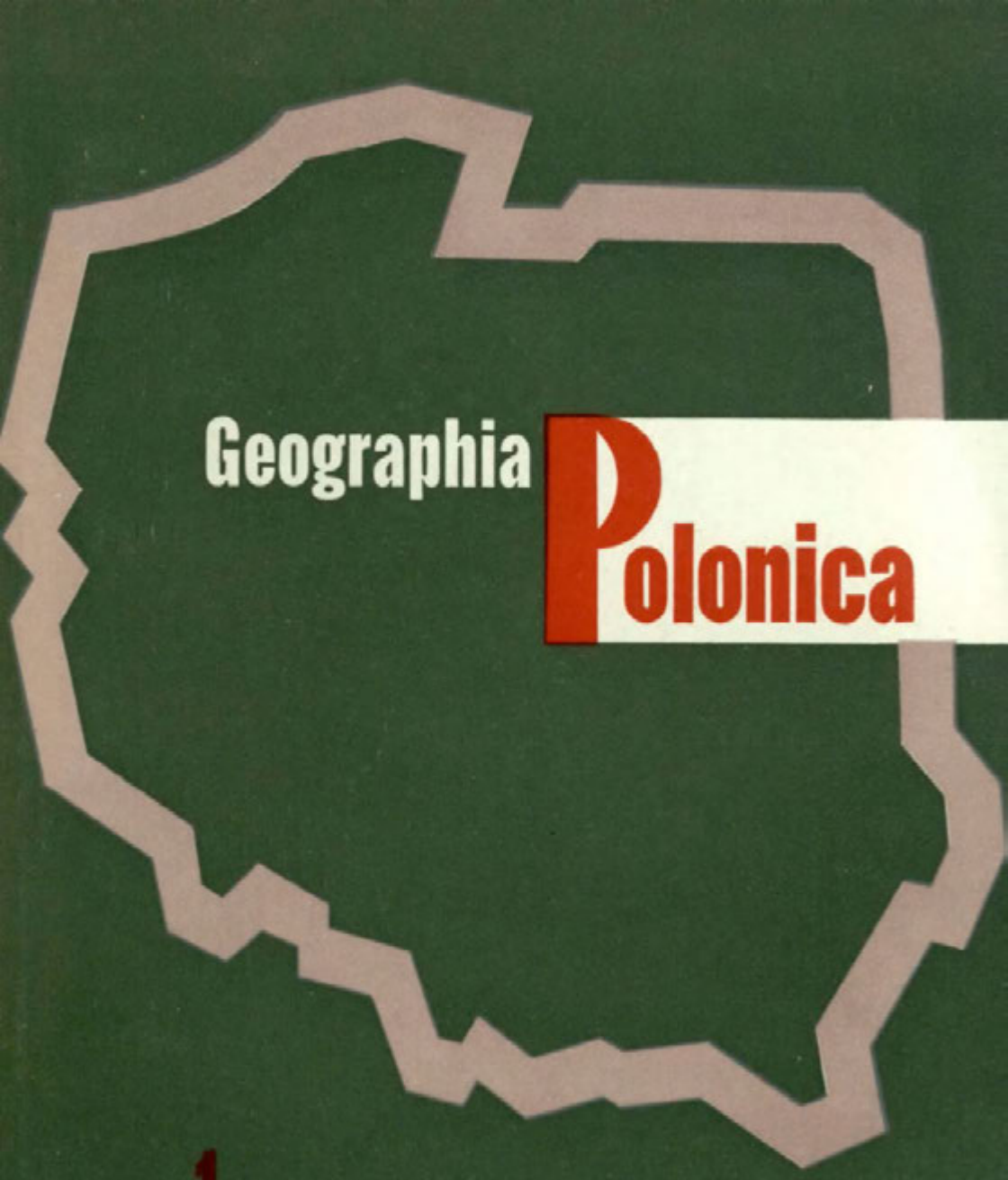

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FOREWORD

In spite of the fact that there appear, throughout the world, about one thousand geographical periodicals in various languages, making it difficult, with the present state of the information and bibliographical services to obtain a precise idea of their contents, it has, nevertheless, been decided in Poland to begin the publication of a new geographical journal. The journal initially has been conceived as an annual or periodic publication, but, as time goes on and the journal develops, it it hoped that it will become a semi-annual or even quarterly publication. The new journal, entitled «Geographia Polonica» will be published in several foreign languages.

Geographical studies published in the Polish language, even though they reach a considerable number of geographical centres, are rarely read because of a lack of knowledge of Polish. The brief summaries in foreign languages provide too superficial a coverage of the contents of the articles published. Yet geography in Poland continues to make progress, just as it does in a great many other countries. Making available evidence of this progress is possible only through publication in the most widely-known languages. We have, in Poland, made several attempts to demonstrate our progress in the years from 1956 to 1962, by printing supplements to the «Przegląd Geograficzny» (Geographical Review) in foreign languages (in 1956, 1959 and 1960), primarily on the occasion of International Geographical Congresses. Reports on the Anglo-Polish Seminar and other international conferences which took place in Poland have also been published in foreign languages. All such publications, even though they have appeared but sporadically, have been favourably received by foreign geographers. Evidence of this reception may be found in the fairly numerous reviews published in foreign geographical journals, principally in the English-speaking countries.

It was for the reasons mentioned above, that we have decided to begin issuing a special publication, instead of the sporadic supplements. It will be printed mostly in English, but not to the exclusion of other languages used at international geographical meetings.

A no less important reason for undertaking a new publication of this type is the fact that we consider the geographical sciences to be international sciences, which can develop correctly only under conditions of the fullest possible international co-operation. For that purpose mutual understanding is indispensable, and this requires the use of a common language and, more particularly, of clearly defined concepts, designated by established terms. We are of the opinion that, up till the present day, national tendencies have predominated in geography, a fact which is borne out by the great number of geographical publications which, as demonstrated in the bibliographies, quote essentially only the works published in the authors' own language or country. The new publication, «Geographia Polonica», is intended to stress international co-operation and these elements of international understanding will receive first priority, in order to contribute, however little it may be, to the transformation of the geographical sciences into a truly international science.

In the beginning we intend to publish the contributions by Polish geographers which bring new values to the development of the geographical sciences, or, at the very least, sum up the achievements of Polish geographers in certain fields, as particular contributions at the international level. There will be summaries of articles or translations of more comprehensive original studies, previously printed in Polish or else especially written in order to inform foreign geographers of the results achieved in Poland. For this reason the principal emphasis will be placed on methods of study and methodological contributions, as well as on survey- and information articles. Later we shall include in «Geographia Polonica», the reports prepared by Polish geographers for international congresses and conferences, as well as the proceedings of those conferences which will have been organized by Polish geographers, or will have taken place in Poland.

In the future, when our publication has become sufficiently known abroad, we intend also to open the columns of the «Geographia Polonica» to foreign geographers, who incline to the idea of international co-operation and aim at providing the geographical sciences with an international character.

The present volume is the first of the series planned. Unfortunately it falls short of the aims which we have enumerated above. We hope, however, that the succeeding volumes will approach more nearly the objectives outlined by the editors.

Warsaw, July 1963.

Prof. Dr STANISŁAW LESZCZYCKI
Editor-in-Chief of the
«Geographia Polonica»

GEOGRAPHIA POLONICA 1, 1964

RESEARCH PROBLEMS IN POLISH GEOGRAPHY

Stanisław Leszczycki

The present article is an attempt to describe the characteristic features of geographic research now conducted in Poland. Elsewhere [4] I have presented the history of Polish geography, a history which dates to the fifteenth century, and have provided an evaluation of Polish geographic science both in the inter-war period [5] and after World War II [6]. It should be emphasized that the present situation of geographic science in Poland is altogether different from what it was in the inter-war period, since nowadays Polish geographic science has developed widely and has considerably larger possibilities at its disposal than was the case before the war. This is due to two factors: first, the government of the People's Republic of Poland devotes to science (including geography) incomparably larger financial resources, and, second, the role and importance of geography as a science have considerably increased, since the problems dealt with by geographic research are frequently closely related to everyday life, while the results of geographic research are made use of by State executive organs.

The organizational and financial basis of geography in Poland

In order to be able to evaluate properly the progress made and the development possibilities of Polish geographic science, it is necessary to describe its organizational and financial basis. A detailed scheme of the organization of geographic science in Poland has been provided at the end of the present volume. At the present moment there exist in Poland seven University faculties in which geography is taught and two special faculties of geography at Teachers' Training Colleges which train secondary-school teachers. Apart from those there exist departments of economic geography in six Colleges of Economics and two departments of geography in the Colleges of Technology in Warsaw and Szcze-

cin. All the above geographic centres simultaneously conduct research work. The largest research centre is the Institute of Geography of the Polish Academy of Sciences, which employes about one hundred and fifty persons. Altogether all the above-mentioned institutions between them dispose of about eighty independent scientific workers (professors, associate professors and lecturers), including 25 in physical geography, 23 in economic geography, 15 in regional geography, 6 in cartography, 4 in historical geography and 4 in history of geography, as well as nearly three hundred auxiliary scientific workers (instructors, assistants and technical assistants). To the above numbers should be added about one hundred geographers, who do not work in any scientific teaching centre, and who yet conduct scientific research. They are mostly secondary-school teachers and employees of planning offices, of publishing and cartographic institutions, of non-geographic scientific institutions, etc. It may therefore be assumed that there are, in Poland, about five hundred geographers who contribute to the development of geographic science.

A considerable part of the research undertaken is published. In Poland there are published four geographical periodicals, more than ten serial publications, and every year there appear about fifteen books as well as many various articles printed in miscellaneous non-geographic publications. A list of the more important geographical publications which appear in Poland has been provided elsewhere in the present issue. Altogether about 6400 to 8000 pages of text are printed every year [1]. It is worth mentioning the fact that the Polish Geographical Society publishes a popular monthly *Poznaj Świat* (Know the World), whose distribution amounts to about 110,000 copies, a striking witness to the considerable popularity of geography in our country.

About two thousand Polish geographers are members of the Polish Geographical Society, which has existed since 1918. The Society has about fifteen local branches, publishes its own publications and concerns itself with the popularization of geography. At the same time, however, it also organizes scientific research and discussions on methods of teaching geography.

The planning of geographical research is dealt with by the Committee of Geographical Sciences of the Polish Academy of Sciences, which is the highest authority on geographical matters in Poland. The Committee co-ordinates research work and controls the trends of development in Polish geography.

[1] The majority of the geographic publications are published by the Polish Scientific Publishers (Państwowe Wydawnictwo Naukowe), where there is a special editorial board for geography. The largest cartographic publishing house are the Polish Cartographic Publishers (Państwowe Przedsiębiorstwo Wydawnictw Kartograficznych).

For purposes of co-operation with other countries there exists a Polish National Committee, an organ connected with the International Geographical Union. Polish geographers maintain lively contacts with foreign countries and take part in many international activities, more particularly in those fields connected with the I.G.U. In some of its work they play an important role (e.g. the Commission on Periglacial Morphology of the I.G.U., the Commision on Methods of Economic Regionalization of the I.G.U., the Sub-Commission on Geomorphological Mapping of the I.G.U., the I.N.Q.U.A., and still others).

For the training of geographers in the academic schools there is a panel of experts attached to the Central Council, called into being by the Ministry of Higher Education. The studies in Poland take five years, and geography is their only subject. The curriculum of studies is uniform in all the universities. The curriculum of the first three years is the same for all undergraduate. During the next two years specialization takes place in one of several branches of geography (physical geography, geomorphology, climatology, hydrography, cartography, economic geography, the economic geography of Poland). The curricula of such special studies are, in principle, established in cooperation with the institutions which are later on to employ these geographers. It has been found that nearly one-half of the geographers who graduated from Polish universities within recent years find employment outside the schools, mostly in town-planning offices. The necessity arises, therefore, of changing the hitherto existing system of training geographers in the universities.

Selection of subject-matter for research

The range of geographical problems investigated in Poland is fairly wide and continually widens, as the number of scientific personnel increase. The starting-point for such scientific research after World War II was a continuation of the work conducted in the inter-war period, and consequently similar to that conducted in other European countries. Geography was at that time developing under the influence of Hettner's landscape theories, and geomorphology, climatology and anthropology were studied, as well as political and regional geography. In cartography E. Romer's method of pure hypsometry reigned supreme. Specialized work also developed in the field of geomorphology, mostly of the Quaternary period, of climatology, hydrography, and particularly of limnology. In the field of anthropogeography the most popular branch of research was that on the geography of settlement from a historical point of view, or else with a strong emphasis upon the external, physiognomic features of settlement. Less popular was the geography of population

(nationality problems), and contributions to the geography of agriculture or the geography of industry were great rarities. Cartometric work was also undertaken and new methods were sought in economic cartography.

In the post-war period it was the research connected with the reconstruction of the country that took first place, such as e.g. the work connected with the tracing of new boundaries, descriptions of the new territories, and, finally, various regional contributions for physical planning. The practical needs of post-war Polish life greatly influenced the nature and topic of geographic research. After World War II Polish geographers became acquainted in greater detail with the achievements of Soviet geography. This influenced, first and foremost, a change of methodology in the approach to geographical problems, more particularly so in economic geography, as well as in the selection of subject-matter and the methods of research. A fundamental feature of this change was the conversion to a materialist philosophical basis, and to the interpretation of various phenomena, principally social and economic, from the Marxist position. Of course, this did not take place without difficulties and discussions. As, however, Polish geographers had always considered it to be their task to investigate reality, and to approach that reality in an objective way, the overcoming of the thinking habits of idealist philosophic systems was not unduly difficult. At the same time contacts were not broken with other countries, and we attempted to watch the changes that were taking place in foreign geography after World War II. As time went on, contacts between Polish geographers and those from both East and West grew closer, comprising countries belonging to either of these zones. The maintaining of wide contacts with foreign countries has made it possible to introduce into Polish geographic research ever new and actual problems, as well as new methods of research.

Division of the geographical sciences

The social and political situation favoured, and indeed imposed the necessity of, discussing the methodological foundations of geography as a science. Tasks of a practical nature demanded the assistance of geographers in many sectors of life. Such assistance could only be extended by geographers properly trained and specialized. Geographic research went in for specialization. This has made possible the making of the bases of research more profound, but has, at the same time, caused a division of the geographical sciences into a number of divisions, branches and specializations. This has exerted a great influence on the further development of geography, and thereby also on its present status. On

the basis of an analysis of the contributions published by Polish geographers it is possible to distinguish the following divisions in the geographic sciences: 1) physical geography, 2) economic geography, 3) regional geography, 4) cartography, 5) historical geography, 6) history of geography, 7) mathematical geography, 8) other contributions not included under any of the above seven divisions.

The several divisions of geography are unequally developed, and the achievements of Polish geographers in these divisions varies. Side by side with large divisions such as physical geography or economic geography, in which the achievements are relatively considerable, there exist much smaller divisions, such as mathematical geography, in which the achievements are relatively small.

Physical geography

In the domain of physical geography it is geomorphology that is most highly developed. It has a long tradition behind it, an important group of specialists, as well as numerous young scientists. Contributions in the field of geomorphology are the largest, both in their quantitative and in their qualitative aspects. Since Polish geomorphology has been written about many times, both by Polish and by foreign geographers [1, 2, 3] there is no need to dwell at length on the subject[2]. It may be worth while merely to mention the fact that research here is concerned mainly with quaternary relief. Of course, neither the older tertiary relief nor the more recent holocene relief are entirely neglected.

