be reflected and which will contain certain new proposals as to how to solve the problem.

The units analysed in the basic investigations (*poviats*) were compared by means of the deviation method. The pattern of indices was codified in the following form:

$$T = 1, 2 \begin{matrix} 3, 4, 5, 6, 7 \\ 8, 9, 10, 11 \end{matrix}$$

in which the numbers stand respectively for the variables, expressed by the magnitude of classes 1-5 of the world range of the given index.

The described methods were used to prepare the typology of Poland's agriculture for the years 1960 and 1967⁵ (cf. cartograms in Figs. 2 and 3). The comparison of the results of both typologies made it possible to identify the trends of transformations which had taken place in the spatial organization of agriculture between 1960 and 1967.

As far as social and ownership characteristics are concerned, changes were relatively slight: the share of socialized farming increased and certain small changes occurred in the average size of individual holdings. Changes in the indices representing inputs for agricultural production were much bigger. Very significant, although unevenly distributed, was the increase of mineral fertilizing. It was particularly high in socialized farming; the use of fertilizers in private holdings increased greatly but differences were quite considerable depending on the area. The use of mechanical power, though increased as a whole, was again very unequal. The slow rate of mechanization was accompanied by persistent high inputs of animal draught power, which were ones of the highest in the world. Simultaneously, labour resources, and therefore labour inputs, were

⁵ The selection of 1967 was dictated by the fact that respective data were available and because the years 1969 and 1970 had been rather exceptional.



Fig. 3. Types of agriculture in Poland in 1967

steadily decreasing. This phenomenon occurred not only in such areas, as the south-eastern voivodships, where labour resources were still big, but also — for example — in the voivodship of Wrocław or in the north of Poland, where they were much lower. In certain areas decrease in labour resources was not accompanied by greater mechanization.

As far as production characteristics are concerned, the degree of commercialization of agriculture increased rapidly (Fig. 1). This phenomenon can be easily explained, as almost entire increased agricultural production was placed on sale. A particularly high degree of commercialization was observed not only in the northern voivodships, i.e., in the area where the percentage rate of socialized farming is quite high, but also in the southern part of the Poznań voivodship, in the Białystok voivodship, and in the eastern part of the Warsaw voivodship, i.e., the formerly agriculturally backward area with a low degree of commercialization, where, however, the holdings are relatively large or medium-sized. Land productivity, with the exception of certain parts, increased only slightly. Labour productivity, however, increased, especially in the areas with a higher percentage of socialized holdings, as well as in the east-central voivodships and the suburban zone of Warsaw, where it had been quite high. More-

over, labour productivity also increased in the area of fertile soils in south-eastern Poland, where it used to be rather low.

Generally speaking, the rate of development was rather uneven in the agriculture of the discussed period. A more rapid rate of development in socialized farming precipitated changes in the northern areas. A quite high rate characterized large portions of Greater Poland and Lower Vistula Region (*Powiśle*), the fertile land of Little Poland Upland, Lublin Plateau and the Subcarpathian Basins. The *poviats* of central and southern parts of the Kielce voivodship, the mountainous *poviats* in Cracow voivodship, the western *poviats* in Łódź voivodship and the Cassubian *poviats* were marked by very low rates.

These changes brought about great transformations in agricultural types: the area under the least developed, least productive and least commercial types shrank to the benefit of that with more highly developed types of agriculture, which, in turn, gave way to still more developed, more productive and more commercial types. As a consequence, a certain kind of migration occurred: the more developed types from the west moved to the east and were replaced in their former area by even higher types.

The simple extrapolation of tendencies and of the rate of development in 1960–1967 to the period from 1970 to 1980 revealed the existence of certain deficiencies in the spatial pattern and the rate of development of Polish agriculture. It shows that if proper measures are not undertaken, the level of mechanization will be still very low in certain areas even in 1980. Only half of the area, mainly the western and northern voivodships, may have reached the average world level of mechanization of agriculture by 1980. The inadequate rate of mechanization will be accompanied on large parts of central and south-eastern Poland by a high number of horses and by high inputs of labour. Simultaneously, north-eastern Poland, Cassubia and the Sudetes Region, will suffer from shortages of labour which, if the level of mechanization is not raised, will hamper the growth of agricultural production.

If the present rate of the intensification of mineral fertilization is retained, almost 40 per cent of the country's territory will have reached the high level and most of the remaining area — the medium world level by 1980.

Consequently, if the tendencies and rate of the development of agricultural production of 1960–1967 period are retained, low land productivity, low or even very low labour productivity and low commercialization will prevail on quite a large area of Poland, its south-eastern and central parts in particular; on a large area of central Poland land and labour productivity and in the northern and western voivodships labour productivity will be also low. The at least medium world standards of land and labour productivity as well as the medium world level of commercialization will be attained only by a large part of the Poznań, Wrocław, Opole and Katowice voivodships, as well as the region of the Lower Vistula Region (*Powiśle*), and single *poviats* in other voivodships. It should however be borne in mind that the medium world level by 1980 will not be the same as that of 1960–1967.

The spatial pattern of agricultural types in Poland in 1980 is presented in typological terms on Fig. 4. It shows up quite clearly that — if the tendencies and rate of development prevailing in 1960–1967 were unchanged — agricultural types, characterized by a low level of development, would be replaced by higher forms. New, highly developed types would appear in the western and northern voivodships. At the same time, the little productive and little commercialized type, connected with peasant-workers' holdings, would strongly expand in the vast areas of southern and central Poland.

Certain tendencies are beneficial and should therefore be encouraged; certain other as undesirable should be counteracted. For example, the expansion of intensive, highly productive and highly commercialized types of mixed agriculture are worth supporting on areas where labour resources are sufficient, while, on the areas where man-power is scarce, less intensive, but highly commercialized, highly effective and more specialized agriculture should be encouraged. On the other hand, the maintenance of low productive, very low effective



Fig. 4. Types of agriculture in Poland in 1880. Extrapolation

tive and low commercial types on certain territories should be considered as undesirable. The territorial expansion of peasant-workers' farming, which is low productive and low commercial, should also be discouraged as it practically excludes large tracts of land from market economy.

The application of the method of extrapolation in prognoses has often been criticised. However, in relation to agriculture, individual in particular, which is characterized by considerable inertia resulting from both its own character and dependence on natural conditions, such a critical evaluation would have been correct if results obtained by means of this method had been the only ba-

sis for prognosing transformations in the spatial structure of agriculture. It is a known fact that the failures of the years 1969–1970 unequally disturbed the tendencies prevailing in the years 1960–1967. On the other hand, it is also evident that both the trends and the rate of agricultural development were altered after 1970 following new agricultural policies. The short period which separates us from that time, as well as the fact that certain important statistical data were not available, made it impossible to evaluate new tendencies and their impact upon the spatial organization of Polish agriculture. This topic will be the subject of further research.

It should be emphasized, however, that in agriculture many conditions and properties are quite stable, or their change is very slow; the analysis of current trends and their extrapolation are, therefore, not groundless on condition that the results thus obtained are completed from other sources. In the described study the results of extrapolation were first of all — as already mentioned — revised on the basis of data relating to productive tasks and means allotted, which were taken from the long-term plan.

The long-term plan was based upon the following assumptions: the percentage rate of socialized holdings in Poland's agricultural land will continue to increase; the use of mineral fertilizers will also increase, although at a lower rate than formerly; labour resources will continue to shrink, which however was not balanced with adequately high progress in mechanization. On the basis of these and other inputs and in accordance with trends extrapolated in the study the plan implies a further significant growth of sugar beet production, of the number of cattle and of the size of beef and poultry production. The assumed rates of growth of cereal and potato production slightly and of vegetables, fruit, milk and particularly pork highly exceed the extrapolated data. The increase in pork production is based upon trends prevailing in 1971–1974. Certain assumptions of the long-term plan were critically evaluated in the study as incompatible with either the country's potential or needs. In some way or another implementation of those assumptions will bring about a higher land productivity and agricultural commercialization, as well as — owing to the simultaneous decrease in labour inputs — a higher labour productivity.

The program of the development of agriculture laid down in the long-term plan is not easy to implement, especially in the realm of tasks implying an increased production of milk, cereals, fodders, vegetables and fruit. The big fall in labour resources should be accompanied by a decrease in the number of horses, as they overburden reserves of fodders. The program requires that the rate of mechanization of production processes should however be more rapid, not only in relation to the cultivation and harvesting, but also livestock breeding. The increased production of cereals, necessary if the higher rate of livestock production set by the program, is to be obtained, as well as that of fodders, vegetables and fruit, requires a simultaneous higher use of mineral fertilizers and increased outlays for plant protection, improvement of water conditions, and purchases of agricultural machinery. The realization of the task of increased agricultural production will make it necessary to solve many such problems lying outside agriculture *sensu stricto*, as better supplies of water and power to farmsteads, construction of new farm buildings and roads, improved organization of supply and sale of agricultural products, expansion of food processing industry, a better agricultural education, etc.

If these goals are to be attained, necessary financial means must be allotted. To secure their rational use they must be supplied in the first place to those areas which promise the highest productive effects. An additional, profound study of these problems is therefore of vital importance.

If inputs are to be effective, it is necessary to utilize many, still existing reserves and to eliminate various factors hampering the expansion of agricultural production. Those factors reside within the local natural and other exogenous conditions and also in agriculture itself. These problems were raised in the study in a general way only; a more detailed analysis will follow. However, it can already be pointed out that irrespective of the smallness of its territory, the natural conditions, labour resources and other external factors are greatly differentiated in Poland. Moreover, this phenomenon will not wear away, and if agricultural production is to grow and economic effects are to be higher, it is necessary to be fully aware of its existence. Various agricultural systems and various orientations in agricultural production should therefore be introduced in compliance with the local natural and other exogenous conditions (markets, food processing facilities, transport conditions) as well as with actual labour reserves, which under given conditions will give the best productive effects. Everything emphasizes the necessity to depart from a stereotyped application of the same agricultural policies everywhere in the country; they should be replaced by a more elastic procedure, in which the spatial differentiation of agriculture and conditions, under which it develops, are taken into account.

As mentioned before, besides the discussed sources and methods the method of analogy was also used for the determination of further transformations in the spatial organization of agriculture. This method implies an inference from experiences gained in other countries or regions which have obtained a higher standard of agriculture under comparable natural and other exogenous conditions.

These experiences prove above all that the modern agriculture is a commercial agriculture, oriented — in compliance with actual labour resources and distance from markets — towards obtaining agricultural production by maximizing either land or labour productivity. In the first case a high level of land productivity and a high level of commercialization can be obtained with lower labour productivity and a lower degree of specialization owing to high labour and capital inputs directed primarily towards obtaining increased yields per hectare and higher effectiveness of livestock production, as well as to tying together the various branches of agriculture. In the second case, owing to high capital inputs directed mainly towards the replacement of labour inputs by those of mechanical power, higher labour productivity and a high degree of commercialization are obtained, i.e., also by greater specialization of production.

The first trend is usually followed by countries or regions densely populated, in which higher labour resources make it possible to obtain higher inputs of labour, while the absorptive power of the markets and lower transport expenses make it worth while to undertake various, more or less durable investments and procedures aimed at increasing agricultural production per unit of land. Thus a high and steady income could be obtained even from relatively small holdings. A high income permits also the owners of larger holdings to hire manpower from outside, if local labour resources are insufficient. At the same time, however, durable investment and inputs impede the adjustment of production trends to market fluctuations. Inputs are sometimes so high that both the natural values of the soil and their preservation by rational rotations play a secondary role. But in general the inputs are more effective, in the area, where natural conditions favour agricultural production.

The second trend is usually followed by countries or regions with scarce labour resources, high labour cost, and more distant markets. In such conditions the dominant tendency is to save as much as possible on man power, to mechanize production processes as much as possible, and to introduce high specializa-

tion. In such conditions high incomes are conditioned by a larger size of agricultural holdings; at the same time, not too high inputs on durable investment make it possible to adjust easily both the area of land used for agricultural purposes and the production orientation to market demands.

Many examples of such solutions can be quoted from countries with a highly developed agriculture. There are also many other countries in which these solutions are intermingled. Finally, the practice of subsidizing agriculture, adopted by an increasing number of countries, as well as different goals set before agriculture in socialist countries, cause various deviations from these theoretical models.

The typology of Polish agriculture for 1980, obtained by means of simple extrapolation, was then confronted with experiences of other countries or regions, as well as with tasks set before Polish agriculture in the long-term plan



Fig. 5. Spatial structure of agriculture in 1980. A model

and funds allotted for their implementation. The effect of the revision is the model of the spatial organization of Polish agriculture for 1980 (Fig. 5).

In relation to the pattern obtained by way of extrapolation the proposed organization tends, on the one hand, to limit the range of types representing a low

agricultural standard while enlarging — whenever it was within the bounds of possibility — the range of types representing a higher agricultural standard, and, on the other hand, to develop the existing or, in certain conditions, to introduce certain new types. Thus, for example, agriculture on the fertile plains of Lower Silesia, operating in conditions of low and steadily decreasing labour resources, should develop into a highly mechanized and highly specialized type oriented towards crop production, mainly of cereals, wheat in particular, sometimes with maize or even with sugar beet, possibly also with malting barley and cattle breeding. This type of agriculture can be adopted mainly by socialized farming, and individual farming on condition of a gradual increase of the sizes of the holdings. On the other hand, the tendency of agriculture in the Sudetes and Bieszczady Mountains, and also on the morainic hills of the northern lakelands, i.e., the area with varied relief making mechanized cultivation hardly possible, with heavy soils combined with high rainfall, where labour reserves are scarce, should be the transformation of the existing mixed agriculture into a new, more specialized form, oriented towards beef cattle breeding, based upon field-grass or grazing system of land use. This new type can again be introduced mainly in socialized farming and in individual farming only on condition of the increased sizes of farms. The situation is quite different in the area of the Carpathian Mountains with their fairly high (even if decreasing) density of agricultural population. A gradual transformation of agriculture into a type oriented towards field-grass system of land use and dairy cattle breeding is proposed, which requires however a particularly well organized dairy industry.

Agriculture oriented towards the cultivation of fruits and vegetables and the production of vegetables or hard fruits, proof against transport to more remote markets, or of fruits, berries or vegetables for processing on the spot, should be developed in the areas with particularly favourable natural conditions and sufficient labour resources, if tasks set by the long-term plan are to be fulfilled. The selection of such areas will require careful study. In this or other way the spatial structure of agricultural types can and should be verified, as far as their compliance with productive effects and the volume of necessary financial means is concerned, with the premises of the long-term plan. However, this analysis was not carried out during the preparation of the study and the typology was not corrected, as the basic data were not fully reliable, as already explained.

When the prognosis of the spatial organization of agriculture in Poland after 1980 is made, changes in the external conditions of its development should be taken into account. On the one hand, a rapid increase of urbanization, the growth of great urban agglomerations and the effects of such phenomena in particular, are to be taken into consideration. On the other hand, a tendency towards greater specialization in various production and service functions of the areas lying between the agglomerations, as well as the growing need for protecting certain areas of special value for agriculture, forestry and recreation, should also be foreseen.

Liberated from its historical burdens, modern, industrialized, highly productive, effective and highly commercialized Polish agriculture could be transformed into forms which will better be connected with the local patterns of natural and other conditions, labour reserves, etc.

Because of the length of the period, separating us from the year 1990 and lack of many data, these basic forms could not be presented in the quantitative way by sets of properties characterizing agricultural types. Of necessity, they were presented in a more general manner. However, the comparison of patterns presented in Fig. 6 will make it quite easy to recognize the way along which the types presented for earlier periods will evolve into new ones.



Fig. 6. Spatial structure of agriculture in 1990. A model

1—a highly mechanized, highly productive and highly commercial agriculture with crop orientations, depending upon local conditions and possibilities; cereal (wheat), cereal-rape seed or cereal-sugar beet, possibly with cattle breeding, 2—a less highly mechanized agriculture oriented mainly towards crop production, cereal-root crops with a high share of industrial and other crops requiring good soils and high inputs of labour, 3—mixed agriculture, predominantly crop production with orientations: cereal-root crops: wheat, barley or rye with sugar beet, potatoes and with dairy cattle breeding, 4—mixed agriculture with orientations: cattle-pigs-cereal-root crops: wheat-sugar beet, rye-sugar beet or rye-potatoes, 5—mixed agriculture: predominantly livestock breeding, dairy and beef cattle or cattle-pigs with rye and potato production, 6—mixed agriculture, predominantly livestock breeding, pigs or dairy cattle-pigs with poultry, as well with potatoes and rye, 7—agriculture with a livestock breeding, dairy cattle orientation based upon the cultivation of fodder root and other crops, and meadow hay with the production of potatoes, rape seed, sugar beet and cereals, 8—agriculture with a livestock breeding orientation beef cattle possibly with sheep breeding, 9—agriculture with a livestock breeding, beef cattle orientation, 10—agriculture with a livestock breeding orientation, dairy cattle possibly with sheep breeding and the production of potatoes and cereals (oats), 11—agriculture oriented towards the production of vegetables or vegetables and fruits for local consumption, 12—agriculture with a fruit and vegetable orientation, mainly for industrial processing on the spot, 13—larger forest complexes

As it can be seen from the above, differences between the situation in 1967 and the models for 1980 and 1990 are greater in the areas where socialized farming plays a more important role. It is not only because any transformation is easier in socialized agriculture, but also because as a large-scale activity, it is more commercial and therefore can easily more specialized. The share of socialized agriculture will certainly increase, and the rate of transformations in the

spatial organization of Polish agriculture will largely depend upon the rate of changes in the agrarian structure. With more rapid changes the 1980 model can be attained during the next six years, otherwise the period will be longer.

In the same way the 1990 model may also be attained with delay, if the rate of changes in the agrarian structure is slower. The present study differs from some other studies in its approach to the problem of establishing *a priori* the rate of changes in the agrarian structure. Such a rate is unknown, as adequate data were lacking. Instead, a reverse procedure was applied. Models of the spatial organization of agriculture were set up which were both desirable and attainable, and which could be realized earlier if the rate of changes in the agrarian structure was sufficiently rapid. It was also assumed that those changes would not be simultaneously put into effect on the whole area of the country, but they would be introduced first of all where they are economically justified, where they are most needed, where they condition the rise of agricultural production, and also where such changes would be most effective, i.e., where inputs related to them would be most effective, and finally where they would be the easiest to carry out, would cause least disturbance, which could hamper the growth of agricultural production.

The above assumptions justify the conclusion that changes in the agrarian structure should be first introduced in the areas with a shortage of agricultural labour, or where such a phenomenon is likely to occur quite soon because of the outflow of population from agriculture, where the natural conditions either make easier a higher degree of mechanization of field work, or where capital inputs will bring about the highest possible production effects, or finally where with low labour resources their best utilization makes it necessary to introduce far-going changes. At the latest they should be effectuated in the areas where the relative surpluses of agricultural man-power will continue to exist for the longest time, and where the natural conditions do not favour the mechanization of field work or reduce the effectiveness of capital inputs.

The study contains a detailed discussion of the possible sequence of transformations in the agrarian structure of Poland. It need not be emphasized that transformations in the agrarian structure, required by a modern, highly industrialized, highly productive, highly commercial and specialized agriculture, not necessarily must be effected by the creation of large-scale holdings, by the socialization of agriculture in the classical meaning of the word. For a certain time at least it would be enough to let individual holdings increase to a size which will permit their owners to manage them without any hired help. With a high degree of mechanization, such a holding should not be necessarily a small one and its labour productivity and commercialization may be high enough to reach an income comparable with the earnings of urban population.

The selection of this or another solution, as well as of the extent and rate of transformations, is not however a task which science should decide upon, but lies within the realm of government policies.

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PROBLEMS OF THE INTEGRATED ORGANIZATION OF TRANSPORT

MARIAN MADEYSKI AND ELŻBIETA LISSOWSKA

Within the scope of activity of the theme: "Social and economic infrastructure" many methodical, monographic and prognostic works have been written on transport problems. Also many works elaborated by different scientific and administrative centres have been used. These works, however did not provide sufficient indication towards future trends, but they contributed to the formulation of the development prognostic for transport up to 1990, and to the undertaking of certain tasks in connection with a similar prognostic up to the year 2000.

All the data and materials used showed, that because of the much quicker development of the national economy than had been assumed, the level of transport tasks for the year 2000 will already have been reached by 1990 that is 10 years ahead of schedule. This also shows, that by 1990 transport of freight will increase, over 3.5 times as compared with 1972 while intersettlement passenger transport will be more than doubled.

In view of the rapidly growing tasks and because of the difficulties, our transport actually copes with, the future policy regarding this important domain of the national economy must be handled with special care. We are aware of the fact that transport is an integral element of the social process of production and material turnover. In the majority of cases it is a repeated performance of the stage of the technological process of production. In some cases, which should be emphasized here, it becomes a substitute of the investment activity. In any case, it is one of the conditions of increasing and keeping up the level of the living standards and cultural developments of our society.

From these statements it is clear, that transport is a most important, and both an active and a passive factor of the spatial development of the country, and its regions, and a factor in the location and regionalization of production and also of the location and development of the settlement network. As the back-bone of the country's economic and technical infrastructure, transport, due to its activity and the possibilities it offers, evolves numerous stimulating and activating processes which contribute to the stabilization of the already existing economic and social, spatial structure.

The role of transport is most important in all international trade and tourist exchanges. The role of transport is also of great importance in serving the co-operation of the neighbouring CMEA countries. Due to its geographic situation, Poland has great possibilities of providing transport services between the Soviet Union and the West European countries and also between Scandinavia and the countries situated to the south of Poland.

As a "supporting structure" of the entire national economy, transport should be treated as an important instrument for strengthening the economic, cultural

and political integration of the country and also as a strengthening factor of unity between cooperating countries and a correlation of all societies. All this indicates that the future transport system should not evolve just as a passive result of the processes of social and economic development, but it should actively influence the economic and social development.

The present, insufficient development of transport and its transporting capacity is the result of numerous objective and subjective factors within the transport system, and also some external factors, some of which contradict tendencies towards improving the transport and goods turnover. Limiting ourselves to the most important reasons, we have to state that the formation of the transport infrastructure and its standard is, to a large extent, the result of historical factors and also of insufficiently coordinated or not efficient enough measures taken with regard to the particular modes of transport.

Because of the above and in spite of the few elements of modernity, there are many out-of-date features in the techniques and organization of the transport system and its methods of activity. In particular, in spite of several undertakings and efforts over the past few years each mode of transport, and in the truck transport each of its units, form a separate and independently active and developing organism.

The result is then that transport does not fully satisfy all the appearing and potential needs mainly with regard to the standard of transport services. Transport is not operative enough, and therefore clients (with only a few exceptions) are unnecessarily charged with functions connected with the organization or performance of certain phases of the transportation operation. The division of functions between particular transport branches or organizations does not comply in many cases, with certain general economic criteria; the changes in this division are not able to follow the evolution of transport demand.

However, there are still quite substantial possibilities of increasing the transportation capacity which are not utilized due to inferior techniques and the poor state of roads and means of transport. Taking into consideration the described actual position of transport and also the forecast multiple increase of tasks for the coming years, it is absolutely indispensable to outline a new, dynamic transport policy within the framework of the general development policy. This policy should result from particular intensive activity of the state. Transport policy conducted through authorized institutions (above all though the Office of the Minister of Communication) and based on experience and scientific methods should lead to the formation of a prospective dynamic model of an up-to-date transport system. This system should lead to the best possible way of satisfying the future transport needs regarding both standards and quantity. Transport policy should also evaluate and point out the required parameters for the development of particular modes of transport, i.e., the range and level of services, and the respective organizational forms in different stages of development.

In transport policy, indeed, there is the possibility of applying different methods of development. Among them, the only proper and sensible method is a dynamic development aimed at the basic reconstruction of the transport system and the shaping of a new, modern model of transport. This of course should be undertaken in all branches and organizational forms, including nonconventional means of transport.

The new model of transport, elaborated on the basis of accepted practice and scientific organization and principles of management, which also takes into consideration the basic laws and regulations of economy should be the nation-wide integrated transport system which means a planned, systematically ranged sys-

tem of means and actions of all branches of transport, disregarding their intended and organizational subordination, harmonized in its activity with the whole of the national economy and social life. This system should be:

- adapted to the range, character and spatial differentiation of transport needs,

- internally coordinated from the point of view of the efficient utilization of technical, operative and economic features of modernized branches and means of transportation in order to improve the transport services with a simultaneous tendency to minimize the total effort of welfare work for transport investments and exploitation and also consumption of energy and scarcity of materials.

Dynamic activity should be one of the most essential features of the transport system. It should be fit for flexible adaptation, not only to the substantial increase of transport needs, but also to the general economic conditions, including those which originate from international relations. The framework of this dynamic activity and flexibility is shaped by the most durable and almost immeasurable element of the transport system — which is its infrastructure.

Therefore the key to this problem depends on the infrastructure of transport, which should be predicted from the point of view of:

- required systems of connections,
- multiplicity of branches and mileage of connecting roads,
- standards of connecting roads,
- distribution of transport and communication roads.

The required connections within the transport network of domestic importance should comply with certain factors which may be classified into several groups (not ranged hierarchically). One of these groups consists of factors arising from administrative needs, which impose the necessity of connections between spatially individual administrative units. Therefore the network of domestic importance must include connection between all regional centres with the capital, disregarding the range of other needs appearing in these relations. The second factor of general character is the necessity for creating an atmosphere for spatial economic integration which leads to the necessity for including in the domestic transport network all economic centres of domestic importance (of a non-regionalized range of activity).

The third factor is the necessity of accessibility of tourist and cultural centres of domestic importance. The last two factors are linked with the specialization of particular centres, which are often dependent on natural conditions. They also influence the shaping of the communication network; the higher the specialization and the smaller the administrative function of these regional centres — the bigger is the influence of the two factors. Finally the fourth factor of this group is the demand for incorporating the domestic network into the international system which imposes the necessity of securing connections between the domestic network and that of neighbouring countries.

All these demands, including the problem of defence determine points which must be connected by a system of transport network of domestic importance. The number of centres performing the said functions determines the number of domestic junctions and along with the spatial localization of the centres it is the basic information for the shaping of the network.

The source of information for that purpose is the estimated spatial administration from which the following conclusions can be drawn with respect to the local conditions in Poland:

- (1) There is no assumed classification of functions of towns, so that administrative centres would have to be considered separately and the economic ones

separately; due to this we do not have to seek conceptions of administrative classification because they have not been formulated in the aforesaid works, although this problem is under discussion.

(2) The conception of polycentric concentration and the development of industrialized municipal agglomerations leads to the reduction of points which have to be included in the network of domestic transport services to be rendered by these agglomerations (internal connections of agglomerations are not included in this system — see the conception of spot elements).

(3) The assumed development of municipal centres (and their complexes) of domestic importance will have an influence upon the increase in the number of spots to be included in the domestic network which is emphasized by the assumptions regarding the improvement of regional specialization.

(4) Like-wise, the assumed development of tourist and recreation regions will influence the administration of new regions.

The total number of points should be increased due to connections within the international system by the frontier points, sea, and airports which enable connections with the main centres in neighbouring countries, thus entering the world system of transport infrastructure. Connections between the above mentioned points may be secured by means of various modes of transport of different mileage and standards of the network. This however will depend on other factors, among which the actual state of the transport infrastructure should be mentioned due to its durability and due to the principles of its development, and above all due to the modernization of the existing system, and only in particular cases due to new routes — which largely determine the future system in many aspects. While considering the network of domestic importance one should not forget that the development will take place also by the inclusion in this system of the relevant elements of the existing network of the regional system (connecting new centres of domestic importance with the former system of the domestic road network) which, with regard to quality, comply with the requirements of the domestic system.

Connections between the basic points may, only in particular cases be sufficient by means of one branch of transport whereas in most cases it is indispensable to secure two or multi-line connections. This depends on:

- reliability of service (possibility of substituting in cases of damage to a given line), ability of adapting to actual needs (possibility of mutual assisting during overcharge periods) — hence, on external factors,

- differentiation of utility of transportation means (differentiated standards of services and adaptability to given demands) and differentiated transport needs and susceptibility to being serviced by defined lines of transport.

Even in centres of narrow specialization transport needs are differentiated and therefore the mono-line connections appear only as result of particular limitations (e.g. natural conditions, environmental protection).

Location of roads in each of the lines (and therefore their mileage) depends on the following factors:

- required direct connections between defined pairs of points determined by the intensity of problems in common, shown by intensity of stream which operates differently in each line owing to the susceptibility of transport to this line and also because of different ... values which justify direct connections in particular lines,

- location of technological transportation points (marshalling yards reloading points, forwarder's warehouses etc.) in particular lines which depend on different factors also having different influence on the location of roads,

- the range of the utilization of the network by the transport infrastruc-

re of the domestic system in order to serve the transport needs of regional or local reach.

Essential differentiation may be observed between certain lines with regard to the intensity of the serviced lower range traffic and its share in the general road traffic of the domestic system and its influence on the location of roads.

One should however take into consideration that:

- there will be an increase of demand for direct connections mainly between agglomerations and touring and recreation centres and the border points,
- the expected concentration of transport processes should aim at reducing the number of technological points, whereas their capacity would be largely increased,
- the range of utilization of the domestic network to serve the transportation needs of regional range will show decreasing tendencies, while the local traffic should be completely eliminated.

The standard of roads depends on the assumed standard of services, the intensity and structure of traffic and on the technology of transportation processes. The total of these factors, different in each line, and imposing different demands with regard to the technical level of roads reveals relations with the above discussed factors which:

- influence the multitude of connections, since the general standard of transport services may be achieved by means of the differentiated structure of services offered by particular branches,
- influence the location of roads, because the intensity and structure of traffic are the criteria for the choice of location or its result, but their functions in servicing the regional traffic at a required standard impose definite demands with regard to the quality of roads.

A new group of factors are the features which characterize the technology of transportation processes. In that respect, in all lines of vehicle transport (i.e. excluding pipelines) an increase of loading capacity and speed of means of transport is expected, followed by an increased demand for roads to suit that purpose.

The number and location of communication points are just as important features of the transport infrastructure as the elements of its network, and with regard to air and sea transport, they are the only ones.

The full range of factors which influence the formation of the network and the network itself, decide the point elements, and furthermore:

- the spatial reaches typical of a given transportation branch of interregional and regional relations (if at all assumed),
- required approach to particular branches in direct transports of similar relations,
- principles of interbranch cooperation in combined interregional transports of different process technologies which decide the displacement of touching points (reloading points),
- principles of including regional flows into nationwide system of the infrastructure.

It is a general principle to secure the possibility of organizing transport at any point to any point in the country and abroad: however the overwhelming majority of transport of interregional reach takes place between centres of domestic reach. Location of points for the transportation of goods will depend on the development of the storage system. The prospective line of activity in storage is the tendency to concentrate and to select storage districts or even to create satellite centres to render storage services for the big agglomerations.

As in every prospective activity, also with regard to the shaping of the integrated transport system we should take into consideration certain factors which limit or slow down the required development. These factors may be in the form of obstacles which, temporarily limit the development, but may cease or disappear in the future; or they may also be constant limitations which have to be taken into consideration as a rule or at least over the period of the forecast development. The definition of these factors and of their intensity and the duration of their activity, determines the range and methods of action taken against the temporary obstacles to development, and the indispensable adaptation to constant limitations. Among the temporary obstacles to development which differ in regard to quality, the following should be mentioned as important, from the point of view of:

- economy — limitations of funds for highly expensive transport investments and scientific research,

- techniques — limiting the introduction of new techniques,

- technology and organization, which limits the creative introduction of modern techniques and organization,

- materials, limitations of free use of raw materials, energy and short supply materials,

- time of performance of all novelties, especially extended in all investments within the transport infrastructure,

- qualified staff — the lack of which limits the possibility of the smooth introduction of modern techniques and organization,

- computer science and mathematical methods and planning,

- routine and conservatism among transport employees and the users.

Among the constant obstacles, the following seem to be the most essential:

- low level of knowledge on transport (which should always be increased),

- necessity of respecting the principle of the protection of the environment with regard to which transport is the subject and the object of its activity,

- necessity of taking into consideration the actual transport organization of the country and its regions, and above all,

- the expected, insufficient increase of labour which is already being noticed and which is not to be avoided after 1980.