Moreover, geographic research deals with karst phenomena, with various contemporary geomorphological processes, with the processes active on slopes, with granulogical research on sands, and so forth.

The second place belongs to climatology, which Polish geographers had studied since the beginning of the twentieth century[3]. In the field of climatology there are as many as five departments in Geographic Institutes, and a large group of both older and younger climatologists. The range of the problems investigated is wide. Side by side with research on the various meteorological elements, such as, e.g. temperature, precipitation, pressure, and so forth, whether on the territory of Poland or over larger areas an ever greater emphasis is being laid on complex research on climate as a whole. Such complex research is conducted on selected types of geographical environment, or in settlements, such as e.g. health resorts, from a bio-climatic point of view, or else

[2] The contributions which deal with Northern Poland are discussed in the present issue by R. Galon, p. 23–39.

[3] Cf. the article by W. Okołowicz, p. 41–51.

in industrial towns, from the point of view of the anthropogenic deformation of the climate. Lately research has been undertaken on the heat balance-sheet, which is to serve also in the regionalization of climate, and, in the future, possibly also the compilation of climatic maps. Research has been also conducted in foreign countries, e.g. on Spitsbergen or in Vietnam. Glacial research has also been on Spitsbergen and in the high mountains (the Tatras and the Sudety) and so forth.

The third branch of physical geography is hydrography [4]. Here the possibilities of achievement are considerably more modest, since there exists only one department at the University of Lublin, as well as four small sections. I should like to add, incidentally, that in this sector, too, the development trends are quite obvious. One of the most long-standing specializations which Polish geographers had long gone in form is limnology. It began with making a list of lakes: a catalogue was made, the soundings of the larger lakes were carried out for purposes of fish-breeding, and then research was undertaken on the physical features of the waters as well as on the typology and origin of the lakes. Lately attention had been drawn to the processes of the disappearance of lakes. At the same time, a fundamental change has taken place in the approach to limnological research. Nowadays a lake is considered to be a specific type of geographical environment, which should be investigated in its entity, while at the same time its influence upon its surroundings should be established. Research has been developed on underground waters, which are examined as a fundamental component part of the geographical environment. The same approach is also true with respect to the problems of surface waters. On the occasion of the compilation of a detailed hydrographic map, the circulation of water in the whole drainage area is investigated, as well as the part played by it in the formation of the type of geographical environment.

Oceanography is dealt with by two geographical centers: the University of Toruń and the Teachers' Training College in Gdańsk. Apart from these centers, several other geographers are also interested in the subject. Research is almost exclusively concerned with the Baltic, or, properly speaking, with its southern part, adjoining the Polish shore. They are concerned most with the physical properties of the waters. Somewhat more systematic is the research conducted on the shore line, on its changes with time, i.e. on the morphogenesis of shores.

Far less well developed is research on the geography of soils and on biogeography. These problems are dealt with only by a few younger geographers. They deal with peatbogs, with the plant agglomerations

[4] Cf. the article by T. Wilgat, p. 53–59.

on dunes, with forest agglomerations, as well as with the attempts to establish connections on a feeding basis, between certain groups of insects and certain sets of plants.

On the other hand, interesting research has been undertaken in the field of integrated physical geography [5].

Economic Geography

In economic geography specializing tendencies have also taken shape, particularly within its particular branches and fields. The above trend was greatly strengthened after the Osieczna Conference of 1955. Traditionally, the field to which most research had been devoted was the geography of population and settlement. The subject-matter, however, has undergone a change. Interest has been shifted from villages to towns, parallel to the big urbanization processes which have taken place in Poland at the same time. Simultaneously less attention was given to physiognomic and landscape features, with more focus on functional and genetic aspects in order to grasp the economic bases of the creation and the development of the network of settlements. Monographic studies have also been prepared on towns, in connection with the planning needs of the extension of towns. The change in economic structure has brought to light a transitional crisis of small towns — and this problem has concerned geographers also. A few years ago research on rural settlement was once more undertaken, to which the method elaborated in the geography of towns was transferred. Geographers have also begun to be interested in the functional typology of villages. Greater attention has been paid to historical processes of settlements.

Population problems are frequently treated along with the settlements. There exist only one specialized department at the Institute of Geography of the Polish Academy of Sciences, and, apart from it, such problems are dealt with by other geographers, attached to departments of Economic Geography [6].

Here, also, present-day problems, prompted by the realities of life, have introduced certain subjects for research. These are: problems of the settlement of the Regained Territories, repatriation and migrations of the population, and the processes of industrialization and urbanization, which have caused large migrations of the population from the countryside to the towns. Further, the demographic structure of the population, its birth-rate, has also become a subject of research. As time has passed,

[5] Cf. the article by J. Kondracki, p. 51–77.
[6] Cf. the article by L. Kosiński, p. 79–95.

such research has become more and more centered on two problems: the balance-sheet of manpower and the demographic prognoses for purposes of planning.

As far as the geography of agriculture is concerned, there also exists but one department at the Institute of Geography of the Polish Academy of Sciences; apart from that, a certain number of geographers also deal with problems of agricultural geography.

Research is being conducted in the fields of both vegetal and animal production, from the point of view of their spatial differentiation and of their historical development. The natural conditions of the development of agriculture have been established. In this connection special attention has been drawn to the problem of the land use. At the outset, survey maps of a couple of fundamental elements were compiled, followed by detailed maps, and by an evaluation of the hitherto prevailing modes of land use. This has led to the elaboration of a Polish method, of compiling detailed maps of land use, on the basis of the principles of the Commission of the I.G.U. The compilation of many detailed maps, their interpretation and the evaluation of the type of farming, all have led to the study of the geographical typology of agriculture [7]. In this way the road has been fairly clearly mapped out: research proceeded from elements to agricultural productions sets.

A similar situation prevails in the geography of industry. Side by side with a special department at the Institute of Geography of the Polish Academy of Sciences, a certain number of geographers throughout the country are interested in this subject. The geography of industry is dealt with by a larger number of geographers, because the industrialization processes are strong, run rapidly, and fundamentally alter the economic structure of the country. Research is concentrated on several problems. It began with the examination of the location of the production plant of the several branches of industry, and proceeded, through research on the spatial structure of the several branches of industry to the total structure of the country's industrialization. The geographic research conducted by several departments has gone in two directions: 1) the studying of the connections between the production and the location of the industrial enterprise, and the geographic environment. In this connection attempts were undertaken to represent such connections on the basis of production costs (e.g. of the brick and cement industries). 2) the studying of the co-operation of various production plants dispersed in the country with the production of the main works (e.g. of the production of motorcars at Żerań, the shipbuilding industry and so forth).

[7] Cf. the article by J. Kostrowicki, p. 111–145.

The third direction has dealt with research on industrial regions, treated as territorial production complexes. The greatest achievement was the compilation, by 1960, of a detailed atlas of Poland's industries [8].

Other branches of economic geography are much less well developed which, among others, are the geography of transport, the geography of services, the geography of forestry, the geography of culture, and so forth.

The geography of transport is dealt with by only a few geographers. Only one department of this subject exists, at the College of Technology in Szczecin. Research is focussed principally on the spatial structure of the network of transport, chiefly of railway, bus and the waterways. Several studies have been devoted to sea and air transport. Traffic on these lines is also investigated, and is being treated as a manifestation of spatial economic and social connections. Attention is paid to the role played by transport junctions in the extension of settlements [9].

The geography of services is limited to a few studies on the geography of tourism, studies on foreign trade, and so forth.

As in the case of physical geography, there also develops an integrated economic geography. It develops along two lines: 1) a number of monographs have been compiled, dealing with the economic geography of towns together with their respective hinterlands, monographs of *powiats*, industrial districts, voivodeships, economic regions, and so forth; 2) the theoretical foundations are elaborated for an economic region, which constitutes the basis for integrated spatial elaborations of economic and social structures [10].

Regional geography

Regional geography is at present poorly developed in Poland. No one denies its utility as a source of information, for teaching and such purposes. There exist several departments of regional geography and, apart from these, there are, among the Polish geographers, numerous fervent followers of regional geography. Scientific achievements in this field are insignificant. The probable explanation of this is the fact that little attention is being paid to the theoretical foundations of regional geography. The existing achievements include a fair number of monographs of individual *powiats*, and even of voivodeships. Part of them have ap-

[8] A more detailed description is given in the article by S. Leszczycki and J. Grzeszczak, p. 147–160.

[9] Cf. the article by T. Lijewski, p. 161–168 and Z. Chojnicki, p. 213–230.

[10] Cf. the article by K. Dziewoński, p. 171–185 and A. Wróbel, p. 231–239.

peared in print. A small number of monographs of foreign countries have also appeared. In order to fill up the gap, foreign contributions are being translated, and, moreover, a considerable amount of books on various countries also appear mostly written not by geographers. The most serious undertaking of that kind is the starting of the printing of a five-volume *Geografia Powszechna* (Universal Geography).

Cartography

The situation in cartography, treated as a division of the geographical sciences, is not too good. There exist three departments of cartography, but several geographers are also busy with cartographic problems. Nevertheless the scientific achievements are relatively small. Particularly interesting are works in the field of the history of cartography, as well as original methods of investigating the exactitude of ancient maps. A National Atlas of Poland is under preparation. The cartographic institutions outside the academic schools cater to social, didactic, tourist needs. An "Atlas of the World" is being prepared, which is the largest publication in the field of cartography ever undertaken in Poland.

Historical geography

In the domain of historical geography there are a number of specialists, as well as a laboratory within the Institute of Geography of the Polish Academy of Sciences. Two interests are of importance here: (1) research on the historical pattern of fields and the shapes of villages, and, (2) research on the development of the population of towns or of certain regions over as long a period of time as possible (chiefly the 18th and 19th centuries). Recently research has also been undertaken on the reconstruction of the historical landscape, and its historical and anthropogenic stratification [11].

History of Geography

In the field of the history of geography and of cartography there exist two specialized centres as well as several specialists. Research is principally concerned with the history of geography in Poland, of Polish travellers and with the development of the cartography dealing with Polish territories. The achievements of individual geographers and traveller-explorers is also being elaborated. Research on the history of non-

[11] Cf. the article by M. Kiełczewska-Zaleska, p. 97–110.

-Polish geography takes on considerably smaller proportions. There are, however, contributions on the history of ancient geography. With such studies are also connected contributions concerning problems of the methodology of geography.

Other branches of the geographical sciences

No research work whatsoever is being conducted in mathematical (astronomical) geography, the latter being treated only as a subject for teaching. Among the other branches of the geographical sciences we may mention the studies in medical geography and in military geography (carried out in General Staff Academies), etc.

Further specialization in geographical research

Further specialization unceasingly continues. Subjects of research are becoming ever narrower. The groups of geographical sciences enumerated above, are being split up into more and more numerous sub-groups. At the same time methods of research are becoming more profound, more and more precise measurements, analyses and calculations are applied. Methods are becoming more precise. This causes the creation of narrow specialities. Even the state of things prevalent at the present moment has brought about a situation where specialists in certain branches of geography, being unable to find similar specialists at home, look for contacts abroad. The phenomenon is becoming more and more universal with a given specialist being well informed of what is being done in his own field of research throughout the world, but notknowing what his colleague is doing in the adjoining room. More and more difficult is the finding of a basis of understanding between physical and economic geographers. Specialists find it easier to come to an understanding with specialists in related sciences than with other geographers. Thus e.g. a geographer who deals with the history of geography will find it easier to reach an understanding with historians of science in general than with other geographers, a geographer of forestry is drawing nearer and nearer to specialists in forestry.

It would seem that the above trend is very clearly marked; on the one hand it yields desirable results, in the form of deeper and fuller understanding, while, on the other, it also has some undesirable aspects, for it splits up geography as a uniform science and causes more and more difficulties in the reaching of an understanding among geographers themselves.

Attempts at integrating geographical research

Many Polish geographers think of the deepening specialization as of an undesirable process, one that tends to disrupt geography into independent branches; this is why some of them oppose this process by putting forward integrating problems. Some of the latter, based on traditional, pre-war assumptions, cannot bring about the desired results, while others yield positive results, even though still of an inconsiderable nature.

Among the unsuccessful attempts must be numbered the interest in research on landscape transformed by man as being a kind of whole. This focus cannot yield the desired results, since it does not satisfy the economic geographers, who cannot limit themselves to the investigation of social and economic phenomena merely from the point of view of the effects inherent in the landscape, but must examine, first and foremost, their causes, the dynamics of phenomena and the functions of certain areas; and the latter are usually situated outside the landscape. Neither can calls to cultivate regional geography as an integrating branch of geography, bring about the desired results, since no theoretical foundations of regional geography have so far been elaborated. Concrete studies are conceived in various ways, subjectively, while a fundamental influence is exerted on their conception by the purpose which they are to serve.

Positive results, can, nevertheless, also be recorded. In physical geography this is true of research on physico-geographical regions, natural regions, treated as entities singled out from the surface of the Earth. Another symptom of integration is the treatment of certain phenomena within the framework of types of geographical environment, such as, e.g. dunes, lakes, which are investigated in a many-sided way in their connection with Nature as a whole. The same may also be noticed in economic geography. Research on the spatial economic structure of a certain area, consequently of an economic region, demands many-sided approaches. Finally it should be considered as integrating elements the research in the field of applied geography, particular that which is to provide scientific bases for physical planning. Even though these studies are most frequently analytical studies, yet more and more often we require from them an evaluation of natural conditions from the point of view of the development of certain branches of the national economy; more and more necessary are synthetic compilations and prognoses of the future. It is on that road, therefore, that we may expect further progress towards integration in the geographical sciences, which by their very nature demand collective contributions.

Complex problems

The development of science in connection with life (including geography) more and more often requires, side by side with detailed, analytical research, also synthetic, complex research. The latter is mostly topical, and at the same time regional research. By way of example one may enumerate here: the fulfilling, from the side of the geographical environment, the growing needs of the ever-increasing numbers of the population; the elaboration of the scientific foundations for the construction of spatial plans, or of plans for the positive transformation of the geographical environment, while taking into consideration the effects of such processes. Problems of the torrid zone, whether arid or humid, of the polar regions, of cultivating mountain areas, plans for the development of underdeveloped countries etc. Such examples could be considerably multiplied. The elaboration of such problems demands collective work. An outstanding specialist can elaborate only certain problems, while in others he will feel a dilettante. On the other hand, a large number of specialists can, between them, elaborate all the outstanding problems. This, however, requires new forms of organization in research work, the elaboration of theoretical foundations for collective work, the construction of models, and hypotheses for solving of complex problems. Assistance, here, can be derived from practice, from the objective of the work in question, from the institution for whom the work is being done; all of whom may facilitate the elaboration and give the proper trend to the model for common work. Unfortunately the experience of the Polish geographers in this field still continues to be very small.

Research methods

The development of geography is made dependent, not only upon the selection of problems for research, but also on the application of methods of research. The more precise, the more exact the methods of research, the more precise the results of such research. After World War II Polish geographers devoted a great deal of attention to research methods and to their normalization in order to obtain comparative results.

Before the war research frequently dealt only with selected phenomena, e.g., in geomorphology — with terraces, cones or in anthropogeography — with types of villages, or transport junctions, etc., which made regional generalizations, as well as synthetic comparative contributions, more difficult. Moreover it was necessary every time, when widening the subject-matter of studies, to repeat again and again the same

research in the same area. Since 1950 it has been assumed that the best method for research *in situ* is the compiling of detailed special maps which would register all the phenomena in a given field. This is why a method has been elaborated for the following maps: geomorphological, hydrographical and land utilization. Research is being conducted on the principles of compiling climatic maps. The above maps, based on original methods elaborated in Poland, generally speaking elicit some interest abroad, more particularly so in countries with a medium-size or small territory, where such methods can find full application.

In geomorphological research methods of quantitative and qualitative, mechanic and chemical, analyses have been elaborated. Original instruments for measurements of sand grains have been devised. Dust analyses, the designation of chronology by means of C_{14}, for example, are made use of. On the other hand, aerial photography finds little application. In research in the field of economic geography the rich statistical materials available are made use of. Since a part of the research undertaken is of practical importance, and various State institutions are interested in it, not infrequently are special inquiries carried out, or even censuses made for the geographic studies undertaken. This has its good side, since a geographer obtains ready detailed materials; but it has also its undesirable side, because such materials are often too detailed, which causes the compilations to be treated for service use only. Finally, statistical and mathematical methods are more and more used. Electronic computers are also used for the compilation of statistical or spatial-economic data. In this field Polish geographers have begun to take their first steps only.

Neglected and underdeveloped branches of the geographic sciences

I have already mentioned before a number of branches and specializations in the geographic sciences in Poland which are neglected or underdeveloped.

Such branches are: soil geography, biogeography, oceanography, paleogeography (in Poland studied by geologists), the geography of forestry (mostly the interest of foresters), the geography of fisheries, medical geography, political geography. The geography of services, the geography of tourism and military geography (undertaken mostly at military institutions) are only at the initial stage of their development.

It is to those branches of the geographic sciences that special attention ought to be devoted, by training new young specialists in them. At the same time attention should also be paid to complex (as opposed to

systematic) research, because it is only in this way that it will be possible to achieve the desirable results in the interpretation of the geographic sciences.

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GEOGRAPHIA POLONICA 1, 1964

ON THE GEOMORPHOLOGY OF NORTHERN POLAND

RAJMUND GALON

The present paper discusses the problems of the area of the youngest (Baltic or Würm) glaciation within Poland, and particularly the region of the Vistula basin. The presence here of typical young phenomena has for long attracted the attention of students of Quaternary geomorphology and geology: for example the connection of terminal moraines with ice marginal streamways (*pradolinas*), across plains of outwash sands, and forms of Holocene fluvial erosion superimposed on valleys and channels carved out by fluvioglacial waters. The profusion of polygenetic forms within the area of the last glaciation leads to a determination of the sequence of climatic changes so characteristic of the late glacial and postglacial periods.

Quaternary studies in the above area have been extended increasingly since the end of the World War II. Many views concerning the process of deglaciation have been revised and, what is more important still, the geology and geomorphology of regions of particular genetic significance are now thoroughly documented. During the inter-war period northern Poland (the pre-war province of Pomerania) was studied chiefly by geographers from Poznań. Thus, St. Pawłowski [33, 34] attempted to give a synthetic picture of the relief there and to differentiate the main elements of glacial forms in Pomerania and Wielkopolska, and R. Galon [5] described the development of the lower Vistula valley from a broader stratigraphic and geomorphological approach. These are but the two most important items, for it should be remembered that the work of M. Limanowski [25] was the first valiant attempt at Pleistocene stratigraphy of the lower Vistula, in fact the very first stratigraphic study on the Pleistocene Age in Poland. Moreover, it should be stressed here that papers by P. Woldstedt [42] on the German and Polish lowlands strongly

influenced the evolution of Polish opinions on the origin of glacial forms, particularly concerning the process of glacial recession during the last glaciation period.

The post-war expansion of Polish territory has raised new problems and needs and provided new investigation possibilities. In northern Poland these are being explored in the first place by the newly organized research center at Toruń University, as well as by the Toruń branch of the Institute of Geography of the Polish Academy of Sciences, but geographers and geologists attached to other Polish Universities are showing increasing interest, too. The inter-war period descriptions of Quaternary geomorphology were hampered by territorial limitations, and the surveys then undertaken were on a small scale. In contrast the first step in this field after the war was a general survey of the whole area under consideration. Its initial objective was to compile a general geological map, but subsequently a number of geomorphological studies proved the most useful. Work commenced on a detailed geomorphological survey on the scale of 1 : 25,000 undertaken under the provisions of the 1st Polish Congress of Science in 1951, in order to prepare a 1 : 50,000 geomorphological map of Poland. This was the turning-point in geomorphological studies of the Polish Lowland area and other parts of Poland. This map, compiled sheet by sheet, is one of the main tasks facing Polish geographers, particularly those co-operating with the Institute of Geography of the Polish Academy of Sciences. Two branches of that Institute are actually engaged in this work: the Department of Geomorphology and Hydrography of Mountains and Uplands at Kraków, and that at Toruń dealing with problems of the Lowlands. They are assisted by geographical centers in all other universities in Poland [15, 18].

The detailed geomorphological map of the Polish Lowland area, similarly as that covering other regions, distinguishes the following features:

(a) the morphometric features of landforms (relative heights of morainic hummocks or erosional escarpments, inclinations of slopes within a moraine plateau, etc.),

(b) the morphographic features of the relief (flat moraine plateaus, morainic hummocks, esker ridges, outwash plains, etc.),

(c) the genetic character of landforms (valley terraces, subglacial channels, erosional escarpments, zones of scarp degradation, alluvial fans, dunes, etc.),

(d) the age of landforms (Pleistocene landforms produced by the exarational action of inland ice, lateglacial and postglacial forms of eolian origin, etc.).

The above description of landforms takes into consideration all important relief features: as a rule, the morphometric features and their

Fig. 1. Fragment of the Geomorphological Map of the Polish Lowland

I. Pleistocene landforms produced by the depositional action of inland ice: 1 — Flat moraine plateau (relative heights up to 2 m. inclinations up to 2°); 2 — Undulant moraine plateau (relative heights 2—5 m. inclinations about 5°); 3 — Morainic hummocks (relative heights 5—10 m, varying inclination) preponderantly accumulative structure; 4 — Morainic hills (relative heights above 10 m., varying inclination) preponderantly push structure; 5 — Depressions due to uneven accumulation of inland ice;

II. Pleistocene landforms produced by the depositional action of glacial meltwaters: 6 — Outwash plains; 7 — Esker ridges;

III. Pleistocene landforms produced by the erosional action of glacial meltwaters: 8 — Subglacial channels; 9 — Elevations and swells in the bottom of subglacial channels; 10 — Valleys cut by meltwater river outside ice margin; 11 — Erosional plains;

IV. Other Pleistocene landforms: 12 — Kettles (dead ice depressions);

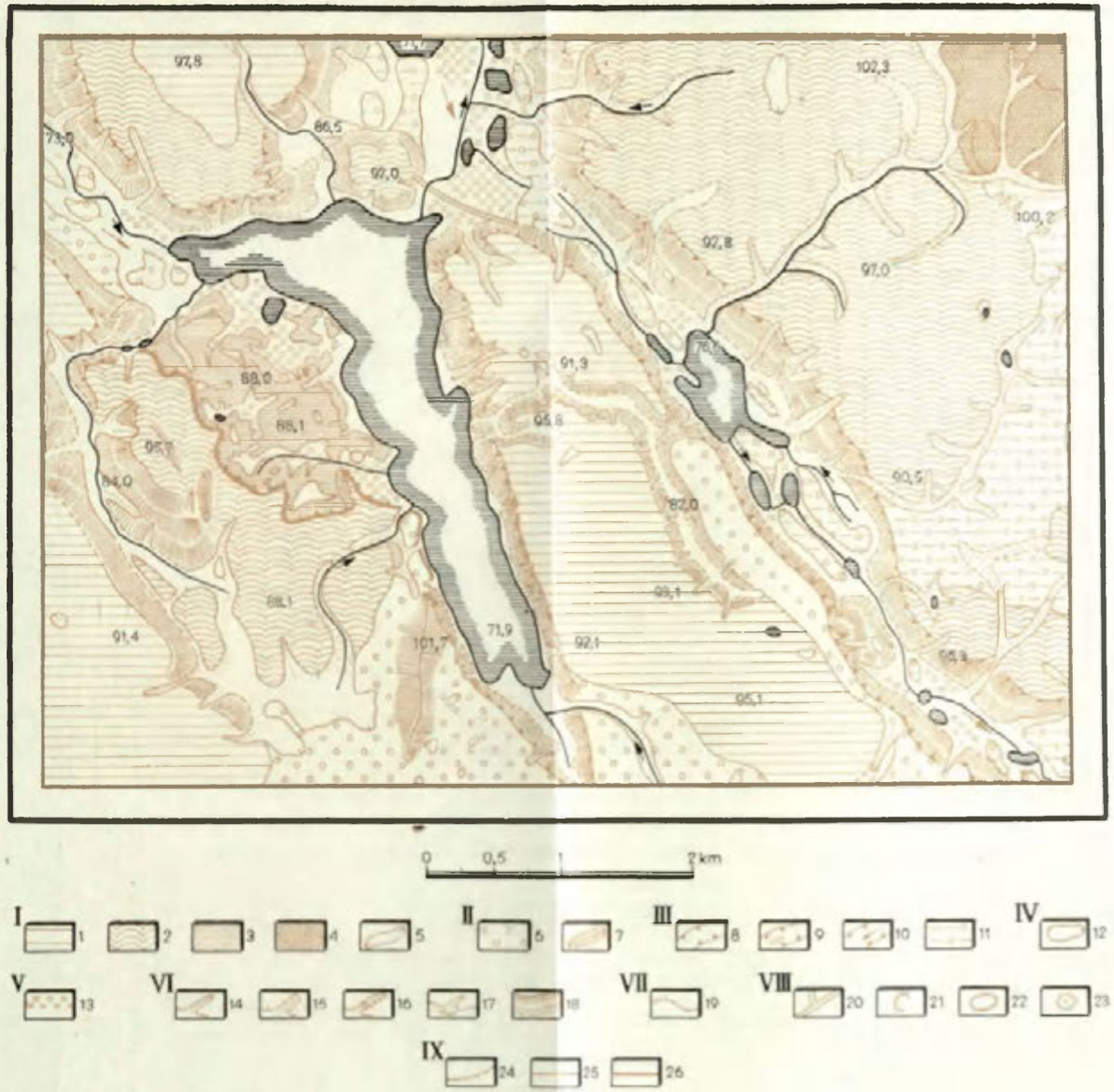
V. Postglacial (Holocene) landforms produced by the depositional action of rivers: 13 — Flood plains and delta plains with peat;

VI. Lateglacial and postglacial (Holocene) landforms of erosional and denudational origin: 14 — Small V-shaped valleys, ravines, gullies; 15 — Small denudation valleys (dells); 16 — Small denudation valleys at the back of erosional valleys; 17 — Alluvial cones; 18 — Gentle denudation slopes;

VII. Postglacial (Holocene) landforms produced by the action of lakes and seas: 19 — Cliffs;

VIII. Anthropogenic forms; 20 — Embankments, dikes, dams, earth walls; 21 — Quarries, clay- and gravel- and other pits; 22 — Mine dumps; 23 — Rimed site of an ancient fortified dwelling;

IX. Scale of line thickness: 24 — Indistinct escarpments of moraine plateau and terraces; 25 — Escarpments 5—10 m.; 26 — Escarpments 10—20 m.



character are expressed by the very name of a landform, whereas their age as well as the type of the relief-forming process is expressed by its appropriate classification. The categories of age and genetics of the various landforms as distinguished in the Geomorphological Map of the Polish Lowland are given below:

1. Pleistocene landforms produced by the depositional action of inland ice.
2. Pleistocene landforms produced by the erosional action of inland ice.
3. Pleistocene landforms which originated in the zone of stagnant and dead ice.
4. Pleistocene landforms produced by the depositional action of glacial meltwaters.
5. Pleistocene landforms produced by the erosional action of glacial meltwaters.
6. Other Pleistocene landforms.
7. Pleistocene landforms which originated under periglacial climate.
8. Lateglacial and postglacial (Holocene) landforms of eolian origin.
9. Lateglacial and postglacial (Holocene) landforms of erosional and denudational origin.
10. Postglacial (Holocene) landforms produced by the depositional action of fluvial waters.
11. Postglacial (Holocene) landforms produced by the erosional action of fluvial waters.
12. Postglacial (Holocene) landforms produced by the action of lake and sea waters.
13. Tectonic forms.
14. Landforms produced by vegatation.
15. Anthropogenetic forms.

This list shows that the geomorphological map illustrates the dynamics of the relief and of its changing pattern. It differentiates between groups of landforms developed under various climatic conditions and landforms developing in the modern climate. Thus the geomorphological map expresses the polygenetic evolution of the lowland relief [Fig. 1].

The geomorphological survey has enhanced the details of particular postglacial forms and correlated their characteristic morphological traits with the geology and structure of the deposits. The accurate geomorphological picture of many areas obtained in this way has led to the preparation of general morphological maps. One such map was that compiled for the province of Bydgoszcz [9].

A characteristic of general maps is that on the one hand they are a measure of the progress of investigations in a given area, while on the other hand they bring out problems which necessitate further special studies. The 1 : 300,000 geological map of northern Poland referred to above was prepared with the eminent cooperation of the geographical research center at Toruń. It has, indeed, been an agent to stimulate such work. Quite a number of monographs have been published on selected forms or on specially characteristic glacial areas. They give more than one new picture of the process of glacial recession in some parts of northern Poland; they also rectify many erroneous views on the me-

chanism of the processes of erosion and accumulation of the retreating ice sheet and its meltwater in the Scandinavian glaciation. Some of these data are given in publications prepared for the 6th I.N.Q.U.A. Congress, Warsaw, 1961, and particularly in the Congress Guide-Book [14, 24, 27, 40].

Evidently, studies carried out within the area here considered deal with problems of the last glaciation [10]. The deposits of older glaciations are accessible in boreholes only, and in very few cases, also on the slopes of larger valleys. There is little doubt, however, that the deposits and forms of the last glaciation observable in exposures, represent but the latter part of this glaciation period, corresponding to about 30,000 years. Hence, deposits representing at least the earlier half of the last glaciation, are also accessible only in drillings and by analysing Pleistocene sediments that occur in deeper valleys.

One of the main problems of the last glaciation is connected with the facts just mentioned. The question namely arises whether J. Büdel [2] and others were correct to postulate that the last glaciation occurred uniformly and that it may be expressed by one major glaciation curve displaying a prolonged maximum, or, whether — as is suggested by P. Woldstedt [44] and others — many oscillations had occurred during the general transgres-gression as well as the recession of the ice sheet, represented by stages and interstadials. The above problem may be solved by determining the number of moraine clay horizons. In theory this number should correspond with the number of the glaciation stages separated by periods of general regression of the ice cap characterised by warmer climate. This problem, however, falls into the competence of geomorphology only when it concerns the later half of the last glaciation which has been preserved in the young glacial topography. It should be mentioned, therefore, that, near the limit of its maximum extent in the Kujawy region (Brandenburg or Leszno stage) the last glaciation is represented by a single moraine clay horizon. This is underlain by the Aurignac interstage which contains the oldest sediments of the Würm glaciation [40] within this region. Farther north, already within the reach of the Poznań (Frankfurt) stage, two moraine clay horizons [4] have been found which do not, however, contain any certain organic deposits of the interstadial type. On the other hand, despite its distinctly transgressive character, the Pomeranian stage has not left a well delimited moraine clay horizon. Perhaps, the intermoraine deposits were eroded by very intense glacial exaration during the transgression. The erosive force of the ice-sheet is indicated by numerous fragments of Tertiary deposits in moraine clay found in the reach of the Pomeranian stage. At the same time the intensity of glacial erosive action in Pleistocene deposits is indicated by moraine clay 100 m thick within the Szymbark Hills which lack inter-morainic deposits.