Integration of the country-wide transport system requires a definite deviation from the branch system of transport. While respecting the peculiarity of different branches of transport which appear in the branch type technological and organizational sub-systems described below, the needs of the national economy and of society should be satisfied by the uniform, country-wide, inter-branch systems of cargo and passenger transport. The notion and essence of integration should be referred to by the complementary and substitutionary economic and exploiting activity of all branches and organizational forms of transport while the organizational integration should be treated as a secondary problem as compared to the integration of activity.

Resulting from long-term programmes of integration of activity, conclusions should be drawn with regard to technical and technological integration of means and objects of transport expressed, among others, in technical standardization and proper cooperation where different branches of transport meet.

Both, the integrated freight and passenger transport systems should base on a sub-system which would meet the requirements of reasonable and economic transportation. Therefore the sub-systems should be:

- in compliance with the requirements of the standard of services and detailed requirements arising from the character of the serviced lines,

- suitable for introduction from the technical and organizational point of view i.e. from the point of view of all partners of the transport processes,
- organized so as to secure the highest possible effectiveness in the macro-economic scale,
- in compliance with the principles of effective activity.

Each of the cargo transport sub-systems should be standardized and based on standard principles of activity and involve a set of transport processes performed according to uniform technology. It is an essential condition that the sub-systems of freight transport should involve the whole process of transport (from the preparation of freight for transport until it has been supplied to the final user) no matter whether this process is performed using one or more modes of transport.

Highly efficient forwarding organizations are the main condition of integration of activity within the freight transport system. The forwarding activity, which may be organized in different forms (public, specialized etc.) should secure the performance of all organizational and operative functions which actually charge the customers. It should also secure full organization and performance of all functions wherever different lines of transport processes meet. The problem of forwarding, which is still under discussion, shows, that the differentiation of its forms, as for the range of acting and means it should be provided with, is its main advantage. The differentiation of forms shows that forwarding may fulfill such functions and tasks which arise from the actual economic needs of the market, which the transport organizations or their customers do not want to, or cannot fulfill, for different reasons, but in a way which would satisfy both parties.

It is understood that specialized forwarders should act according to the needs of the customers and comply with their requests, but they must also respect the general interest of the national economy, mainly with regard to the sharing of transport functions between different branches and organization of transport, the established forms and the utilization of the existing transport sub-systems act; they should also take into consideration the technical, economic and organizational condition of the transport organizations.

The above mentioned problem of storage is connected with problems of forwarding. From the point of view of transport processes treated as a whole, three kinds of storage should be considered:

- in temporary warehouses at the manufacturing plants and wholesalers, with their own forwarding organizations,
- storage yards of bulk goods (e.g. coal, ores, building materials) or containers organized at points of the different transport junctions, and in certain cases, where transport processes within the same branch of transport meet, and
- hired warehouses for long term storage of freight.

In all cases warehouses are the initial, transit and final links of transport processes and therefore their development, both in number and technology is connected with the development of the whole system of freight transportation.

As for the problem of integration of passenger transport one can say, that each transport need should be satisfied as it appears so as to comply with the need of the people. This principle arises from the undoubted relation between the possibility of easy and comfortable travelling and the general living and cultural standard of society. Besides, freedom of travel is one of the basic conditions effecting the feeling of personal freedom.

The task of passenger transport consists in satisfying systematically appearing needs, namely;

(1) those, absolutely obligatory, daily commuting at strictly defined hours and over the same routes, including the daily travel of employees and pupils, and also

(2) relatively obligatory, requiring permanent but not daily journeys at different hours and on different routes, which include:

— journeys connected with professional work, but not subject to definite hours,

— official travel,

— shopping travel.

Besides, passenger transport should meet all needs connected with irregular journeys, namely:

— incidental, connected with health control, disposal of private affairs in office and institutions, individual scientific research, etc.,

— optional, connected with tourism and recreation, cultural needs, social and political activity and keeping up family and social relations.

The passenger transport system should consist of related inter-branch or branch sub-systems which jointly, should secure:

— the required spatial availability,

— direct or easy connections,

— the shortest possible travelling time,

— travelling comfort and safety,

— possibility of choice of the most appropriate means of transport and connections,

— the lowest possible cost.

These sub-systems are, above all, connected with the spatial reach (local, micro-regional, regional, inter-regional and international communication).

The quality and organization will largely depend on the development of individual motorization, whereas the capacity offered by communal transport and the standard of services should act against an excess development of private car traffic in dense urban regions with a limited capacity for vehicles.

Both the freight and passenger transport sub-systems may be of monoline character — within the sphere of activity of one line or interline — within the sphere of complementary or substitutional activity. The sphere of exclusive activity of a transport branch includes a complex of tasks, which no other branch of transport could perform due to technical, technological or organizational reasons, or should not perform for economic reasons. The complementary sphere includes tasks which require cooperation of at least two branches of transport — in order to secure better results than could be achieved in branch sub-systems. Finally, the substitutional sphere includes tasks, which could be performed by different branches of transport, with similar effect.

Within these spheres, tasks are divided between particular branches of transport. The dynamic distribution of tasks may be changed depending on the complexity of factors and conditions among which the following should be mentioned:

— internal factors consisting of the technical, technological and organizational specification of branches of transport, and

— external factors connected with quality, quantity and spatial changes of passage needs or other conditions only to mention raw materials.

Among factors which differentiate transport branches the following should be mentioned:

(1) technological and organizational, such as:

— size of one lot of cargo or intensity of passenger transport,

— required speed of supply or transport,

— flexibility expressed by the quality of adopting to the varied transport intensity,

(2) economic, such as:

— financial funds consuming, increase of road capacity,

— financial funds consuming, increase of loading capacity of means of transport.

— extent of expenditure of welfare work for transport operations,

— labour per unit consumption transport operations.

— These factors and proportions between transport lines are subject to certain changes but their range does not influence the basic differences which determine the basic tasks of every branch.

Within the freight transport system the following sub-systems should be considered as most important:

(1) branch sub-systems:

— bulk cargo transport to large receivers,

— transport of dispersed cargo,

— regional transport.

(2) inter-branch sub-systems

— container transport,

— transport of bulk cargo to dispersed receivers,

— transport of general cargo.

Within these sub-systems, specialized sub-systems should be organized such as — express transport of cargo, centralized transport, centralized control of general utility railway trucks, etc.

The deciding factor for the development of the transport structure according to sub-systems, will, as already mentioned, be the unfortunate shortage of labour, mainly in men of productive age. This factor speaks for the absolute necessity of reducing the labour consuming transport operations which basically determine, the possibility of performing the assumed transport operations at all, and therefore the functioning and development of the national economy.

These questions have been shown in an abbreviated form, giving the general idea of transport problems. All the above considered trends and anticipated actions aimed at the introduction of quality changes require, long term, consequent effort and actions; some of these changes have already been made as a result of existing decision. However, there are still some which have to be carefully studied and examined.

It is obvious, that shaping the future transport system may by no means be made by administrative decisions. Proper economic hints must be made (both stimulative and inhibitive) and also methods of sound and independent appreciation of every action and organization. The share of functions based on such assumption, the organizing of uneconomical transport, the proper shaping of line structure and organizational forms of transport enable the distribution of means, which would be correct from an economic and social point of view. The basic criterion of the above is the rate of utility of the future transport for the clients and therefore for the national economy.

If, in addition, we were able to simplify and adjust properly transport rates (tariffs) and regulate terms of supply and turnover, or finally, work out a system of incentives then — it would perhaps be possible to create conditions under which the transportation activity will tend to become integrated; while the role of administrative measures would be mainly to remove major barriers and limitations as they appear.

Without basic changes, both in transport and the accompanying atmosphere

we would find ourselves in a position in which transport services would have to be ranged among deficit production lines (factors).

Summarising, the possibilities of reducing the growing transport tensions, dangerous to the national economy should be looked for in the external and internal spheres of transport, which means, in the whole of the national economy. Within the internal sphere the problem consists in the systematic and decided shaping of the above mentioned integrated country-wide system of transport and also in the intensification in the utilization of the existing transport potential. Within the external sphere of transport, the total quantity of cargo and the required labour should be reexamined. According to statistics in 1973 as much as 1.8 milliard tons had been transported over 153 milliard ton-kilometres at approx. 2.7 mean transport multiple. This shows, that approx. 700 million effective tons have been transported. It is also typical, that while the multiple in railroad transport is very low and steadily declining, it is high and systematically increasing in truck transport. The multiple of transport is an evident necessity but actually for a planned economy it is too high; the number of ton-kilometres, which are cost and labour consuming could be reduced. The problem, however, depends on insufficient investments and often, the undervalued factor of transport in the spatial location of production and of the sources of goods turnover. One should be aware of the fact, that the level and speed of the growing transport needs of the economic development depend on the strategy of the development which determines the specific and spatial structure of development of the manufacturing potential which in turn, leads to either a lower or higher level of transport need which must be satisfied.

Besides, in many cases we have to deal with the inefficient structure of co-operation and redundant hauls, etc. This however is an external problem of transport, but since it endangers the whole it should be most carefully examined theoretically and practically and proper conclusions should be drawn.

It seems, that one can have a good, but moderate hope for the future because the conception of the shaping of the dislocation of the manufacturing potential and the settlement network aimed at combining their development with the limited number of urban-industrial agglomerations and some selected centres of social and economic activity is intended to meet the two basic demands connected with the problem of transport. Therefore the higher rate of the concentration of the population and productive activity may contribute to the reduction of transport demand creating internal conditions which will achieve a less expensive but up-to-date, modernized technical and economic infrastructure (of the country) based on the transport infrastructure. This infrastructure which is based on contemporary trends in transportation technology should be an important stimulating factor of the growth of the national economy. These problems should certainly be the subject for further works connected with transport.

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THE POWER INDUSTRY INFRASTRUCTURE IN PHYSICAL PLANNING

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1. INTRODUCTION

The fuel and power economy has become so popular in recent years, especially in view of the world crisis of energy, that there is no need to give the reasons for the significance of power industry all over the world.

There are bilateral relations between the national economy development and the development of widely understood power industry: on the one hand industry, transportation, agriculture, and household demands for fuel and energy stimulate the growth of power plants and systems, and on the other hand, both the amount of power supplied to the end-users and power quality and forms affect technology development, economy development, labour productivity, and standard of living to a great extent.

The appropriate furnishing of the nation with power industry facilities, or power industry infrastructure, has become one of more important factors of physical planning under these conditions. Interacting relations can also be seen in this case: on the one hand, the physical planning game is the basis of the planning and designing of power industry systems, on the other hand, the implementation of flexible power systems and availability of energy nearly all over the country can facilitate the physical planning, enable the centralization of industry, equalize the standard of people's living, etc.

However, fuel winning and energy conversion, transmission and utilization pose new economical, technical, sociological, ecological, and other problems.

The uncontrolled environmental side effects of energy utilization becomes more and more alarming; there is a little doubt that these effects will be more and more significant.

Such countries as Poland, whose power economy relies on coal, encounter a particularly difficult task; and this is especially true if the available coal contains sulphur compounds whose economical removal from fuel itself or fuel gases has not been successful yet.

2. POWER SYSTEM OPTIMIZATION

The term "national power system" is understood here as the complete set of equipment intended for producing, transmitting, converting, and distributing the energy in all its forms.

The power system can be divided into the following four subsystem groups:
— Electric-power subsystem,

- Heat-power subsystems,
- Gas-power subsystems,
- Fuel subsystems.

The electric-power subsystem spans all over the country now. The unified natural-gas subsystem is being developed beside the individual present town- and coke-oven gas subsystems.

No unified heat-power subsystem for the entire country will be developed, but widely-spread heatpower subsystems are built up in large city and industry agglomerations the heat distribution network range will be increased, in particular, with the utilization growth of large nuclear thermal-electric power stations for heat production.

The planning of the power subsystems mentioned above has not been co-ordinated until a relatively short time ago in spite of the fact that these subsystems are interrelated by the common utilization of fuel resources and by the capability of energy carrier substitution at end-users' facilities.

The power system must be optimized in a complex manner, where external interrelations with other national economy sectors — beside the internal interrelations (between subsystems) — are to be taken into consideration to a greater and greater extent.

In many cases it is precisely those external interacting relations which may create *thresholds of power system development* that will be difficult to overcome. Such thresholds can be, say, manpower problems, transportation constraints, the necessity of pollution control, a shortage of water, material constraints, site constraints, etc.

With these interrelations taken into consideration in the economical calculations which are to lead to the optimization of the power system, the solution of the problem becomes an exceptionally difficult task because a number of factors in this game are of unmeasurable nature; however, should they be neglected entirely, the solution could be burdened with great errors.

Therefore, a decision — in the field of power system development — relying *only* on the basis of the conventional minimization of the total direct investment and service costs would be an example of "hiding one's head in the sand".

While working on the development of site planning in this country, we thought that it was necessary to introduce the *quality of people's life as an optimization criterion*. Unfortunately, this term is also difficult to define. It may include the value of people's free time as well as the rights to the unlimited selection of any kind and place of employment and permanent residence, the participation in decision taking, the prospects of spending time in the open and of living away from noise and with unpolluted air and water, the provision of culture, and many other facilities which in the majority of cases are of subjective value and, in consequence, it is even more difficult to define them.

Nevertheless, we introduced the following factors successively into our several-year work on the power system development:

- value of free time,
- value of space inside buildings,
- value of housing estate grounds,
- value of national losses caused by power system unreliability,
- value of losses caused by harmful environment pollution with sulphur compounds emitted by power plants.

Now we try to widen the scope of work on the estimation of factors which will constitute the future quality of life in Poland, by means of co-operation with specialists of economy, sociology, ecology, hygiene, and other fields.

The requirements and the subjective sensing of "the quality of life" varies with time; for instance, a water supply and sanitary installation in a house was considered as a triumph of modern conveniences at the beginning of this century — now, new flats are generally furnished with hot water supply installation, and people require air conditioning more often than not and protest against any inconvenient and time-consuming coal cookers and ovens, etc.

A proper, even approximate, estimation of the power system development effects upon the quality of life as well as the appropriate estimation of development thresholds forced by the external interrelations should enable, in our opinion, the economy and site planning to be cleared of serious errors.

3. SPECIFIC PROBLEMS OF POLISH POWER INDUSTRY

Poland is one of the countries that are richest with coal. Liquid fuels and also, to some extent, natural gas are imported.

The native hard coal is mined at relatively deep mines (of averagely 450 m) and this requires great work expenditure from miners.

In 1973, there were 156.6 million tons of hard coal mined and 119.5 million tons were used in this country.

The coal which is fired in our power plants contains as an average about 1.4% of sulphur which causes serious problems if the SO_2 concentration in the polluted atmospheric air is to be kept at an permissible level.

The coal is mined mainly within the Upper Silesia region where its utilization is strongly limited due to the present environment pollution level produced by the industrial plants in this region; another constraint is the shortage of cooling water for thermal generating plants. About 80% of mined coal is taken away from Upper Silesia; this creates a heavy burden for railroads and rolling stock.

The location of brown coal deposits is relatively more favourable. Brown coal mining has achieved an amount of about 40 million tons per year, the coal being taken out almost entirely by means of machines without any considerable employment of manpower. The low calorific value (of about 2.000 kcal/kg) of brown coal makes it necessary to fire the coal in the immediate vicinity of a mine at large electric-power stations of up to 2.000 MW power.

The brown coal also contains sulphur which, under unfavourable meteorological conditions, causes relatively high concentrations of SO_2 in the air within the range of up to 40 km from the electric-power station. Large excavation mines also create environment hazard because they cause the deterioration of large areas of land, lower the level of underground water, etc.

The further development of the Polish power system will depend on the future national conditions of manpower, transportation, water economy, and environment protection.

4. POWER SYSTEM DEVELOPMENT FORECASTS

The interrelations of power systems and national economy would lead to the designing of future power system models based on the economy and site planning models of industry, agriculture, transportation, etc. This technique might be employed for short-term planning only.

However, when long-term planning is considered, this technique must be replaced out of necessity — due to unknown future industry technologies — by

extrapolation of the present trends in power system development, by correlation forecasts (e.g., the correlation between energy consumption and national income) as well as by multivariant investigation of fuel economy development strategy and energy balance structure.

While designing the power system, the energy-consuming industries (such as chemical, iron and steel, building-material- and other industries) are of decisive importance; these industries are usually also material-, water-, and capital-consuming; and, in addition, they are the main sources of environment pollution hazard.

The co-ordination of industry development is a task undertaken by the State Planning Commission. The work on this problem performed parallelly and separately by research institutes yields very useful results and provides materials for creative exchange of opinions and conceptions.

Our collective body working in this manner on the Power System Development within the general outline of the Research Problem of Physical Development of Poland have developed several own forecasts covering other fields of national economy apart from the field of power industry; the forecasts of the development of petroleum refinery, motor industry, agricultural engineering and service, and other industries have been made in this way.

Although such forecasts — as subjective to a great extent and developed by non-specialists in particular branches of national economy — had required rather considerable amendments and polishing-up, they provided the starting-points for discussions and further work; thus, they might be called "provocative forecasts".

The forecast of liquid fuel economy development, which had been developed in this manner, covered an analysis of motor, petrochemical and power industry demands; a comparison has been made between the investigated variants and the conditions of environment protection. This has given the basis for suggesting three conceptions of the development of petroleum refinery industry, which corresponded to three strategies of the development of power and other industries in this country. The next step was — with the probabilities of realization of each of these three strategies being assumed as equal — to select the petroleum refinery industry development conception which provided the smallest risk of inadequate decision for the actual development of national economy. We employed a planning technique based on the strategy game theory and statistical decision theory. There were three different criteria used for taking decisions under conditions of incomplete information: minimax cost criterion, minimax risk criterion (Savage) and average cost criterion (Hurwic).

The investigations also covered the petroleum and petroleum-products industries, and this permitted the optimum locations for both refineries and major liquid-fuel-distribution centres to be selected all over the country.

5. RESULTS OF WORK ON EXTERNAL INTERRELATIONS OF POWER SYSTEMS

5.1. POWER INDUSTRY AND ENVIRONMENT PROTECTION

It is known that the share of power industry in atmosphere pollution is very great. The fight against dustiness of the air is relatively simple owing to the fact that its technology has been already solved. The continuously rising concentration of solid-fuel combustion in large boiler-houses fitted with electrostatic precipitators and other dust-extractors contributes to the decrease of dustiness in many regions (e.g., in Warsaw). The problem of maintaining dustfall within the permissible limits complying with Standards resolves itself into the instal-

lation and proper operation of high-duty dust-extractors. The elimination of harmful effects of sulphur and nitrogen oxides is a much more difficult problem.

The Polish Regulations for the allowable contents of sulphur in the air are more liberal than those in other countries: an average 24-hour concentration of sulphur dioxide (SO_2) in the air should not be greater than 0.35 mg/m^3 and a temporary 20-minute concentration — 0.8 mg/m^3 . The requirements are more severe for the especially protected regions (such as health resorts, national parks, etc.) and these limits equal to 0.075 mg/m^3 and 0.25 mg/m^3 respectively.

The figures mentioned above have been established from the view-point of human health protection mainly. There are a number of contradictory opinions on the harmful effects of sulphur compounds upon forests, plants, animals, building constructions, etc.

It will not be practicable to consider the future problems of air pollution with respect to only individual SO_2 emission sources (such as heating plants, electric-power stations, etc.); it is necessary to estimate the country-wide pollution background produced by all fuel-firing plants.

With a considerable share of coal maintained in the future covering the national power industry demands, and providing that about 240 million tons of hard coal and about 100 million tons of brown coal are to be fired by the year 2000, if no satisfactory sulphur removal techniques were worked out, a pollution background of about 0.1 mg/m^3 would be produced in Poland. (An assumption was made that SO_2 remains in the air for a period of up to 24 hours.) This would mean a threat for all the especially protected regions in this country.

As one might expect, the country-wide pollution background will not be actually uniform in all regions, but, on the other hand, local SO_2 emissions and pollution coming from neighbour countries, etc. will add to the background.

Thus, the anticipated country-wide level of pollution of the air limits the unit-power of coal-firing electric-power plants down to 2,000–2,500 megawatts.

There are the following five strategies of the fight against the sulphating of the air:

(a) Use of less sulphated fuels and mechanical cleaning of the coal mined in this country.

(b) Import of liquid and gaseous fuels because the removal of sulphur from them is much easier than in case of solid fuels.

(c) Removal of sulphur from the coal fuel gases.

(d) Coal gasification.

(e) Development of nuclear energetics.

All these strategies require some costs — it is necessary to pay for the clean air.

5.2. POWER INDUSTRY AND WATER ECONOMY

Water resources in Poland are limited at the present time, and the water shortage in the future will be one of the most important thresholds of the national economy development including the power industry.

The problems of the next 20–30 years can be solved by building-up a number of large and small storage reservoirs whose function will be to store the waters that escape to the sea fruitlessly for the time being.

The demand of power industry for water is rather great and will rise with the building of nuclear power plants.

An investigation made in this range permitted the following statements to be presented:

(a) New electric-power stations with open-cycle cooling-water circulation may be located only within the limited regions of Lower Vistula and Lower Oder.

(b) Development of mixed cooling (where the closed-cycle cooling-water circulation facility is used during the periods of low-level flow in the river) should be anticipated.

(c) By the end of 1990's, the substantial unrecoverable loss (1.5–1.8 kg/kWh) of water for evaporation which occurs in the process of closed-cycle cooling-water circulation may also limit the prospects of the building of electric-power stations with cooling towers.

(d) Theoretical considerations prove that here is no necessity to build large electric-power stations with air cooling systems before the year 2000; however, local needs may sometimes force such a solution.

5.3. POWER INDUSTRY AND TRANSPORTATION

The anticipated problems of crude oil import and, in consequence, difficulties with the utilization of diesel locomotives indicate that it is recommendable to transfer the transportation tasks to the electric traction, but this will result in an increase of primary fuel consumption due to the low (35–40%) efficiency of electric-power stations; and if coal-fired plants are to be used for supplying the energy, the country-wide pollution background *will rise*; also, the burden of water economy, transportation means, etc. will increase additionally.

Another factor which will increase the demands of electric power for transportation is the need to substitute mass transport (fast commuting trains, modern tram-cars and trolley-buses) for the individual-automobile transport used to travel daily to one's work. The development of electric-motor-cars for short-range transport inside large city and industrial agglomerations should be also anticipated.

To relieve the transportation system of its large bulk fuel burden, it is suggested to clean the coal at mine premises to reduce the railroad traffic and, as it was said earlier, the atmosphere pollution.

The possible development of coal gasification plants also creates an important transportation problem; if a simple technology is to be used for production of low-calorific gases, the plants should be located in the vicinity of electric-power stations, i.e. outside the Upper Silesia region. On the other hand, the production of high-calorific gases involves a large water demand which excludes the Upper Silesia region. Thus, the coal gasification will lead to an increase in the coal transportation load.

5.4. POWER INDUSTRY AND EMPLOYMENT

The demographic forecasts for Poland indicate that the number of free hands will decrease from 1,800,000 in 1970–1975 to about 300,000 in 1985–1990. This labour fall will certainly make all economical decisions more difficult and, in many cases, will be the most important factor negatively affecting the development of industry, agriculture, transportation, and services.

To maintain the present economic development rate, it will be necessary to implement the mechanization and automation for many activities that have been performed by hands. This requires the supply of energy in its improved final form, i.e., electric power mainly, to be sufficiently increased.

Particular consideration should be paid to the electrification and mechanization of agriculture because this branch is most exposed to the withdrawal of manpower in the country urbanization and industrialization process.

It should be noted that the modern agriculture and the food-processing industry require more and more power to produce final products, and a considerable amount of energy is consumed for production of agricultural machines, fertilizers, various chemical agents, etc., beside the direct energy consumption for driving, heating and lighting purposes.

The increase of primary fuel consumption may not be as dynamic one as that of final-form energy; a number of conversion processes involving energy losses stand between these two forms of consumed energy, and these losses can be reduced to some extent. A certain amount of energy is also lost in industrial electric-power, heat and gas distribution networks as well as during the transportation of primary fuel.

Therefore, the main task of power engineers for the next years will consist of lowering the losses mentioned above to a level satisfactory from the economical point of view.

The effect of the shortage of hands upon the coal mine work and the service of power equipment is also an important problem.

Coal mining in this country is work-consuming; the output of mines amounted to about 156.6 million tons of coal in 1973 when there were about 340,000 workers employed. The latter figure should be increased by the number of workers employed in the industry supplying the mining industry with materials and machines, which grows with the mechanization of mines. The total number of workers employed in coal mining processes amounts to about 400,000.

The annual output of hard coal per worker employed in mines has risen from 315 tons in 1960 to 400 tons in 1970, the additional rise of employment in auxiliary plants being taken into consideration; thus, this yields a labour productivity rise of about 25% for 10 years.

If this rise rate is maintained for the years of 1970 to 2000, an output of 270 million tons of coal by the year 2000 can be provided without an increase in employment.

Such an amount of fuel together with the simultaneous development of nuclear energetics and crude oil import of about 90 million tons in the year 2000 should satisfy the nation demands and provide means for exporting of about 30–40 million tons of coal per year.

The increase of labour productivity in mining industry is slow out of proportion when compared to the stipulated fourfold nation-wide increase in labour productivity for 1970–2000, and an improvement is necessary to achieve the planned increase in national income.

The further increase in labour productivity in mining and power industries will necessitate a heavy concentration of production in large mines, electric-power stations, thermal plants, etc. beside the plant mechanization and automation. It will be also necessary to reduce the direct work-consuming utilization of coal in small ovens, boiler rooms and thermal plants. The labour could be reduced a couple of times by wider use of liquid fuel and natural gas instead of solid fuel.

Even for the present, the shortage of hands causes a rapid development of electric space-heating — particularly in regions of dispersed settlement, which are not furnished with gas and heat distribution networks — in spite of its considerable cost and the fact that such a development is rather unwanted from the standpoint of national fuel balance (due to the low efficiency of electric-power stations).

There is no doubt concerning the centralization of electric power production; apart from the constraints resulting from the requirements of environment protection mentioned earlier, there are no restrictions — from the view-point

of produced-energy distribution capability — for building of very large electric-power stations.

Owing to a relatively short range (10—15 km) of heat distribution networks, the centralization of heat production is a more difficult problem.

But some recent investigations show that by using nuclear thermal-electric power stations for supplying the heat distribution networks, the economical range may be lengthened up to 20—30 km; thus, a thermal-electric power station located at the outskirts of an agglomeration may be capable of supplying heat to the entire industrial and/or city agglomeration.

5.5. POWER INDUSTRY AND LAND ECONOMICS

The total area occupied by the power industry premises, i.e., electric-power stations, thermal-electric power stations, high and medium voltage transformer and distribution stations, repair centres, stores, and transmission towers — amounts to about 3 300 ha, and the area of limited development under the high and medium voltage overhead transmission lines amounts to about 40 000 ha, i.e., 0.17% of unwooded grounds in this country.

Should a small share of cable lines in high and medium voltage networks be maintained, the permanent occupation of grounds for power industry premises would amount to about 22 000 ha, and the area excluded from building prospects would amount to about 220 000 ha (i.e. 0.8% of unwooded land in this country) by the year 2000.

These figures prove that it is necessary to provide the miniaturization of station equipment and to install medium voltage cable networks as well as, to some extent, high voltage (110 kV and more) cable networks.

The elimination of electric field effects which occur in the vicinity of very high voltage (above 400 kV) transmission lines is an additional problem to be solved. The effects upon animals and human beings are not known exactly yet but it may be suspected that they create some hazard for people and livestock in case of long-term residence in the vicinity of such lines.

6. CONCLUSIONS

The investigations made in the recent years proved a serious lack of skill in the scientific planning of technology infrastructure. Particularly a lot is to be done in the field of interrelations between power, transportation, water, and other systems.

Rash decisions on an investment worth many milliard zlotys, without the *complex investigation of all* significant parameters and interrelations between a given objective and other systems still happen. Also, it often occurs that the *future* operating conditions of the equipment are not taken into consideration due to poor imagination of the designers as well as to the lack of ready-at-hand scientific predictions. For instance, the mentioned above country-wide atmosphere pollution background, future water constraints, etc. are neglected in some new projects.

To ascertain a large investment, the authorities require the results of calculations of its effectiveness and money's worth from the designers. Thus, it seems necessary to conclude each research work with an evaluation, at least an approximate one, of economical outcome due to a given decision. For example, the following points can be mentioned:

(a) Damage to forest caused by temporary or permanent pollution of the air, due to an increase in sulphur fall etc.

(b) As above but with respect to agriculture; naturally, soil quality (acid or basic soil, etc.) should be taken into consideration.

(c) Damage to constructions and buildings caused by increased corrosion, due to pollution of the air.

(d) Present and future costs of water.

(e) Direct and indirect energy and transport expenditures of designed technologies for industry, agriculture, etc.

(f) Losses caused by unreliability of infrastructure systems. The losses in industry, agriculture, transportation, and municipal economy due to interruptions or improper parameters of power supply.

(g) Present and future value of grounds, depending on how advanced their infrastructure, with respect to "the value" of these grounds for recreation purposes.

Many more of such examples could be given. The number of problems is so great that it would pay to organize an international co-operation system to solve them.

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THE PROBLEM OF USE — REPARTITION AND PROTECTION OF WATER RESOURCES

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The conventional title of the thematical group "Water circulation in nature and national economy" already suggests that the program contained therein would comprise not only the problems of management of water resources as a raw material, but also as an element of the natural environment, which also requires protection and forming.

The work on the fundamentals of management of water resources are carried out in two basic directions.

The first direction comprises the characteristics of water resources, their management, their use and pollution. Furthermore, it collects information about the flood hazard and flood control, waterways and inland navigation; also, about the size and kind of water demands, etc. Moreover, it comprises investigations on the methods of forecasting water resources, management and conditions, development thresholds, etc. The aim of all this work was, apart from the presentation of the water resources, their management, and development forecasts, also to make available the data concerning water resources and water conditions. To illustrate better this direction of work, its range and results, several examples of thematical tasks worked out are quoted below.

(a) The information about surface water resources, worked out synthetically at the former State Hydrometeorological Research Institute (now the Institute for Meteorology and Water Economy) in the form of characteristic flows for the 15-year period (1950–1965) for over 200 water-gauge cross-sections over the territory of the whole country has been supplemented with the values of the so-called minimum acceptable flow (the category defined and developed within the Research Problem of Physical Development of Poland and its thematical group). Furthermore, the most suitable methods and ways of transformation of these data for balance cross-sections other than water-gauge cross-sections have been established and empirical formulae for computation of characteristic flows in catchment areas about which there had been no statistical data concerning flows (with the particular consideration of mountain territories of the Carpathian region), have been detected.

(b) The information about surface water resources was supplemented with data about the state of pollution in a dynamic approach aiming at a cartographic illustration of the increase of pollution over the period of the last few years.

(c) The information about underground water resources worked out by the Geological Research Institute for the territory of the whole country, computed as per area unit, has been supplemented with data concerning the technical conditions of exploitation of these waters. Furthermore, potential water resources for 250 towns which face difficulties in surface water supply have been determined in detail from the technical viewpoint.

(d) Methods of determination of water demands for towns, agriculture and industry have been worked out.

(e) The forecast of the development of waterways and inland navigation as a part of the national transport system has been established.

(f) The flood hazard has been investigated in the light of the distribution of mean annual flood damages over the territory of the whole country and systematised by poviats. Also the inundations caused by the flood wave with the probability of 0.1% was taken into account.

(g) The construction of water reservoirs and their influence on the spatial development of mountain areas, on demographical conditions and land utilization structure on border areas has received due attention.

(h) The forecast of the state of pollution of flowing waters in consequence of the economic development in their catchment area has been set and critical situations in attaining water protection have been established.

(i) Protection conditions of the catchment areas, the water resources of which should be designated for retention in water reservoirs as well as the criteria of defining protected and protective catchment areas have been worked out.

The second direction of work deals with the principles of management and the protection of water resources and in this connection, according to the need, also with the principles of management of waters in the process of their uses. It also investigates the consequences of their effect on the functionality and structure of hydrographic systems of particular regions and of the whole country, taking into account the influence of the above factors on counter connections between the water economy and the regional spatial economy.

The unfavourable situation in the scope of management and utilization of waters, generally recognized already on the basis of investigations prior to the work on the Research Problem of Physical Development of Poland and of the statistical data, proved true also in the process of preliminary investigations on the problems of the above-mentioned first direction of work. In many regions there has so far occurred a considerable exhaustion of water resources, not so much due to water consumption, as to the pollution and to the excessive transgression of the level of natural restorativeness of usable underground waters, i.e., on the whole, in consequence of a wasteful exploitation of water resources.