Hence, as is suggested by the number of moraine clay horizons, the nature of the last glaciation still remains an open question, though some available data indicate oscillations during the main stages of the recession of the ice-sheet.

On the other hand, one may now note several new attainments and some important results concerning the analysis of deposits and of the marginal forms of the ice-sheet. They are really the main object of interest to investigators attached to the geographical research centers at Toruń. A revision of the limits of the last glaciation by S. Majdanowski [26] initiated studies on the distribution of the marginal forms of the ice-sheet. That author replaced the former criterion of the occurrence of channel lakes by that of subglacial channels. It was proved that many minor marginal zones are present independently of terminal moraines which indicate the maximum extent of the last three main glaciation stages distinguished by P. Woldstedt [42]. They are represented by an assemblage of hummocks with numerous closed kettles, occasionally connected with an outwash sand plain. About 26 minor phases of the retreat of the ice-sheet have been found by R. Galon [7] in an interval of about 3.5 km within the area bounded by the *pradolina* (ice marginal streamway) of the Noteć and the Pomeranian stage. 12 smaller but very distinct recession phases have been observed by L. Roszkówna [36] within the zone of marginal forms of the Pomeranian stage, east of the Vistula valley, and 8–10 well developed marginal zones are recorded by J. Kondracki [19] within the Mazury Region. Moreover, St. Kozarski [20] found 10 recession stages within the Poznań stage of the Poznań Lowland area. All the minor phases of the recession that have been recognized so far are shown in the successive morphological sketch maps [10, 12, 14] of the marginal forms of the last glaciation. Yet it has not so far been possible to correlate reliably these recession substages of inland ice with the corresponding climatic oscillations. On taking into consideration the whole period of glacial recession it might roughly be estimated that these short climatic oscillations, corresponding with these minor marginal forms of the ice-sheet, did not exceed 100–200 years. Present climatic and palynologic studies may probably determine whether this climatic rhythm was continuous and whether it may also be traced throughout the Holocene period. Many investigations in this respect are under way in various countries and the outlook seems promising. Nevertheless much detailed discussion is still necessary pending the clarification of this problem.

The profusion of minor phases in the recession of the inland ice suggests a revision of the views on the mechanism of glacial recession. These amendments are supported by the fact that the outermost marginal

zones of the successive recession phases of the ice-sheet consist of numerous contiguous moraine ridges, the outermost one of which — contrary to common opinion — is by no means the highest. It might, however, be added here, that many investigations show that the majority of the end moraines belong to the push-moraine type. Hence, glacial

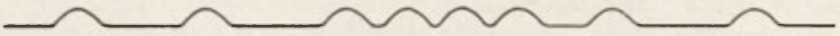


Fig. 2. Rhythmical marginal deposition of the retreating inland ice

recession progressed without a break, at one time it was accelerated, at another retarded, but invariably it displays oscillations (Fig. 2) and expresses at least a dual climatic rhythm [11].

The latest studies indicate that, between the extreme end moraines of the Poznań stage and the Pomeranian stage, end moraines and other marginal forms are concentrated at two zones, i.e. in the regions of Kujawy and Ziemia Dobrzyńska, and again in the moraine plateaus of Krajna and Ziemia Chełmińska (Fig. 3). The former is referred to as the Kujawy substage or phase, the latter as the Krajna substage or phase. Between these two phases occur the moraines on the banks of the Noteć, i.e. the isolated morainic hills stretching on either side of the *pradolina* of the Noteć. Major floes of Miocene and Pliocene deposits are encountered in the interior of these hills. The origin of the hills has not as yet been fully clarified. Doubtless, they belong to the push-moraine type, but their morphological situation and strong differentiation suggest genetic connections with the Kujawy-Pomerania Anticlinorium which at this very point stretches below the *pradolina* [13].

So many kame-like structures have been recognized during the last years within the Krajna phase, that it is justifiable to speak of the kame character of the Krajna phase. These forms have been in detail described by W. Niewiarowski [30] on the moraine plateau of Chełmno, subsequently also by T. Murawski [27] on the plateau of Krajna. In the first place we have here all deposits connected with accumulation within the dead-ice zone, such as kame hills and ridges, eskers and the so called dead-ice moraines; all forms lying in the vicinity of dead-ice depressions.

Another problem arises in connection with the lack of distinctly marginal forms on certain areas of the morainic plateau. Possibly we are dealing here with the process of the calm ablation of extensive lobes of fractureless stagnant ice. This problem, however, which is one of a general character, calls for more detailed analysis.

The Pomeranian stage with its numerous lobes, particularly those of the Vistula and the Odra, is particularly interesting. The areal limits

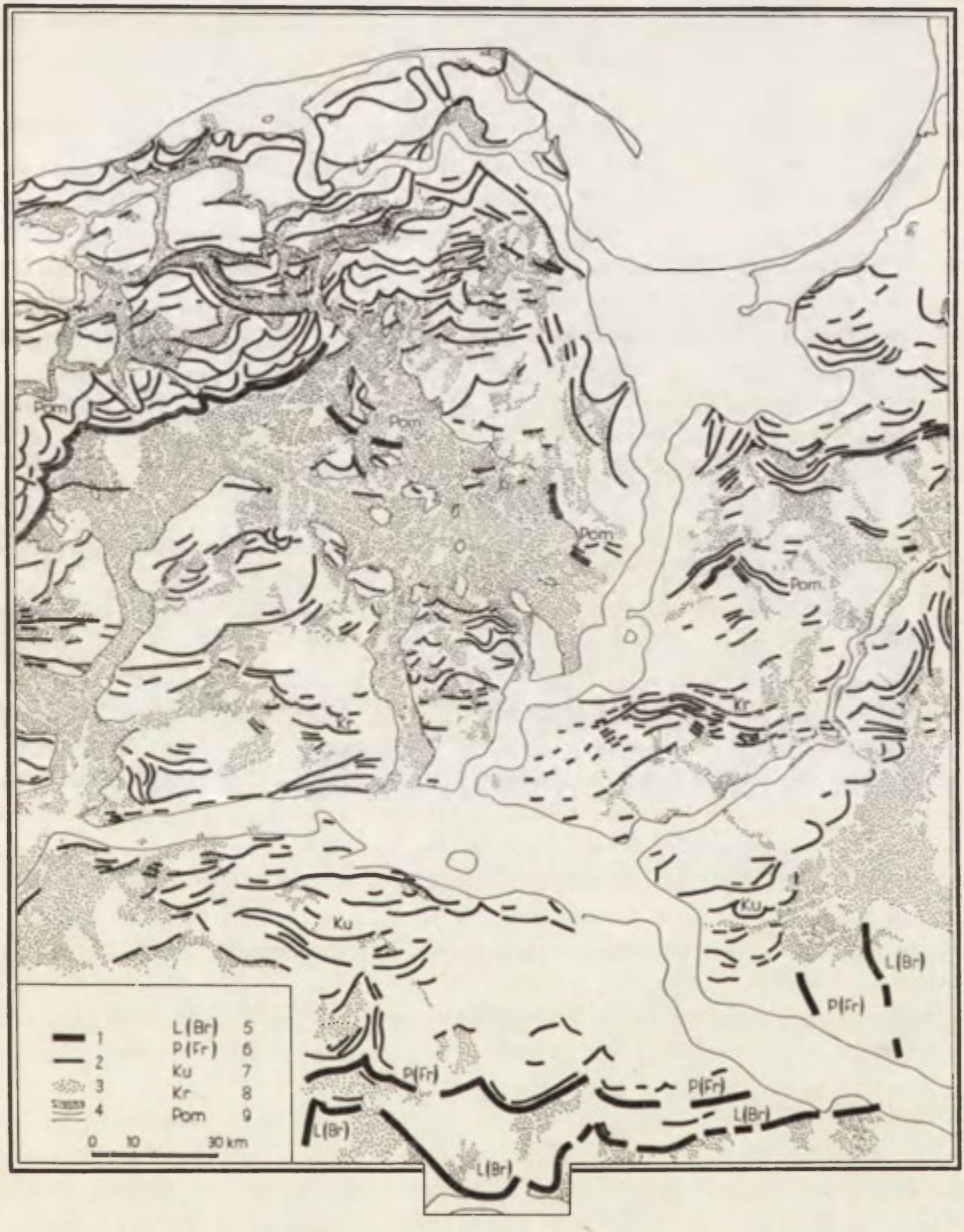


Fig. 3. Proceeding of deglaciation during the last glaciation on the area of the Lower Vistula and adjacent territories

1 — Limits of stages of deglaciation; 2 — Halts of ice-front during the recession and short advances; 3 — Outwash plains; 4 — Main valleys of outwash and rivers; 5 — Limit of Leszno (Brandenburg) stage; 6 — Limit of Poznań (Frankfurt) stage; 7 — Kujavian phase (substage); 8 — Krajna phase (substage); 9 — Pomeranian stage

of this stage within Polish territory has been discussed of late with reference to P. Woldstedt's [43] suggestion to shift it farther south, i.e. into the proximity of Więcbork and Wąbrzeźno which is transversed by the zone of marginal forms, here above called the phase of Krajna. R. Galon [7, 10] has pointed out that the Pomeranian stage, being a transgressive one, has several characteristic lobes (that of the Odra, the Vistula, the Łyna etc.) which invade the old parallel moraines and truncate them. For example the lobe of the Odra truncates the marginal forms of the Krajna phase. In the light of structural studies of the end moraines to the east of the lower Vistula valley L. Roszkówna [37] has shown that the beginning of the Pomeranian stage occurs in the vicinity of Gardeja, thus coinciding with the lobe of the Vistula.

The lobe-like character of the marginal zone of the Pomeranian stage has doubtless connections with the exarating action of inland ice. Most probably it has reference to the tectonic changes in surface relief that took place during the overthrusting of the ice-sheet. The surface of the territory of the lower Vistula and the lower Odra then subsided while that in the extended part of Pomerania became uplifted.

The difference between the lobe of the Vistula and that of the Odra is readily discernible. The former is indistinctly outlined but its interior abounds in numerous terminal moraines that may be helpful in the reconstruction of a number of smaller glacial lobes (see Fig. 3). The lobe of the Odra, on the other hand, has a very clear, even a classical outline, but its interior is relatively empty. A feature common to both these lobes is the presence of drumlin fields in their interior. The origin of the drumlins, however, does not seem to be the same as that of drumlins within the arch of terminal moraines of the Kujawy phase in the moraine plateau of Dobrzyń [24]. Investigations on lobes are still under way. Like those in the neighbouring areas, these lobes present many essential problems concerning glacial recession. They are of an overall significance in the advancement of knowledge on the role of the substratum [22] and of vertical movements as well as that of glacial exaration in the climatic process of glaciation and glacial recession [38, 39].

The action of proglacial meltwater has not yet been discussed in the present paper. A. Penck's old conception of the "glacial series" concerning the sub-alpine glaciation is fully applicable to deposits of the Scandinavian glaciation, particularly to those of the last glaciation. As is commonly known the Alpine glacial series embraces the terminal moraine together with its respective fluvioglacial fan which later, grades into the corresponding Pleistocene valley terrace. Sandy outwash plains were formed in the Lowland during the retarded retreat of the ice cap. In the process of the superimposition of outwash plains during successive recession

phases, the younger outwash plain was commonly incised into the older one. This fact is a useful criterion for determining the number and sequence of major recession phases, among others also those within the Lowland of Poznań (St. Kozarski).

The sandy outwash plains connected with the Pomeranian stage, particularly the Brda outwash, have been studied in detail [8, 16]. Earlier investigations deal with the sandy outwash plain of the Gwda and the Drawa [31], while those of the Mazury Region are now under way. In contrast to the older glaciation stages of the last glaciation, the sandy outwash plains are associated with the marginal terminal moraines of the Pomeranian stage all along its extent, although meltwater flowed out mainly from the interlobal crevasses. The erosional terraces on the sandy Brda outwash plain give reliable evidence of a polyphasic formation of the plain during the Pomeranian stage.

On its way through the old moraines and outwash plains, particularly through the marginal forms of the Krajna phase the sandy Brda outwash plain functionally connects the Pomeranian stage with the pradolina of the Noteć-Warta named also Toruń—Eberswalde *pradolina* (*Urstromtal*). This is indeed one of the most important phases in the evolution of the valley system in the postglacial lowland, an evolution which has been revised by St. Kozarski and J. Szupryczyński [20, 21] but more largely by R. Galon [13]. The above *pradolina* acted but very briefly in the exact meaning of that term, i.e. as a streamway fed by the meltwater of the ice-sheet in the north as well as fluvial water from the south. For quite a long time, in any case until the Alleröd interstadial this *pradolina* collected the fluvial water from the northern and the southern river basins. Bifurcation seems the most characteristic evolutional feature of the fluvial pattern within the glacial lowland. It represents a state of transition from the westward Pleistocene drainage, i.e. one along the *pradolina* to the Holocene outflow (in the morphological sense-6) directed northward through the gap valley. This kind of bifurcation was first observed in the course of the Vistula; namely a part of its waters flowed out westward along the *pradolina*, while another part flowed northward along the valley of the lower Vistula [5]. By now it has been shown that similar bifurcations also occurred in the western part of the *pradolina* near Eberswalde, as well as in the present valley of the lower Odra [13]. The evolutionary pattern of the river system in northern Poland as suggested above may supply basic data for similar research work in adjacent areas or for the study of older stages of glacial recession [1].

Numerous minor river valleys of a specific character were formed independently of the main valley pattern within the areas of the last glaciation, which consisted of *pradolinas* directed E–W, of the northward

gap river valleys and of the southward sandy outwash plains. These minor river valleys are partly made up of subglacial channels and lake basins, varying in length and direction, or partly of broad dead-ice depressions and as a rule of very short gap valley sections. As a result the courses of these valleys are either meandering or sharply bent, of varying width and differentiated gradient. This valley type is observable for example in the upper Brda [8, 28] and Bielska Struga [23] on the Brda outwash plain; in the Liwa [3] within the main zone of the Pomeranian stage E of the Vistula valley, in Lutryna on the moraine plateau of Chełmno, and also in many other smaller streams draining either the moraine plateau or the sandy outwash plain.These are mostly tributaries of the Vistula, Drwęca, Brda and Noteć. Most of these valleys have been investigated. Their origin is very interesting but by no means completely clarified. The main factor responsible for their formation is probably the period of the thawing of dead-ice blocks, i.e. the process of forming the various dead-ice landforms and of subglacial channels. It dates back as far as the Allerod period [17] but evidence is available to show that the dead-ice (and winter-ice) thawing period continued until the post-glacial climatic optimum [8].

Some of the afore mentioned minor valleys were formed directly after glacial recession as a result of the normal outflow of small rivulets, but their differentiated trends and their more complicated valley patterns were later determined by the appearing kettles and subglacial channels. Other minor valleys, however, were formed as a result of the development of dead-ice landforms. In this case the valleys of small streams follow the courses of subglacial channels. Anyhow the network of small valleys within the area of the last glaciation is very distinct from the mainly rectalinear system of main valleys. It is not adjusted to the natural slope of the land within the particular main river basins. Nor does it develop the symmetrical pattern of tributary streams so characteristic of a normal fluvial land relief, but is closely adjusted to the subglacial channel pattern and deviates owing to the appearance of dead-ice forms and lake basins (Fig. 4). This lack of order in the valley system, characteristic of the young postglacial relief pattern observed first by W. Nechay [29] is slowly changed by recent processes of fluvial erosion. At the same time the former subglacial channels, followed by streams, lose their original character, the channel lakes are filled in with peat, other depressions at the bottom of channels are levelled by silt and sand while the evorsion swells separating them are cut up. The resulting longitudinal river profile is regulated.

Studies on the evolution of the valley system in the glacial Lowland call for a detailed analysis of the valley terraces, particularly of those

in the valleys of the Vistula and its tributaries as well as in the system of the *pradolina* of the Noteć-Warta. Investigations concerning the valley and the sandy outwash plain of the Brda [8] were the first step taken in the post-war study of the valley terraces of northern Poland. The greatest number of valley terraces, having connections both with *pradolina* of the Noteć-Warta and with the present valley of the lower Vistula, have so far been encountered there. The area near the mouth of the Brda

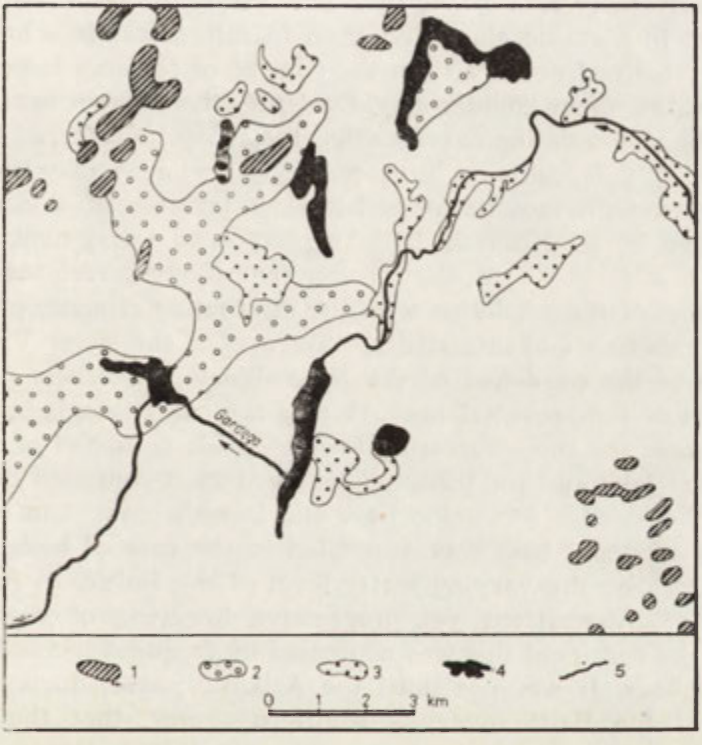


Fig. 4. Example of diversion of a small river caused by appearing (melting out) of subglacial channels. The Gardęga River, situated East of the Lower Vistula Valley

1 — Morainic hummocks and hills; 2 — Outwash; 3 — Kettles; 4 — Lakes; 5 — Rivers

both to the *pradolina* and the present valley of the lower Vistula is a key for solving problems concerning the valley terraces in the Polish Lowland; the valley terraces and the outwash terraces of the Brda represent the full period of valley development in northern Poland, from the period of lateglacial outwash outflow to that of young Holocene erosion and river bottom accumulation. Thus, the valley terraces of the Brda provide

a full scale comparison of the morphological relations in many other valleys. For example it might be stated that some of the lower Vistula tributaries, e.g. the Osa and the Liwa, are relatively very young since their valley terraces pass into the lower terraces of the Vistula valley.

It can now be seen that, with the exception of the lowest one, the valley terraces in northern Poland, as a rule bear an erosional character. Such is the case in the present lower Vistula valley and its tributaries as well as in the Noteć-Warta *pradolina*. The valley terraces are commonly carved out in moraine clays and even in intermorainic sands and silts. Boulders remained preserved on the surface of terraces indicate the destroying of the upper boulder clay. Evidently the terraces here considered do not lack accumulation covers; often they may be referred to as partly erosional partly depositional terraces. Never, however, may these terraces be identified with mountain- or highland terraces of a climatic type, as suggested by St. Kozarski [20]. In relation to a fragment of the *pradolina* of the Noteć-Warta, that author tentatively correlated the individual terraces of the *pradolina* with the alternating climatic phases of the lateglacial stadials and interstadials. Terraces of the lower Vistula valley and those of the *pradolina* of the Noteć-Warta, owe their formation to oscillations of the erosional base. During the early lateglacial phase, the erosional base for the bifurcating lower Vistula consisted of the Gdańsk ice dammed lake and for the *pradolina* waters it consisted of the Baltic ice lake then under formation near the Danish coast. During the next phase the erosional base was controlled in the case of both the Vistula and the Odra by the varying water level of the Baltic. In fact this was a period of intermittent yet progressive lowering of the Baltic sea level. On the continent this was expressed by frequent incision of streams into their beds. It was not until the Atlantic phase, during the transgression of the Baltic over its southern shores, that the process of accumulation in river valleys was intensified [35]. Hence, the lowest terraces of the lower Vistula valley and of its tributary valleys are carved out in young fluvial deposits.

The problem of the origin of valley terraces, therefore, is connected with that of the origin of the Baltic sea and the evolution of its southern coast. Among the post-war research work, that of B. Rosa [35], which was continued for a number of years, comes into the foremost rank. It is devoted to littoral transgression along the Polish coast and is approached in the light of post-glacial evolution of the southern shoreline of the Baltic. These studies cover a part of the international research work concerning postglacial changes of the shoreline of the southern part of the Baltic sea which is now under way in Baltic states under the program of the Baltic and Scandinavian shorelines sub-committee of the I.N.Q.U.A.

One of the main objects now set before Polish investigators is to determine the original northern boundary of sub-aerial glacial accumulation on the floor of the Baltic sea and to study the sunken glacial forms in correlation with the recent glacial relief of the sea-coast region. Another task is to trace the successive shore lines of the southern Baltic by analysing the sediments and forms observable on the floor of that sea (S. Rosa et al.), and by reference to the tectonics of the substratum, particularly the Mesozoic substratum [41]. In this connection it will be necessary to correlate the successive levels and ranges of the Baltic with the corresponding river terraces, in the first place those in the Vistula valley. Still another problem is the determination of the effect of postglacial and modern vertical movements on the course of the former shore lines in the southern part of the Baltic (*Ancylus, Litorina*). According to the observations of S. Rosa these former shore lines are below the present sea level near the mouths of the Vistula and Odra, while they are several meters above the present sea level along the part of Pomerania extended to the North and also east of the delta of the Vistula. Thus we would be dealing here with a continuation of the vertical movements which the present writer [7, 10] thinks responsible for the lobal character of the transgressing ice sheet during the Pomeranian stage. Further investigations to confirm this concept are now under way. Their need is all the more obvious in view of another concept advanced by J. Bączyk who postulates that the submarine occurrence of peats within the Bay of Gdańsk (near the Hel peninsula), is not due to lowering by a vertical movement but to compaction of the bottom deposits. In any case the origin of the present seashore line in the south Baltic is evidently a complicated one.

The polygenetics of the lowland relief is one of the numerous problems concerning the geomorphology of young postglacial topography that calls for at least a brief discussion here. We are dealing with a sphere of climatic geomorphology described from the postglacial lowland in several works by W. Okołowicz [32]. The successive climatic phases during the lateglacial and postglacial periods correspond with the particular superimposed assemblages of forms with their peculiar plant covers which have been preserved in the peatbogs and are being reconstructed by palynologists. The work of the morphogenetic processes during the successive climatic phases seems to diverge and this would favour the preservation of the form assemblages. The forms distinguished within the area under consideration are chronologically as follow: glacial, fluvioglacial, limniglacial and periglacial, eolian (re-occurring in several phases of a somewhat dry climate), dead-ice forms from the Alleröd interstadial until the postglacial optimum of climate, and finally form assemblages

due to fluvial erosion during more moist climatic phases. The role of minor river valleys in the evolution of postglacial relief has already been mentioned.

The above-mentioned form assemblages occur in various combinations with the glacial forms as the initial relief, while fluvial forms usually represent the latest relief. The mutually superimposed forms of denudation or erosional type correspond with bedded slope deposits or valley deposits. Their stratigraphic, sedimentologic and petrographic features facilitate the determination of the sequence of mutually superimposed form assemblages, the investigation of climatic conditions during their formation and an estimation of their geologic or even absolute age. In addition to geomorphological methods this work calls for the use of geological and palynological studies. They will lead to an exact determination of the successive phases in the evolution of glacial relief and its transformation under changing conditions prevailing during a late-glacial and postglacial climate and, at the same time provide a better knowledge of similar paleogeographic evolutions in the course of earlier glaciations and interglacials. Thus, investigations of the forms and deposits associated with the last glaciation and the postglacial period are of value for research on the whole Pleistocene period.

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CLIMATOLOGY IN POLAND

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In this paper, concerned as it is with the present state and trends of development of Polish climatology, it is impossible to omit some facts of the history of its development.

This is justified all the more, since climatology with its related science, meteorology, served, or at least tried to serve, during the last decades, the economy of our country. To accomplish this so important social role, these sciences must meet with certain favourable conditions. Above all there must be an understanding of the necessity for the appropriation of such an aid, of the possibility for its utilisation. These conditions grow usually together with acquired social experience, developed in the atmosphere of the tradition.

Since older times works connected essentially with meteorology appeared in Poland, e.g., Erazm Ciołek, *vel* Vitello, 13-th century; one noted for the results of many years systematic observations (Marcin Biem, 1490–1540); one made experiments with atmospheric pressure (Walerian Magni, 1640–1644 or 1647). In the second half of the 18th century, in so called Lublin High Schools the examination questions from physics contained also 20 questions concerning strictly meteorological problems [1, 9].

In Warszawa, which belonged in the past also to the so called florentine meteorological network, systematic continuous observations began in 1779 [11]. Later, towards the beginning of 19th century, similar observational series in many other localities were started. About 1885 the number of stations in Poland had increased to 200. At the beginning of 20th century "many hundreds" of meteorological stations operated on farms, cultivating sugar beets. Thanks to the care of the Polish Agricultural Society of the Kingdom of Poland, an "Outline of Meteorology in the Service of Agriculture" was published by St. Turczynowicz, reflecting a real social demand for such a work [6].

Coming back to the past century it is to be emphasized, that in 1891, at the Congress of International Meteorological Organization in Munich, the Polish Meteorological Service was represented by W. Kwietniewski, the director of the Central Meteorological Station which had been founded at the Museum of Industry and Agriculture in Warszawa in 1885. After his death, the Central Station and subject to it the "Warsaw" network was directed really, as it seems, by R. Merecki, and after 1909 by W. Gorczyński. Then, after World War I, it became known officially as the Polish State Meteorological Service, for which it had been prepared for a long time. At the end of 19th century many prominent scientists developed their activity in Poland. One of them was, for example, W. Satko, a keen investigator of many phenomena, including upper winds, too (on the base of detailed observations of the cloud motion). Later R. Merecki came into prominence as already mentioned. One can find in his works above all in his "Climatology of the Polish Lands", a great wealth of ideas, which are valid still at the present time. W. Gorczyński became famous above all in the field of actinometry, and also as the author of many monographs on pressure and air temperature and their distribution in Poland, Europe and in the world. At the same time E. Romer, an eminent geographer and author of the conception of climatic regions of Poland, began his fruitful scientific activity. The names of H. Arctowski and A. B. Dobrowolski, from the time of the "Belgica" expedition became known. The latter was in reality the autor of the conception of "cloud systems", unknown outside Poland until it was proposed independently by French meteorologists.

The achievements of the scientists both mentioned and unmentioned here were very great before the end of World War I. On the contrary in the period between the two World Wars not much changed in Polish climatology. The work was concentrated mainly on the development of the meteorological service conducted by the State Meteorological Institute, which suffered many difficulties. The main obstacle to a mere intensive progress in meteorology and climatology in this period consisted in the lack of qualified specialists and of sufficient disposable funds.

Before the last World War in the Polish universities there were only three departments of meteorology, and moreover only at schools conducting agricultural studies. The only exception was the Lwów University centre with an Institute of Meteorology and Geophysics, directed by H. Arctowski.

To the most valuable works on climate of Poland published in the inter-war period, belong: apart from the new conception of climatic regions of Poland of E. Romer, monographs of S. Kosińska-Bartnicka on precipitation. of L. Bartnicki — on winds.

World War II inflicted new losses on Polish climatology: complete destruction of the stations network, new interruptions in observations, a destruction of libraries and archives, and above all, heavy losses in men. As a matter of fact, the last war to a greater degree than the first, caused a painful breach in the growth of the Polish young scientists generation.

The main concern of the after-war period was the reconstruction of the network of observing stations. The second concern, not only of the State Meteorological Service (joined after the war with Hydrological Service), but also of the university centers, was the lack of observational material, in the first place of published annuals. Before the war they had covered only some years, and in addition some ready elaborations of annuals had been burnt. During the war and in the first years of the post-war period the annuals were not being worked out. The increase in these arrears was not stopped until 1955. About the same time one started with the elaboration of the annuals for past years.

The lack of qualified staff caused the greatest difficulty. On the other hand — specific conditions of living during the war, overwork and advanced age contributed to a serious reduction in the number of Polish climatologists in the first years after the war. The older generation, all the persons mentioned earlier in this paper died. Among the younger died R. Gumiński, professor of the Warszawa University and of the College of Agriculture in Warszawa, at the same time vice-director of the State Hydrological and Meteorological Institute, and also prof. W. Milata, who had developed fruitful activity at Kraków centre, and many others. Such was the post-war harvest of death, partly at least originating in the seeds sown in the War.

This survey of events proves, that the history of the Polish climatology, linked up with the history of our country, based on very old and fine traditions, was stormy and cloudy. The post-war beginning was difficult.

Following the needs of the new Poland in conducting a planned economy, life began to put many far-reaching demands for various climatological investigations. This demand was much helped by financial resources. Owing to the lack of qualified staff, one began to organize at the academic schools departments, or laboratories for meteorology and climatology, chiefly at university geographical centers. Similar departments exist now at all the Colleges of Agriculture in Poland. The latter, of course, have for their main task, the meteorological, or, strictly speaking, agrometeorological, training of the agricultural, forestry and other specialists graduating there. Departments in the universities

Warszawa and Wrocław for many years have conducted a two-years specialized course in climatology. This specialization in climatology is based on a three-years general course in geography. Such a specialization in climatology does not exist at the remaining five universities (Kraków, Lublin, Łódź, Poznań, Toruń) although there the students of geography take up subjects in climatology as master-works in the course of physical geography.

The majority of graduates in climatology usually are employed as assistants in the corresponding departments in other Colleges, in some posts of the Polish Academy of Sciences, in the State Hydrological and Meteorological Service and in the institutions conducting or using the results of meteorological research.

Besides University centers and the corresponding departments of the State Hydrological and Meteorological Service some branches of the Polish Academy of Sciences — as for example the Institute of Geography with its special Department of Climatology, the Institute of Geophysics, and others — are also interested in climatological and related research. Outside the Academy such interest is also shown by many research institutes in agriculture, the Institute of Hygiene, and so on.