A great qualitative differentiation of water resources, which has occurred and is developing systematically further on in consequence of the utilization of waters, land and atmospheric air, makes it necessary to take into account the qualitative requirements of particular water uses at balancing the water requirements and the available resources. With time this differentiation will become more pronounced. Waters of upper catchment area parts of our rivers are less exposed to pollution and can be more easily protected against it that waters in medium and lower river sectors, which receive different harmful and hard-to-control pollutants from wide areas. Such a state of things makes it necessary to balance the water requirements and the available water resources of given territories according to the quality of water and to the demand of particular users, and not only, as it was in practice hitherto, according to the hydrographical criteria.¹

¹ It is assumed that all water in rivers and lakes, irrespective of its pollution constitutes water resources of equal quality, which, determined in the given profile, is balanced with the sum of postulated demands within the catchment area enclosed by this profile. In case of a negative balance result, the priority is given to units which are stronger economically.

This practice is, as it appeared, of a significant importance for balance results and for the respective conclusions concerning the possibility of covering the demands, since in many territories with a great volume of polluted water resources which had been determined only according to quantitative hydrological criteria, really significant deficiencies of water resources occur, resulting from the impossibility to cope with the qualitative requirements.

The examples of such a situation can be observed at present in several regions of the country, particularly in the Upper Silesian — Cracow, the Lower Silesian, and in Szczecin and Gdańsk regions; also in other regions, among others around Warsaw and Lublin, this situation may occur in the near future.

In this connection the repartition of water resources outlined in water economy investment plans and programs, worked out hitherto on the basis of hydrologic-hydrographical and economic criteria only, proved wrong and was not realized in the practice, as it would lead to faulty programmes as far as water economy was concerned. Therefore, the establishment of the correct principles and criteria of the repartition of water resources has been acknowledged as one of the basic within our thematical group.

In the last few years the question of the repartition of water resources arose also with the analysis of other basic water economy tasks, not less important than water demand, particularly concerning the maintenance of the water of many rivers and lakes in the state of purity ensuring its useful value. For, in some heavily urbanized and industrialized regions it is no longer feasible to eliminate pollutants introduced with waste waters by traditional methods, complying, however, to the water law. As a matter of fact, even a high, technically possible level of waste water purification by all water users would not ensure the maintenance of water purity of the recipient. Such a situation can be exemplified by the region of the upper Vistula river near Cracow, the upper Odra by the mouth of Kłodnica, the upper Bóbr, Bystrzyca, Narew, Bzura and other rivers. In these regions the achievement of the water economy goal, namely, the maintenance of water purity of rivers, reservoirs and streams — the recipients of wastes, would be possible only by a technico-organizational integration of the processes of water supply, water purification and waste water discharge according to the scheme (c) in Fig. 1, resulting from the transformation of the schemes (a) and (b), in which, through a recirculation of municipal waste waters and through a regional system of waste water purification, a limitation of access of some industrial or agricultural users to primary water resources² (with regard to both water intake and waste water discharge) would take place.

In consequence, a radical restriction of water intake and of discharge of wastes and, first of all, of contaminants will take place. Also, this would make it possible to give the priority of the utilization of primary water resources to the purposes of water supply for population rather³ than to industrial or agricultural purposes.

It is easy to imagine the effect of the above changes of water utilization principles on the spatial solution of water economy, and consequently, on the spatial patterns of settlements and industrial and agricultural production centres in the regions of urban and industrial agglomerations which ought to develop in accordance with the solutions suggested by water economy.

² In the repartition process of water resources only.

³ Which is justified from the point of view of population distribution and settlement within the spatial development plans, as well as when the public health and sanitation are considered.

It is also evident, how decisive the effect on the state of management and the exhaustion of water resources on the one hand, and on the spatial solutions of water economy systems rendering possible the rational patterns of settlements and industrial and agricultural production centres in urban and industrial agglomerations on the other, is rendered by the principles of water management in the course of water utilization and how important they are as a factor in spatial development plans.

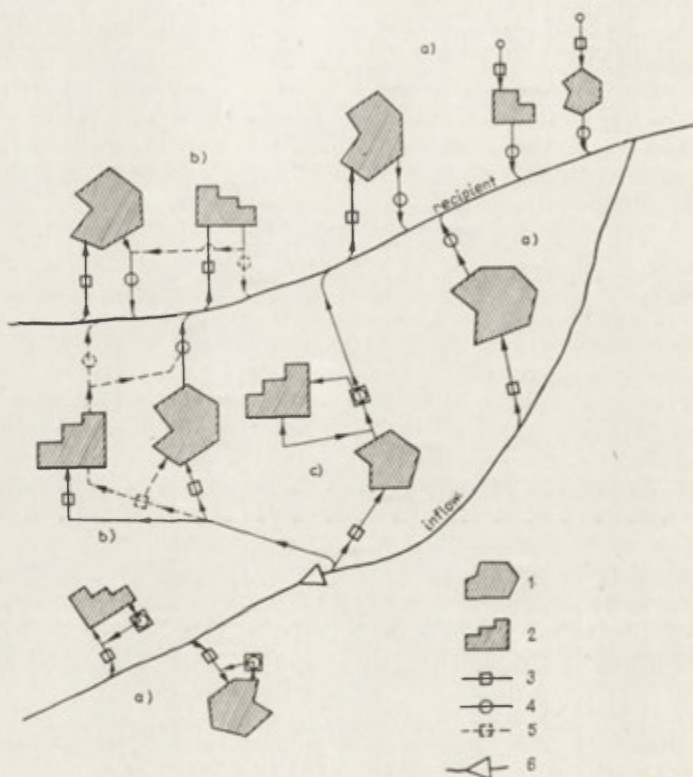


Fig. 1. Basic pure and waste water circulation types

(a) conventional, (b) and (c) integrated
 1 — settlement, 2 — industrial plant, 3 — water treatment and purification, 4 — sewage treatment, 5 — variants, 6 — retention reservoir

The spreading of the above integration processes, as the world wide experience and the situation in many of our regions with a stringent water economy balance prove, undoubtedly forms a trend along which water supply systems in Poland's water economy will develop. That leads to radical changes in opinions concerning the formation of natural outflow and the quality of waters.

The development of flows of medium and large rivers in the direction of levelling outflows and of a systematical raising of low outflows by means of retentional water reservoirs, assumed in all the hitherto technical conceptions of water economy, does not seem attainable in this light. Retentioning waters

in the upper sectors of these rivers would contribute rather to the irreturnable needs of industry and agriculture (in conditions of water recirculation from waste waters) than to outflow levelling, which, anyway, is not highly effective in hydrographical conditions prevailing in Poland. Therefore, the anticipated increase of the existing water reserved in the medium and large river beds, originating from their upper basin parts, hitherto insufficiently utilized, is not justified. Neither should be expected any considerable improvement of the purity of these waters with the advance of the urbanization and industrialization according to agglomeration conceptions. Nor will the development of general chemization of national economy, particularly of agriculture help; on the contrary, it will rather contribute to a rapid increase of pollution levels.

It should be stated, therefore that the formation of the hitherto accepted technical conceptions of water economy occurred under a powerful influence of the priorities and locations of the so-called water requirements of the industry. This principle proved incorrect in the light of a more general principle valid in the conceptions of the spatial development plan at the national level which assumes that it would be the forecasts and decisions of the population

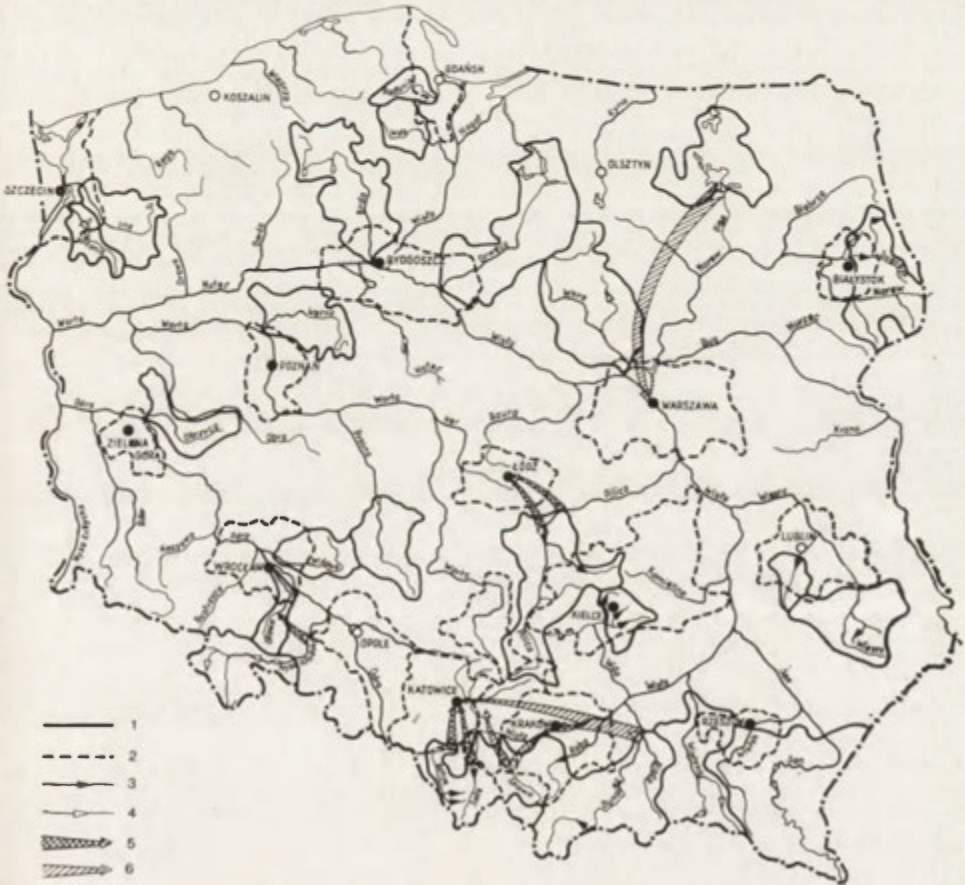


Fig. 2. Protected catchment areas of high-quality waters for:

1—limits of the catchment area of high-quality water resources, 2—limits of urban and industrial agglomeration, 3—water reservoirs: existing and under construction, 4—designed water reservoirs, 5—existing water transfers, 6—future water transfers

distribution rather than any other factors which would constitute a starting point for planning. For water economy this principle is equal to the principle of the priority of population water demands, being at the same time in accordance with the water protection problem.

Another general assumption in the conception of the spatial development of Poland, which would exert a basic effect on the development of water economy systems, is the growth level of the national capital and income in urban and industrial agglomerations. In this light there should be envisaged a reconstruction of these agglomerations in the sense of spatial development, the conditions of which would be the reconstruction and a considerable enlargement of the existing technical and economic structure. This will contribute to the implementation of the above discussed revision of the principles of management and utilization of water resources, without which the tasks and aims of water economy resulting from the assumed conceptions of the spatial development at the national level could not be realized.

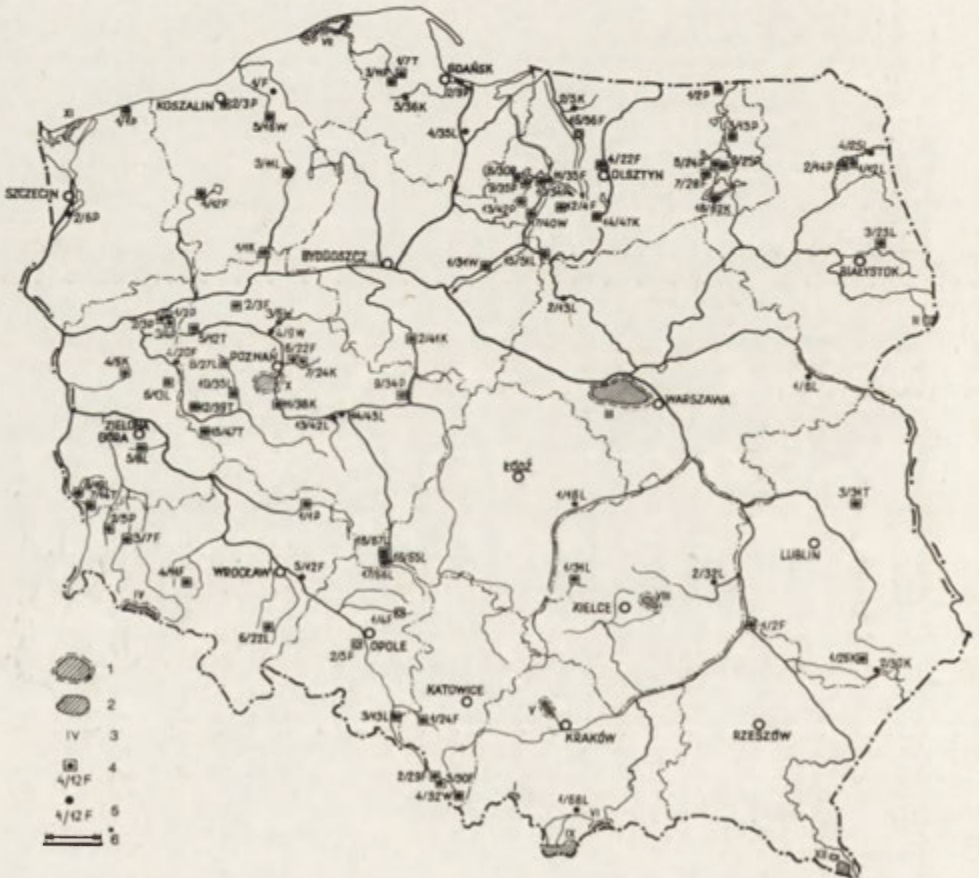


Fig. 3. National parks and nature reserves

1—National Park with protection zone, 2—National Park without protection zone, 3—symbol of National Park, 4—its successive symbol, by voivodships according to the Water Economy Research Institute with protection zone, 5—its successive symbol, by voivodships according to the Water Economy Research Institute without protection zone, 6—river under protection

In order to meet half-way the more important questions presented as examples here, a number of themes subordinated to or connected with the basic problem of the "Repartition criteria of water resources" have been undertaken.

While realizing the thesis of the priority of urban agglomeration in water demands, with the simultaneous consideration of practical possibilities of securing water purity, 20 so-called high-quality water catchment areas have been distinguished. These provide water reserves for supplying the population of the agglomerations; they can and should be protected through the establishment of definite conditions under which their land and water may be utilized (Fig. 2). Among others, mountain catchment areas have been distinguished, exemplified by those in the Carpathian and Subcarpathian territory, in which the economy should comply with some definite criteria, taking into consideration the specific physical features and social-economic functions of these territories as well as the protection against eutrophization of the water reservoirs to be built in the given catchment area.

The legal status of national parks and nature reserves is in many cases of considerable importance, yet only if the conditions of the protection of waters constituting an element of the given object or a catchment area protected according to the said status are legally defined. In this connection the investigations of this problem were carried out. In consequence, the concrete proposals of the criteria and delimitation of the territories to be protected have been formulated. They are illustrated in Figs. 2 and 3.

For more than 20 years a category called minimum acceptable flow in the repartition of water resources and balances has been taken into consideration. It was defined, without success, mainly on the basis of the hydrological category as SNQ, i.e., a part of the so-called many-year mean low water; besides, sometimes economic or navigational categories have been used as auxiliary ones in order to define it. Within the framework of the research on the theme "Water circulation in nature and national economy" an explicit definition of this flow has been obtained together with its criteria based on the categories of social and natural, and non-economic character. On this basis the magnitudes of this flow have been determined for the rivers of the whole country (Figs. 4 and 5).

To the minimum acceptable flow, as its name and socio-natural aims suggest, the priority in water economy balance should be given, together with the high-quality water catchment areas, the water resources of the protected catchment areas and the resources of national parks or nature reserves, all of which have been mentioned above.

It is, therefore, of vital importance to single out and define the resources of high-quality water catchment areas, the protected catchment areas and the national parks and nature reserves; also the protected zones of water intake for population needs and the minimum acceptable flow, and to give to them the priority in water economy balance on the basis of non-economic categories. This has, as can easily be perceived, a significant importance in the development of principles of repartition of water resources, considering the existing qualitative differentiation of these resources and, accordingly, in the meeting of water demands and of other water economy purposes, e.g. the protection of resources. It is also of a decisive significance in balancing the existing resources and demands, and, consequently, affects the technical solutions of water economy as well as the intraregional flows of resources and means.

The expenditures for water economy and water protection objects and systems, conditioning the attainment of aims of perspective socio-economic plans, estimated recently at the occasion of works on complex water economy and

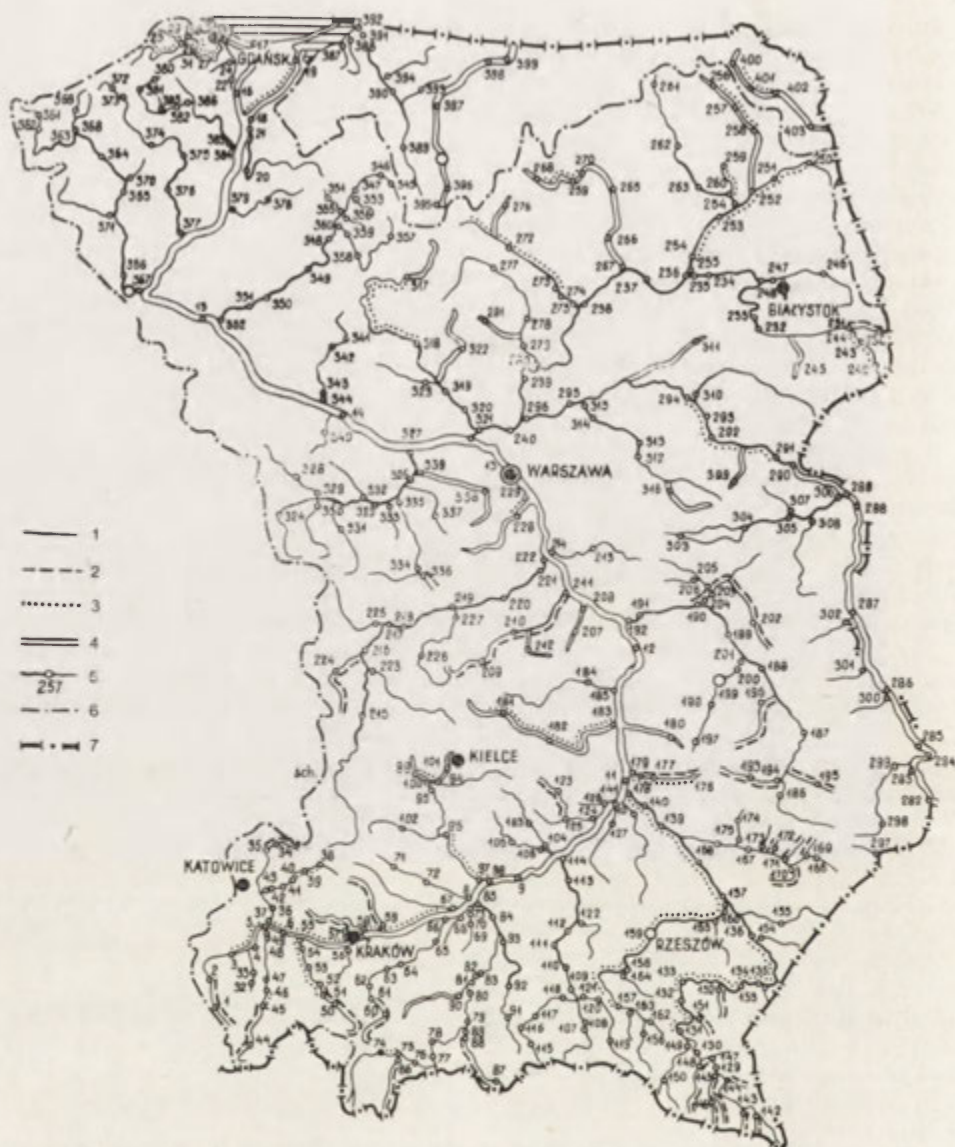


Fig. 4. Minimum acceptable flow in catchment areas of the Vistula river and of the Eastern Baltic Coast rivers

The decisive criterion for determining minimum acceptable flow of a river or its sector

1 — angling throughout the year, 2 — angling in the period of March-May or September-November, 3 — tourism in the period of June-September, 4 — hydrobiology etc. throughout the year, 5 — symbol of control or water-gauge control profile, 6 — limit of catchment areas of the Vistula river and the Eastern Baltic Coast rivers, 7 — state boundary

environment protection problems, amount to over 1 billion zł. This, however, is a figure too high to attain still at the present development stage of our national economy. Therefore, limited investments ought to be expected in the period in question, caused by a comparatively slow development of the technical-economic infrastructure of water economy.



Fig. 5. Minimum acceptable flow in catchment areas of the Odra river and of the Western Baltic Coast rivers. For explanations see Fig. 4

Within the framework of the theme in question and guided by earlier forecasts in this respect, the work on the economic criteria of the repartition of water resources has been undertaken. It should result, as it is expected, in obtaining the estimates of the value of potential water resources in particular regions, in the conditions of systematic outflow control. These estimates will be based on the evaluation of the costs of the resources in the course of their enrichment by means of the retention and transport of water and electronic computers will be employed for the work. Adequate algorithms and computation programs have been worked out and verified on examples. At the same time the required cost indices have been collected on the basis of some water economy investments appropriate for the purposes of the research, recently realized.

This type of economic estimation of water resources for particular regions of the country ought to be of use in seeking for economic solutions of water systems; it ought to help in the choice of the solutions of particular variants and in decision-making (from the water economy viewpoint) about location of economic activity particularly of industrial, agricultural, and livestock-raising investments.

The above estimation will also be of use in detecting and forecasting the regions which become ripe for the introduction of the above integration, technological-organizational processes, justified by technical-economic criteria. In this case their readiness will be disclosed by the levelling of values of potential water resources in the given region with the costs of water recirculation from municipal waste waters.

The set of the criteria employed for repartition of water resources, briefly described above, undoubtedly enriches the set of instruments, too poor hitherto in relation to needs, for the investigation of water economy, the development of water economy objects and systems, principally of the technical-economic infrastructure, in the spatial development plan. The demand for these instruments has been great, as the examples of their current use can prove best. For instance, the proposal of the catchment areas protected and protecting, distinguished on the basis of social and natural criteria, has been generally approved and employed lately.

We have already stressed the importance of changes in water management principles and in water use for spatial solutions of water economy as well as for mutual links between the conceptions of its development and the spatial development of other fundamental economic sectors and branches in particular regions and in the whole country. It manifests itself most distinctly in changes of the water demand on part of main water users; first of all of industry, partly of agriculture, and, though to a less degree, of the population, tending towards a reduction of the demand per unit of the product, of irrigated area, etc. It leads, consequently, to changes of the water systems in particular regions and in the whole country, as well as to changes of proportions of their subsystems and of the pollution of waters, mainly surface waters.

The hitherto principles of extensive water economy (among others: the meeting of demands determined by particular users, regardless of the state of water economy; the application, as a rule, of open water circulation; the individual, non-systematic solutions of questions of water supply and treatment, the waste water discharge, etc.) resulted in the high rate of exhaustion and pollution of waters, leading in many regions to adverse water balance and "thresholds" in their economic development.

The removal of these "thresholds" under the principles enumerated above proved to be both too expensive for the national economy and non economical.

This was corroborated by the programs and models of the water system, worked out successively from 1960s once in every several years.⁴ In this connection the necessity arose to undertake the work on the national and regional water systems from the viewpoint of their dynamical development. A proper research task was formulated. The correctness of the decision was confirmed already by the preliminary investigations. Thus, if one takes into consideration both the counter connections between water economy and basic economical branches in the development, and the mutual interaction degree at their characteristic development stages, one notices that the water system effect at some development stages would be predominant, contrary to the hitherto views. It manifested itself practically in the results of the work on the "Preliminary project of spatial development at the national level for 1990" carried out within the State Planning Commission: it was also proved by the work carried out by the Institute for Meteorology and Water Economy on the conditions of economic locations from the point of view of water economy, within the framework of the Research Problem of Physical Development of Poland.⁵

Deeper analysis resulted in considerable changes in the hypothetical distribution, first of all, of industry and partly of agriculture, in view of an established inefficiency of previously formed water system to meet the water demand. In this connection the necessity arose to translocate water demands from places traditionally favourable for the development of certain branches of economy to places more suitable for the water system.

At the same time it has been established that, given other proportions of the structure of inefficient regional water system, which could well develop with the application of different principles and ways of water management,⁶ these systems would be able to satisfy future growing demands.

Therefore it is to be expected that the investigations on water system development which will objectively take into consideration the character of the mentioned counter connections, would prove its functional and structural autonomy despite the fact that it is developing, as a rule, under the pressure of growing water demands. It should, however, be adequately considered in forecasts of economic development of particular regions. Its autonomy results, first of all, from the natural conditions of water resources and water conditions, but also from the distribution scheme of raw materials. Moreover, on the one hand the historical formation of the economic potential must be considered and on the other, the historical development of water utilization principles, methods and ways of the solution of water economy tasks.

These natural and historical conditions characteristic of Poland, where the abundance of water resources in the first period of intensive industrialization and urbanization contributed to the development of extensive water economy, beside some other factors, resulted in the non-continuous, step-like development of this economy.

The problem is that the necessity of changing to more intensive forms of economy, at a point of considerable inefficiency of water systems which characterize with long functioning period makes this transition from one stage to another occur in conditions of growing inefficiency of the water system, through a series of critical situations, which can only be solved by radical changes of principles and ways of management of water resources and water

⁴ Recently a *Complex water economy development program* has been published.

⁵ J. Tylko et al., *A map of indications and counterindications concerning location from the point of view of water economy*.

⁶ M. Zajbert, *The effect of technological integration of water supply and waste water purification on water balance and water protection*.

utilization, accompanied by counterpart by technical and organizational changes.

Thus the water system is developing not only under the effect of structural changes of spatial development of particular regions and of the country as a whole, but also under a significant influence of its inner technological, organizational and legal changes which are of decisive importance for the growth of its efficiency.

Although the control of water systems and their development occurs within the framework of a general theory of systems, the natural and historical conditions of socio-economic development in which water systems are developing, require indigenous investigations of those systems within the boundaries of the given region and of the whole country, in order to secure their correct development through control. This is the condition which must be taken into account in working out of the program for the investigations on spatial development in the period 1976-1980.

The hitherto works concerning the water systems of particular regions and of the whole territory of a given country, carried out both in Poland and in other countries, undertook the task of the establishment and solution of the water system model, which would fulfil functional and structural conditions set by water demands defined in advance *in ultimo* of the concrete year, resulting from the general cyclicity of planning covering 5-year periods. The correctness of water economy was conditioned by the meeting of all postulated demands by means of such a technical conception variant which would ensure the lowest costs or the smallest losses, in case it could not satisfy all demands. Such a model could not, of course, take into consideration the effect of the feedbacks mentioned above which manifest themselves distinctly only in critical situations of particular development stages of the system. Hence, in order to work out the model of the water system of particular regions and of the whole country, the necessity arose to investigate them at time intervals characteristic for particular stages of their development, i.e. for critical situations, and not only in 5-year cycles characteristic for economic planning.

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A PRELIMINARY CONCEPT OF THE DISTRIBUTION OF SOCIAL INFRASTRUCTURE IN POLAND

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The term social infrastructure is not uniformly understood in the Polish scientific literature to date. Without engaging in debates that are still going on, we shall understand by this term the set of public utility institutions and facilities, including the employees on their staff, and buildings to accommodate them, and the necessary equipment — that all meet the purpose of satisfying the educational, cultural and social requirements of the population, and serve jointly the promotion of the social advancement.

The development of social infrastructure is above all connected with satisfying the human requirements which are known to be varying and growing as the successive development stages of the country or region in question are reached.

Notwithstanding the fact that the satisfaction of the human requirements by the infrastructure must be given priority, one can at the same time hardly forget the essential importance of the infrastructure for increasing the labour efficiency, i.e., its indirect influence upon the increase of the social product.

In a more narrow meaning social infrastructure facilities embrace the institutions serving the purposes of education, culture, recreation and sport, public health service and social security. An essential link with the above facilities is noted on the part of the housing, although a part of demand in this respect is met by private resources. In a broader meaning, we shall furthermore reckon among the social infrastructure facilities in the service of internal and external security, of justice as well as public administration; also, the organs protecting the material environment of the man. In this article, we shall deal exclusively with the social infrastructure facilities in the strict sense.

Work on the future dislocation of the social infrastructure has been conducted in Poland since 1971, within the framework of the research theme: Physical Development of Poland; in 1973 a special team has been appointed to engage in the problems of the social infrastructure *sensu stricto*. The group have initiated studies on a number of topics. By the end of 1973 several syn-
thetical studies have been attempted in which initial hypotheses were offered. The heretofore conducted studies on the social infrastructure included mainly the following themes:

- (1) Transactions concerning methodology and classification.
- (2) Detailed analytical research concerning the heretofore trends in, and the present development trends on the social infrastructure in Poland.
- (3) Selected problems involved in the research on the interrelation and impact of the individual factors upon the change in the dislocation and the level of satisfying the needs by the social infrastructure facilities.

(4) Proposals concerning the principles of the general future dislocation of individual branches of social infrastructure, their distribution in individual regions and settlement units of complexes.

(5) Preliminary synthetic studies.

The procedure adopted was the organization of discussions on selected problems among experts in the field. Detailed studies were oriented towards the problems to be elucidated in the final report on the development of social infrastructure.

The work conducted took into account the results of directives adopted under the plan of the physical development of Poland, and in many cases it specified more precisely problems that were but generally outlined under the above plan. Also, many a new concept has been put forward which were left over under the plan, since certain problems listed therein had been given but a summary consideration. Many a variant proposal had been put forward that required a series of additional research to be accomplished. The work along this line is still in progress, many hypotheses and proposals are subject to be gradually defined more precisely.

Whereas during the initial development stage of the socialist state, with the immense needs in all fields, as well as the necessity to, above all, develop the material production, the possibility of expanding social infrastructure used sometimes to be limited, now, at the stage Poland has entered at present, both the possibility and the necessity exist to accelerate considerably the rate of growth of infrastructure facilities. Certain delays which had occurred in the process were caused by both objective circumstances beyond control, and by the human factor — a specific underestimation of the importance of infrastructure development. Such an underestimation may be deemed subject to certain conditions, and error in the social-and-economic policy, and at the same time a factor impeding development processes. Since 1971 particular attention has been paid to a rapid expansion of the social infrastructure facilities in Poland. Many relevant decisions have been taken since, and actions initiated to reduce the contrasts noted in this field between the regions of Poland. The closing of the gap between regions as well as between urban and rural areas is, however, a long-lasting process. The equalization in the domain of infrastructure is above all necessary as far as basic services are concerned, since the higher order functions have to be located in voivodship and supra-regional centres.

Without indulging at this point in the qualitative analysis of the relationships between service demand and supply as well as of differences between the regions, one can consider the circumstances that are of a decisive impact upon the augmentation of and changes in the demand for social infrastructure which necessitate the latter to be developed to a considerably higher degree than heretofore. These circumstances are as follows:

(a) the occurrence in many fields of an unsatisfied demand for services, like, e.g., in education, public health service, and of the increase in the demand,

(b) a change as concerns the needs of the population that results out of the increase of the level of education, and consequently of culture which puts additional requirements on the part of infrastructure facilities and their standards,

(c) the increasing proportion of leisure time and the need to develop recreation, entertainment, and public health service facilities,

(d) a marked expansion of the scope and range of services to be rendered to elderly persons (the process of ageing of the society may be looked upon as a general rule in developed countries),

(e) the growing importance of large enterprises in meeting the social needs

of their employees, with the simultaneous change of the scope and type of services rendered, and even with certain facilities being turned over to the responsibility of the local authorities whenever this may contribute to a more efficient satisfaction of the needs. This problem still requires additional studies,

(f) a link between the rendered services and the problems of the preservation of the natural environment; also, the investigation of prospective consequences of the balance being upset in this respect,

(g) the trend towards the concentration of facilities of the social infrastructure to allow a better than heretofore satisfaction of the demand (e.g. as concerns the general education in the rural areas), towards establishing facilities to meet several types of demands at a time (e.g. local schools, performing educational, recreational and social functions); such establishment of larger-scale facilities of social infrastructure, plus an improvement of the public transportation system would help to render the individual facilities more accessible,

(h) the trend towards levelling-off the possibilities of meeting the basic needs within the field of social infrastructure by the population of the whole territory of this country; however, while at the same time securing the necessary rational changes to be effected in this respect, both from the social and the economic point of view. In this connection, it seems necessary to adopt a possibly flexible approach towards planning the dislocation of social infrastructure facilities. This involves, furthermore, the maximum use of the hitherto existing property and the staff employment, with the expansion to be avoided in settlement centres offering no development potential, in which the facilities would not in the future operate efficiently. Sometimes there is a necessity to plan social infrastructure facilities in a city to enable a possible change of function, at the cost of but a minor conversion of the interior.