With what do the individual climatological centres in Poland deal? The main charge of the Department of Climatology of the State Hydrological and Meteorological Institute, as the State Service, is the elaboration of the "Climatological Atlas". This work is conducted according to the recommendations of the World Meteorological Organisation (W.M.O). The specific difficulty in this sector results from the problems discussed in the introduction — many breaches in the observational series, and the impossibility of stabilizing the network of stations in Poland during the last decades.

The Department of Climatology of the Institute of Geography, Polish Academy of Sciences (under Assoc. Prof. J. Paszyński), takes up mainly the research on radiation and heat balance in various conditions of geographical environment. The radiation measurements were used and are still applied, by this scientific centre, to such problems as atmospheric pollution by industrial dust and smoke (the determination of extinction of the polluted atmosphere, within and outside industrial centres). This department participated in geographical research in the field, together with departments specialized in other branches of physical geography [3].

Departments and sections of meteorology and climatology of universities outside Warszawa conduct research mainly on the climate of their surrounding regions (geographic region, province etc.) or on problems important to the economy of those areas. The department of climatology

of the University of Wrocław (directed by Prof. A. Kosiba) works mainly on climate of Silesia, conducts research in the Sudety Mountains, bound up *inter alia* with nival problems. The Kraków centre is chiefly interested in mountain climates and in the terracy of mountain climate. The centre at Łódź (Prof. St. Zych) which is the biggest town of Poland after Warszawa and at the same a great industrial center, deals mainly with urban climates in the first place of Łódź itself with its polluted air and its bioclimatological effects. In this research one has applied among others, the method of determining from aircraft the vertical visibility which is the feebler the greater is the air contamination. The Lublin University (Prof. W. Zinkiewicz) worked out many subjects on climate of Lublin Plateau, some selected localities in subcarpathian area [5, 13].

The Department of Climatology of the Warszawa University (Prof. W. Okołowicz), while elaborating many climatological elements, conducts research on the structure and regionalization of Poland's climate. By its research on local climate as well as on the microclimates of the Great Mazurian Lakes, and the valleys or the middle Vistula and Bug, it has led to a better undestanding of the influence of relief and water basins on climate. The climate of Warszawa and the air pollution occurring there belong also to the sphere of interest of this department.

It is not possible in this paper to give a full account of all the climatological problems, interesting the individual research posts in Poland. Therefore we will make acquaintance only with certain selected examples of the research and methods applied there, examples which the author knows best from his personal experience. It is worthy here to present some more general problems, before we come to more concrete details.

The Institute of Geography of the Polish Academy of Sciences initiated the publication of "National Atlas", to meet the needs and acute interest of many economic and planning authorities. The physiographic part contains a vast chapter of climatological maps. Those maps represent the distribution of many climatological elements by months, seasons and years, there are maps of the frequency of thunderstorms, hail, snow-fall, phenological phenomena etc. This climatological section of the National Atlas does not compete with the Climatological Atlas, prepared in State Hydrological and Meteorological Institute according to the guiding principles of WMO, but forms its supplement. The latter will be ready later and will be based on long-period averages, up to 75-years including. The National Atlas of the Polish Academy of Sciences should furnish a quick source of current information, and will summarize the climatic conditions reflecting our present state of knowledge, deduced from rather shorter period series. The conceptions of elaborating individual maps, not limited by the recommendations of W.M.O., can differ much from

the accepted standard methods of preparing climatological atlasses. The maps of cloudiness furnish a striking example. Four maps of cloud cover (degree of cloudiness 0–2, 2–5, 5–8, 8–10) destined for publication in National Atlas are based mainly on observational material from synoptic stations, that is from more frequent observations, than climatological, made at three fixed hours. The clouds of highest level (C_H) are here completely omitted. The author explained his reasons for that in another publication [7].

In compiling this paper, a survey of the Polish periodicals in which climatological papers are most frequently printed was made. The number of works and papers exceeded 170. The analysis showed the following distribution of subjects in works printed in the years 1948–1962: thermal conditions, air temperature *c.* 10%, lower wind — 9%, precipitation — 9%, radiation — *c.* 7%, air humidity and evaporation — 6%, cloudiness — 5%, insolation — 4%, etc.

About 15 % of published works consider theoretical and methodical problems, 8 % — bioclimatological and 6 % agrometeorological problems.

The majority of publications pertained to one locality (*c.* 24%), secondly to individual regions (16 %) and to the whole area of Poland (15 %). Among works, begun in recent times (in the years 1961/1962) and being in the research plans, studies of the climate of greater, or smaller regions, certain areas (administrative, industrial and other) important due to realized or planned investments take the first place. These works on the regional climatology of Poland represent in general 57 % of all planned subjects. Of this 57 %, *c.* 20 % comprise works, undispensable to agriculture, nearly 15 % pertain to the climate of smaller areas, but particularly important for economic reasons (not agricultural). Finally there are studies on the climate of one locality, above all of greater towns (under 10 %).

From this one can deduce a conclusion on the change in choice of subjects for climatological studies. In the prior period (works published till 1962) they were mostly linked with one locality, and in a lesser degree with one region; at the present time (works begun but not finished) subjects, connected with a region prevail in the ratio 6 : 1 to these pertaining to one locality. Moreover the majority of the investigations commenced do not treat one single element, but try to investigate the climate as a whole.

These numbers are of rather informative character. To acquire more exact data, one should review not only selected periodicals, but the publications of scientific societies too, the works published in the publications of other universities etc.

Let us now come back to the presentation of results and methods applied in certain selected works. As in many other countries so in Poland there appears a water shortage in certain regions, primarily in industrial areas. There is also an opinion — based on a vast literature — that this water deficit is caused not only by increased water demand but also by the decrease in precipitation averages, or, that it is the result of the fluctuations and changes in the climate. The existence of many fluctuations in precipitation average is undoubted.

In a work, published one year ago, an attempt was made to appreciate to what degree these fluctuations and changes occur in Poland. The author, Z. Kaczorowska [2] using all disposable material, investigated trends, over many years fluctuations occuring generally in yearly, seasonal averages of precipitation for the whole area of Poland and in the selected regions, the probability of occurence of seasons extremely wet and dry etc. The results, acquired by the means of the most elaborate methods of mathematical statistics, by the use of electronic computers, prove, that:

(1) There are practically no definite trends in precipitation in the long-period averages; changes seem to have little real occurrence.

(2) The regularity of periodic changes is not well marked, while in different localities one can prove the existence of periods of various length.

(3) The probability of occurrence of extremely wet or extremely dry years and seasons is the same for the whole Poland, but in individual climatic regions the probability of occurrence of extremely dry seasons is greater than that of extremely wet.

(4) The autumn in Poland shows the most symmetrical distribution of probability of occurrence of dry and wet periods, extremely wet and dry periods.

(5) The water shortage in certain areas is not due to changes in the amount of precipitation, but rather to changes in other components of the water balance, caused perhaps by changes in the conditions of geographic environment.

The number of stations with long and continuous series of precipitation measurements is small. A detailed analysis of the precipitation in long period averages, and at the same time with special regard to particular regional division of Poland — is not possible. The question remains open of the representativeness of the precipitation measurements just being made. This remark pertains not only to the Poland's area, but seems to be of general character[1]. Therefore in 1958 the Department of Clima-

[1] During the I Session of the Working Group on Hydrology of Regional Association VI (Europe) of the World Meteorological Organization in Warszawa (Poland)

tology of the Geographical Institute of the Warszawa University developed the idea of specialised research on precipitation in the open country. Two years later, to realize this conception, one started with the research on the influence of relief and water basins on the distribution of precipitation, and on their influence on other features of climate. A dense network of temporary stations was established with a more dense network of field rain gauges easy to attend. A part of the preliminary research results is just being printed, the further plans are just being worked out. Up-to-date results concern mainly the influence of great lakes, which is marked in a very different manner, depending on the specific conditions of occurrence and on the species of precipitation, and also on cloudiness. This last factor was specially taken into account.

It became evident, that, to find out the influence of these or other geographic factors (relief, lakes etc.) on the formation of atmospheric processes on the scale of a small area it is not sufficient to make use of averaged values of magnitudes from meteorological measurements. The analysis of individual concrete cases is necessary for such a purpose. For example the influence of lakes on thermal conditions is manifested on maps, on which there are plotted the results of observations from one time — on selected days — from all the neighbouring stations. The same is the case for cloudiness and precipitation. The effects of this influence can be of different kind and can be manifested once on this side of the lakes, for the second case on the other side, depending on the prevailing direction of air motion. Mean daily averages, the more from longer periods, efface completely all the effects of the influence, above all, if the stations network is not dense enough [10].

This method of plotting the "microsynoptic" charts based on observations of climatological stations from a limited area, was in Poland applied by J. Michalczewski to analyse the sea breezes on the Polish coast of the Baltic Sea. Due to this method acquired results allow to state, how far are reaching the breezes in different parts of the coast, at different atmospheric situations. The author of this research could prove, that, with favourable weather conditions, the sea breeze can locally reach as

1958, some members emphasized in the discussion, that the distribution of precipitation stations and the results of measurements in many countries are not sufficiently representative for the needs of hydrology, although they can be sufficient for climatology. This opinion may be justified by the fact that hydrologists, to a certain degree, can control the results of precipitation measurements while computing the water balance, and the climatologists, who do not perform such calculations, cannot see these faults in the manner of collecting the observational material concerning precipitation. The opinion of hydrologists is in that case more competent since if the precipitation measurements do not present sufficiently representative data for hydrology, these data cannot be good for the needs of climatology either.

far as 50–70 km. deep into the land, that is much farther as it was believed till now [4].

Returning now to the problem of cloudiness, it is worth noting, that in the above mentioned work the author distinguished determined types of cloudiness (not only its degree according to cloud amount): cloudless, convective, convective with stratified, variable, stratified below 8/10, and stratified 8/10 and greater. These types of cloudiness show in Poland a very clear annual course. It varies in different baric systems: cyclonic or anticyclonic, in individual regions. By applying this method of division into the above mentioned types of cloudiness, the author attempted to prove, how the geographical factors influence the general very varied states of cloudiness in Poland. It seems to be a precious results, since till now prevailed the opinion on great monotony of this feature of Poland's climate. This results encouraged the undertaking of the detailed research on cloudiness in the field. In addition it is to be remarked, that in the research expedition conducted by the Department of Climatology of the Warszawa University photographic documentations of clouds is now applied.

The work on thunderstorms in Poland has brought some striking results [12]. An attempt was made to distinguish "thunderstorm zones". There are the areas, in which, at a distance of some kilometers, the frequency of thuderstorms varies almost two times. There are places, where the thunderstorms occur relatively very rarely and places, where, as a rule, in favourable wheather conditions, thunderstorms appear. The last works, as the other too, with the related character, are included in a series entitled: "Structure and regionalization of Poland's climate". In the light of the presented exemplary works it seems that this common name linking different subjects devoted to the selected elements is justified, because it designes a certain direction, in which they tend and should tend. It is favouring a certain concentration of efforts undertaken in scientific research. This concentration can be noticed not only in general subjects on the climate of the whole area of Poland, but between the latter and the detailed regional research conducted in the field. The author tried to prove this on the example of works on cloudiness. This apparent duplicity of the ways of development: from the general ideas to more detailed and vice versa, unifies at the end both ways and acquired from them results. It seems that this mode of the development of climatological research in Poland is justified and in fact was at one time proposed [8].

In many cases in field research one makes attempts to determine in a more precise manner the physical properties of the climatic features of the area worked out. One of these attempts consists of determining

the turbulent heat conductivity (temperature conductivity), air humidity (water vapour) etc. in the ground layer of the air, from the daily amplitudes of air temperature measured at several levels. Measurements of extreme temperature were made using thermometers placed at different heights in meteorogical screens.

The formerly mentioned maps of meteorological elements destined for the "National Atlas", should serve as the basis for further monographic works on selected elements (geographic distribution in different seasons etc.). These works will be also used for a new attempt at a climatic division of Poland. The results of field research, a better knowledge of the climate of individual regions, will be very useful in this new attempt.

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GEOGRAPHIA POLONICA 1, 1964

TRENDS IN THE DEVELOPMENT OF POLISH HYDROGEOGRAPHY

Tadeusz Wilgat

In spite of a long tradition, geographic research on the inland waters of Poland had until recently a one-sided character. The main topie of interest to geographers was limnology, and as a result we now have many valuable works on that subject in the geographical literature dating from the post-war as well as the pre-war period. Other branches of hydrogeography were underdeveloped or quite neglected. The essential change has begun with the year 1951 as a result of the introduction of a method of hydrographical mapping. Prior to the First Congress of Polish Science, i.e. in the years 1950–1951, a scheme was set up for preparing a Hydrographical Map of Poland, based on detailed field surveys. By 1953 all university centres had started on mapping. The initial years must be considered an introductory period, when field surveys were accomplished, after provisional instruction, on maps of different scales (1 : 25,000, 1 : 50,000, 1 : 100,000). They afforded experience which was discussed at national conferences, and allowed work to be coordinated after new, more detailed instructions were issued dating from 1954. Fragmentary parts of the hydrographic map were presented to wider circles of scholars during the numerous conferences, creating sharper interest not only among geographers. The discussions which took place on the effectiveness of the map, its content and methods of mapping, were reflected — though not quite fully — in reports in the *Przegląd Geograficzny* and in many other articles elsewhere [2, 5]. They showed the necessity of modifying the original instructions, a task which was carried out by a larger group and published in 1958.

The instructions deal with equipment and the training of the worker for field work, the work itself, and the working out of the results of hydrographical mapping. The field mapping consists of the recording of all water phenomena and water objects found in a given terrain and of mapping them on a scale of 1 : 25 000. In order to avoid only a mechanical

registration of loosely connected facts, which happened in the first stage of field work, stress was laid in the instructions of 1954 on the principle of the "recognition of the water circulation in connection with all elements of the geographical environment". Since this was principle purpose of hydrographic research, hydrographic mapping was recognized as one of the ways leading to this objective. Not every geographer agreed with the purpose of hydrological research as stated in this manner. One group recognized on the other hand the value of research on the water occurence and the role of water in the geographical environment [11]. In spite of the essential differences in their formulae both principles are connected with one another since they tend to treat water phenomena as part of the entire geographical environment. This tendency is distinctly marked in the instruction for hydrographic mapping, which calls attention to the necessity of analyzing the climate, substratum, soil and vegetation, which are the factors modifying water conditions and the rate of water circulation.

Existing technical facilities do not allow us to fulfil research on water conditions over a vast area so that they could be approached in all their spatial variability and temporal changeability. The full picture, in the spatial sense, may be attained only by field mapping and the universal characteristic determined only by considering the rhythm and the amplitude of the changes which can be had only by repeating the measurements and observation sequences. Both approaches cannot be realized in a completely satisfying manner. It is quite impossible to repeat field mapping frequently, and the number of points of continuous observations of the Hydro-Meteorological Survey remains too scarce. Geographers, who originally planned to prepare the hydrographic map at a scale of 1 : 50,000, were obliged to retreat in advance from their aim of approaching the changeability of the water phenomena through time. They had to accept the method of instantaneous mapping restricted to the summer season alone. However, since the water element in the geographical environment is so changeable, mapping at a single period of time (since it differs for nearly every part of the mapped terrain) affords a picture which can not be used for comparative purposes. For comparisons one must apply very complicated reductions, the results of which are certainly problematic. Since this way was not accepted it was nevertheless thought that more valuable scientific material would come from the registration of the actual state, even if that should be only momentary. To attain some comparability, however, which is necessary in such an undertaking, one must apply some means. This involves first, the dating of the mapping and with the aid of continuous observations made by the Hydro-Meteorological Survey, the marking

of the zone of the conditions under which the field work was done. Secondly, some observations are repeated at chosen points of the work sheet of map in different seasons of the year in order to get an idea about the nature of the periodical changes. Thirdly, during the mapping observations and information are obtained from the country people, which might explain the changeability of the phenomena. In this way could be determined, for example, the character of the episodical and periodical streams, the flooded areas, the periodically wet terrains, the periodical outflows of the underground waters and other phenomena.