By 1990 or even 2000, the most essential factors of change with regard to the distribution of institutions and facilities of the social infrastructure, would include the following:

(1) *The demographic factor.* The demographic forecast by age groups points towards the fact that the number of children within 0-2 age category would until 2000 display a moderately decline; the demand for nursery services will thus be relatively stabilized. The number of children within the preschool age category will exceed in 1980 the corresponding figure for 1975 by 0.2 million to diminish again until the year 2000 by 0.3 million. Thus, the demand for kindergartens will also be gradually diminishing. The group of children and youth aged 7-17 years will be declining until 1980 (6.2 million in 1975, 5.8 million in 1980). It can be expected that by 1990 the post-war demographic peak will be "re-echoed", owing to which this age class would then total 6.3 million, against only 5.7 million in the year 2000. A decline is noted also within 18-24 age category. Since this group will total 4.9 million in 1975, but it will number 3.6 million in 1990. A recurring increase will occur until 2000, up to the anticipated 4.0 million.

Within the age group of over 60 an increase is anticipated between 1975 and 2000, of 2.1 million (4.7 million in 1975; 6.8 million in 2000) which will necessitate in the wake a considerable expansion as regards the volume of services to be rendered by the social infrastructure for the benefit of the above age group.

Despite the progressing stabilization of the demographic structure a more far-reaching change in the territorial distribution of the network of social infrastructure facilities must be anticipated by the year 2000. The changes in the territorial distribution of population, and consequently those in the settlement network will be much evident than heretofore. In rural areas many settlement

units will vanish and this will result in a gradual concentration of infrastructural facilities in administrative (township) centres. The socialization of agriculture will result in a marked increase of labour productivity in agriculture, the migrations to cities, particularly to large urban agglomerations, the migrations favoured by the shortage of labour on urban areas.

(2) *The social-and-economic development*, and above all the several-times increase of the divided national product, and in this connection also an increase of per capita incomes, changes in the occupational structure, the increase of the employment within the broadly understood service sector, the increasing leisure time and spatial mobility. All this will encourage the expansion of social infrastructure, and will bring about a change in the pattern of demand for social infrastructure facilities.

(3) *The scientific-and-technological progress* with all the social and economic consequences thereof. This will promote the advent of new demands within the sphere of the social infrastructure, which now can not be fully predicted.

(4) *The growing degree of education*, public health service or culture, by their becoming obligatory; generation of new demands by creating new facilities of social infrastructure (promotion of prophylactic medical examinations of various kind and so forth). In this connection, an increase will arise in the demands for higher order services with the simultaneous improvement in service quality. One can anticipate an extension of the obligatory education period and some obligatory forms of education for adults. The above phenomena would exert an essential influence upon the services to be rendered by the network of social infrastructure facilities.

(5) *Changes* resulting from technological improvements and the increase in skills of service personnel. This would involve, to a certain degree, the already mentioned concentration of such facilities, their higher specialization, the occurrence of considerable demand for investments, and the growing proportion of infrastructure in the total of expenditures on the national scale.

With the trends as listed so far and basic factors identified, a consideration must be given to the need for and the possibilities of a development of uniform, nation-wide rules pertaining to the territorial distribution of basic facilities of infrastructure taking into account the local conditions. This applies both to the township centres (irrespective of whether these are rural settlements or small towns) and to urban places. The project must generally aim at establishing multi-functional centres to be accommodated either in the same building, or at a short distance between one another. The needs as concerns basic facilities are more or less alike everywhere. One must not neglect, of course, the specific features of physical development of individual rural areas as resulting out of natural conditions of various settlement patterns, of the distance from large urban agglomerations, of the present development levels etc. Differences as concerns the present development would be of an essential impact upon the manner and time required for transformations to be effected. A part of such differences will persist. It is impossible to assume, e.g., that the population density will always be the same, and the same public transportation system, and that uniform types of centres can be developed. Another factor are local habits concerning the mode of satisfying specific requirements that will probably persist in future. The size of basic facilities of social infrastructure must be adapted to the number of inhabitants within the region in question calculated on the basis of a reasonably set commuting time, different for various age groups. In thinner populated regions, it would be the lesser degree of certain infrastructure services being used that must be taken into consideration, and this is accounted for by such service units being indivisible.

Specific conditions must be taken into account of areas undergoing rapid urbanization. Those latter would include by 2000 above all the Southern Macro-region, the Warsaw region, and the Gdansk-Gdynia region. This problem requires further studies, and the definition of the regions themselves stands open to a discussion. The fact remains, however, that even in basic social infrastructure services, the above regions will present specific differences. It will pose an essential problem to plan the distribution of infrastructure facilities within the urbanized belts, extending from urban agglomerations. The agglomerations themselves, with their public transportation systems may be selected as centres of large-scale facilities. A specific type of social infrastructure centres would present major border crossings serving tourist movements.

We have been considering so far the general principles of arrangement of basic facilities of social infrastructure. However, each branch of infrastructure has also its specific locational factors, which have to be considered by the planner. The distribution of specialized services is above all decided upon by their functioning.

As concerns many types of services offered, one can talk about an active influence of service development upon service demand, even with use being made of an obligatory form of claiming such services. It seems that this circumstance may also play an essential role in the future spatial distribution of facilities of social infrastructure.

The general principles as outlined above may furnish the base for a discussion of certain problems involved in the selected fields of social infrastructure in Poland.

In the university education the crucial problem will be the location of new college and university branches since founding new universities will be restricted to the existing centres. These branch units may possibly be located in the developing or potential agglomerations or in other growing urban centres of nation-wide importance. This latter choice is favoured by complementarity of secondary and university education, the increasing importance of large working enterprises as regards not only vocational (secondary level) but also university education, and even post-graduate training. A wide expansion of branch departments of universities might appear disadvantageous if it involved high development and operation costs. The present trends, however, seem to prove that branch departments of university schools are established at an increasing rate.

The proposal seems acceptable to establish within every voivodship regional branch departments of universities, offering introductory programmes or initial years of studies. In this case, the university schools would become more dispersed than heretofore.

The increasing importance of large-scale working enterprises in the promotion of vocational education systems, including centres of "permanent" training at this level, must be deemed justified. The vocational training will thus become closer involved with the future employment.

Without excluding the possibility of future location of vocational schools also in other towns the main vocational education centres should be urban agglomerations and other growth centres. Agricultural education establishments should be more evenly spread and located in the majority of poviats and other places.

With regard to vocational education it will be necessary to expand considerably the network of schools offering full board. Not less urgent is the widespread growth of kindergartens (their network must be dispersed and rather little related to working establishments).

TABLE 1. The distribution of social infrastructure facilities: A preliminary hypothesis

Type of settlement unit	Public health service	Education	Culture
National capital	Institutions engaged in: (a) research on diseases of major social concern, (b) scientific exchange on an international level, purchase of equipment and medicines, (c) supervision of medicinal production. — medical aviation command post — artificial organs manufacturing plant — tissue bank for transplants	— University education in unique fields — post-graduate studies (for research workers) — research institutions in the field of education — production and repair of educational equipment — extension education centre (highly specialized) — education centre based on TV system	National institutions: — central board of creative unions — theatres of all types — opera, and operetta house, orchestral halls — national and specialist museums — national and specialist libraries — entertainment centres, show and exhibition halls, etc. — central institutions responsible for the management of culture — central culture-supporting institutions (publishing houses, etc.) — central research institutions in the field of culture — mass media headquarters
Centres of national importance, large urban agglomerations	— certain scientific-research institutes — medical academies with clinics for 800-1000 beds and a regional post-graduate educational establishment — cancer treatment centres — clinics and specialized hospitals — specialist extension centres — mental hospitals and alcoholic treatment centres — medical and vocational rehabilitation centres — health resort-type facilities — orthopaedic surgery centres and artificial limbs plants — ambulance aviation centre — apparatus and equipment repair (highly specialized establishment)	— centre for specialized university and vocational education — youth education and sport centre	Institutions of supra-regional level: — opera, and operetta house, theatres of various types, show halls and entertainment centres (fun fairs, circuses, etc.) — museums and libraries (general and specialized, study-cinemas, creative clubs and associations, specialist bookshops, research institute branch centres of a culture-oriented character, culture management, supply and service centre — mass media centres (editorial offices and studios) — specialized units, e.g. Maritime Culture Centres

Regional centres (voivodship capitals, smaller urban agglomerations)

- medical academies where needed
- post-graduate education centres
- scientific institutes for the treatment of diseases specific for particular occupations
- hospitals: including orthopaedic and accident surgery divisions
- specialist treatment extension centres
- medical aviation centre
- homes for seriously retarded children
- welfare homes for chronic mental cases
- industrial health service agencies
- epidemic supervision units
- specialized ambulance stations
- medical centres for school and university students
- dental prosthetics establishments
- medical apparatus and equipment repair establishments
- colleges or branch colleges
- vocational education centres
- training course centres
- secondary music schools
- culture centres for children and young people
- touring hostels for school children
- excursion centres
- theatres, orchestral halls, music halls
- entertainment centres
- museums and art galleries
- libraries — district and branch level
- scientific lending-libraries and specialist bookshops
- mass media branch units (local editorial offices)
- audio-visual media technical base
- cultural institutes with specialized interest circles
- creative associations, branches and clubs at regional level, etc.

Powiat centres (middle-size city)

- 400-bed hospital with 5-6 divisions including a diagnostic-and-treatment division
- up to 10 specialist consulting centres
- district extension centres with laboratory facilities
- labour health-conditions advisory centres
- ambulance stations
- pensioners homes and welfare homes for chronic cases
- dental prosthetics establishments
- children's homes
- convalescent homes
- branches of extension units of university (possibly 2-year colleges) when needed
- vocational schools
- training course centres at work establishments
- extension education centres for adults
- boarding schools
- special tutorial centres
- children's homes
- school-and-tutoring centres
- emergency centres for children
- culture and recreational centres for young people
- Multi-functional cultural complex including:
 - cultural institute together with clubs, exhibition hall, musical and fine arts centre, multi-functional entertainment hall (for travelling shows etc.)
 - permanent cinema
 - public library integral with press and book club, bookshops with good selection of stock
 - possibly a museum and a theatre

Contd. Table 1

	<ul style="list-style-type: none"> — epidemiological supervision units — blood donor stations — medical equipment repair units — pharmacies — nurseries — health service units provided by industrial enterprises 	<ul style="list-style-type: none"> — school sports centre — kindergardens 	
Township centres (also small towns other than seats of administration)	<ul style="list-style-type: none"> — township health centre with 6 divisions — township school dispensary — pharmacy — nursery — analytical laboratory — district dispensary in small towns — cure centre for chronic cases — ambulance branch station 	<ul style="list-style-type: none"> — general-education secondary school — boarding or semi-boarding school — agricultural secondary school — certain other vocational schools — kindergardens — popular lecture unit — playgrounds — agricultural training courses — training centre for adults 	<ul style="list-style-type: none"> Multi-functional township cultural centre integrated with township school including: <ul style="list-style-type: none"> — interest circles — multi-functional entertainment hall — public library — press and book club with sales of books, periodicals, etc. — possibly a permanent cinema
Settlement units below township centre level	<ul style="list-style-type: none"> — health centre (general dispensary) — treatment unit — small pharmacy 	<ul style="list-style-type: none"> — general-education secondary school (branch) — kindergarden (possibly integrated with the school) 	<ul style="list-style-type: none"> — club or common room — public library branch or library lending unit

The plan of the expansion in Poland, until 1983, of the system of 10-year grammar schools should be implemented with due consideration given to the specific conditions prevailing in individual regions, as well as to the future transformations of the settlement network and the demographic structure.

Basic public health service facilities will be closely connected with the spatial distribution of population and with the occurrence of diseases as caused by the environmental disfunctions.

Supra-regional medical care centres should offer services within rare or unique medical specializations. Such centres may be the existing seats of Medical Academies, i.e., Białystok, Gdańsk, Katowice, Cracow, Lublin, Łódź, Poznań, Szczecin, Warsaw and Wrocław. The remaining voivodship capitals will perform specialized medical services for their respective regions.

The size of general hospitals to be erected in regional and supra-regional centres should amount to 800-1000 beds per hospital. The most controversial in this respect is the location of hospitals in poviats centres. In this connection, one may put forward two following variants: (1) an expansion of network of hospitals in large cities — growth centres of nation-wide and regional importance, (2) a more uniform distribution of hospitals within individual poviats. Each of the two possibilities offers certain advantages and disadvantages. It may be deemed that the actual policy will be based upon a compromise concept which will give a consideration to the present distribution, with larger hospitals to be erected in supra-regional centres.

Pensioners' homes must be situated so as to secure the inhabitants all possibilities of remaining in touch with their former dwelling or working environment. The network of such homes calls for a considerable expansion, not including centres of a new type, like boarding houses, individual appartments with access to medical care at any time, etc.

Township public health service centres must be in the future established complete with pharmacies, and in justified cases also with retired farmer's homes.

The distribution of the network of entertainment services must be pursued in accordance with the principle that the lower the level of services offered, the closer should the location of the centre follow the pattern of distribution of its patrons. While, the higher the level of services the more the location depends on the size and potential of the artist community and the managerial capacities. A necessity is noted as regards services of more than a local range, to link them with the groups of potential audience by public transportation systems, and thus to enable a division of functions between the individual specialized centres.

Entertainment centres of any order shall be combined with other social infrastructure systems thus to raise the effectiveness of functioning of integrated centres. The lower the order of the centre, the closer the connection.

The role of social infrastructure facilities owned by large working enterprises should depend upon the character of the facility in question. This role must undergo a gradual evolution. The growing importance of large enterprises may be appreciated, as already mentioned, in the field of education, and in justified cases in culture or health prophylactics. Such plants will render services as concerns the work safety and working conditions, cafeteria services, etc. Their role may, however, be found to be diminishing in the organization of recreation, running kindergardens and nurseries; in this respect it would rather be reduced to financing such services as rendered to certain groups of employees, instead of managing of such facilities. Similar is their situation with view to sport facilities. The above matters require a further amount of studies.

This paper has given but a brief treatment of selected problems. On Table 1 a hypothesis has been presented of future spatial distribution of social infrastructure facilities. The problems are still under discussion. The present aim was solely posing the problem pointing to the future alternatives in conditions of changing demands and requirements and with view to the foreseen considerable expansion of facilities of infrastructure which is expected within certain fields to develop *de facto* into new social infrastructure. The need to anticipate and apply the most rational developments which would take into account the lasting principles of territorial distribution together with the long operational life of infrastructural facilities is beyond any doubt.

Many problems would be represented more precisely in course of further discussions, some out of possible variants of distribution of the social infrastructure will be selected. We have entered a stage which requires permanent scientific research to secure the effectiveness of decisions, and furthermore, a constant attention paid to the phenomena and processes in the making. In the light of the present importance of social infrastructure such research will grow in importance.

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THE STRUCTURE OF POPULATION AND THE FUTURE SETTLEMENT SYSTEM IN POLAND

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The present structural differentiation of the population in Poland, a result of the past and present migrations influences and will influence deeply the whole settlement system and its transformations.

The following analysis, based on recently accomplished research aims, at giving a general picture of the past and future problems; the details of the problem will be presented in a larger publication, prepared at present by the Institute of Geography of the Polish Academy of Sciences and scheduled to appear in 1976. Some of the supporting evidence and information concerning the present outline may be found in numerous publications of the Central Statistical Office from the last ten years.

It must be stated, first of all, that Poland belongs to the group of European countries which have a greater-than-average density of population, and are characterized by a larger-than-mean (although lately falling) rate of natural increase. The population forecasts recently published for Poland by the Central Statistical Office are very detailed and methodically subtle but clearly rather pessimistic. Their comparison with forecasts published for other countries shows the latter to be much more optimistic. The explanation may lie in the fact that those countries take into account also the immigration from abroad, while the Polish forecast does not. Another reason may consist of the unduly pessimistic assumptions as far as the fall in the fertility and birth indices are concerned. Whatever explanation of these differences, however, one fact seems to remain certain — Poland, as all Europe, will face in the near future (just precisely when it is difficult to predict, but not later than in the middle of the coming, 21st century) a complete stabilization (or even a light fall) in the number of its population. This number may be assumed to be somewhere in the vicinity of 40, at the most of 45 millions of inhabitants. However, closer analysis indicates that it is not the number of the whole population which really matters, far more important is the number of the working or productive part, and its reproduction. This obviously introduces the structural problems as well the issue of proper proportions between people in pre-productive, productive and post-productive classes of age.

It is easy to observe that while the number of people in pre-productive age is decisive for the later size of the people in productive age, the number of people in the post-productive age is the simple function of the longevity or the average length of life. At present it is already comparatively high and, although it will still grow in the coming years, the rate of growth is clearly diminishing and, except for some unforeseeable break-through in medicine, the average age shall be stabilized somewhere about 75 years of age. The very large percentages

of older people may turn out to be a rather relative blessing for the social and economic life of a nation, but the proper size of population in the pre-productive age is crucial not only for the growth but for the very existence of the nation. Hence any rational population policies have to take care that the number of births would not fall below a specific level, which is possible to define as one ensuring the proper reproduction of the productive (or working) population. All these rather abstract statements may be reduced to and expressed in a more practical, operative way by stating that the most important element for a community in its demographic aspects and prospects is the family, its prevailing types and models.

From that point of view the spatial differentiation of population in Poland is very large and the existing disparities are indeed very significant both for the present and the future. This differentiation depends on the past history of individual regions and the recent migratory movements. The consequences of historical regional differences in their economic, cultural and political development are rather difficult to define clearly; moreover they have lost most of their importance because of the great present integration of the Polish society, which is the result of the great economic, social, and cultural upheavals of the war and post-war years. On the other hand, the great migrations of the past form the main basis of the present regional differences in the demographic structure.

Generally speaking, one has to face here three most important migratory phenomena and processes: first — the economic and partly political emigration to foreign countries at the end of the 19th and the beginning of the 20th centuries (caused on the one hand by the population explosion after the abolishment of serfdom and the agrarian reforms of the 19th century, and on the other by the economic and social stagnation and underdevelopment in what used to be Polish lands, the result of their political division at that time between three occupying powers); second — the transfers of populations in the 20th century, caused by the changes in the size and boundaries of the national territory, especially at the end of the Second World War; third — modern industrialization and urbanization, the full, intense growth of which has taken place only after the last war, in connection with the development and in conditions of the socialist planned economy.

The first of these three migratory movements and processes, although it ended practically with the First World War has left significant disparities between various regions of Poland, with large tracts of densely populated agricultural land in the southern, eastern and partly central parts of the country, and areas of much smaller densities in the remaining parts. The density in the former was so large that those areas were considered in the inter-war years to be grossly overpopulated and characterized by the "hidden unemployment" or rather overemployment in agriculture. In result those areas served in the postwar period as the main sources of the new population in the resettlement of the western and northern parts of the country, recovered after the war, and later — in the last thirty years they supplied the largest number of migrants to the urban and industrial agglomerations. In those areas the fragmentation of peasant holdings and the dispersal of agricultural settlements were and are still significantly high.

The second process of the post-war resettlement has diminished the differences, existing earlier in the distribution of the population but it has very largely increased the structural variances. This was caused by the dominance of the younger people among migrants. The differentiation which has developed, created in the northern and western regions areas of very high rates of natural

increase (the high number of births, low — of deaths) characteristics, which tend to regain their intensity (although on a slowly diminishing scale) with every generation (i.e., in every 25-30 years).

The third process, the migrations to industrialized or urbanized zones, both old and traditional or new, reached its peak intensity in the fifties and in spite of a certain slowing down observed nowadays is still going strongly. It leads to strong concentrations of population around the largest industrial and urban centres. The research studies which had been carried out for almost twenty years by A. Jelonek indicate some significant changes in the importance and influence of these migratory waves on the actual distribution and on structural differences of the population by regions. They show that the regional variances created by the first two migratory movements are losing their importance and are slowly fading away.

They are replaced by the third one which is now clearly dominant. From the demographic point of view its influence may be defined as the spreading of industrial civilization and urban culture. But this is neither a simple phenomenon, nor is its structure straightforward. The latest research shows it to be rather complicated. Even migrations themselves do not present a homogeneous picture.

The first approximation, a traditional interpretation, is that the population tends to concentrate in industrial and urban areas (the larger the city, the bigger the concentration) and that the process of polarization into urban and rural ways of life is going on at a steadily increasing rate. A closer analysis, however, shows that this is a very schematic and evidently an oversimplified point of view. First, the line of division between the rural and the urban seems to have changed. It runs now rather between urban agglomerations and larger cities on one side, and the remaining areas with their characteristic local rural-urban settlement complexes on the other.

But even this corrected view is oversimplified. Urban agglomerations with their specific population structure are growing further but their growth is based on the influx of population from the outside. These areas increasing, with migrants, in their size and relative importance have to be counterparted by other areas losing population and relative importance. However, the latter do not fully correspond to the agricultural and rural territories. The outflows are not the same everywhere. To understand this phenomenon it is necessary to study the mechanism of the migrations.

The research carried out in the Institute of Geography of the Polish Academy of Sciences allows one to answer this question, at least partly and provisionally. (Mrs) A. Żurek in her monograph on migrations to cities and towns in the voivodship of Kielce shows that there exist three different types of rural-urban migration: local, regional and inter-regional.

Two main motives figure behind these migrations: the search for work and the search for better living conditions. The third one which is sometimes mentioned, i.e. the reunion of families, although very numerous may be treated as secondary when one considers that people live in families and all migrations of individuals are in reality migrations of families even when the migration of some members of the family are delayed in time. To the search for work (supply) corresponds the search for workers (demand). The first is expressed spatially by the distribution of productive population, the second by the labour market. It is obvious that the urban agglomeration and larger industrial regions represent highly concentrated labour markets — hence their attraction and importance; while the rural, mainly agriculture areas represent very dispersed labour market — hence their small power of attraction. The second motive, i.e.

the search for better living conditions is much more difficult to identify. However, recent sociological studies indicate that such aims (as far as the living conditions are concerned) are very similar among population of various groups, types of settlement, and regions and that only in cities with over 100 thousand inhabitants the available services are general considered as relatively satisfactory. This of course means that, again, urban agglomerations and larger cities have at present an additional power of attraction. Whether, with the raising living standards some other areas, those for instance of more agreeable natural environment, will not become major points of attraction for migrants (although very probable) is still an open question.

There exists, however, at present a very effective constraint for the stronger influx of immigrants to the large cities, namely the lack of available housing. Workers in those areas often have to wait for years before obtaining a satisfactory place to live. In the result rural-urban migrations take a distinctly different form depending whether they are to be directed to smaller towns or to larger cities.

It may be said that the influx into smaller towns is similar to the traditional model, i.e., the surplus of younger and more active groups of population in search of non-agricultural employment move into those towns. The drainage area of such towns is comparatively large but the number of migrants is not very high. The spatial network of drainage areas develops according to patterns of central place theory with some hierarchical elements (drainage areas of towns of higher order superimposed on places of the lower one).

With larger cities the patterns are composed of: central areas with very high influx from comparatively narrow neighbourhood (these are immigrants which had so far been already working in and commuting to the central area, who after receiving a proper dwelling move there permanently), and a surrounding ring of rural areas and adjacent smaller towns into which migrants move from a more distant outer ring (or drainage area) mainly in order to commute to the central area.

It is characteristic for the present situation that with very few and rare exceptions, the influx to the surrounding, inner ring is greater (although dispersed over much larger surface) than the influx to the central area. Thus we face here two or even three-stage migrations, often within the life-span of one generation, of one individual. The question whether this type of rural-urban migration is stabilized and lasting (permanent), or whether when the deficit of housing is liquidated it will not first diminish and then disappear — remains open. There may easily develop another additional stage of these migrations, characteristic of large urban agglomerations, in form of a migration from the central areas to the inner suburban ring in search of better living conditions. This last stage may be also connected with the construction of satellite (and at the worst dormitory) towns and cities.

The first, traditional type of rural-urban migration is essentially local and only rarely regional in scale; the second, at present prevailing (in the number of migrants) is by the size of larger cities (urban agglomerations) and of the drainage areas regional. There still exists another type of rural-urban migrations on a national level, inter-regional in scale. It concerns only the largest agglomerations, whose deficit of manpower is so large that they have to draw migrants from the most distant regions with the phenomenon of intervening opportunity influencing strongly the spatial patterns. This type of migration was observed so far only in the case of the Upper Silesian Mining and Industrial Region. Some traces were also evident in the case of Warsaw, the political and cultural capital of the whole country, as well as in some of the new

mining and industrial districts. However, from the point of view of interregional migrations, the most important ones now and in the future are urban-urban migrations and, among them, those between urban agglomerations and those from smaller towns to larger cities. The first are reflecting adjustments in the distribution of qualified personnel, the second are caused by better possibilities for employment existing in form of alternate places of work in larger cities, and by better conditions of living there, especially as far as the services of higher order are concerned. The future of the migrations from smaller towns into larger cities is not very clear. There are two opposite tendencies in their character and direction. On the one hand, with growing standards of living the services now available only in the largest cities may be present also in the smaller ones and, at the same time, the growing concentration of population may easily lead to the deterioration of the quality of environment and of living conditions; however, on the other hand, with technological progress and in the essentially polycentric structure of the network of urban agglomerations in Poland their attractiveness may not diminish but grow even stronger in time.

In the discussion of the interregional migratory problems in present-day Poland one type of migration has to be also taken into account. The Poles possess, generally speaking, a very strong sense and even love of the locality and region within which they were born and have grown up. In the result the phenomenon of return-migrations does develop quite often; indeed, whenever new possibilities of non-agricultural employment are created or the conditions of living improve significantly in the regions from which the migrants originally came. This phenomenon develops naturally only among the migrants of the first generation, who had actually moved from one region to another. The return migration may also occur at the retirement age of migrants.

In assessing the spatial patterns of migration it is necessary to take into account the differentiation which exists in spatial patterns of labour markets for men and women. Such differentiation is a direct result of the dominance of men or women in various professions and employment groups. In particular, men form a strong majority among miners, in heavy industries and in building and construction industries; women are employed mainly in light industries and in services. Moreover, there is a general prevalence of women in the field of education, especially in humanities. The spatial consequence of this division is that there is a larger than average (accounting to about 106 women per 100 men) percentage of women in the central areas of cities (sometimes even up to 130 women per 100 men) with a close positive correlation between the size of the city and the percentage of women. On the other hand in areas of greater influx of industrial workers, in particular in new mining and industrial districts, as well as in the suburban areas of quickly growing agglomerations the number of men is even higher than that of women.

Such differences in the distribution of male and female population have their consequences for the development of family life and the rates of natural growth. In eastern regions with very low quality housing in rural areas the rates of natural growth are significantly (even 50%) higher in cities than in the surrounding communes.

The greater influx of women to urban agglomerations has its correlate in their outflows from rural, especially from backward areas and is marked by a negative influence on families and on natural growth. The fall of the birth-rate in some rural areas is very quick and in fact there are already some areas where the indices do not show a marked difference from those of large cities or urban agglomerations.

Therefore with the steady growth of urban agglomerations specific social

support for young families seems to be necessary if even the simple reproduction of population is to be achieved. Incidentally, this may involve changes in housing policies and even efforts to diminish the rates and the tempo of migrations from rural to urban areas, steering them away from the largest concentrations.

Thus the next issue which must obviously be considered and scrutinized in this context is the settlement system and its problems. It should remember that it has been assumed for the purpose of the whole analysis that in present-day Poland there are three main forms of settlement, three specific settlement subsystems; first — of urban agglomerations, second — of regional and sub-regional centers (some of which will certainly grow into urban agglomerations), and third — of local rural-urban complexes. These were recently been accepted as the basis of the administrative territorial division of the whole country into the smallest units, grouping all agricultural settlements around the largest one (mostly in form of a small town) in which all basic services, especially of the higher level are to be concentrated. The assumed hypothetical existence of such subsystems is supported so far by the obtained results of research.

The first two subsystems are at present growing — whilst the second, the regional centers, and a part of the first, representing smaller and younger urban agglomerations are developing at a much higher rate than the largest agglomerations. This phenomenon typical not only of Poland but also of other more developed countries, is used in the national plan of physical development till 1990 for strengthening of the polycentric, moderately concentrated structure of settlement system at the regional level.

The research into structures of the local settlement complexes indicates the existence of large regional variations. No model can serve all cases, in fact the opinion prevails now that the policies pertaining to that topic should vary regionally. The question to be solved in such policies is the optimal degree of concentration of services on one side, and of dwellings on the other, depending on the conditions of natural environment (and needs for its conservation), on the value of the settlement pattern as developed historically, on the fixed assets represented by the existing buildings and transport lines and other elements.

The number of agglomerations developed, developing and potential (regional centers which can and are foreseen for significant development) is such that the whole country may be considered in future as a set of urban regions, each with an agglomeration in its centre. Generally, there may be cases when larger agglomerations may in their growth cover the whole of such urban region — then the region and the agglomeration will become identical. There may even be cases when the agglomeration will overflow the boundaries of its region. Such cases will be treated furthermore. But for a long time to come in the majority of regions there will be some differentiation between the areas of the agglomeration and of the region. It may be interpreted in terms of migration rings — the central area with a suburban ring forming the agglomeration proper; the outer ring, the migratory drainage zone forming the remaining part of the region. From the social point of view it is very important that every settlement or community in this outer zone should have an easy access to the services of the higher level located in the agglomeration, mostly in its central area — the main city. There is another possibility of a new pattern to emerge, which would involve a discontinuous and dispersed structure of an agglomeration with elements of all three zones (central, suburban and remaining) fragmented and intermingled. Such a pattern is highly probable (perhaps it is already existing) but it will involve the need for very careful and stringent planning.

All these three basic forms of settlement are heavily involved in problems

of migration and natural increase. The local settlement complexes possessing the highest rates of natural increase are considered as generating flows of migrants. Higher wages, urban culture and better living conditions have been the economic and social factors supporting such flows so far. But such a characterization of the situation has to be at least qualified. The increased emigration of younger people, in particular of women has led in the last years to a significant fall in rates of natural increase. An additional factor which may impede further emigration is the socialization of agriculture (transforming farmers into wage earners with limited hours of work), the improvement in living conditions and services in the rural areas, and the spread of the urban way of life there through the easily accessible information mass media. So in the future only there where the emigration did not distort the age structure patterns the rural areas will be able to supply migrants to other urban areas larger and more distant than local service centers — i.e. small towns. These are located mainly in the northern half of the country. The regional growth centers if they are to grow will have to use to a greater extent and at a faster rate population surpluses from rural areas and smaller towns within their own regions. For the next twenty or thirty years perhaps there are still sufficient reserves for such migrations. The positive factor in their case is that they are still able to ensure the simple reproduction of their present population.

The large urban agglomerations are in the worst position. Even the keeping of their population at the present level involves immigration. Their growth has been and is completely dependent on the influx from other areas. The size of their needs makes the interregional migrations necessary. From that point of view the northern part of country is in a better position. The involved migrations will have to cover shorter distances, without more serious intervening opportunities. The urban environment of these regions is both healthier and with amenities higher in quality. The surrounding regions possess at present the highest indices of natural increase and birth rate, and all available information suggests that the relative proportions between these regions and other parts of the country as far as the birth rates are concerned will remain unchanged.

In the result of our present knowledge based on recent research and analyses one conclusion is therefore unavoidable. To preserve and to ensure even a moderate growth of the population rate in urban agglomerations, without at the same time endangering the population equilibrium of the whole nation and of other settlement subsystems, the significant change of family models and of resulting indices of the natural increase of population in those agglomerations are necessary. This involves also the need for specific policies concerning population, housing and services. In addition, it should be stressed very strongly that such national policies should be regionally adjusted and diversified.

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SPATIAL STRUCTURE OF SMALL AND MIDDLE-SIZE TOWNS

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Following the progress of urbanization in Poland it is necessary to pay attention not only to big urban agglomerations but also to small and middle-size towns. As a result of the forecasted belt-nodal settlement pattern development, a part of these towns will be within the settlement belts pattern or in their close neighbourhood, thus, within the range of economic and social developments taking place there. The other part develop in the interstitial areas, mainly in agricultural regions, to serve as links providing all kinds of services for the population of the surrounding rural areas.

The origins of a great majority of small towns go back to the Middle Ages or Renaissance periods, and their plans have the specific features of historic towns. Many of them are very valuable cultural monuments owing to their old architecture. The war caused disaster in small towns too, and the first period of spontaneous reconstruction in the first post-war years resulted in the spoiling of many fine architectural monuments by not planned, chaotic and of poor style building. To counteract this, generalized plans for the spatial development of towns were worked out, making it possible to show the directions of development of these towns and to protect the town planning values and historic monuments. In the years 1947-1948, "generalized" plans were mainly drawn for the towns situated in the western and northern voivodships, i.e., the territories Poland regained after the Second World War. In later years in the normal course of work on the plans for the spatial development of all towns, also small towns have been encompassed by this work. The method of drawing general plans worked out to be applied in big cities, and not adapted to the specific needs of small towns, has not brought the expected results and has not stimulated rational re-development and reconstruction of a proper spatial structure. In the absence of detailed plans on which every existing building and every building which is to be erected form the planned vision of the town, hasty decisions have been issued on the location of housing projects, services and industrial plants. In later years, as a result of economic growth, big city-type blocks of flats began to appear in small towns. They were either typified projects erected in all the towns of the respective voivodship or the whole country, or else buildings assembled from large pre-cast elements, also designed for large housing estates in big cities. Alongside those blocks of flats typical trade and service units were built. These projects have often been complete "strangers" in small towns, and they occupied areas which, according to the requirements of the spatial structure of those towns, should serve different aims, or should allow the creation of a different architectural forms.

Following those shortcomings in building investments viewed against the background of crystallized but outdated methods of compiling development

plans, attention was drawn in the Research Problem of Physical Development of Poland to the study of the spatial structure of small and middle-size towns, with the aim of working out patterns or model designs for basic categories of small towns.

So the objective of the present study is to find out the premises for a concrete design which would be followed in the redevelopment of the spatial structure of small towns in the years 1980-1985 and in later years. So the present study is of practical nature. It leaves aside involved theoretical deliberations and approaches, while treating the elements and the area which form the structure of the town, as urban tissue.

As the theory of urban spatial structure, with its numerous analogies taken from the domain of other than social sciences, is not suitable for the making of model spatial patterns, the method applied in this study consists of approximate evaluation of spatial elements alone, which are easily read on the plans of towns or on air photographs. Resorting to statistical methods or very detailed inventories of technical resources and social phenomena was considered to be of limited use in current town planning, particularly in view of the great possibilities of planned spatial economy created by the social system in Poland.

The studies carried out in the years 1971-1973, encompassed the majority of small towns in the Poznań, Kielce, Białystok and Lublin voivodships, and a number of small towns in other voivodships, selected at random to serve as a sample. The investigation has confirmed the results of earlier studies on the structure of small towns, carried out since the year 1940, viz., the markedly typical character of certain features of the plan, occurring either independently, or — with certain modifications — dependently on the local features of

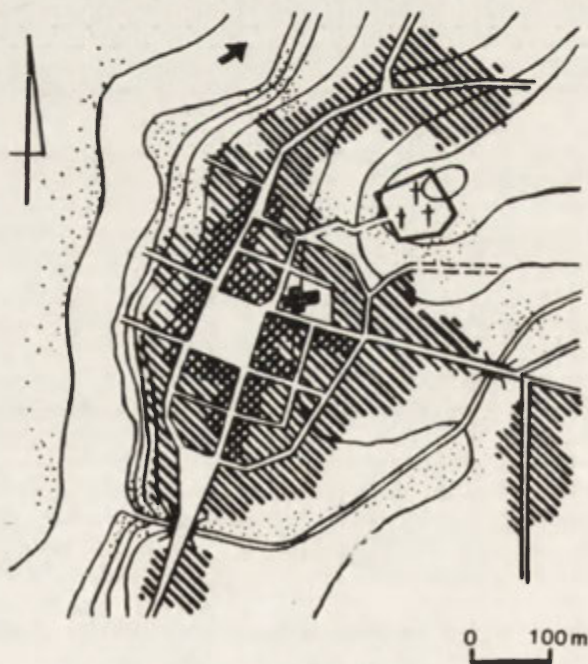


Fig. 1. Plan of a small town in Poland, showing the characteristic features of the plan and spatial structure

the respective regions, resulting from their economic structure or specific topography.

The typical features include a number of repeated elements crystallizing the urban structure and the plans of towns. They include the patterns of market squares which decide on typical building round these squares, and the main streets along which commercial and social services have been located (Fig. 1).

The crystallizing elements make it that the plan is easy to read and they clearly depict the spatial development pattern, contributing to a consistent implementation of the spatial structure of the town.

The investigations of the presence of crystallizing elements in urban structure were conducted on the example of a group of towns in Poznań voivodship, because the small towns there have well-developed (or "mature") urban forms. In these towns it was often recorded that the development of the town was planned — for different reasons — in the form of designing a "new", or second market square, thus introducing new crystallizing elements in the urban structure. These new crystallizing elements had an effect on the adjacent area, and, just as the original elements, they determined the planned development of urban area. Beyond the zone of influence of the crystallizing elements non-planned development was occurring. The question arose whether it was possible to use the positive influence of crystallizing elements in modern plans for spatial development. In a separate study the present development plans were examined, also for Poznań voivodship, and it was discovered that such elements almost did not exist in the new plans, and even the evident advantages of the old crystallizing elements were neglected in a way that did not make the drawing of a new plan easier. The studies carried out on the towns of Poznań voivodship suggest the need to revise the development plans and to examine the possibility of introducing new crystallizing elements, using their field of gravity for the acceleration of the rate of development of the town.

Other typical features of the spatial structure of small towns include the division into several clearly determined structural zones. They are: the central zone, the intermediate zone, the external zone, and the outer zone, which may also be called the "landscape" zone.

Even a quick look on the division into the mentioned zones, on the example of a few towns, and a comparison between the actual structure and the binding plans for spatial development reveal contradictions that must make the implementation of the plan difficult and make it necessary to depart from planned provisions, with adverse effects on the spatial structure. In addition, the departure from the provisions of the plan leads to the disregarding of its principles and the issuing of hasty decisions by municipal and *powiat* authorities. In this situation it is necessary to carry out a thorough analysis of the specific features of each zone in order of determining technically and spatially logical possibilities of their transformation and redevelopment, so that each zone has its share in the modern functional and social needs of the town.

The central zone, situated round the market square, in the smallest towns usually does not extend farther than the network of alleys separating the blocks round the market square from the rest of the town. If this zone is to perform its traditional role in the changed conditions imposed by modern trade and handicrafts, a detailed analysis is to be made of its technical equipment, including single elements. The investigation carried out in several towns gives ground to suppose that it will be possible to isolate a number of basic structural types characteristic of central zones, making it possible to apply similar or identical methods, while taking into consideration forecasts concerning the development of the town. The central zone is most often the conservation zone, i.e.,

any investment project in this zone must be approved by the district conservator. The structure of this zone often imparts specific features to the townscape, determining the individual spatial character of the town (Fig. 2).

In bigger towns this zone extends a little farther, but it is always easy to demarcate its boundaries. They are nearly always clearly visible as a result of the different density of building, compact on the one side and scattered on the other.

The possibility was examined of delimiting the zones on the basis of measurements of the percentage of built-up area, the number of buildings per square unit of the area, or the number of buildings in a single block, but these methods do not seem to be useful, because the results of similar methods applied in sociological and economic investigations do not provide a picture necessary

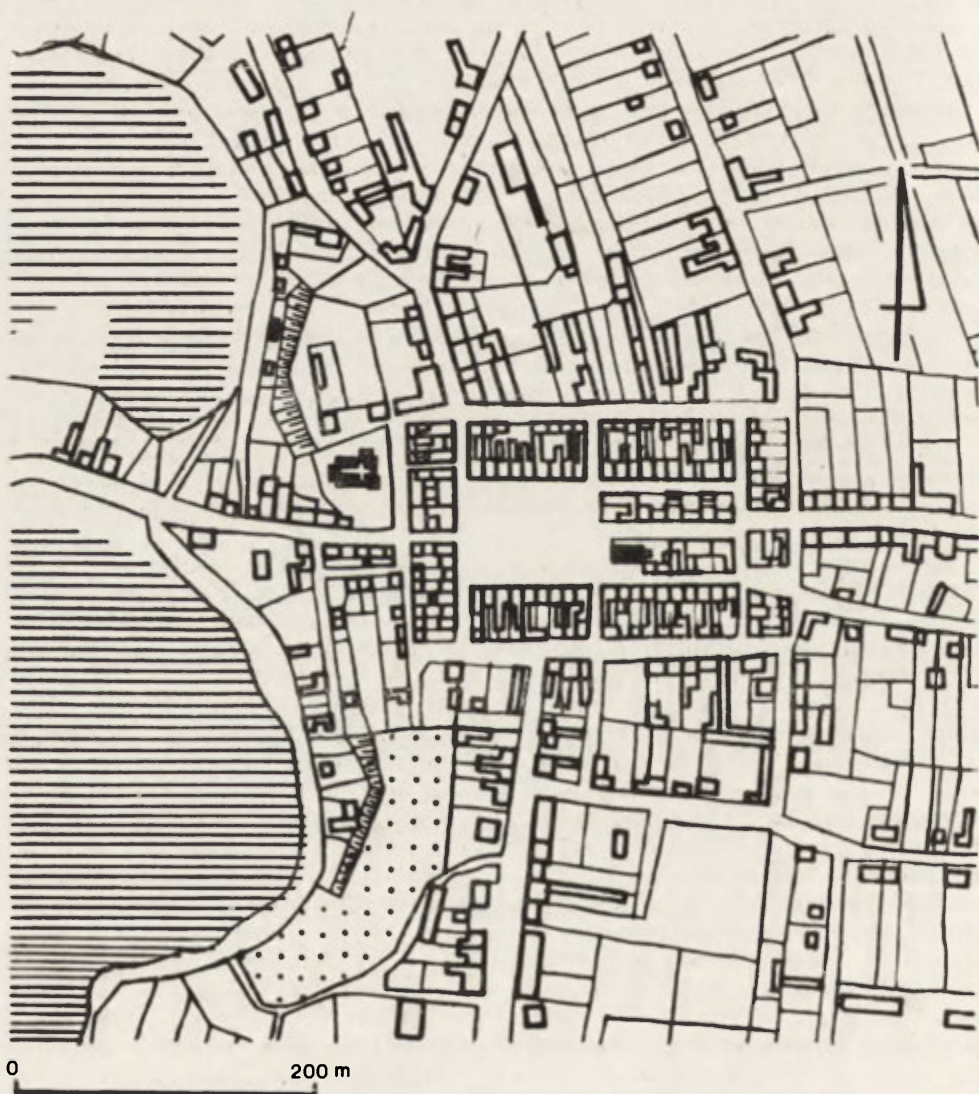


Fig. 2. Example of clearly separated central zone in the spatial structure of a town

in town planning. In addition, there is always a gap in time between the moment of carrying out the investigation and of making the plan or starting investment projects. During that lapse of time the building substance can be re-



Fig. 3. Characteristic style of intermediate and external zones found in the majority of small towns

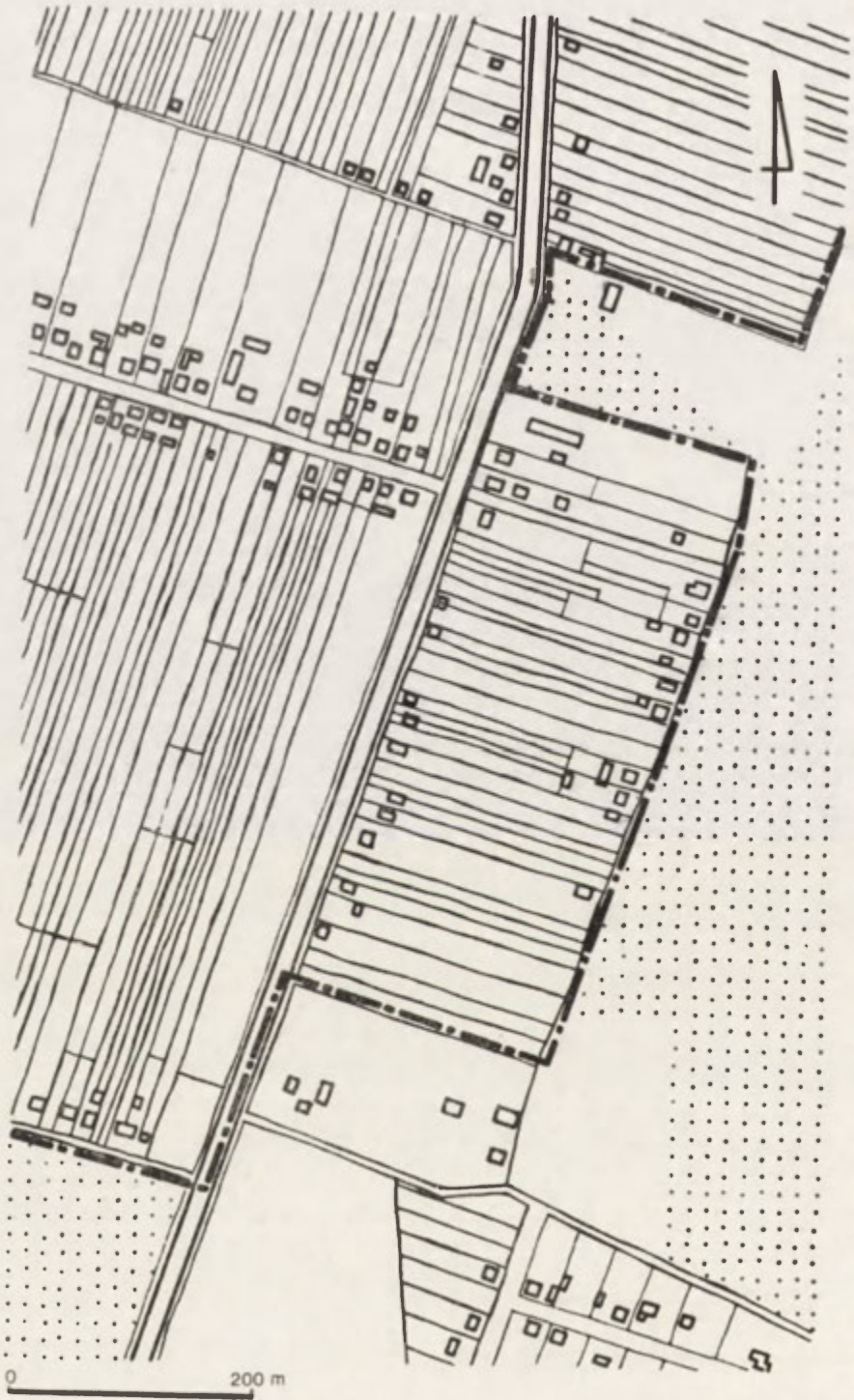


Fig. 4. Examples of road and highway ribbons in the external zone. The dotted line marks the external boundary of developed areas

duced or increased, and the limits of the zone can be changed. Assuming that there can be errors in the estimates made on the ground of plan reading, one must emphasize that a precise demarcation of the theoretical boundaries of the zones is of no avail for a detailed plan for spatial development because — as proved by practical experience — many housing and services projects do not respect this boundary wherever it does not run along well-developed streets.

Scattered building is the characteristic feature of the *intermediate zone*. Apart from typical town buildings, a large percentage of rural and farm buildings are to be found there, particularly in the eastern regions of the country. During the past 25 years many service units have been built in that zone: schools, hospitals, office buildings and small industrial plants have been built in the open space. This zone presents particular difficulties to redevelopment or making a certain order in town plans, because of diversified urban tissue, representing a wide range of functions, thus also different needs for easy access and transport facilities. All this, combined with the lack of the crystallizing elements of urban structure, are the characteristic features of this zone.

It was very difficult to delineate the external boundary of this zone, mostly because it usually does not run along the streets separating the different types of buildings and land use. It is usually concentric in relation to the town centre, and runs through town blocks with poorly-defined patterns (Fig. 3).

Additional difficulties in delimitation procedures result from the fact that compact building extends along highways and rural roads. Applying the same criteria and tolerance in this case as those adopted to demarcate the boundaries of the central zone, one had to approach the problem of highway ribbons as a separate and important subject of study. The collected town planning material has confirmed the immense danger of overlooking this problem in the spatial development plans. The highway ribbons come into existence spontaneously, in many different variants resulting from the pattern of agricultural land and the division of plots. The advancing division and fragmentation of land, being the effect of inheritance and other factors, results in further division of lots and the formation of built-up ribbons (Fig. 4). These patterns usually reveal symptoms of "spatial pathology": the architecture is accidental, with many blind walls and unexpected roofs. "Spatial pathology" gives birth to technical problems: it makes difficult the rational planning of transport facilities, of utility lines, and rational lay-out of open space. The earlier plans for spatial developments suggested the inclusion of areas with such specific type of development in the intermediate zone in the programme of intense building investments, which suggested that typical five-storey blocks of flats were to be erected in these places. There is an evident contradiction between the actual situation and the mentioned provisions of the plan. The study of ribbon patterns included the following aspects: the defining of the types of built-up areas and of the factors of their development, including social, economic, technical and legal factors. As a result of the study it will be possible to lay out the guiding lines of planned building developments, and perhaps also to inhibit the present spontaneous and harmful process.

The analysis of the intermediate zone has drawn the attention to the fact that a new type of buildings, viz., to city-type blocks of flats, usually five-storey buildings, have appeared in the urban tissue not only of that zone, but all over the small town. Such blocks of flats have been built in many towns, either according to the development plans, or against the provisions of such plans, on the ground of temporary decisions. Some of them have emerged close to the border of the conservation zone, directly neighbouring on historical areas, and destroying the original spatial proportions. They have also appeared in the

very central zone, and in the marginal zone; they invade the historical areas or the suburban landscape, adding new, aggressive features to the previous townscape (e.g. Figs. 5 and 6).

As they are usually erected according to typical designs, they are uniformly oriented in respect to compass directions, consequently, they are often built not at the right angle to the earlier built rows of houses and to the streets.

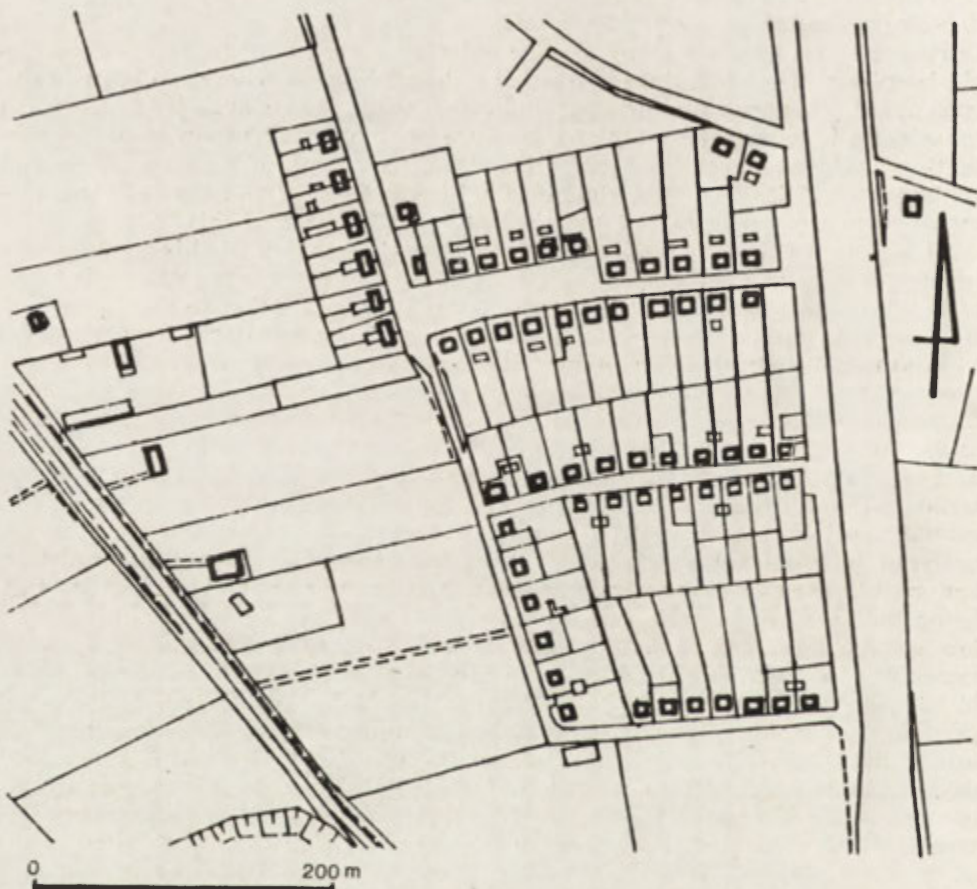


Fig. 5. "Colony"-type development of the external zone

It often happens that new developments form a housing estate, paying no attention to the existing functional values and convenient network of streets, disregarding the proximity of such historical monuments as an old town hall or a cathedral, renovated with great care. The data collected in this respect encompassed many towns in different voivodships. The choice of the towns was, on the one hand, the result of the possibility of obtaining the necessary data, and, on the other hand, it was based on information about the most glaring examples of violation of spatial structure. This way a picture of the average situation was obtained and the most alarming cases were also recorded. Apart from this, taking advantage of the investigation of the respective areas, examples of positive developments were collected, in which the new building was



Fig. 6. New five-storey blocks of flats erected directly on the border of conservation zone, i.e., the historical area of the town. The thick line marks the external boundary of the historical area

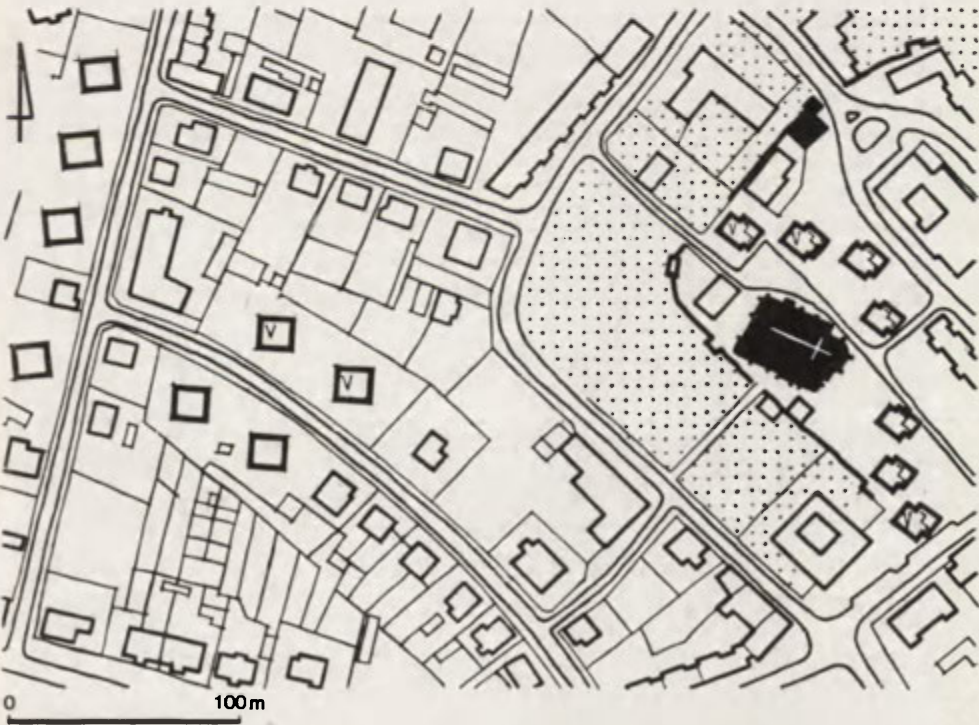


Fig. 7. Typical “tall buildings” (five-storey buildings) in a Mediaeval town, near to the historical area

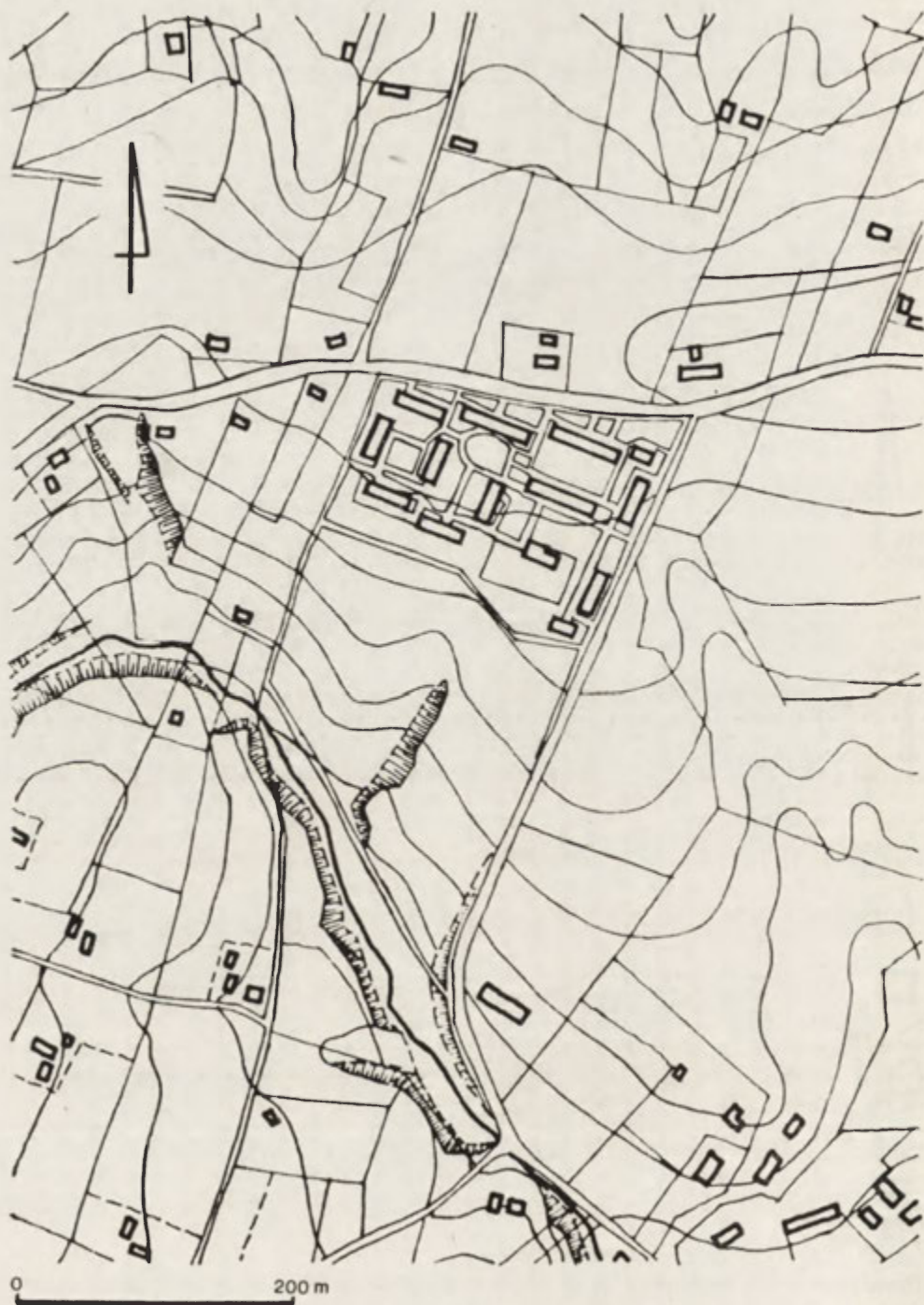


Fig. 8. A group of new blocks of flats, the housing estate situated in the external zone, far from the town service centres

adapted to the scale of the town, enriched its spatial structure and organized its modern functions in a harmoniously formed space.

The external zone, considerably differing in scope, depending on the size of the town and the topographic features which can stimulate scattered building development, is characterized by the presence of farm buildings, groups of barns, or even whole streets with rows of barns, and by sporadic presence of industrial buildings, storehouses, and buildings used by agricultural service establishments, sometimes also services which have been transferred to towns because of accessibility considerations.

For the above reasons there is no purpose in drawing a precise line marking the border of the external zone. Nevertheless it can be assumed that the line running through the most distant buildings or even a little farther, can serve as a borderline. If it is farther than the buildings, it encompasses courtyards, house gardens and so forth. In the examined plans the borderlines fixed according to the above principles were further amended by including areas divided into typical urban lots in the external zone. Owing to this, further discussion on planning will encompass less disintegrated areas, better suited to form an organized system of building which should be created in small towns.

Out of the problems related to this zone, that of the location of industrial and storage areas was studied separately. Despite the difficulties resulting from the regulations about the limited-circulation character of planning documents, it was possible to reduce certain plans to generalized schemes. The analysis of a great number of such schemes has demonstrated that the distribution of the mentioned areas was accidental, and their choice did not depend as much as could be expected on the vicinity of railway sidelines or road transport facilities.

Industrial buildings very rarely add positive features to the spatial structure of towns. The analysis has revealed many possibilities of improving accessibility reduced by incorrect location and inadequate distribution of street traffic. Problems of inter-city transportation were also studied, first of all the effect of the location of the railway stations and inter-city bus stations. Such stations can become the crystallizing elements in the present structure of small and medium-size towns. A number of typical spatial links between the town and the railway stations were identified. The most characteristic patterns are: a railway station situated far from the town, sometimes as far as five kilometres, and connected with the town by the "railway station street" which reveals a trend to be transformed into the main street; the railway station in the town, in its intermediate zone, tending to form a "monumental" pattern at the scale of the town, but, as a rule, a one-sided pattern, separating the area beyond the railway tracks and the station from the urban centre; the railway station situated in the outskirts of the town, almost on the border of the external zone, but still within reasonable limits of pedestrian traffic from the central zone. A review of the development plans has proved that the crystallizing possibilities of railway stations have not been taken into consideration.

The same is true with regard to the stations and stops of the inter-city bus network, which is particularly important in small towns, situated far from railway lines. The stops can be found in each one of the three zones, with little regularity. This is due, among other things, to the still insufficient modernization of the inter-city transportation and the fact that stops or stations are located in places which can easily be used for this purpose, because of ownership considerations or the possibility of demolishing the pre-existing buildings. It should be expected that in the model patterns these bus stations will become

a crystallizing element in urban structure, particularly with reference to pedestrian traffic.

The studies of the "*landscape*" *zone* surrounding the town also included the analysis of land use, of the scattered housing development and of the road network. No final conclusions have been drawn so far in view of the great variety of the types of areas surrounding the town and the need to examine the problem against the background of the forecasts of development and the structure of agriculture.

One of the working hypotheses that can be adopted suggests that the town can be surrounded by rural areas producing in large-scale units, farm goods for the urban population. In such production system people working on these farms could live in the town and make use of all services and cultural facilities offered to the town inhabitants.

The study of only a few plans for spatial development sufficed to put forward the postulate of giving due consideration to the problems of landscape, either as protection of natural environment, or as directives for the organization of recreational areas.

The total of the research carried out so far has provided material for general conclusions, viz., the differentiation of several types of the elements of spatial structure forming an urban pattern. On the ground of the analysis of the types of these elements, the next stage of the work has been started, i.e., the investigation of the possibilities of rational redevelopment and modernization of urban space. The material for study will include, among other things, the work carried out by college students under the guidance of research workers who have been involved in the study on the spatial structure of small and middle-size towns.

Another line of the study now being carried out deals with the problem of settlement belts patterns, small towns being possibly encompassed by these belts, and the problem of settlement patterns which could replace a number of small towns. Material about the theory of belt patterns has been collected from all over the world and theoretical proposals have been submitted concerning the solution of this problem in Poland.

The next stage of the work will consist in the drawing of a tentative design of a settlement belt pattern. This work will come very close to the study on the development and the formation of large urban agglomerations.