The hydrographical map, in spite of certain objections which are based on the lack of full comparability and lack of a quantitative analysis important for water economy, has undoubtedly great practical and scientific significance. At the outset, it forms the fullest register at our disposal of water phenomena and water objects. This alone qualifies it as suitable in practice. Secondly, it facilitates the recognition of water circulation, giving data however incomplete, on outflow and superficial and underground retention. Thirdly, it comprises, for the first time in one composite, superficial and underground waters. Until recently there was in water research, a fairly strict division of competences between hydrogeologists on the one side and hydrologists and geographers on the other, which affected negatively both the development of the sciences on water as well as human economy. Waters circulating on and under the surface of the ground form an organic unity and an underlining that unity is of undoubted contribution of the hydrographic map. Finally, the instructions for hydrographic mapping have set the mapmakers to investigate water as a component of the geographical environment, depending on and affecting other components.

Field work done on the Hydrographic Map of Poland created considerable interest and activity among geographers. This is reflected in the increasing number of publications. In contrast to the preceding period of time, however, articles on limnology form rather a secondary interest, although many papers on that subject have appeared too. The most numerous works, however, are those which deal with water conditions as a whole or with the main hydrographic problems of a chosen area, such as a region, river basin, a sheet of map. A characteristic feature of these articles is a tendency to approach all water phenomena within the geographic environment and to explain their mutual connections.

Studies are appearing also on subterranean waters a subject previously almost entirely neglected in geographic research. In the first place must be mentioned the research accomplished by H. Więckowska. Her articles dating from the period when the methodology of the hydrographical mapping was in a state of crystallization [8], undoubtedly caused the

inclusion of subterranean waters in the mapping, which essentially enriched the hydrographical map. More recent works [6, 7, 9, 10] dealing with watersheds may be considered and example of taking advantage of hydrographic mapping to explain the problem in which the author is interested, i.e. the occurrence of upper ground water horizons according to the relief, substratum composition, and above all the climate. H. Więckowska has analysed most effectively the problem of the occurence and periodical changes of ground water divides and their connection with the superficial watersheds. In a convincing manner she has determined the main types of the hydrodynamic equilibrium of the the free ground water table. She has also given proof of a regionalization of types of equilibrium over the whole globe. Mention should be made also of the studies of the Lublin University Centre, which have changed opinion on the character of the occurence of the subterranean waters in the Lublin Plateau bringing a new method of graphical representation of waters of the fissure type [12]. A penetrating study on the fluctuations of the upper ground water table-level was prepared by A. Kowalska [3].

The papers concerning other ranges of hydrogeography, like potamology, crenology and so forth are less numerous. The predominance of monographic works and of articles dealing with subterranean waters is undoubtedly a consequence of a wide application of the method of hydrographic mapping which not only widened the outlook on hydrography, but also directed geographers to study water phenomena on a universal scale.

Moreover, the method of hydrographic mapping has contributed to the defining of the tasks and the scope of hydrogeography. Water investigation developed over several decades within many different branches of science and developed some seperate lines of study. One of them involves the geographic current, commonly called hydrography and considered as a part of physical geography. The unimportant contribution of geographers in that branch of science has caused it to lose the character of an independent field of geography and to remain on the side lines of the geophysic "current" called hydrology. Rapid progress took place in the science with practical indications. Hydrology began to be treated as a science comprising a complex of natural sciences on water. However, even when the extent of hydrology is limited to a science investigating the occurrence of water in nature, hydrography remains subordinate to it as a descriptive part of hydrology. Such a notion is represented by one of the most eminent representants of geophysics in Poland — K. Dębski [1].

Together with a quickening of interest on the part of geographers in the study of inland waters, they became convinced of the separateness

of their own tasks. Some stimulus was given by the discussions which took place in the Soviet Union on the trends in the development of the sciences of water and on the values of the geographic and geophysic approach to the research on water phenomena. The discussions were echoed in the Polish literature [4]. Agreeing with scholars of the Soviet Union, Z. Mikulski recognized the need to synthesize both approaches. But, from the side of geographers, objections of a practical and substantial nature were raised. Training in investigation of inland waters takes place within different specializations (hydrology, geography, geology etc.), but none of them comprises and cannot comprise the whole of the problem. As regards geography, the latter is not able to contain the whole of hydrology so as to create uniform science on inland waters. On the other hand, however, it cannot resign its interest in independent study of water which is an important component of the geographical environment. Neither can geography consent to subordinating its research to hydrology, because it would mean limiting of the study to description, which does not reflect the essential nature of geography as a science whose aim is to seek casual connections. Therefore, the geographers have postulated a parallel development of hydrology and of that part of geography which investigates waters and which, in order to avoid any misunderstanding should be called hydrogeography [11]. As result of the attempt to determine the mutual relations of both branches of science was the definition of the tasks underlying the study of hydrogeography. Through a study of quantitative as well as the qualitative characteristics of all water phenomena in their spatial and temporal differentiation, hydrogeography has as its objective an understanding of the connections between water and other components of the geographical environment in order to determine the role water plays in the environment and to indicate within the natural hydrogeographic regions the directions in which the water economy should be developed in line with the postulates of natural conservation.

Hydrogeography is considered a part of physical geography, but the scope of its research reaches deeply into the economic domain. One of the main topics of hydrogeographical investigation is the dependence of society upon water conditions and the influence of these conditions on them. It sets for hydrogeography the important task of delimiting the ways to exploit correctly and with respect to nature the available supplies of water without causing any harm to the geographical environment. The importance of the task is all the greater the more intensive is the exploitation of the natural supplies. In the case of water the situation is alarming and requires attention. A knowledge of the geographic environment is necessary not only in a static sense but also as it permits

an understanding of potential changes, mainly those, which are caused by human action. This means also protection against an action, which — although profitable at the moment — may bring, in the more distant future, unfavorable changes within the environment. Universal investigation of the water conditions of environment permits the establishment of sure foundations for correct planning of man's water economy. These values of geographic water research are more and more appreciated by economic authorities in Poland. A result of this is the including of hydrogeographic research within the sphere of regional schemes for the economic planning. An element of this research is the hydrographic map on the scale of 1 : 50,000.

Realizing the difficulties in the preparation of a map on that scale for the whole country in a short period of time — which is the desideratum of the economic authorities — workers have temporalily abandoned the original editorial plan. The map will be prepared only for areas economically important. At the same time the thought of elaborating the map for the whole country on the scale of 1 : 500,000 has arisen. The map will be prepared on the basis of existing materials supplemented with reconnaissance field investigations. The content, much simpler than that in the detailed map, will permit the intended work to be accomplished within the short space of several years.

Before Polish hydrogeography stand at present two concrete tasks: a hydrographical map of Poland on the scale 1 : 500,000, and the mapping of the economically important areas as material for the map on the scale of 1 : 50,000. On the base of the field investigation destined for the maps, the research will deepen the knowledge of water conditions in this country.

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PROBLEMS OF PHYSICAL GEOGRAPHY AND PHYSICO-GEOGRAPHICAL REGIONALIZATION OF POLAND

Jerzy Kondracki

As the starting point of our discussion we assume that physical geography concerns itself with the landscapes of the earth's surface, the geosphere as a whole (general physical geography) or of its particular parts; these are certain natural complexes of various taxonomic categories (regional physical geography). We do not approach physical geography thus as some amalgamation of sciences which study individual elements of the earth's surface, such as relief, water, climate, soils, vegetation and fauna; these are the subjects of specialized disciplines in physical geography-geomorphology, hydrography, climatology, pedogeography, and biogeography. Regional physical geography is therefore a science of territorial complexes which can be studied typologically as landscapes or individually as regional units at various in a hierarchy levels.

As the advocates of landscape research and of complex analysis of phenomena found on the earth's surface are considered A. Humboldt, A. Hettner, S. Passarge, C. Troll and other outstanding representatives of German geography, as well as W. Dokuchaev, L. Berg, A. Grigoriev, S. Kalesnik the founders of the Russian and Soviet school of landscape research. The evolution of these ideas was discussed by A. Isachenko, while a synthesis of general physical geography was made by S. Kalesnik [11, 13].

One can mention here also some geographers of other countries such as H. Carol and O. Wernli of Switzerland or P. Supino of Italy.

The Swiss authors [3, 4, 5, 39] reject the notion that a landscape is the concept of an area of specific character. According to them it is a general concept describing a fragment of the threedimensional spherical space (*geomer*) chosen and delimited at will, in which fragments of the lithosphere, hydrosphere, atmosphere, biosphere and anthroposphere interact. That spherical space is called by them the geosphere and they consider

that to be the proper object of geographer's study. They approach the Soviet geographers who are speaking of "the geographical or landscape cover", though they arrived at that position independently and do not cite Russian sources. It seems that the school of American geography was also influential in rejecting the concept that regional differences exist objectively in the complex of natural phenomena on the earth's surface. The recognised theoretician R. Hartshorne had already stated earlier that "areas cannot be classified logically according to their total character".

The work of the Italian author develops from other theoretical assumptions [37]. While the author thinks that the landscape is a natural complex, he analyzes that complex from various points of view, speaking of four "types" of landscape: morphological, climatic, biogeographic, and anthropogenic. To describe that complex he proposed a system based on numerical symbols in the decimal code, different for each "type". Thus he proposes that morphological type be denoted by Roman numerals and letters (to denote the type of rocks), the climatic type by two Arabic numbers, the biogeographic type by single Arabic numbers, and finally the economic (anthropogenic) type by a multiposition number beginning with O. This is an interesting but also very formalistic system.

In common Polish usage, the word *krajobraz* (landscape) means simply the view of an area. As a scientific term it means a physiognomic type of territory. In this sense J. Smoleński used it in 1912 [36]. He wrote in his popular-scientific book on the landscape of Poland that on the Polish lands one can isolate a series of territories which differ from each other both in structure and morphology, in which each is characterized by a different landscape. It is true that the author considers primarily the relief and its origin but he did also supplement his description with an account of waters and vegetation, frequently using quotations from the fine literature. St. Lencewicz understood the term landscape in the same way. He differentiated in Poland 6 basic types of landscape: the coastal landscape; the hilly landscape of lake district; the flat and monotonous landscape of plains; the undulated plateau landscape; the submountain landscape and the mountain landscape [27]. The third outstanding geographer from before World War II St. Pawłowski, agreed rather with the views of Hettner, considering not only the natural but also the cultural phenomena as parts of the landscape. He also equated the landscape with the region, which he considered to be the principal object of geographical research [30].

In physico-geographical research itself, the studies were limited, however, mainly to relief and sometimes the surface waters. The other components of the landscape, particularly the vegetative cover and soils

were not studied to any extent. There was some interest however in the so called cultural landscape, i.e. mostly the physiognomic types of settlement. St. Lencewicz in a fragment of a larger study published after his death had the following concept of the landscape: "... the notion of the geographic region can be connected with the notion of a landscape, but they are not identical. The landscape is only a physiognomic trail, based on the external appearance. The concept of natural landscape was introduced into science by Humboldt in 1808. Later on more and more types of landscapes were differentiated classifying them into natural, and the anthropogenetic those which are the result of man's efforts, as for instance large cities, tilled lands on cleared or drained territories. The individual landscapes do not conform uniformly to geographical regions however, frequently they form islands of one within another and they do not reflect the complex of geographic traits, which form the character of a given area" [25].

Representatives of the biological sciences also operate with the concept of landscape as a certain unit of nature. A. Wodziczko considered it to be synonymous to the psysiocoenose [40]. W. Szafer also uses this meaning of the term. These authors consider the landscape as a unit of nature within a naturally limited section of the earth's surface [38]. S. Jarosz in a beautifully illustrated book on the landscapes of Poland [12], showed the existing fragments of the natural vegetative cover and the fauna reservations against a background of geomorphic units.

After 1945 an applied branch of physical geography, connected with the planning of towns and settlements and called urban physiography, began to develop in Poland. It is concerned with the study and evaluation of areas designated for construction and has employed many young geographers in specially established bureaux or enterprises [33].

The studies of urban physiography take into account as a rule the conditions of relief and the characteristics of the ground water, local climate, and sometimes also soils and vegetation. The synthesis is a land adaptability map showing a division of the area into units of defined natural characteristics, grouped according to their adaptability for construction.

These materials are unfortunately unpublished and remain in archives of the bureaux and enterprises. Their volume has become quite considerable, covering the majority of cities. The development of urban physiography contributed to the establishment at the universities of regional physical geography as a specialized discipline like the previously existing specializations, geomorphology, climatology, and hydrography. As a result, the students wrote many master theses containing physico-geographic descriptions of small areas (frequently corresponding in size

to an area covered on a single map sheet at 1 : 25,000). The subject of such studies was called as a rule not the landscape but the geographical environment. The differences between these two concepts are being formalized only in recent times. Two recently published books on the geography of Poland may serve as examples: *Geographical Environment of Poland* by J. Kostrowicki [21], and *Physical Geography of Poland* by St. Lencewicz and J. Kondracki [26]. J. Kostrowicki surveys the geology, relief, water, climate, soils, vegetation and fauna from the point of view of the national economy, seeking no connections between the enumerated factors, and refraining from an analysis of spatial complexes and their regional differentiation. In the second book mentioned the same factors are analysed as components of a landscape allowing the division of the country into natural regions, each of which is composed of certain defined landscape types and has certain specific traits differentiating it from the neighbouring regions. The larger part of the book is taken up by the description of the regions. As one can thus see, the natural conditions in which society develops are called the geographical environment and the physiognomy of the natural complex (together with the changes caused by man) is called the natural landscape. The geographical environment is of interest to economic geographers, the natural landscape is the subject of research of physical geography. The two concepts are to a degree coextensive both concerned the same current condition, but the way of analyses differs between the two. The common object of research binds however the two basic branches of the geographic sciences.

The direction of studies in physical geography has developed in recent years within the framework of the concepts described above. Thus, for instance, 76 master's theses were written (in regional physical geography) in the years 1955–1962 in the Department of Physical Geography of University of Warszawa. The greater part of these studies regarding methodology, were based upon a schematic treatment of the land according to individual components of the landscape which in conclusion gave a synthetic division of the land into small regional or typological units. Detailed studies were also carried out devoted to individual items (for example a lake or peat-bog). Quite independently of student investigations complex surveys on selected part of the Mazurian Lake District were organized in the years 1956–1957. Scientific workers of the Department of Physical Geography in the University of Warszawa and the Institute of Geography (Polish Academy of Sciences), who are specialized in physico-geographical disciplines, took part in these surveys. This aimed at deepening the analysis of individual components in order to understand their mutual connection and the evolution of the whole

complex. Consideration of the anthropogenic transformation brought to the forefront the differentiation of landscapes into the chief forms of land use, that is into forests, meadows, cultivated fields and water, which are together the fundamental biotic types. Because one of these studies had been parallel to leading surveys in agricultural geography, the results were published in 1959 under the title *Studies on the Natural Landscape* [17].