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THE GROWTH LIMITS OF URBAN-INDUSTRIAL AGGLOMERATIONS IN SPATIAL DEVELOPMENT AT THE NATIONAL LEVEL

STANISŁAW LESZCZYCKI

1. DETERMINATION OF THE NUMBER OF POPULATION IN A LONG-TERM PERSPECTIVE

The determination of the number of inhabitants for urban agglomerations in long-term plans is a difficult problem. The attempts carried out so far have not given positive results. It is possible to predict the number of population for the whole country on the basis of demographic structure of the population and such forecasts can be relatively accurate, especially if drawn for a short period of time, because they result mainly from the women's fertility factor and from demographic structure of the living population. Therefore, despite different assumptions and estimations of the state of departure, the biological prognosis is accurate enough to form a significant element on which can be based the planning of socio-economic development of the country, adjusted to the age and sex of the population. In the case of Poland biological prognoses can also be drawn for particular voivodships.

However, the development of the country is differentiated territorially, there are incessant inner migrations which shift large numbers of the population from one place to another. Among the migrations, those from rural to urban areas, as well as from small towns to large cities, are most characteristic, and this process does not seem to be a temporary one.

Especially large are the inflows of population into the urban-industrial agglomerations. This is shown by the increase of population in the 16 selected agglomerations. In the years 1960-1970 this increase was of 1,836 thousand people, which equalled 65.3% of the country total growth. Such a rapid increase of population means that new great investments are necessary, especially in the field of municipal economy which has an essential influence on the living conditions in large agglomerations of population, production and services. That is why the determination of the number of population for particular agglomerations is of great importance. The biological prognoses are insufficient in this case; it is necessary to prepare post-migrational prognoses, based on the number of anticipated work-places, family structure, percentage of employed women, and the like. Post-migrational prognoses are much more difficult to elaborate and the obtained results are much less exact. Nevertheless, prognoses of this kind are, as already mentioned, indispensable for urban planning; it must be known how many people will inhabit a certain settlement unit in order to adjust to it the spatial structure, the development of municipal facilities, housing construction, etc. Most frequently these numbers for the twenty-year plans are determined not on the basis of performed studies, but of arbitrarily and

frequently voluntarily-made decisions which, as a rule, reflect socio-economic concepts characteristic of the given period of time (e.g., limiting the size of cities within administrative boundaries, curbing the growth of urban agglomerations, etc.). When reviewing the plans worked out during the last 20 years we encounter various numbers which mostly show constant growth of the planned, target size of population.

Thus it is clearly seen that the number of inhabitants will constantly increase in time. This implies a similar constant growth of population in particular agglomerations. In order to adjust the plans of spatial development to the increasing number of inhabitants, certain growth thresholds are assumed, which, if overstepped, will make impossible the improvement of the living standard of the population. This gives positive results for middle-term periods, e.g., for 5-year plans. At the end of these periods very often difficulties and disproportions appear, the plans of population growth are not realized adequately to initial assumptions, and the number of population largely exceeds the planned size. In effect of all this some bottlenecks appear, so that in the approaching 5-year plans it is necessary to increase the number of population again (cf. for instance the experiences of planning in the Upper-Silesian Industrial District). This results from a general tendency according to which the number of people demanded in production and services constantly increases. To this must be added professionally non-active population and temporary inhabitants of the given agglomeration. Therefore the determination of concrete numbers for an agglomeration in long-term plans cannot be strict and binding, but only approximate.

• This problem is especially difficult for those agglomerations which owing to the development of internal and external transport network rapidly expand territorially beyond their administrative boundaries. Therefore the assumed numbers should not be only given as falling within certain classes but it should be stated from the very beginning that the number of inhabitants of an agglomeration is changeable with a tendency to constant increase, and so it can be determined successfully only for short periods of time, e.g. for five years.

In long-term plans, i.e., for the periods of 20–30 years large increases of the population of the given agglomeration should be assumed. If there exist any essential premisses that would justify certain alternative values of the number of population, they should be taken into account in these plans. Larger numbers should be assumed in order to preserve the areas that will be necessary for a proper development of the agglomeration in the future.

The forms of development of an agglomeration can be different, but one should avoid investments adjusted to too small a number of the population. Improperly planned agglomerations can be changed in the future only by their rebuilding (e.g. in the centre) and building the new ones, calculated for a much larger number of inhabitants. For this purpose the so-called threshold theory developed by B. Malisz can well be used.

This line of thinking is not contradictory to the proposals included in the Central Planning Commission long-term plan of spatial development, 1990. This plan predicts that during 20 years the population in the agglomerations will increase by 25–36%. Out of this the already developed agglomerations will grow by 24–33%, the developing agglomerations by 25–44%, and the planned ones — by 42–73%.

On the basis of the above we can conclude that long-term spatial plans should be adjusted to a much larger number of population, than that resulting from the assumed rate of socio-economic development. At the same time rates of growth should be determined for five-year periods (e.g., for 1976–1980), and

the means for the development of the agglomeration should be adjusted to meet the needs of population who so far failed a lack of proper municipal facilities. This should also be accomplished by the expansion, of production and services functions, that condition the planned inflow of new population. In the first place it is important to meet the demands for manpower.

On the other hand, it is very dangerous to treat too strictly the numbers of the future population in particular agglomerations (as provided in long-term plans), and to pass them over to the organs of regional and local planning. These organs will treat the numbers as binding and will adjust to them the city plans and investments. There are many examples of stepwise development of towns and settlements. For instance, in Slynchev Bryag in Bulgaria the plan in 1957 forecasted the building of hotels for 600 beds, in 1959 this number was raised up to 2,000, and at present the recreational capacity of this seaside resort is over 20,000 beds. Naturally, each change of the previously determined number of beds had to be accompanied by changes in city development plans and in the development of municipal economy. All this was done in a relatively short time. As another example can serve the planned Central Canal in Poland, the object of many discussions. Not deciding about the date of its beginning one should remember, however, to preserve lands for its future course so as to avoid possible conflicts with earlier investments. In other words, more emphasis should be put on anticipating changes in land use during long-term periods in order to facilitate the implementation of succeeding 5-year plans.

2. INTEGRATED PLANNING IN SPACE

In view of planned economy the concept of integrated planning can be put forward supplementing the concepts of local, regional and national planning, all of which in a characteristic way overlap each other. By integrated planning we understand the planning of the whole country in a systematic way but at the same time, in a way differentiated as to the degree of detail, and adjusted to the needs resulting from the development of particular regions and their parts. After elaboration of the national plan which presents in a general way the concept of spatial development of the country, the planners' attention should be turned toward detailed (i.e. urban spatial) plans for areas representing the most important nodes of socio-economic life.

My opinion is that the more differentiated or even conflicting are individual and social interests of the population on a given territory, the stronger is the necessity for spatial planning. In other words, not every area, say, poorly invested, must have the detailed plan of spatial development. It is worthwhile to elaborate detailed plans only for the areas well invested on which as a result of a great variety of functions considerable pressures have appeared. Furthermore, this means that not the whole Poland must have detailed spatial plans. For most parts of the country the general or regional plans will suffice. The detailed spatial plans should cover more and more heavily invested areas, beginning with the urban-industrial agglomeration centres. It can easily be seen that these urban-industrial agglomerations, in the course of their development cover larger and larger areas, thus resulting in a constant expansion of hinterland areas which are connected with the centre of agglomeration.

The agglomerations expand in varied ways, most often however along the lines of technical infrastructure. The process of intensive economic development proceeds outward, either in a continuous way or stepwise, nevertheless

each strongly invested area remains in functional relations with the agglomeration centre, as well as, frequently, with its other areas.

The rate of expansion of economic development is decided by the plan of socio-economic development, and the process is organized in space by internal and external transport network. The more efficient it is, the easier large areas can be linked with the centre. The trends of development and of expansion depend on a number of various factors, therefore each agglomeration should develop in a different way, making suitable use of all favourable conditions. Thus the settlements formed can be satellite, linear, clustered, dispersed, and other. The inventiveness of urban planners should not be limited in this respect. The same applies to the aesthetics of the development of the landscape created by man. Th heavily invested areas should be interwoven with less invested ones, compact build up areas should mix with settlements of a more loose layout, high buildings with low ones, one-family houses with multi-family dwellings.

It must be foreseen that after the period when the most important needs of the population (such as each family in its own flat, and each person in a separate room), are quantitatively met in the next period attention should be drawn towards the qualitative satisfaction of diversified preferences of the population, giving wide possibilities as to the choice of job, place of living and style of life. In this way the agglomerations will expand in accordance with spatial plans and their margin will be determined by transport — comfortable journey to the centre, not longer than, say, one hour.

In the course of development of the agglomerations spatial plan should cover successively areas more and more distant from the centre, irrespectively of whether these are industrial districts, service centres, housing estates, public transport centres, agricultural or recreational areas, forests and woodlands, inland water areas, etc. This way of spatial planning is called integrated planning and I see in it the most proper way for stage implementation of the plans.

The whole developing agglomeration should be governed by the central administrative unit, representing spatial organization of its socio-economic life. In other words, the area of an agglomeration should consist of many various parts whose different functions would be revealed in landscape and land use. Moreover, all settlements, irrespectively of their size, character, or the functions performed, should develop in connection with the centre.

No inhabitant of the agglomeration, no matter where he lives, should feel discriminated, especially as regard the choice of the style of life, employment and place of living. This contribute to the development of small towns and villages by way of their integration with large centres. This would remove the situation when inhabitants of small towns can frequently complain of isolation and discrimination in comparison with those living in large urban centres. This applies even to a higher extent to rural areas. Therefore urbanization processes of rural areas situated close to urban agglomerations are so important. Certainly, this process will shorten the supply of manpower in agriculture. This problem must be solved in another way, but it is beyond the scope of the present paper.

3. CONTINUOUS PLANNING IN TIME

There is nothing new in saying that spatial planning in time is a permanent, continuous process. After being a subject of frequent discussions it was finally accepted as such in Poland. As continuous planning we interpret, among

others, long-term plans for 20 year periods. At the same time it is assumed that every five years the time horizon of long-term plans is shifted.

The spatial short-term (5-year) planning is closely connected with the general socio-economic planning and can be regarded as its integral part. The plans are balanced, i.e. open to implementation. Five-year plans are divided in time into annual implementation plans.

In order that 5-year plans of spatial development optimally promote the implementation of socio-economic plans, they must be based on principles resulting from long-term plans. Those are long-term 20-year plans and long-term development prognoses. Long-term prognoses belong to scientific studies and as such should not be of normative character.

What remains to be precised is the determination of normative competences of long-term spatial plans which are modified (or changeable) every 5 years. Owing to their character they should be general, should concern mainly the very concepts of spatial development at the national level, i.e., include only fundamental elements which exert a decisive influence on the development of national economy in particular regions. They should not include any details or elements of local significance. Problems of this kind should be dealt with in long-term plans of the regions. The long-term plan should present a certain concept of spatial development of the country, shown in a concise way. Moreover, an essential part of this plan in its clear cartographical representation.

Its normative validity should be limited only to most important matters, the rest remaining in the form of general guide-lines differentiated in space, i.e. of instructions as regards the trends of economy in the regions (regional policy). The concept need not be strictly determined in time (as it can change with the socio-economic development) and be flexible enough to allow for the modifications in the 5-year plans. The experiences gained during the elaboration of the long-term plan till 1990 by the State Planning Commission make possible the determination of the scope and content of the plan. As mentioned before, its normative character must be confined to the most important problems, therefore it must be drawn up in a compact and clear way. The spatial planning of urban-industrial agglomerations should be handled in an analogous way.

4. ADJUSTMENT OF TERRITORIAL ADMINISTRATIVE UNITS TO URBAN-INDUSTRIAL AGGLOMERATIONS

There is a discrepancy between administrative division of the country and the developing socio-economic life, which is expressed in steadily territorially expanding nodal regions of different sizes, the highest hierarchical level of which consist of urban-industrial agglomeration. These discrepancies are due to the fact that the development of economy expands in space along with the development of technology, and in particular of transportation and information transmission system. Therefore, with the development of motor transportation the administrative units can be much larger than in conditions of horse-drawn vehicles. Sufficient development of motor transport, organization of socio-economic life in space, larger mobility of population — all these factors fully justify the transfer from smaller to larger territorial units. As an example in this respect we can mention the change of administrative division in Poland (valid from January 1st, 1973) from the previous *gromada* (community) to the present larger units: *gmina* (township).

On the level of larger townships one can already think of the beginning of local planning of spatial development. However, within the framework of town-

ships it is impossible to organize the whole of socio-economic life, as the obtained level of social development requires much broader organization of frameworks. In conditions of the present rate of socio-economic development in Poland further changes in the management of economy in space are necessary.

First of all, administrations of city-voivodships and of territorial voivodships should be joined, as there is a close relationship between the voivodship capital and its hinterland and they both can develop only in mutual interrelationship. The same applies to city-*poviats*. This is the first reform which is already ripe and the implementation of which has become urgent in view of proper spatial development. One should also strive to unify the administrative division with urban-industrial agglomerations.

The voivodship borders should be adjusted to the extent of agglomerations treated as nodal regions. Because the agglomerations differ in size, this may result in varying size of voivodships. At this stage again difficulties arise which should be studied thoroughly.

If we decide to base the development of Poland on, say, 10 largest agglomerations, then automatically we assume a decentralized system of management of the country, and it may happen that the size of *poviats* will have to be adjusted to the size of townships (*gmina*). In effect of this it will be necessary to delimit the competences of voivodship and *poviat* authorities again, taking into account the requirements of planned economy, organized and directed in space in a way that will allow the fulfilment of ubiquitous and specialized needs of the citizens. On the other hand, if to the developed, the developing and the potential agglomerations we add multifunctional regional growth centres of national importance, then the number of voivodships will be much larger (30-40) and small voivodships will appear which will make easier the central system of management and will create conditions in which *poviats*, intermediate territorial units, will disappear.

The decision however results from political assumptions. From the point of view of planned economy in space the first project seems to be better.

The problem is of great significance and thorough, comprehensive investigations are necessary to solve it. Nevertheless, the delay in territorial-administrative division is alarming. If continued, it can eventually hamper the developing planned economy in space which needs better and better organization, aiming at integration of the whole country.

At present already it is estimated that at least one third of Poland's territory undergoes urbanization processes. It can be observed that the standard of technical equipment of life in small towns is much lower than in big ones. This concerns both the level of services, collective consumption, as well as the standard of municipal facilities, in particular of housing. The people live in different conditions and in most cases tend to move to large cities in order to improve their living conditions. The same is characteristic, although to a lesser extent, of medium-sized towns. And the differences in the living conditions of the inhabitants of rural areas on one hand and large cities on the other are very pronounced. This explains spontaneous surge to the cities, to overpopulate the centres in agglomerations. If these natural aspirations of the population toward moving to large cities are not controlled, then these concentrations will continue to develop spontaneously. The counterbalance of this tendency can be integrated planning, which is dynamic, expansive, and as a result of which larger and larger areas are included in the agglomeration (by means of their equipment in municipal facilities, and by means of their linking with the centre by efficient transportation networks). In this way it will be possible to avoid

spontaneous inflow of the population and a number of difficult problems connected with it.

Also, by means of proper spatial planning of particular agglomerations it is possible to avoid certain disfunctions of excessive concentration of people, production, services and transport. The size of an agglomeration is conditioned not only by the functions it performs, but also by the functions of its expanding hinterland. This remains in full agreement with the systems approach to the development of settlement network as well as with the general socio-economic law of concentration and of polarized development in space.

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RESEARCH WORK AS AN INPUT IN THE CONSTRUCTION OF THE NATIONAL PLAN

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A research programme undertaken, within the framework of the key problem: "Basic research for the National Plan" — as indicated in the title — has been aimed at creating scientific premises for the preparation of the National Plan.

It has to be explained at the beginning that within the Polish system of planned economy the term: National Plan is to be understood as a countrywide physical (environmental) plan concerning the spatial organization of socio-economic activities. Such a plan, being the top-level of the system of physical planning, constitutes an integral part of a long-range plan for the development of the national economy. In its general proportions it is determined by the general assumptions made for the developing national economy, but its main aim is to create principles for the spatial policy of the government. Defining the spatial interrelations between all the elements of the country's physical structure, the National Plan can (and should) influence the construction of economic plans within all the branches of the national economy. This is why this plan can be treated as the key-stone linking economic (vertical) and physical (horizontal) planning.

Other articles in this volume are concerned with results reached up till now in research work carried out in individual theme groups relating to different elements of the physical structure of the country. In the present article synthetic problems will be discussed emerging on the grounds of the particular direction of research.

Already during the period of constructing the research programme of the key-problem, it was felt that a special group of themes would be necessary for the purpose of unifying the various partial results. The goal of this research group consisted in creating transmission between research carried out within particular study groups and the needs of the planning apparatus on a country-wide scale.

The difficulty in fulfilling this task consisted in the fact that the research-programme for the key-problem was elaborated during the years 1969-1970 whereas the year 1971 was the starting point for the preparation of the National Plan. The plan had to be completed in the summer of 1973 whereas the final report on the whole key-problem was foreseen in the beginning of 1976. It seems more than obvious that one could not expect in those conditions the results of research to become the basis for a National Plan parallelly conceived.

Evidently, a solution was needed for at least the partial consumption of the research-work being carried out. For this purpose within the synthetic group a special theme was introduced under the title: Preliminary synthetic elaborations.

It has to be conceded that such a "localization" of this difficulty could har-

dly be identified as the solution of the dilemma concerned. It had, however, the advantage of emphasizing the anticipation of the expected results of the studies. In particular it stimulated the elaboration of some hypotheses which might be useful not only for the inner purposes of the research work itself, but also for the practical aims of the plan-preparation.

The first of such hypothetic elaborations was the "Preliminary concept of the country's physical organization". This concept was based on the prognostic studies previously prepared by individual authors within the framework of two Committees of the Polish Academy of Sciences: "the Committee for Space Economy and Regional Planning" and the "Committee: Poland—2000". In particular, this concept was grounded on proposals presented by S. Leszczycki (with his team) and by the author of this article. In those proposals the 16 urban agglomerations have been identified as the focal points of the settlement system. Besides, the interrelations between those agglomerations were explored, as they are expressed in "bands" of technical infrastructure installations. It has been proved that there is a feed-back relation between urban growth and the step-like improvement of transportation lines linking together the urban centres. Thus, the band-node model was conceived as the back-bone of the country's physical structure (See Appendix).

The elaboration of this preliminary concept had two aims: on the one hand, it had to constitute a common frame of reference for the research carried in all the theme groups, on the other, it had to represent an attempt to formulate the basic principles of the country's spatial organization.

The need for a common frame of reference was already felt from the beginning of the research work. It should be remembered here that the problems of the particular theme groups were defined in relation to the separate elements of the physical structure of the country. Thus, problems such as the spatial structure of agriculture and forestry, the distribution of industry, the settlement network, social and technical infrastructure and so forth were dealt with separately. In these conditions it might be feared that research carried on in all the theme groups would not easily lead to the formulation of a synthetic and consistant whole. The more so, that from the beginning the parties concerned were fully aware of the feedback interrelation between particular elements of the geographical environment. This means that the results of the separate research directions were mutually interdependent and changes within one element influenced all the others. Especially strong interrelations occur between the location of productive forces and the settlement network on the one hand and the technical infrastructure and water economy on the other. That is why in the research conducted a proper staging of work had to be assumed.

In the first stage in each of the theme groups the *status quo* had to be identified and its genetic background. The trends found by this procedure had to serve in constructing partial prognoses (i.e., for particular elements of the country's physical structure), both simple ones, based on extrapolation, and conditional, that is depending on definite assumptions of the spatial policy. Different variants of these partial conditional forecasts had to be unified into a consistent whole. From these, in the third stage, recommended solutions had to be chosen, on the ground of the criteria of social goals.

The role of the preliminary concept — as it has been shown had to consist in directing the partial prognoses. In this sense, it had to be the so-called "basic variant" from which particular partial forecasts could deviate, according to the specific features of the element concerned. It is exactly these deviations which had to serve as the starting point for the construction of sound alternatives.

The meaning of the preliminary concept for the practical planning work on the National Plan was evident. Because, according to the time-table within the first phase of the planning process a hypothetical concept had to be elaborated which afterwards would be subject to corrections introduced as a result of more detailed studies.

Besides other proposals the preliminary concept of the spatial organization of the country as worked out at the Institute of Geography (Polish Academy of Sciences) was discussed within the State Planning Commission and afterwards at one of the meeting of the Experts' Committee. Its main theses have been incorporated into the first-draft project of the National Plan as the model of the so-called moderate, polycentric concentration of socio-economic activity.

The second item of the preliminary synthetic elaborations was: Analysis of Poland's physical structure, completed in 1973. In purpose, this analysis had to be a summing up of the results achieved by the theme groups in the first phase of their research work. In reality, however, work in the particular theme groups was unevenly advanced; in result, at the end 1972 the material collected for purposes of a synthesis was incomplete. That is why complementary investigations had to be made. The material so completed was composed of about 30 maps (to the scale 1 : 1 million) showing the country's physical structure disaggregated according to the conditions necessary for different socio-economic functions: agricultural production, industry, the settlement network and tourism. Emphasis in these maps was laid on constraining, as well as stimulating factors. In this way, an attempt was made to elaborate premises which would be of direct use to the planners.

The third item of these preliminary synthetic investigations called: "Proposals to be included in the National Plan", was accomplished and presented to the State Planning Commission at the end of 1972. Such timing was the consequence of the date on which the project of the National Plan had to be submitted for approval. The essence of this elaboration consisted in developing the previously mentioned preliminary concept of the plan and making it more precise. This documentation was composed of two parts. Within the first, general part, in accordance with the guidelines for developing the national economy, up to the year 1990, the following proposals were formulated:

- the definition of planning goals disaggregated into basic objectives and individual tasks, as well as the strategic principles of the plan,
- the theoretical principles of the band-node model in which nodes are represented by urban agglomerations and complementary focal centres and the bands are formed by "bundles" of technical infrastructure installations,
- the principles of forming the nodal points, that is the urban agglomerations and other important urban centres,
- the principles of the layout of the technical infrastructure networks, and,
- the principles of the spatial organization of zones defined for agricultural functions, forestry and tourism. Within the second part more detailed conclusions and recommendations were drawn from studies made within the particular theme groups.

Since June 1973 the project of the National Plan, prepared by the State Planning Commission has been revised and refined and finally submitted for approval, which was given by the government on 19 March 1974. In this situation, within the framework of the research programme of the key problem it was considered pointless to continue the work directed towards the improvement of the present version of the National Plan. The more so, that in two years time the first cycle of research work has to be completed. So, it was de-

cided to concentrate the efforts of the group of synthetic themes on the elaboration of the final report.

In accordance with the accepted blue print this final report is to be composed of five chapters:

- (1) A synthetic review of the existing spatial organization of the country;
- (2) Recommendations drawn from the research work in particular theme groups;
- (3) Proposals concerning the formation of the future physical structure of the country;
- (4) Conclusions concerning the methods and organization of planning;
- (5) The research-programme for the next period (1976-1980) for the elaboration of the key-problem concerned.

It is to be understood that the final report will exert an influence on the next version of the National Plan, which, most probably, will be elaborated for the target year 2000. In this way, the research work will be properly advanced in relation to the needs of the planning apparatus.

Independently of this provision, it was also decided that the next period of years (1974-1975) should be made use of as regards even closer interrelation between the programming of research and the practice of planning. For this purpose two elaborations have been undertaken within the synthetic group of themes. The first, already completed, is entitled: "Analysis of the National Plan documentation from the point of view of further research for planning purposes". The need for such a study was the consequence of the parallelness of the research and planning work in the previous period. It seems evident that the present version of the National Plan could not be fully supported by the results of the research programme. Besides, each project of this kind discloses new problems which have to be scientifically dealt with. This is why there was a feeling that the present version of the National Plan should be examined in relation to the gaps in its scientific substructure. Of course, the conclusions drawn from this analysis can be useful only in the next cycle of work on the National Plan. Notwithstanding, the results of this analysis should be helpful in the construction of the research programme for the years 1976-1980.

The second of the two elaborations mentioned before is concerned with "Problems of implementation of the National Plan". The aim of this analytical work, which has merely started, is an attempt to formulate conclusions relating to the conditions of a harmonious implementation of the directives contained within the National Plan.

From the addresses of the representatives of the State Planning Commission held at the 20 Anniversary Session of the Institute of Geography, it follows that it is the intention of the Authorities not only to formulate and approve the National Plan but also to create conditions for bringing it to life. In the aim to create such a mechanism it is necessary to explore first the existing system of influencing the location policy in individual branches of the national economy by the provisions of physical planning. It has also to be elucidated what really are the powers of local authorities to coordinate the investment processes from the point of view of spatial relations and staging in time. Only on this basis it would be feasible to find the weak links in the apparatus of economic administration and propose a more refined procedure. Such material based on scientific research would aid the authorities in the creation of mechanisms which would transmit the rules and principles of the National Plan into everyday praxis of both the branch ministries and their agencies and of the local authorities concerned.

Presentation of the rather formal approach to the use being made of the

research work in the planning praxis seemed necessary in this report in order to emphasise the problem of transmission and the need for its improvement. However, against the background of what has been said it might be worth-while to go deeper into the matter of some selected problems. It is not purposeful here to describe once more the concept of the spatial organization of the country worked out within the framework of the research programme. This concept was the theme of many publications and discussions among students and practitioners of planning. It seems far more important to point out some research tasks which in the light of present experience, are confronting research workers in the field of physical planning.

The first of the problems to be mentioned here is the settlement network conceived as a system, that is a whole composed of elements (subsystems) and considered from the point of view of their mutual interrelations. Within this system three sub-systems have been discerned: the urban agglomerations, the regional growth poles and the tissue of small towns and villages. It is understandable that up till now investigations were mainly concerned with the sub-systems of agglomerations and regional centres, which together are treated as the focal and most dynamic elements of the settlement network. It seems, however that such an approach, although admissible in the first phase of research work, is not sufficient in the long run, because the aim of the National Plan is the optimal meeting of needs of the whole population of the country. Consequently, it should be postulated that within the National Plan itself more stress has to be laid on these vast areas, where the living conditions will likely deviate from the optimal ones. Thought should be given before all to the conditions of life within those agglomerations which already are endangered by the degradation of the natural environment as well as to the areas outside the nodes and bands of the system. Solving the problems of the lower levels of settlements is obviously the task of regional and local planning. But solutions taken at those levels of planning will be inadequate if they are not based on the general provisions of the National Plan. Against this background the following research tasks are emerging:

— First, the interrelations of the three subsystems mentioned before should be investigated. It is evident that they do not only depend on each other but even represent a kind of balanced connection. It can be foreseen that the living conditions will be worse within the subsystem of local centres the greater the impact of migration on urban agglomerations.

On the other hand, a considerable increase in the standard of living within all the small towns and rural settlements might involve very high investment assets, which will surpass the limits set up in the budget.

— Further, the present level of living conditions is to be investigated within all small towns and rural settlements outside agglomerations and the supplementary urban centres. It is to be expected that neighbouring towns in different respects have differentiated levels of development. This fact, besides the interlinking of exogenous functions, should lead to the investigation of what in the U.S.S.R. is called "group settlement systems". In particular it is worth studying how far groups of neighbouring towns within different parts of the country can be treated as complementary settlement systems, and what is to be done to develop them. The cooperation of particular urban centres within such a system should allow the use of their spare capacities for the meeting of common needs. In this field of special importance would be the investigation of the accessibility of central places of higher orders. Because, easy access to such centres is the basic condition for eliminating the disparities in the level of services between town and country.

— The efficiency of service activities is closely connected with the territorial division of the country — the problem which up till now has not been sufficiently dealt with in the context of the National Plan. It seems that as a consequence of recent reform, consisting in the creation of commune (*gmina*) and in enlarging the range of power given to the communal authorities, comparable reform is needed on the county (*powiat*) level. In particular the present average size of *poviats* seems to be too small in proportion to the newly created communes. From this point of view different solutions have to be studied. The most advantageous variant seems to consist in increasing the size of *poviats* up to the category of sub-regions. Such territorial units, covering approximately the area of several present *poviats* would be capable of performing specialized socio-economic functions leaving free the possibility for functional cooperation between concerned urban centres. As far as the territorial division of the country is concerned emphasis in research should be also laid on the role of agglomerations and other important urban centres in the adequate serving of the population all over the country. In particular the validity of the principle should be verified concerning the exclusion of major towns from the administrative area of the *poviats*. The same relates to those regional capitals which constitute separate metropolitan areas (excluded from the surrounding voivodship area). Experience gained up to now shows that such an exclusion hampers the rational land-use pattern of nodal regions.*

The second problem challenging scientific research is the impact of developing and modernizing the technical infrastructure on the socio-economic growth of the country. Although in research carried out until now the principle of integrating the technical infrastructure networks was recognized, insufficient attention was given to the stimulating influence of those networks on the "activation" of underdeveloped areas. It is but broadly accepted that the development of infrastructural networks is the main tool of the "activizing" policy. It is exactly due to these networks that advantageous conditions are created for the location of industry which remains the motoring force of socio-economic growth. Since one of the strategic aims of the National Plan is the shifting of economic potential towards the northern and eastern parts of the country the instruments for doing so demand close investigation. In this context before all, a real degree of flexibility of decisions should be considered to determine the achievement of this goal.

Efforts should be concentrated on the one hand on the power of inertia connected with the existing pattern of industrial distribution and on the other, on the premises for the creation of new industrial districts. Among these latter premises an important role is being played by the development axis based on strong bands of technical infrastructure lines as well as by industrial complexes based on cooperation and the principle of multiplier effects on the regional economy. Such investigations would strongly support the strategy inherent in the National Plan which until now has been defined only in a very general way.

One of the important tasks confronting research work is also the further definition of the principle contained within the National Plan, concerning the specialization of regions. Already in the preliminary concept of the plan the

* After this report had been written, the next stage of the administrative reform came into life in June 1975. Instead of counties and provinces intermediate territorial units were introduced. The territory of the country is now subdivided into 49 such nodal regions (voivodships) each with a centre (existing or to be developed). Thus the services of higher order are now made accessible for the whole population.

thesis was expressed that geographical differentiation of the environment should serve as a basis for the allocation of relating socio-economic functions to all the regions and their subdivisions. For, it follows from the notion of social rationality that within regions such functions should be developed for which the best conditions prevail due to both the natural and man-made features.

In accordance with this thesis, in the present version of the National Plan preliminary proposals were presented concerning the functional specialization of the regions. It seems, however, that this problem demands closer investigation, mainly directed towards the refinement of the methodological tools applied.

As a starting point for investigations of this kind the principles of the threshold analysis seem to be acceptable. This method conceived by the author of this article in the early sixties aims at defining the threshold limitations of various kinds which confront towns and regions on their expansion. Evaluating all the feasible alternatives of regional growth in the light of those limitations appears to be a comparatively simple tool for defining the optimal level of development.

In each of the regions and their functional subdivisions such an analysis should be undertaken concerning the natural and man-made resources, including the labour potential. Such a procedure would allow to define in quantified categories not only the conditions existing within particular regions but also the threshold limitations which are to be eventually by passed by adequate investment assets. A matrix of resources thus obtained would facilitate the optimization procedure carried on at the central level in accordance with the general assumptions for developing the national economy. The outline of the method proposed here should be, of course, subject to refinement and precision within the framework of the research programme. On this basis a routine procedure is to be formulated for the use of all regional planning offices.

Summing up the results of research work carried out for purposes of the National Plan one is permitted to state that research conducted until now was mainly directed towards the meeting of the current needs of the planning apparatus. This tendency found its expression in close connections between the theme groups and the branches of the national economy as much as in the staging of the research works resulting from the investigation of the *status quo* towards conditional prognoses and eventually to the recommended solutions. Work of the synthetic group of themes was characterized by the tendency to combine the results into one consistent and sound concept of the plan.

One has to concede, however, that due to this tendency, although understandable in given conditions, research work much resembled the planning methods themselves. Besides, it has to be remembered that the planning apparatus is in possession of a better set of instruments for purposes of survey and construction of consistent variants of solutions than the research groups engaged in the key problem. There is a feeling that in future the demarcation line between research and practical planning should be drawn more distinctly. The planning apparatus should be made responsible for the survey and balancing of the variant solutions from many points of view whereas scientific work should be concentrated rather on basic research in interdisciplinary categories. A major part in this research should be given to the methodological problems concerning regional analysis and ways of constructing the plan as well as the tools for its harmonious implementation.

APPENDIX

THE BAND-NODE MODEL OF THE SETTLEMENT NETWORK IN POLAND *

BOLESŁAW MALISZ

The settlement network is the key element of the physical structure of a country. It represents the distribution of the population and thereby determines the utilization of the geographical environment by man.

Nowadays when the system of forecasting is being extensively developed as a basis for planning, it is important to visualize the future picture of the settlement network.

Bearing this in mind, two possible approaches can be differentiated. The first consists in forecasting in the strict sense of the word, that is, in foreseeing future possible changes in the settlement network based on the extrapolation of phenomena observed today and on the possible changes of these trends depending on the adopted assumptions for development. The second approach is more subjective. It consists in presenting the probable future picture of the settlement network of the country as it seems to fulfill justified social goals.

I wish to present in this article, the methodological premises and the reasoning, which lead to the construction of objective prognoses as regards the settlement network of the country. At the same time I should like to make use of these same premises for the construction of one version of the future settlement pattern of Poland which — on the basis of available information — I believe to be the most probable and the most desirable.

It has to be mentioned that the version of prognosis presented here for the settlement network of Poland is in essence an attempt to expand earlier ideas on this subject¹. This new version seems to be more comprehensive and much better substantiated.

I further wish to explain, still as an introductory remark, that I have adopted the year 2000 as the time horizon of forecasting. I do not, however, attach any particular importance to this date for I think that in forecasting for the distant future especially concerning the physical structure, the setting up of a definite time limit is less important than thinking in terms of so-called "open" models which contain in themselves a considerable degree of flexibility and can be harmoniously developed in conditions of changing circumstances.

THEORETICAL MODELS OF THE SETTLEMENT NETWORK

The basis for forecasting a definite process consists in revealing its "mechanism" — that is, the laws or at least the regularities that govern its development. Therefore it is worthwhile beginning with a survey of the principal theoretical models of the settlement network.

Christaller's model — known as the theory of central place — is undoubtedly the concept which for a long time had the strongest influence on views as regards to shaping the settlement network and was the inspiration of many derivative models.

* This article has been originally published in Polish in *Gospodarka Planowa* 1971, 5, pp. 292-300.

¹ B. Malisz, Teoretyczny model sieci miast w Polsce (Theoretical model of the settlement network in Poland), *Biul. IUA*, 28, 1969, pp. 5-23.

This model, based on studies conducted by Christaller in Bavaria — as is well known — consisted in a hierarchy of town centres to which on each level a definite influence area in the form of a regular hexagon was subordinated. At the base of this model, later developed by A. Losch, lay the assumption formulated by the latter in the words:² "... we assume that industrial raw materials are evenly distributed over a wide plain, in which the agricultural population also is evenly distributed and lives in a similar fashion. All industries and their production methods are assumed to be accessible to every one".

Christaller himself was aware, of course, of the limitations of his model especially as far as the influence of the transport factor was considered; but he was so attached to his "market principle" that he treated all kinds of deflections from it as "deviations".

A. Losch also appreciated the importance of "complicating factors" but he continued with the assumption of a uniform distribution of the population.

Critics of this theory in the West stressed mainly the importance of the differentiation of the geographical environment and the distorting effect of transportation routes. Recently K. Dziewoński³ questioned the principle of the correlation between the size of the city and its central functions and the principle of the hierarchy of centres, indicating the continuity of the curve of city sizes, as well as the case of dual centres.

The attempts I have made to verify this model in the conditions existing in our country — with the exception of a few cases — did not arrive at a positive result. The divergencies arose not only from the differentiation of the geographical environment and the deforming influence of the transportation routes but also because of the conditions of socio-economic development of the country during its history.

Recent attempts at a verification of the model of central places conducted in areas of Canada, especially in the Ontario region, led to the same conclusion. In view of these adverse experiences, another theoretical model was sought as the foundation for the interpretation of the settlement processes of this region. The concept of a linear model was considered and on this basis the "corridor" hypothesis was formulated.⁴

The linear model has a long history. It was originated by A. Soria y Mata⁵ but its versions are numerous and very diverse. Its first application was developed by Milutin (in his plan for Stalingrad) and, among the authors of its various versions, mention should be made of Le Corbusier, A. Hilberseimer and recently by C. Buchanan.

It is worth noting that this conception was expressed in an original way in the thirties by J. Chmielewski and S. Syrkus.⁶ On this basis, Chmielewski then worked out the concept of so-called "dynamized bands" which was applied and expanded in the preliminary work on the National Plan carried out within the Central Board for Physical Planning (GUPP) during the immediate years after the war.⁷

One must admit, however, that although this fertile idea has been used several times in the form of a more or less definite model, there has been so far a lack of more theoretical formulations. An attempt to define its assumptions and theorems was recently made by C. F. J. Whebell.⁸

The "corridor" hypothesis is based on three empirically confirmed premises:

(1) The face of the earth is geographically considerably diversified in regard to both its natural and man-made features.

(2) Changes in technology and other innovations which exert an influence on the character and intensity of land utilization do not occur simultaneously over large areas but spread from one, or more initial points and are disseminated at different speeds.

(3) The achievements of man are ultimately the result of the sum of both rational and mistaken decision, and on the whole are based on the principle of least effort; a corollary of this principle is the "inertia" of fixed assets and the socioeconomic structure.

² A. Losch, *The economics of location*, Yale University Press, 1954, p. 94, footnote.

³ K. Dziewoński, O nowy model sieci osadniczej i urbanizacji kraju (For a new model of settlement network and urbanization of the country), *Sprawy mieszk.*, 2-3, 1969, pp. 89-100.

⁴ C. F. J. Whebell, Corridors: a theory of urban systems, *Ekistiks*, 28, 168, Nov. 1969.

⁵ Soria y Mata, *La ciudad lineal*, Madrid 1896, 2nd ed. 1931.

⁶ J. Chmielewski, S. Syrkus, *Warszawa funkcjonalna* (Functional Warsaw), SARP, Warszawa 1939.

⁷ *Atlas. Studium Planu Krajowego* (Atlas: Study of the National Plan), GUPP, Warszawa 1947.

⁸ Cf. footnote 4.

From the first premise it follows that the attractiveness of some areas for settlement may be considerably greater than that of others and therefore the advantageous areas will be utilized earlier. It also follows that for purposes of movement between two points, routes of least effort will be more or less obvious. This applies, too, to technical innovations which spread out with or without the migration of people by routes strongly determined by the total accessibility of the receptive areas.

Innovations can be conveniently divided into ideological, organizational and material ones. The first need only to have the information transmitted and spread more quickly, whereas the others are dependent on the passenger and freight transportation means and must diffuse along the suitably arranged routes to urban centres that are properly prepared as far as labour and investment potential is concerned.

The "corridor" concept should therefore be understood as a system of towns along a "bundle" of transportation routes. Incidentally, it is worthwhile recalling that the same term "bundle" (or "bunch") was used by Chmielewski in the thirties. Corridors thus represent an historically determined system for diffusing innovations. One can speak here of "corridors" of the first order, connecting the points of "entrance" to the given territory with the main urban centres (nodes) and secondary "corridors" linking other towns (secondary nodes). In view of the tendency to arrange urban structural units along such infrastructure bundles, the settlement network should be conceived as a linear pattern rather than as a system of central places.

Bundles have a varied ability to transfer innovations depending on the number and equipment of tracks within them. The small influence of the railway, however, has to be mentioned when the lines are used to carry raw materials of one kind only. This has been confirmed by the experiences gained from the "Silesian line" built in Poland in the thirties by foreign capital, for purposes of coal exploitation. On the other hand, water courses, especially in the early periods of civilization, exerted (and where they are properly invested still exert) an influence which strengthens the role of "corridors". The river makes transportation more efficient if it flows in the direction which coincides with the diffusion of innovations, otherwise, it may be an obstacle. Then, however, according to the principle of least effort, passages are often built across the river which offer possibilities for the development of the major urban centres.

The directions in which innovations are diffused, in terms of traffic engineering, can be defined as "desire lines" otherwise expressed in Polish as directive tendencies. It is worth stressing that this concept, too, lay at the foundation of our national plan in the forties.⁹

The "corridor" hypothesis seems to me to be a prolific model, especially adapted for the consideration of the physical aspect of the country's settlement network. Besides, it is, as I endeavoured to show, a conception lying, as it were, in the main stram of the Polish physical planning tradition. In this context it is helpful insofar as it strongly supports the model I wish to present.¹⁰

The first outline of the band-node model was presented in the middle sixties.¹¹ At its basis lay the understanding of the settlement network as a functional-physical structure composed of settlement systems. By this notion I understand the system of settling down as determined by the influence of the place of work. From the point of view of their dominant function three kinds of settlement systems are to be discerned: extractive, processing and the system of tertiary occupations. A definite degree of concentration of the place of work and, consequently, of the place of residence corresponds to each of these three kinds of activity. Hence, each kind of settlement system is characterized by a definite commuting pattern. On this basis, within the settlement network, three types of location of settlement systems can be seen: systems with dominant tertiary functions (public administration, management, financing, education, public services) for which the most suitable is the nodal location, systems linked with processing (industry), which most conveniently can be located along the transportation routes connecting the nodes (owing to the transport facilities for raw materials, products and employees) and systems connected with agriculture, forestry and also with recreational and tourist activities which need open areas protected against the investments for industrial and urban purposes.

⁹ *Atlas. Studium Planu Krajowego: Tendencje kierunkowe* (Atlas: Study of the National Plan: Directional tendencies).

¹⁰ Cf. footnote 1 and also G. Isbary, H. Jurgen von der Heide, and G. Müller, *Areas of sound structures and living conditions*, G. Jänecke Verlag, Hannover 1970.

¹¹ B. Malisz, *Zarys teorii kształtowania układów osadniczych* (Theory outline of shaping settlement systems), Arkady, Warszawa 1966, chapt. 3. Cf. also French edition: *La formation des systèmes d'habitat*, Dunod, Paris 1960.

These systems fill out the "meshes" of the net formed by the bands. From this description it can be seen that the band-node system coincides to a considerable degree with the "corridor hypothesis". In both these concepts the feedback phenomenon plays an important role: it is along the infrastructure bands (transportation routes) that the most favourable conditions exist for urban development; on the other hand developing urban centres create the need for further improvement and modernization of the infrastructure bands.

In order to verify how far this hypothesis agrees with the pattern of the existing settlement network of Poland, I have marked the bands (transportation corridors) assuming that they can be defined as main railway lines and a country distributors running parallelly within a distance of about 10 kilometres. I considered as bands of the first order those which connect our country with neighbouring states or with the sea. There are three W-E bands (running along the seacoast, along the mountains and the European plain which fork out towards the east) and N-S bands connecting the countries to the south of Poland with the Baltic Sea ports. These bands intersect, forming the principal nodes whose interconnections constitute bands of the second order. It has to be noted that, due to the former historical boundaries of Poland, there are gaps in this network of bands (i.e., sections within which the railway and highway diverge). Therefore actual and potential bands had to be distinguished as is shown in Fig. 1.

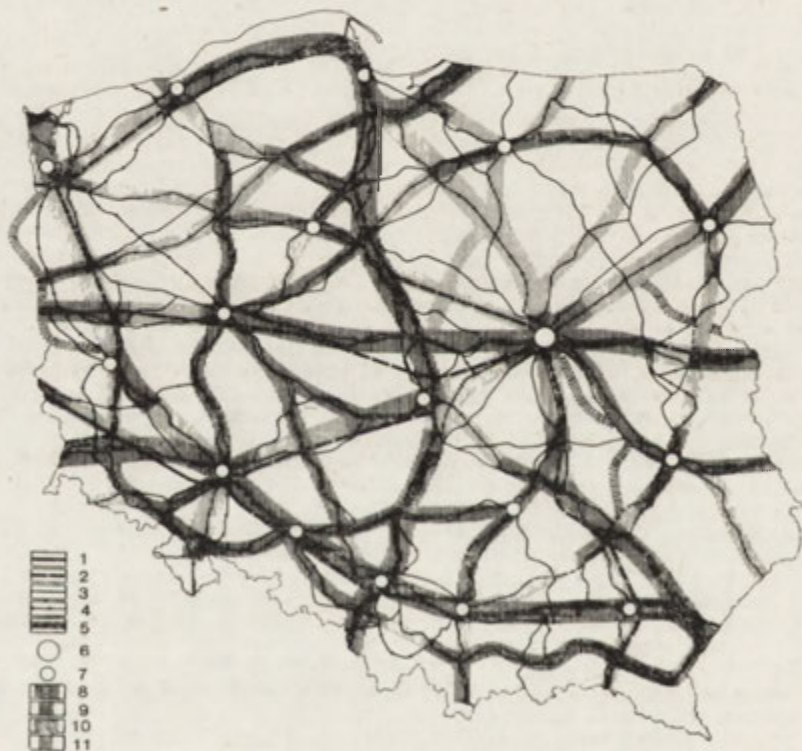


Fig. 1. System of directions (corridors)

1 — existing motorways, 2 — proposed motorways, 3 — highways, 4 — railways, 5 — waterways, 6 — capital city, 7 — regional centres, 8 — existing directions (corridors) of the first order, 9 — existing directions (corridors) of the second order, 10 — postulated directions (corridors) of the first order, 11 — postulated directions (corridors) of the second order

Computation showed that already in the year 1950 — 83% of the urban population lived within the band-node network defined in this way; this percentage increased to 87% by 1965 (Fig. 2). Within the period 1950-1965 the growth index of towns within the band-node system was 165 whereas it was only 160 for the urban population as a whole. Hence the towns lying outside the system (within the "meshes") grew half

as slowly as towns lying inside it. Irrespective of this, it has been found that all the existing and developing industrial districts and centres lie within the same system of bands and nodes.

The results of this research seem to justify the statement that the band-node model is an adequate presentation of reality as it properly reflects the regularities governing the development of the settlement network in Poland.

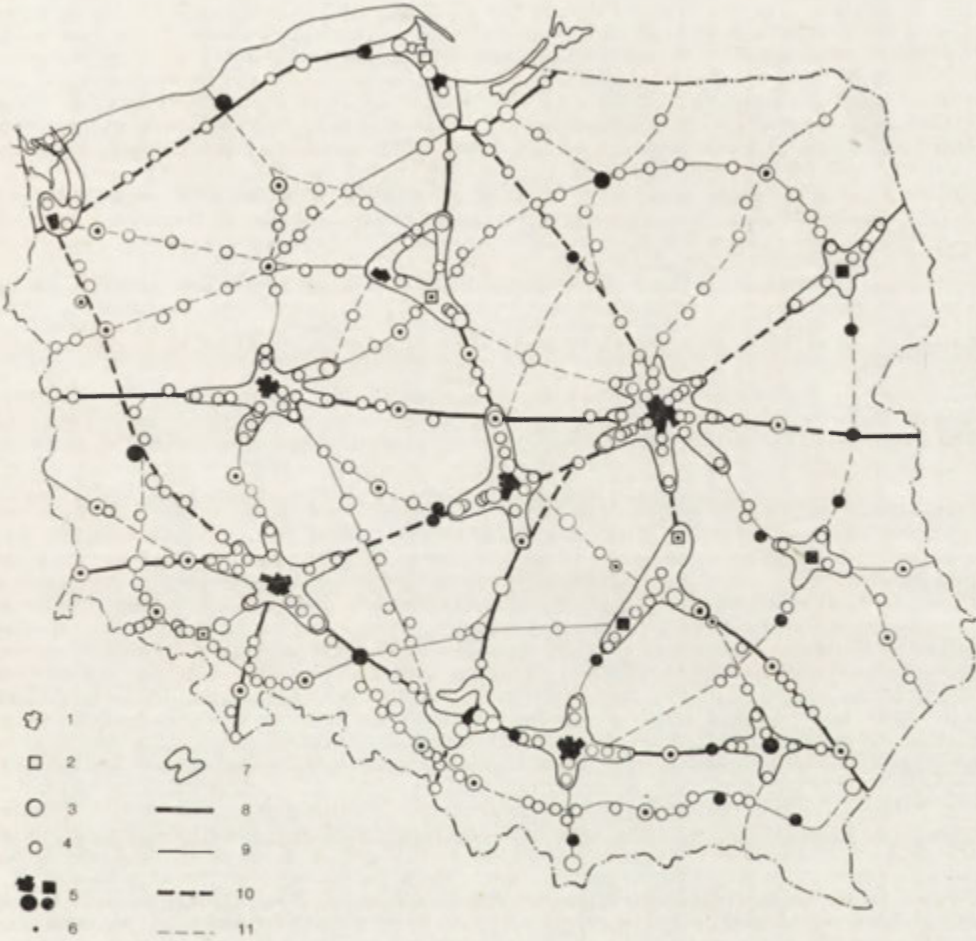


Fig. 2. Urban settlements within the system of corridors (1970)

1 - cities with over 250,000 inhabitants, 2 - cities 100,000-250,000, 3 - cities 25,000-100,000, 4 - cities with less than 25,000, 5 - regional centres (voivodship centres), 6 - sub-regional centres, 7 - approximate extent of urban agglomerations, 8 - corridors of the first order (existing), 9 - corridors of the second order (existing), 10 - postulated corridors of the first order, 11 - postulated corridors of the second order

FACTORS INFLUENCING THE FUTURE PATTERN OF THE SETTLEMENT NETWORK

The “mechanism” of growth of the settlement network conceived in this way functions in definite conditions. In order to construct a forecast it is essential to investigate these conditions and to find to what degree they can affect the shaping of the real picture of the future settlement network. In particular, it is important to determine the upper and lower limits of the possible changes caused by individual

groups of conditions. Obviously within the framework of this article only the most typical problems can be indicated.

I believe that at least the following fundamental groups of such factors should be distinguished:

The first group consists of conditions which form the human environment, that is, both natural conditions and those created by man.

Natural conditions, which consist of components such as the geographic location, relief, hydrographic conditions, climate, mineral resources, and soil and vegetation, determine the potential possibilities in the utilization of the environment. All of these features are marked by a considerable degree of stability which, from the point of view of constructing forecasts, is essential because it offers a good starting point for picturing the future. Some of these conditions, however, are more apt to be influenced by the activities of man and, consequently, may change considerably. Unfortunately these are mostly unfavourable changes such as deforestation, soil erosion, the pollution of air and water and the devastation of the natural landscape which, usually, lead to the degradation of the natural environment and, consequently, constitute a threat to man's existence. Observation of these unfavourable changes makes a forecast possible, which consists in the extrapolation of the discovered trends. If the picture obtained in this way is sufficiently frightening, one may judge that steps counteracting these harmful phenomena will be undertaken.

As far as changes in the settlement network are concerned strong impact can be exerted by the distribution of mineral resources. The geological explorations that are steadily being conducted lead to the discovery of new deposits, the exploitation of which changes the picture of the distribution of productive forces and, consequently, may lead to the creation of new settlements.

Water similarly exerts an essential influence. In the conditions of our country, where water resources are unevenly distributed, it is to be expected that areas abundant in water will strongly determine the intensity of the urbanization process. Finally, the distribution of forests and areas of natural amenities has an essential influence since the growing urban agglomerations strengthen the need for tourism and recreation.

The impact of man-made features mainly in the form of fixed assets in the domain of the infrastructure, production and housing — from the point of view of making forecasts — will be expressed through the so-called inertia of investment. Considering the validity of the "least effort" principle one can judge that whatever man has already created will somehow be included in the future picture of the settlement network. Obviously development and modernization processes will take place but the location of the major urban centres will remain. This means that the "field of manoeuvre" in the free distribution of the new settlement units is not at all as wide as one might judge on the basis of the expected increase of the urban population. One must take into account the fact that the larger, and more active a given agglomeration is today, the greater will be its inertia as regards to further growth. For being ahead of other urban centres — due to the feedback phenomenon — it will have stronger growth tendencies. Therefore one should not delude oneself that the already existing agglomerations (metropolitan areas) can be radically arrested in their growth. Experience gained so far with the so-called deglomeration policies throughout the world, proved such action to be very costly and hardly effective. It seems therefore more reasonable — accepting this regularity — to make use of such development, that is, to steer it toward a form of physical organization satisfactory from the socio-economic point of view. On the basis of previous reasoning, the band-node model seems to be what is probable and what is needed. Its development is in conformity with the tendencies of all kinds of investors and, at the same time, makes it possible to ensure reasonable conditions for the basic functions of various kinds of work, housing accommodation and recreation. This system does not exclude at all the formation of new links of human activity, either in the form of major expansion of individual towns or in creating new agglomerations and conurbations. It is to be expected however, that these rapidly growing links of the settlement network will generally be formed on the basis of newly created production possibilities and always along the routes of the innovations, most probably in the model locations.

Let us consider in turn the effect of such factors as growth of the population and the changes in the demographic structure. The future picture of the settlement network of the country will obviously depend on the course of demographic changes and especially on the rate and character of the urbanization process.

Throughout all continents the increase in population is one of the factors most intensely influencing the formation of the settlement network. The doubling of the

world population is expected at the end of the 20th century and is already causing concepts of the *Ecumenopolis* type. I shall confine myself here, however, only to Polish conditions. It is known, on the basis of the demographic forecasts recently carried out, that the population of our country will not exceed 38 million in 1990 and at the turn of the century will be most probably still below 40 million whereas it is 32 million today. It is worthwhile realizing that an increase of this order cannot exert a strong impact on the future model of settlement. The present density of 103 inhabitants per square kilometre will still be below the 130 index. This is certainly not a quantity which would introduce new qualitative phenomena. In many parts of Poland this index has already been exceeded. At any rate the possible fluctuations in the number of inhabitants are so small that they do not demand new (quantitatively different) patterns of settlement to be separately constructed.

Much more essential for the future pattern of the settlement network is the demographic structure of the population and especially the split into agriculture and other sectors, i.e., population within the secondary and tertiary sector. Incidentally population connected with the "fourth sector"—that is science, information and automation should be at present distinguished among the tertiary occupations. Trends clearly indicate that this is the group with the most outstanding growth potential. Assuming a reasonable rate of modernization of agricultural production, it can be expected that the agricultural population will not exceed 10% of the total population—that is, it should amount to about 4 million persons in the year 2000. If a further 4 million are added for serving agricultural production and farm population, the upper limit of what is called today the urban population, can be set at 32 million—that is, twice as many as today. An increase of 16 million persons may seem to be considerable. One must remember, however, that this increase will take place gradually through a period of 30 years; this would mean that in each five-year period the urban population will increase by about 2.5 million persons. If we assume only 3% as the annual growth in the existing agglomerations and urban centres, the computation will hardly leave a margin for the newly formed elements of the settlement network.

It is worth stressing that if the population directly and indirectly connected with farming constitutes only 20% of the total population then the band-node system will become visible more clearly against the background of "open" spaces. On the other hand, an increase in the services sector and the "fourth" sector will certainly exert an impact on the development of the nodal elements of the settlement network. For it seems highly probable that employment, connected with education and information-processing centres, will be located in the main nodes of this system.

Finally, among the factors influencing the future settlement network, technical progress should be discussed. This influence is difficult to evaluate since its effect on the settlement structure can not be verified. On the other hand, expectations in this field are bound to be taken into consideration. In such a situation it seems to be advisable to omit too futuristic ideas, and to limit the reasoning only to those trends of technical progress which were checked in laboratory conditions. One must also realize that new technical equipment and improvements are generally introduced when the efficiency of the existing system is completely unsatisfactory. Assuming these limitations, we shall note only the fields of technical progress which have obvious importance for forecasts of the settlement network.

Human settlements always were and will be dependent on the possibilities of a water supply. In Poland's condition of uneven distribution of water resources, essential limitations may be expected in the growth of towns in areas with inadequate supplies. This can partly be regulated by the local switchover of water, but the world trend is to form large closed water circuits (on a regional and national scale) supplemented by water "renewal" stations. Desalination of seawater is also taken into account. Hence economic activities (sources of energy primarily) are at present being shifted towards the seashore.

Making use of such possibilities in our country, with the already visible limitations of water economy in Upper Silesia and the industrial districts of Częstochowa and Łódź, may become a factor towards a more uniform distribution of economic activities and, hence, of changes in the development of the settlement network.

As the second basic factor influencing the urbanization process, the power supply should be considered. The trends of technical progress in this field amount to an increasing utilization of nuclear power, to the integration of the power system (one power carrier) and to the miniaturization of equipment. Actually the northern regions of the country are more and more taken into account in the programme of ex-

pansion of the power systems, mainly in view of the indispensable quantities of water needed for cooling turbines.

From the point of view of the geometric pattern of the settlement network, it is important that the highest tension lines should be perhaps the only element of the technical infrastructure which will "break loose" from the bands of the system. It is worthwhile noticing however, that recent experiments (carried out in the Soviet Union and the USA) in the field of cryogenics may radically change the situation. Aerial lines not only cause considerable loss in the transmission of power but also take up much surface area. And with their increasing density they are becoming a considerable obstacle in urbanized areas and in the reasonable utilization of land. Basing these lines on "superconductors" (underground) would make it possible to avoid these inconveniences. An advance in this field which seems to be desirable for many reasons would at the same time be a factor supporting the band-node system.

Irrespective of possibilities in power transmission the quantity itself of the power produced will have a fundamental effect on the human environment. With a radical increase in power production, it will be possible to form closed circuits of water economy, decrease water and air pollution on a large scale and even to change the soil structure for farming purposes.

Last but not least progress in transportation is believed to exert an essential impact on the development of the settlement network. Progress in this field with spacecraft seems to be fascinating. It is worth noting however that, in spite of experiments with completely new means of transportation, research carried out in many countries, even in the most technologically advanced ones (for instance, the USA), indicate a strong tendency to modernize the conventional means. Attention must furthermore be given to the fact that an increase in the speed of vehicles in itself is not yet a factor that would solve the problems of municipal and suburban transport. Mass transportation in Poland is based mainly on means of public transport. It is worth noting that traffic experts, even in the United States, are more and more in favour of these systems. After all, when car traffic grows excessively, it will have to be used on automatic steering bands which bring this kind of traffic closer to the conditions of public transport.

The frequency of stops radically reduces the commercial speed of locomotion. Here, a dilemma arises which is difficult to solve: in order to shorten the commuting time the number of stops must be limited—that is, they must be distributed more sparsely, but then the intermediate localities will not be adequately served. One means of transport, therefore, cannot solve this difficulty. The solution should be sought in combining several means of transport so that each line would serve another type of traffic (of a local or through character). This is exactly the technological reason, which supports the thesis of "bundles" of routes forming the linking element of the band-node system.

It follows from this reasoning that only within the range of the agglomerations it is feasible to develop linear urban structures (along the multiple transportation routes). In between these nodes, separate settlement units (towns) will be developing along the infrastructure bands.

Technical and organizational progress will also exert an impact in such fields as waste disposal, water and air purification, as well as organization of shopping and rationalization of household activities. The scale of possible changes in these fields will obviously depend on accepted standards of life.

THE INFLUENCE OF THE SOCIO-ECONOMIC POLICY

In the first part of the article I endeavoured to discover the mechanism of the transformations of the settlement network. In the second part I presented a concise review of conditions under which this mechanism functions. In studying their stabilizing, eventually dynamic character, it should be possible to define what I call "the field of possible solutions". What shape the process of actual transformations within this "field" will assume, however, is a matter which depends on the socio-economic policy of the state. Thus, the basic possible trends of this policy have to be considered which exert an influence on the evolution of the country's settlement network. In particular four groups of problems will be tackled.

The first is the problem of the level on which economic integration occurs. Here two opposite tendencies should be mentioned: one would be directed toward the "uniform development of each region"—that is, the principle of socio-economic integration would have to be expressed at the level of regions and would, consequently,

lead to the expansion of "everything everywhere". The second is the strategy of development consisting in the specialization of regional functions resulting in the socio-economic integration taking place at the level of the country as a whole. Individual regions fulfil in it a definite role depending on their predisposition as expressed in their natural conditions and man's activities.

It is almost obvious that only the second trend is correct, but it is not an indifferent matter to what degree secondary or supplementary functions outside of the leading function (specialization) will be attributed to the regions. For it seems unquestionable that the strategy of intensive and selective development can be effectively carried out only when society is adequately prepared for this. It is clear that in order to raise the average technical culture, to release creative initiative and to increase the efficiency of work, suitable material conditions must be created throughout the country. Hence the necessity of investing not only in production but also in man.

Finding a wise compromise between these two extreme variants demands profound thought, and decisions in this matter will have a fundamental effect on the picture of the future settlement network of the country.

Problems concerning the degree of concentration of the population and socio-economic activity. An extreme case of concentration would be to let one agglomeration develop without any restraint on a countrywide scale. This case, however, does not appertain to Poland whose settlement network already has a polycentric character today.

There is still a choice left, between the various degrees of concentration. The model concepts advanced so far in this respect seem to cover the range of possible solutions. The first model has been represented by Professor S. Leszczycki's (and co-workers) concept of the further development of several large agglomerations as the basic links of the settlement network which together bring about one third of the country's population and the majority of the industrial production and service activities. I would define this concept as a simple prognosis—that is, based on the extrapolation of the existing trend. This is a concept with the highest degree of probability and many economic and social advantages, since the effectiveness of such agglomerations has been proved. It has, however, its shortcomings which consist mainly in the danger of urban sprawl.

The second concept, advanced by Professor K. Dziewoński, is characterized by a lower degree of concentration. It consists in the development of about thirty urbanized regions based on existing agglomerations and major town centres with "catchment" areas within the range of a 50-km radius. Such urbanized regions would cover almost the entire country forming convenient conditions both for the development of production and for the servicing of the population. Obviously the spontaneous growth of major agglomerations would have to be restrained with a view to promoting development of other centres of those regions.

A still further advanced deconcentration is represented by the proposal made several years ago by dr. T. Mrzygłód. It consists in consciously stopping the growth of large agglomerations and saturation of the country's territory with economic activity by forming about sixty "growth poles" of intensive industrialization. This concept, originated from the idea of a uniform development of regions does not seem to be feasible and can be argued from the economic point of view. The inertia inherent in the growth of large agglomerations has been underestimated in it, whereas the investment efforts necessary for developing so many growth points are going beyond the economic possibilities of the country.

It is worth stressing that the concept of the band-node system that I am advancing (together with Professor P. Zaremba) is not at variance with the development of large agglomerations nor with the model of urbanized regions. Its essence lies, however, not in the quantity of selected urban centres and their scale but in the stress being laid on the physical organization of growing urban agglomerations based on bands of intensive infrastructural equipment.

Participation of production and consumption spheres in the investment fund. It is known that an expanded socialist production system must maintain a relatively high percentage of accumulation. There are, however, variants of the socio-economic policy as far as the division of the investment fund into the spheres of production and consumption is concerned.

Until recently, investments for production had a very high priority whereas the share of the consumption sphere (outside of housing) was held comparatively low.

Consequently, the technical infrastructure equipment in communities and socio-cultural services, on which production indirectly depends, were constantly exposed to under investment. Such a state seems to be at variance with the postulates of in-

tensive socio-economic development. Outside of science, which already has been acknowledged as strongly affecting production, it seems that emphasis should be placed on the technical and social infrastructure without which an intensive growth is out of the question.

The scale of this transference of resources for so-called "consumptive" investments should obviously become the subject of considerations based on the verification of the system balancing the national economy. I only wish to stress here that the variant of the investment policy applied up till now should be compared to another variants which would facilitate radical improvements in water economy and in the power and transportation systems, as well as in communication economy and also one which would allow a higher standard of living.

The influence of cooperation with the Council for Mutual Economic Aid. The range of our cultural and economic cooperation with CMEA countries, and especially with the neighbouring countries of Poland, will also exert an influence on the future shape of the settlement network. If the diffusion of innovations is acknowledged as the prerequisite for development and, consequently, proper importance is attached to the entrance points into the country's territory, then the model of the settlement network should not be built up in isolation from neighbouring countries. In doing this it does not suffice to define the transit roads and railways on the map, but consequences must be drawn from such connections for the location of productive forces as well as for the development of urban centres.

Depending on the level of cooperation with the neighbouring countries two extreme cases can be envisaged: the negative case in which the frontier territories remain empty and the focal points of both countries would be limited only to their internal innovations, and the positive case in which the frontier regions would flourish owing to their cooperation based on supplementary economic activities, whereas the important centres of both countries would be "fed" with innovations by "life-giving" traffic routes.

THE PRINCIPLES OF THE BAND-NODE SYSTEM

The feasibility study of various possible assumptions of the socio-economic policy is a research task of fundamental importance requiring the combined efforts of many scientific bodies.

At the end of this article — not going further into the analytical problems — I want to confine myself to the presentation of a picture of the future settlement network which I personally think to be as much probable as desirable.

The base of this picture is a web of bands already defined, which is divided into bands of the first order (in principle connecting the "entrances" to the territory of Poland), bands of the second order (connecting the capital and the regional centres with one another) and a few supplementary bands of lower order. Besides the bands already fully equipped, certain sections, (e.g., between Łódź and Wrocław), were introduced on the map (Fig. 3) for reasons which seem to be obvious. There is nothing to prevent a supplementing web of bands, being used, as new factors are introduced (e.g., newly discovered mineral deposits may justify this).

It is assumed that future tendencies of urbanization (in conformity with the principle of diffusing innovations) will spread out along the indicated bands including in future 95% of the so-called urban population. The map presents the "corridors" or axes of more intensive urbanization and probable ranges of urban agglomerations (Fig. 3.)

In order to get one's bearing, the areas with mineral raw materials and the major areas of high recreational-touring values should also be introduced on the map as well as areas of good soils for agriculture (protected). Bands may gradually be filled with structural settlement units with preference given to the higher order of these. These bands, when passing areas of mineral resources or highly urbanized regions, can grow in width, whereas on areas with good soils, forest coverage and touring-recreational amenities they may become thinner or even be reduced to through routes.

This picture is consciously simplified in order to present its basic features: the country's settlement network is treated as one system, and gives arbitrary possibilities for the location of new settlement units along the indicated bands. Several items must be added however which are not reflected in the legend of the map.

First, attention must be drawn to the fact that the growth of urban centres is in a feedback relation in respect to gradual improvement of the transportation routes

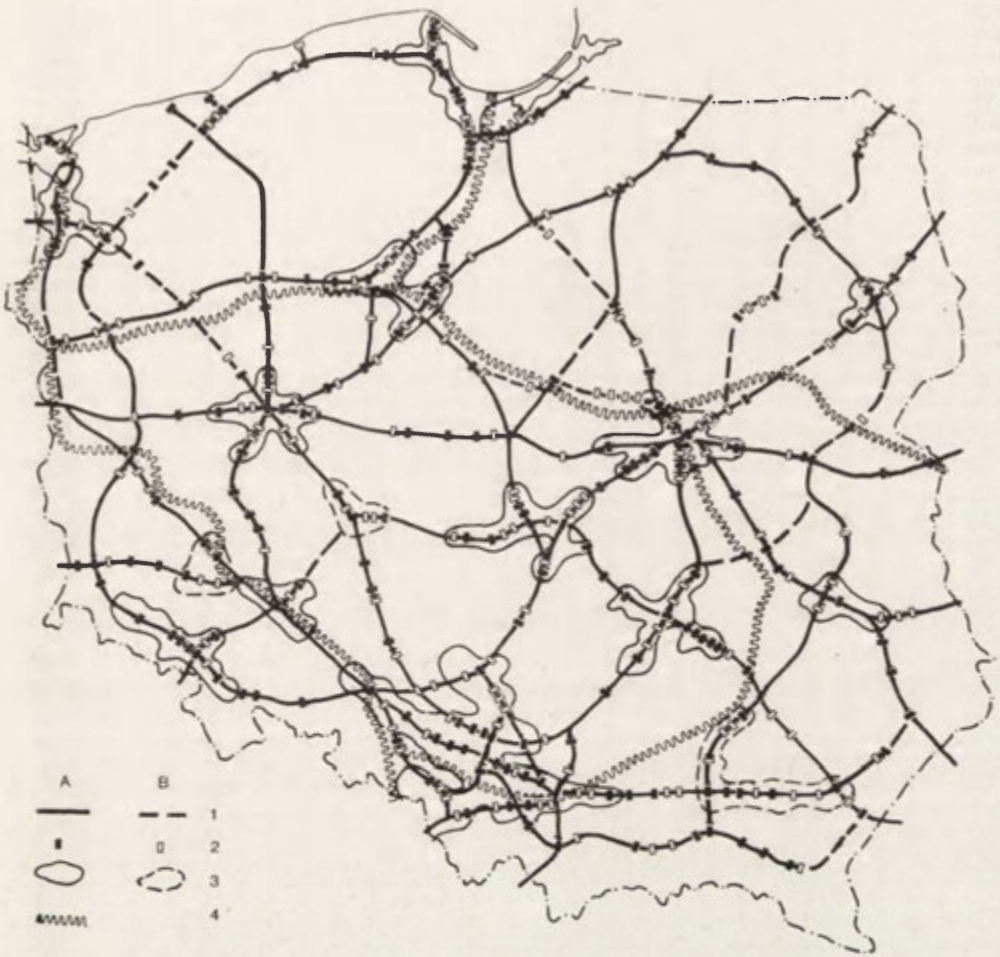


Fig. 3. Band-node system (hypothesis for the year 2000)

A — Existing: 1 — bands, 2 — settlement units, 3 — urban agglomerations, 4 — waterways
B — Postulated

connecting them. As towns grow, certain bands may need reinforcement by introducing motor roads, doubling the existing highways. Similarly railway lines need modernization or even doubling for purposes of traffic segregation (local and long distance). High tension power lines may be introduced into these bands, and even artificial systems of water supply and effluent disposal. The more, the infrastructural equipment is developed however, the more possibilities arise for urban growth along the given band. And it is within the nodes that the best conditions always prevail.

According to the scope and scale of infrastructural equipment along the bands, urban expansion may be of a dual character. The existing "towns" can be expanded as still separate units at relatively sparse distances (15–30 km). Their development, however, should be controlled so as to prevent concentric growth as well as ribbon development. Adding new urban units along the bands would probably take place primarily along the "branches" of existing agglomerations or in sections on which functionally determined conurbations emerge.

A separate problem, (not shown in the map) is the settlement pattern connected with farming. The "meshes" or open spaces of the band-node model are filled up by a tissue of farmland and forest. Due to historical reasons, however, the agricultural band is covered by a dispersed pattern of some 70,000 villages and hamlets,

which obviously require some sort of concentration and should be integrated in a radical way. Efforts toward concentration of the rural settlement network so far have been based on the model of central places which — to my belief — should be replaced now by a pattern that is the consequence of the band-node model. This matter needs to be comprehensively studied. As I see it, however, the tendencies should be to arrange the rural settlements along transportation strips either perpendicular or parallel to the course of the urbanized bands ("corridors"). The point is that the "meshes", i.e., open spaces within the band-node system, should be freed of development so as to facilitate the integration of farmland. Thus rural population will be closer connected with service centres and the current of urban life. I am aware that the ideas expressed here could only be carried out gradually and would need adaptation to local conditions. The point is, however, that it seems to conform more to the expectations of the population than the model used so far. It may help to eliminate "provincialism" and raise the technical and cultural potential of rural society.

The differentiation of tourist and recreational areas would require a similar comprehensive study (probably also on a regional scale). The settlement network connected with this function could be given diverse forms, depending on the physiographic features of the region (seacoast, lakes, mountains), and functional premises of the tourist industry.

In concluding this article I should like to emphasize that the model presented here, although based on one general rule (lines of innovations diffusion), should by no means be treated as uniform for all the regions. Proper consideration of all essential features of the geographical environment (natural or created by man) should make it possible to differentiate this overall pattern in the regional and local scale so as to make it best suited to the needs of the population.

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NEW METHODS AND TECHNIQUES IN SPATIAL PLANNING

RYSZARD DOMAŃSKI

Research work in new methods and techniques of spatial planning has been carried out with the intention of working out more efficient methods which would help to make studies of the spatial patterns of economic activity more effective and to improve the planning of such patterns. The research efforts focus on effecting advances in cartography, statistics and applied mathematics. Cartographic, statistical and mathematical methods involve the use of electronic computing techniques, which are treated as a tool of increasing the efficiency and further developing the available research methods.

In cartography, researchers concentrate on two major topics: modern methods of map preparation with the use of orthophotography, and methods of analyzing and processing cartographic data on digital computers. The former research project is being worked on under the supervision of Professor Zbigniew Sitek. The concept of the project and the results obtained so far can be summed up as follows.¹

Processed air photos set together into a photoplan are at present used to prepare various topographic or special maps. Photomaps both have a full metric value and retain all the characteristics of air photos thus providing data on the surface configuration, crops, plant cover etc. But they yield highly accurate photoplans only for surfaces with no significant drops, which obviously limits their applicability. Since photoplans have so far been used to cover selected areas only, they could not be incorporated in the final product, that is in the printed map. Photoplans are used merely as semi-products serving for the preparation of line maps and thus fail to reach a wide public of map users.

Orthophoto, instead, permits to produce accurate photomaps even for surfaces marked by high differences of the terrain. Orthophotographs are obtained by means of special instruments, generally furnished with slit devices, and using stereograms rather than individual air photos.

In producing orthophotographs it is possible to record data concerning the land surface configuration such that make it possible to prepare contour maps. Work on the application of this modern method in the production of topographic maps has been carried out for quite some time in the Soviet Union. In Western Europe it is already employed in current industrial production.

In Poland researches are carried out to develop methods of producing orthophotoplans and utilizing them for the needs of cartography in our country. Special attention is paid in it to the needs of spatial planning. The kind of machinery and apparatus currently available to Poland's geodetic and photo-

¹ The data on the particular research topics are taken from synopses submitted by the topic supervisors or authors, from phase reports and from reviews of completed works.

grammetric firms must be taken into account in these researches, as must the specific geomorphological conditions.

Analyses of literature data enabled Polish photogrammetrists to get information on modern appliances for orthophotography and to identify the optimal technology of producing orthophotographs. It has been established that the optimal technology is provided either by the GZ-1 Zeiss Aerotopo orthoprojector or by the 910-SFOM orthophotograph called the third camera. Each of these can be used to produce orthophotographs, in direct coupling either with an autograph or with an electronic control unit which guides the X, Y, and Z movements of the orthoprojector.

As regards the best way of supplying the geodetic control points for the preparation of orthophotomaps, analytical aerotriangulation has been identified as the most suitable method. The preliminary solution of this problem and experimental measurements of image coordinates on the photos suggest that the 15 Zeiss 18×18 stereocomparators safeguard sufficiently accurate measurements after eliminating the stereocomparator's systematic errors.

The second phase of the research project scheduled a practical study of the different systems of orthophotography used in Western Europe and in North America. Within this objective, members of the research team visited foreign centres. The studies carried out there and, more important, actual work on modern prototypes of orthophotographic apparatus enabled our specialists in geodesy and photogrammetry to get acquainted with new ideas and techniques in this respect.

The Department of Photogrammetry of the Academy of Mining and Metallurgy in Cracow carried out researches in three directions; their results helped, on the one hand, to explain the possibilities of determination of cross-sections by points for the needs of orthophotography, and, on the other, to work out methods of studying orthophotograms and to establish a way of control points extension for orthophotographic purposes.

The idea of obtaining analytical altitude data for the production of orthophotograms by carrying out measurements on stereocomparators and calculating vertical cross-sections of relatively small altitude differentiation (not exceeding 2% of flight altitude) and orthophotograms at medium scales (1 : 5,000) can be of practical use. The obtained data made it possible to calculate mean measurement errors and to analyse the error distribution by the chi-square test. This enabled to establish the number of points necessary for 1 sq.km of relatively even land at 1 : 4,000 and of jagged land forms at 1 : 1,000.

Researches on the accuracy of differential rectification helped to establish a technique which by analysing the deviations of coordinates of the points registered on the orthophotograms permits not only to determine the accuracy of the orthophotogram but also to distinguish systematic errors, indicate their causes and estimate what accuracy of differential rectification can be possibly achieved after eliminating the systematic errors.

As regards the determination of the control points indispensable for producing orthophotomaps, a detailed analysis was made of the problem of image coordinates determination by introducing certain modifications into the computer programs. This comprises the method of studying the stereocomparator and identifying its systematic errors. It was established that the stereocomparator employed has systematic errors such that may be neglected in the computing technique. Analytical aerotriangulation for one series of photos was made, and preliminary results seem to suggest that this map provides sufficient control points for the production of orthophotograms.

The third phase of researches comprised mainly the practical aspects using orthophotography in producing maps. The experience gained permitted to work out a shortened instruction for the orientation of photographs on Topocart and Orthofot, and to establish the usefulness of both appliances. This evaluation turned out to be unfavourable, especially for Topocart, which suggests that the future of orthophotography in Poland must not be based on these devices. Both are fairly unreliable, their frequent disrectification or inefficiency enforce long breaks in production and since there are no servicing stations in Poland their owner may have to face substantial losses in capacity. To oust Topocart from the production of orthophotomaps and to divorce the process of producing orthophotographs from that of obtaining data for the rectification, i.e., from the model profiling, it was proposed to construct a supplementary analog recording appliance. It is difficult to judge the usefulness of this idea at this stage as the technique of recording and playing back the analog signals is now in the phase of practical testing. This idea, according to an expert's opinion, seems to be worth supporting.

As regards the photogrammetric control points indispensable for producing orthophotomaps, attention focused on the absolute levelling of aerotriangulation. Three methods of adjustment — planimetric strip adjustment, three-dimensional strip adjustment, and X, Y, Z block adjustment of independent models — were submitted to experimental testing. Each of these three methods was shown to be useful in aerotriangulation levelling.

The mean errors in each of these methods meet all the requirements for the control points to be used in map production. It was also shown that absolute model levelling can be achieved with considerable approximation to prepare orthophotographs. However, the tables of mean errors of aerotriangulation contain too few of the points included in the study and thus are not fully representative.

The existing methods of producing large-scale maps with the use of orthophotographs were analysed against the background of foreign achievements in this respect. Various forms of presenting orthophotomaps intended for different uses were described. Seven examples of foreign publications are given to illustrate the final form of the map.

In Polish conditions, orthophotomaps can be reproduced by one of two methods (according to Dr K. Podlacha): photocopying or offset printing. Specific technologies were proposed for each of these methods to produce prints of orthophotomaps which contain both halftone pictures of the area and line elements together with the indispensable verbal explanations on the map. The proposed technologies permit to adjust the quantity of information contained in the line picture of the orthophotomap according to current needs, without the necessity to switch over to another technology.

The problem of reproducing orthophotomaps can be solved in Polish cartographic practice if the following methods are adopted: (1) the optical montage method which permits to give identical contrast to all photos of orthophotomaps and to eliminate traces of film cutting (along the edges of the photos); (2) the contact screen method which permits to transform the halftone picture of the orthophotomap into a picture composed of points thus making it possible to print them by the offset technique.

Work on the "Methods of analysis and transformation of cartographic data on computers" is carried out under the supervision of Professor Michał Odlanicki-Poczobutt.

The current needs of national economy include the use of maps of different scales and various contents in solving spatial problems. The practical methods

of cartography used up to now are very time-consuming and reduce the possibility of representing topographical contents. Problem maps and generalizations of map contents are predominantly made by hand. This encumbers the cartometric quality of the maps and makes the study, planning and technological designing of maps both more time-consuming and difficult.

In many advanced countries automatic coordinatographs and computers have been successfully introduced for the purposes of cartographic production.

The planned research work is intended to adapt the now available cartographic apparatus and mathematical machines together with possibly constructing new appliances such that are suitable for analysing and processing cartographic data on computers in Polish conditions. The methods now developed permit to extend the scope of the analysed problems, to improve their cartographic quality and to reduce the time of work.

Using the foreign literature of the subject and in view of the current national needs, a preliminary project of a computer system for preparing problem maps has been prepared (Professor Jerzy Gaździcki). In the first phase this project provided for the use of the ODRA-1204 computers and the OPTIMA automatic printing devices, both widely used in Poland. The second phase comprised a preliminary version of the system including programs for two kinds of maps composed of rectangular (square) unit fields: (a) maps of unit fields containing suitable combinations of printing types according to a preselected scale of blackening; (b) maps of unit fields in which the particular problems are presented in the form of numerical values.

These programs were submitted to tests and used practically to prepare 15 maps of Poland's population and population potential in 1950-1970 for the Committee of Space Economy and Regional Planning of the Polish Academy of Sciences.

Computer methods are useful and indispensable to produce what may be called moment maps, which are employed in analyses of the spatial distribution in sparse or large sets of rapidly ageing data. Maps obtained in this way find their practical use as synthetic cartographic illustrations of a definite system of the data bank, which is continually in operation and is continually updated.

Moreover, a program of computing and printing simplified maps of isolines on the basis of a numerical model of the presented area has been worked out. The basic source of information concerning a given problem is the set of dispersed points written as x , y , c , where c is the feature of a point of coordinates x , y . This program makes it possible to use any printing device and to produce maps in any graphic version to any scale.

Although appreciable results have already been achieved, it is necessary to point out the need of further work, especially toward improving the techniques of isoline maps and devising special printing type to represent different intensities of phenomena.

Other researches yielded the documentation and a model of a graphic-numerical converter to be used with the GEO-2 computer. The converter permits to digitalize maps and designs by points. The coordinates of any point are recorded directly in the computer memory by adjusting the device to that point and pressing a special button. The graphic-numerical converter consists of: (1) a mechanical-photoelectric module, and (2) an electronic module.

Tests showed that the model works with an accuracy of ± 0.2 mm and that it is possible to improve this accuracy. The working surface is 350×500 mm. Whenever it is necessary to produce larger formats, the transformation of coordinates recorded in several arbitrary positions converter positions can be used.

It became possible to extend work in this field after the Institute of Mining and Industrial Geodesy of the Academy of Mining and Metallurgy had started operating its automatic coordinatograph CARTIMAT III. A number of people finished an instruction course of operating the device.

Computers can also be used in the interpretation of cartographic data concerning the geographic environment for the purposes of spatial planning. One research project (Dr Regina Truszkowska) is intended to work out a method of obtaining analytical and synthetic descriptions of the elements of the geographic environment from the source information contained in the cartographic documentation. So far the principles of numerical recording of source data from cartographic documentation have been established in researches which comprised:

(1) An attempt to record — in various ways — data from the elements of contents of maps of different scale and different topics. This included the recording of surface elements from the following maps: 1 : 1,000 — the principal map, 1 : 5,000 (1 : 4000) — the map of properties and 1 : 10,000 — the topographic map. The distinguished areas of the map contents elements (the source data on the features of the geographic environment) were recorded with a KART-2 coordinatometer and through a grid of square fields of 0.4 cm and 1 cm long sides. In recording by fields two ways of determining the area of the identified map contents elements were employed: with accuracy of 0.1 of the grid field, and with accuracy of up to the whole grid field, i.e. by the "yes" or "no" method (data either do occur in a field or not).

(2) The adaptation and extension of the index of source data concerning the geographic environment prepared before. In the new form, the "index" was adapted to practical use in recording the numerical data on the geographic environment that are at all possible to achieve from the large-scale cartographic documentation which is formally employed in Poland. The data contained in the index were recorded on an 8-channel perforated tape and can at any moment be made accessible whenever it is necessary to obtain data from large-scale maps.

(3) A description of the method of numerical recording of source data on the geographic environment.

A prerequisite for spatial planning and space-economic decision-making is the availability of statistical data concerning socio-economic development in territorial cross-sections. The efficiency of planning and decision-making is dependent on the information basis. Statistical data can be collected, processed and used efficiently provided they constitute a well-ordered information system rather than a random congeries, and hence it was suggested to work out the problem of "Organizing a bank of statistical data on socio-economic development in territorial cross-sections".

This problem was taken up by the Central Statistical Office with Dr Tadeusz Walczak, Dr Jan Iszkowski and Mr Janusz Stepiński sharing the responsibility for the progress of the work. Data on the spatial development of Poland are part of the national system of statistical information. Within the framework of this system, data on the country's spatial development are to be collected on two levels:

— the central level, which comprises the basic data on the socio-economic development of the individual administrative units of Poland (rural communities, poviats, voivodships), and

— the voivodship level, which covers a wide range of detailed data relating, if necessary, to spatial patterns.

The organizational structure of the data system provides for the central bank of statistical data run by the Central Statistical Office Electronic Centre

in Warsaw and the regional banks of statistical data run by the electronic centres of each voivodship statistical office. One subsystem of the central data bank called Local Data Bank (BADATER) will collect and update information on each administrative division unit. Up to now, within the BADATER framework a set of statistical indexes characterizing the socio-economic development of the administrative division units has been worked out.

Parallel to the preliminary work on the BADATER problems, to CSO Electronic Centre organized and started operating a system called Population Summary Data Bank (BADASEL). Basing on the data collected in the 1970 Population Census this system updates the population number and age and sex structures for each unit of the nation's administrative division revising them against natural increase and migration data (births, deaths, changes of address). The Population Summary Data Bank is to be incorporated into the BADATER as soon as this latter has been organized.

As regards the preparatory work on the regional data banks, an experimental data bank for the industrial enterprises located in the Katowice voivodship was devised and put into operation. Its basic function is to integrate all information on each enterprise that can be derived both from various statistical reports and from direct access to the desired information. The total body of information collected and updated in that bank can be aggregated in terms of the administrative division units and by industrial districts.

Since the regional data bank comprises — in its experimental phase — merely the sector of "Industry", the gradual incorporation of further fields of economic and noneconomic activity is planned.

The first of these sectors to be put on the working schedule was "Agriculture" which, in its prototype version, is to be localized in Poznań. In 1972 an analysis was made of the information system on the contracting and purchasing by the state of farmers' supplies of agricultural produce which constitutes but the first phase of concrete work on the development of this data bank.

In the field of applied mathematics, the research project stipulated the theoretical development and empirical verification of the mathematical methods used:

- (1) in projecting, analysing and evaluating the spatial patterns of economic activity,
- (2) in optimization of these patterns,
- (3) in process modelling and in the planning of socio-economic development in space.

The actual work in progress covers but a part of this extensive research area.

The following are some of the topics pertaining to the first group of problems: "Numerical methods in the integrated comparative analysis of urbanized areas from the standpoint of transport network efficiency" (supervisor: Assistant Professor Tadeusz Zipser), "Model analysis of the output and economic structure of the Poznań region and its internal and external links" (supervisor: Professor Seweryn Kruszczyński), "Approximation of regression function in space-economic models" (supervisor: Assistant Professor Stefan Abt).

To develop further the methods available for representing complex spatial structures the numerical methods involving the approximation of regression functions was submitted to a series of studies. To verify the model of spatial structure against empirical evidence, data on the private expenditures structure were taken. This led to formulating the characteristics of the model. Analyses of projections of interregional differences in living standards permitted

a mathematical evaluation of the factors incorporated in the model and the numerical possibilities of the computers used. Moreover, the accessibility of source information indispensable for research work was discussed.

The second phase consisted in preliminarily verifying the method. The choice of variables and of the functions of the interdependence model with data on the structure of expenditures as empirical evidence was discussed. This phase yielded the following results:

(1) The preliminary analysis of the empirical material as regards the structure of consumption. A description of the statistical data that were at disposal was followed by a formulation of the fundamental research problems. Next, an Odra-1013 computer was used to develop an interdependence model on three levels of generality: with an aggregated vector of expenditures, with an incomplete vector, and with an extended vector of expenditures. The studies on the practical application of each of these versions consisted essentially in searching for the proper forms of functions which could be used to describe the inherent causative relations. As the point of departure, it was hypothetically assumed that the relations of dependence are linear in character. After this hypothesis had been verified, it was possible to formulate further operative hypotheses. This specific procedure yielded a number of approximations which furnished considerable experience as regards the numerical description of the economic regularities detectable in consumption. The parabolic and the Tornquist forms of the function turned out to be the most suitable forms.

(2) The motivation of activities, comprising the working procedure as applied to the empirical material and expressed in terms of cybernetics. Starting with a description of the decision-making process, the system of data processing and the consumption vector against the object submitted to control were discussed. The next problem considered was that of model identification, with special emphasis on regression analysis, which will be a subject of further procedure phases. The intra-model relations suggest some extension of the problems and links with other types of models, especially control models, including models of consumption control.

(3) The problems of choosing the variables required special treatment. Both the methodological assumptions resulting from regression theory and the experience of preliminary application of the material evidence to the suggested model were taken into account. Particular attention was paid to the criteria of choosing the variables and to curvilinear functions. The method of estimating the parameters of curvilinear regression, which so far has not been worked out yet, will have to be developed in the further phases of the work.

In studying the output and economics structure of the Poznań region two methods were used: the analysis of interindustry flows and the Cobb-Douglas function. The first phase of work consisted in collecting and analysing the statistical material indispensable for constructing production function equations and tables of internal and external links for selected industries as well as for the interindustry flows of the regional economy as a whole.

The analysis of the interindustry flows in the Poznań region included statistical data relating to the matrix of direct material-intensiveness coefficients (on the basis of the 1965 national balance in 30×30 aggregation) as well as the value of total output, material costs, power consumption, depreciation, net output, accumulation and others.

The situation is most difficult in agriculture where agricultural censuses, questionnaire polls sponsored by the Institute of Agricultural Economics, and averaged technological normative outputs still of necessity provide the source

bases. Hence the studies of inter-branch flows within agriculture produced so far only a list of internal or external links of agricultural output in the region in 1965/66 and 1969/70.

The construction of input-output tables for selected food industries in 1965 and 1969 was commenced too.

For a 3-factor production function were taken and analyzed data concerning total output, fixed productive capital and total employment in the socialized industries of the Poznań region for 1961–68. These data were compiled by branches, in each case for three subperiods, 1961–1966, 1962–1967, and 1963–1968.

The analysis of the production function starts with studying the relations of capital-intensiveness of production, capital-to-labour ratio and productivity per employee, all of which are moreover indispensable elements of estimation procedures for the parameters of that function. The dynamics of the production process was characterized by means of averaged relations, with special emphasis on comparing the industries of the region with the national indexes.

Currently there is an urgent need in practical urban and regional planning for a set of criteria of an integrated analysis of transport systems. Especially useful could be comparative analyses indicating the optimal choice out of several variants. The criteria now at hand comprise in fact only the capacity of the transportation system (without providing for the necessary elasticity of this feature) and investment costs. Hardly any or no attention is paid to the total time of the system users, total delays, geometric route overlaps, collision likelihood etc. It is already possible to develop objective methods and numerical analyses and to characterize the transports system. Considerable advance has already been made in this respect. But the great number of computational operations involved imposes not only makes it necessary to use the computer but also to seek the most feasible algorithms and related techniques.

The work carried out thus far yielded a set of algorithms and programs concerning:

(a) the computation of traffic exchange between transport regions together with the resulting typology of regions,

(b) the computation of network loads with the use of the computer-identified shortest route and several shortest routes between regions,

(c) indications as to constructing networks on the basis of the obtained loads of traffic lines in an area (cluster-selective plans),

(d) additions to the above programs permitting to follow up the effects of variant stretches of the network and to determine the geometric area of the network's influence (the boundaries of competitive accessibility), the loads of public traffic networks considering the paths of concrete transport lines, loads of the shortest route identified in the transport network considering the network capacity of individual segments and the effect of loading on the average ride time for each segment — the record of loads permitting to record the "traffic interplay" between the nodes of the network — and moreover versions of the cluster-selective plan and of traffic exchange by the "intervening opportunities" method in Algol-1204 language.

Optimization problems were taken up in two studies: "A method of optimal investments location in local plans" (supervisor: Assistant Professor Stanisław Broniewski) and "A method of choosing an optimal variant of Poland's spatial structure" (supervisor: Assistant Professor Jan Goliński). The former is intended to improve and develop the method devised in the course of studies on the general plan of Warsaw city and subsequently employed in optimizing the plans of other cities, including the Yugoslav Skopje. Neither the theoretical founda-

tions nor the procedural rules of this method, created and developed to meet concrete practical needs, have been fully described yet.

The method consists essentially in quantifying as many elements as possible and subsequently to use these in choosing the area; the list of the elements is open. At the same time, the method tends to take account of the largest possible number of nonmeasurable or hardly measurable elements; hence it provides for procedures of taking into account those elements so as to safeguard maximum objectivity for the reasoning. By dividing the procedure into several phases the method permits to seek alternately the minimization of inputs for a given effect or the maximization of effect for previously given inputs; simultaneously, the decisions field is gradually being restricted and the tools of choice used become more and more precise.

For several of the procedure phases mathematical formulations were supplied and adjustments were made to make possible their computer processing.

The second study tries to identify the optimization algorithms that are useful in solving the problems of spatial planning. The study starts with a survey of the algorithms realized on computers in Poland insofar as they are useful for the identification of the optimal variant of the nation's spatial structure. As the model was not assumed to be linear in character, in addition to a consideration of linear methods the study considers a number of nonlinear programming methods, among them

(a) gradient methods:

- those by Rosenbrock and Gauss-Seidel,
- that after Wilde,
- those in which the gradient is calculated in points close to each other from the differences in the goal function.

(b) random methods:

- the unrefined Monte Carlo method,
- a wandering process with free controlling search.

(c) combined methods:

- such that combine elements of gradient and random methods.

This study contains a tentative classification of linear optimization algorithms. In this context the difficulties resulting from the choice of the algorithm which is most suitable for solving the given problem are brought out. The study proposes a way out of these difficulties by providing the foundations of a self-teaching optimization system. The system consists of a number of algorithms that are automatically chosen by a master program. The working algorithm is evaluated against the adopted order of values depending on the results it managed to obtain within the given time interval. The likelihoods of choice for the algorithms changes after each period of work of an algorithm within the time interval allotted to it. The master system "learns" in that it accumulates the experience resulting from solving the current problems. Three possible solutions of the system are given in the study.

Once the principle of creating a self-teaching optimization system for spatial-planning problems is adopted it becomes important to choose the most suitable optimization algorithms. The study describes the optimization algorithms proposed for the system. Their efficiency was checked in a series of test problems.

To secure an adequate classification of problems in spatial planning and to choose the proper method of their solution, the problems and strategies for finding optimal solutions were analyzed. A general description of the problem is provided which is indispensable for studies carried out by linear programming methods.

In justifying the adopted project solution an analysis was made of different criteria of evaluating linear programming algorithms together with tentative suggestions concerning the choice of the proper algorithm for the problem under solution. As a result it was recognized as possible to develop an optimization system that would combine the effects of both strategies. With a view to developing an adaptation system the Bush and Mosteller algorithm was used and an evaluation criterion for algorithms was formulated.

In the realization part of the system a detailed description was given of the network of system operations and the initial parameters were selected. Accurate characteristics were provided of the individual subsystems: the functions of these latter are fulfilled by realizations of various strategies of finding optimal solutions. Next comes a description of the structure of input and output data and selected examples are discussed including the way of writing the user's part.

Dynamic problems in spatial planning are discussed in the study entitled "Computer-simulated forecasting of economic processes in space" (supervisor: Assistant Professor Jan Golinski). The authors of this study argue that the problems of spatial planning worked out on computers always yielded a large number of data and vast, though not always useful analyses. A critical review of earlier research techniques indicated that simulation techniques are best suited for the purposes of planning spatial development. Simulation is free from the deficiencies of other methods and secures a relatively full modelling of spatial development.

In applying simulation techniques to complex problems, the characteristics of the language selected chosen for the simulation are decisive about the success or failure. These include semantic syntax clarity and providing possibilities for writing complex programs in a structurally clear manner. Analyses carried out showed that the language SIMULA 67, an extension of ALGOL 60, is best suited for this purpose. The specific characteristic of this language are described.

The authors employ structures of their own, developed on the basis of SIMULA 67, as an example of process simulation. The process involved is the cooperation of industrial plants localized over a suitably developed area. The example showed that the proposed technique is useful, especially perhaps in verifying different variants of undertakings in the project stage.

The use of computers for constructing models of regional planning is discussed in "The employment of computers in studies of open regional systems" (supervisor: Assistant Professor Stefan Abt). The purpose is to formulate the requirements that models are expected to fulfill, especially models of consumption, and to find what constraints result from different types of machines used already or planned to be used in Poland.

Analyses of models for spatial planning proposed before showed that they contain a number of theoretical concepts that had not been verified empirically yet. Against this background control models and spatial-interdependence models were discussed, together with the implications of borrowing formalized control processes from technology and adapting them to the study of socio-economic phenomena and processes in regional terms. Also indicated were the constraints restricting that adaptation and several requirements concerning the organization of statistical information were formulated. The same study presents then the phases of constructing the model and the choice of explanatory variables and of suitable forms of descriptive functions. This is followed by a discussion of the principal problem of the research project, which is the employment of electronic computers for the control of national economy. The optimization of the consumption structure was taken as example.

To take up the problems of consumption it was necessary to determine the function of needs. Against an analysis of the needs of a capitalist society the authors discuss the evaluation of consumption models in socialism. They also present the difficulties encountered in determining the terminal function of needs in planning the level of private consumption.

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