In 1959 the Department of Physical Geography in Warszawa University made further methodological attempts at landscape studies, this time in two other regions. In the first, the area of Płońsk county in the northern part of the Mazurian Plain, broad action was taken to classify the ground using numerous soils borings and measurements for compiling geomorphological, hydrographic, soil and land use maps on the scale of 1 : 25,000, and based on these, also a map of types of environment from the view point of agricultural needs. The county of Pińczów on the plateau of Lesser Poland (Małopolska) was chosen as the area of the second set of investigations. Here preliminary division of the area into natural units was made on the basis of existing geological maps; subsequently climatological, bio-geographical, pedological, and some geomorphological and hydrographic observations were carried out within the boundaries of the various types of units so defined, thus presenting all the characteristics of the landscape types selected. Types of landscape were mapped independently of these studies. The works carried out in physical geography were parallel to those of mapping land-use made by the agricultural geographers of the Institute of Geography (Polish Academy of Sciences).

Classification of types of landscape depended here on the following bases. Seven major lithogenic types existing in the relevant areas were differentiated. They were arranged in a series according to their natural properties; from the most fertile to the most sterile. On the other hand the relief was classified into four groups resulting from the means of water movement in the ground: alluvial plains and terraces at the foot of slopes, relatively high watershed plains of plateau, gentle slopes, and steep slopes. The movement of water downwards and elluvial process predominates on the top of the plateau, lateral movement on gentle slope displacing dissolved chemical compounds, but not sterilising while depressions are being enriched by nourishing substances. In reality yet greater differences exist in the permeability of rocks, the exposure and steepness of slopes, etc. affecting the development of soils and vegetation climaxes and other consequences which give very great variety in particular classifications. The flooded valley bottoms come into a special category which were defined as the hydrolithogenic type because it is

characterized by shallow occurrence of moving ground water, periods of flooding and the influx of alluvial soils (*mady*). The hydrogenic type consist of the stagnant or flowing waters, and the peat-bogs. A classification of the landscape types in the surroundings of Pińczów can be summarized in the following way:

Lithogenic types: loess, marl and lime, gipsum, clays, loams, sands, clays, sands, loose sands.

Topographic variants: plains in depressions and on terraces, plains on plateau (slopes up to 3°), gentle slopes (with slopes to 7°), steep slopes (with slopes steeper than 7°).

Hydro-Lithogenic type: muds in flooded valley bottoms.

Hydrogenic type: rivers, former river channels, ponds, peat-bogs.

Such a classification permits one to evaluate the settlement conditions and total (overall) of the ground.

The biotic types — which were based on phytosociological criteria — were mapped separately (taking into account anthropogenic conditions), yet by superimposing both maps and eventually adding a local climatological classification of the land it is possible to obtain plenty of complex landscape maps. As a result of the experiment in mapping the environs of Pińczów, it has been concluded that while the physical "landscape" geographer can map quite easily the basic non-biotic complexes (relief, rocks, water), other specialists ought to supplement these above all regarding the biogeographical and climatological elements i.e. to apply diverse study methods and the necessity for special preparation. Other maps: geological, geomorphological, hydrographic and pedological — supplement the map of landscape types and make possible the proper physico-geographical regionalization, but each has its own problems. In units of higher order it is necessary also to consider the relationships of vegetation and macroclimates. A special place for the landscape geographer becomes visible in the complex of natural geographical science, since he carries out independent mapping in a field which is separate from that of other specialists. Fig. 1 represents such kind of map. It gives an objective picture of the natural environment and can be interpreted immediately for the needs of practical agriculture, forestry and planning of villages. Special maps do not make possible such immediate application, but only a genetic interpretation of phenomena which is important in theoretical considerations and in furthering one's acquaintance with processes.

Parallel with the field work, attempts have been made to classify types of natural landscape for all Poland [18]. Following from the as-

sumption of mutual connection between all components of the landscape on the one hand, and of a guiding role of definite factors for definite taxonomic categories on the other, the thesis is established here that under the similar conditions of one climatic-vegetational zone as found in Poland (i.e. the mixed forest zone) two fundamental groups of landscape exist: the glaciated lowland landscape, and the landscape of plateaus,

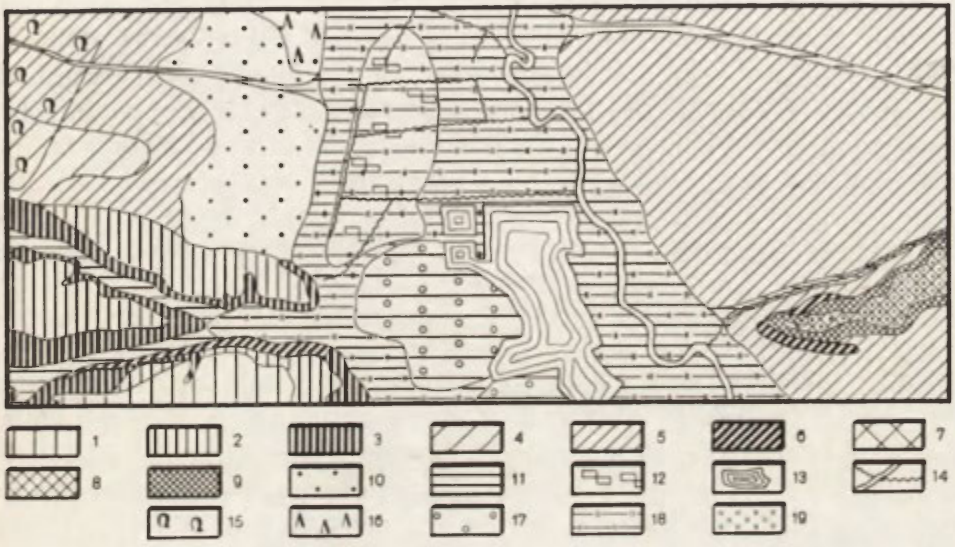

Fig. 1. Landscapes in the surroundings of Młodzawy near Pińczów

Topolithogenic Types: 1 — Loess on elevations inclined at up to 3°; 2 — Loess on slopes at between 3—15; 3 — Loess on slopes greater than 15°; 4 — Carbonates (marly or limey) on elevations inclined at up to 3°; 5 — Carbonates (marly or limey) on slopes between 3° and 15°; 6 — Carbonates (marly or limey) on slopes greater than 15°; 7 — Gypsum on slopes up to 3°; 8 — Gypsum on slopes 3—15°; 9 — Gypsum on slopes over 15°; 10 — Siliceous rocks (sandstones) on plains inclined at less than 3°. Hydro-Lithogenic Type: 11 — Alluvial soil in flooded valley bottoms. Hydrogenic Types: 12 — Peat bogs; 13 — Stagnant water; 14 — Rivers. Biotic Types: 15 — *Grond* forest (oaks) on marls; 16 — *Bor* forest on sands; 17 — Alder; 18 — Flooded meadows; 19 — Post-*grond* meadows on gypsum. Xerothermic grasslands on south-facing slopes are not distinguished.

hills, and mountains. Within this framework one can distinguish in Poland 8 genus and 23 specific varieties of landscape (viewed from various angles), linked with differences in geomorphology and lithology, and in the mountains with the vertical climatic differences. In this way the various differences are underlined between typological or landscape methods of treating natural complexes, and their regional classification which is dependent upon individual differences in geographical position, genesis, and the development of particular areas.

Research into natural landscapes has been started also in other Polish universities. Thus urban physiography is studied in the following centers: Toruń (under R. Galon), Wrocław (T. Szczepankiewicz), Poznań (T. Bartkowski), Łódź (A. Dylikowa). Interesting complex physico-geographical studies in the Tuchola Forest have been made under the direction of R. Galon.

Special landscape studies have not been undertaken in Lublin, though there may be mentioned the work of A. Chałubińska and T. Wilgat concerning the physico-geographical division of Lublin Voivodeship.

Somewhat different in character are the studies on physical geography carried out at Poznań. The Poznań Society of the Friends of Science has been preparing a monograph on the Lowlands of Greater Poland, for several years under the direction of B. Krygowski; this will have the character rather of studies reviewing the individual components of the landscape of the whole region. Apart from this, B. Krygowski, in a popular scientific work entitled *The Landscape of Greater Poland* [23] has distinguished three groups of landscape: (1) plateaus, (2) *pradolinas* and valleys, (3) hills, and within each of these also several types. For example, in the landscape group of *pradolinas* and valleys — flooded areas, dunes, scarps, in the highland group flat ground moraine, undulating ground moraine, terminal moraines, outwash plains. T. Bartowski in Poznań is also interested in landscape problems. He is striving towards the reconstruction of features of the original geographical environment and natural landscape starting from the characteristics of the contemporary geographical environment as analyzed through studies in geomorphology, hydrography, soils, and biogeography [1]. The attempt at qualifying the area, studied from the point of view of its former alimentary base, is the result.

In Łódź certain studies in regional physical geography have been carried out under the direction of J. Jurczyński.

In Kraków J. Flis began landscape research and under his supervision a number of master theses have been executed concerned with the Flysch zone of the Carpathians, while in Wrocław works of this character are being carried out by W. Walczak.

Specialized studies of landscapes in Poland remain only in their beginning, and as a result the methods employed are procured only with difficulty. That is not the least of the various problems that are apparent, yet already its practical application in town and country planning has given positive results. Still more important, however, would be the application of landscape research to rural planning and to evaluating agricultural land use. We are now taking the first steps in this domain

while for instance in some republics of Soviet Union the part played by physical geographers in that sphere is very important.

Science of landscape in Polish Universities does not form a subject for separate lectures whatever within the general course in physical geography. The course on the physical geography of Poland offers certain possibilities for considering these problems and lecturing on selected problems for those specializing in physical geography.

Although the achievements in Poland in research on natural landscapes is not great, in contrast to the inter-war period the study of the whole natural complex is finding greater universal understanding.

The problem of special landscape research still offers many doubts and fundamental ideas are not yet established. Studies are being carried out in the same direction as in the Soviet Union, with the one reservation that landscape is understood there as an overall concept, in physiognomy and typology, and not regionally, meaning the fundamental units of geographical division. Thus the science of landscapes is understood in Poland as a branch of physical geography embracing a classification and objective analysis of existing types of differentiated land areas.

Specific problem establish a territorial division into natural regions. The problem of a division of Poland into natural units has its own long tradition. At the end of the 19th and at the beginning of the 20th century there were two works on the country's physical geography. These have had great influence on the outlook of geographers even until the present time. The author of one concept was A. Rehman [32] professor of Lvov University, the author of the second the prominent Warszawa geographer W. Nałkowski [28]. After World War I problems of regionalization were discussed at a special convened Congress, and the decrees thus made were published in 1922 by L. Sawicki [34].

A return to these problems was made in 1946 when the results of changes in the political boundaries and the needs of cartography and schools required the formation of Polish regional names for the regained territories and the ordering of the divergences in terminology for former Polish territories. The Polish Geographical Society called a special conference to deal with this problem and to make recommendations. Further discussions in progress from the time of that break-through until the present time have taken on chiefly a methodological character. In 1947–1948 in the *Czasopismo Geograficzne* R. Galon, M. Klimaszewski, and S. Pietkiewicz presented their proposals, and in 1956–1957 *Geografia w Szkole* revived the discussion. The author was one of the initiators of discussions immediately after World War II and his suggestions on the theme under consideration are presented in both the journals mentioned above as well as lately in *Przegląd Geograficzny*, 1961 [19].

In this recent publication regional physical geography of Poland is linked on the one hand to analogous studies carried out in neighbouring countries, but on the other hand the results of geo-botanical research presented in the collective work *Vegetation of Poland* [38] were taken into account. Confronted by these views the author has been induced to expand the taxonomic system of regional units.

The point of departure for revising the earlier views was the acquaintance with the works of this type in the U.S.S.R. presented in February 1960 in Kiev at the IIIrd Congress of the Geographical Society of the U.S.S.R. [20]. At this Congress N. Gvozdietski presented a hand-drawn map of a physical division of European Russia (on a scale 1 : 1,500,000) based on the complex work of a whole series of universities. The map set out the following taxonomic system (beginning with the largest units):

1. Major physico-geographical units (lands): The Russian Plain, Urals, Caspian Lowlands, Caucasus, the Crimean Mountains, Carpathians, The Baltic Shield.
2. Physico-geographical zones differentiated within the borders of lands, for example the steppe zone of the Russian Plain.
3. Provinces or areas (*oblasti*) within the framework of the zones. For example the Black-Sea steppe province, the steppe province east of the Volga etc.
4. Sub-zones and in mountains sub-provinces.
5. Physical districts.
6. Regions and sub-regions.

A similar system was applied also on a map of physico-geographical regions of the Ukraine presented at that Congress. In published works on Lithuania, White Russia, and the western Ukraine [2, 7, 8] one can find indicators of small regional units which in the U.S.S.R. are called *rayons*. Thus for example the Republic of Lithuania is divided into 3 districts and 15 regions, White Russia into 4 districts and 28 regions and in the western Ukraine P. Cish differentiates 37 regions.

In the two German Republics studies have been made dividing the country into natural spatial units. Such work is being carried out by the *Bundesanstalt für Landeskunde* in Remagen and the *Deutsches Institut für Länderkunde* in Leipzig, systematic regional applications by German geographers are based on a four-point system which distinguishes the following units:

1) Group of Great Landscapes (*Gruppe von Grosslandschaften*),
2) Great Landscape (*Grosslandschaft*),
3) Landscape (*Landschaft*),
4) Part of Landscape (*Landschaftsteil*).

Thus for example the *Grosslandschaft* are Mecklenburg and Brandenburg Lake Districts, The Flaming, Erzgebirge Foreland and the Erzgebirge, each comprised of several regional landscapes [27, 35]. Somewhat different is the division into natural spatial units (*naturraumliche Gliederung*) appearing in the atlas of the eastern part of Central Europe. Sheet 9 of this Atlas includes a specific, though not always suitable division into units of "first, second, and third order" [22].

The term "region" like that of landscape is a general concept of imprecise taxonomic rank. The problem of the existence of fundamental regional units is questionable, as is also that which states that the natural region is not an existing unit, but only a rung in the ladder of divisions by embracing a series of connected genetic and compact territorially lesser units sometimes called regions of second or third order. If one considers the hierarchy of natural spatial units for Poland, situated as it is (fundamentally) along with the whole of Central Europe within one geographical zone, then the units of higher order are not taken into account. These corresponding units are such as the Russian Plain, or East European Plain, the Baltic Shield (*Fennoscandia*), the Western Europe. In this context perhaps it is possible to apply the somewhat indefinite concept of the geographical area, and above all for intra-zonal units one can use the term "province". Provinces can be divided into sub-provinces or sub-zones and only within their limits do we differentiate regions of various degrees; in differentiating these degrees it is most convenient to use the Greek prefixes macro-, mezo-, and micro. Units of higher degree are the continents and climatic belts.

It is worth noting that as late as 1953 Paffen [29] proposed a similar hierarchy of regional distinctions in which the terms *Microchor, Mezochor, Macrochor* were applied for landscape units of varying sizes; regions denoted larger units generally forming larger parts of continents.

W. Szafer, in describing the vegetation cover in Poland [38], made the chief contribution in expanding the taxonomic system of presenting a geo-botanical division of the Earth. He distinguishes on the continents of the earth three great belts, called "complexes of states", namely:

(a) *Holarctic* complex of states,
(b) Tropical complex of states,
(c) *Holantarctic* complex of states.

In the first of these two states exist: the *Holarctis* and *Mediterraneis*. These are divided in turn into areas, provinces, sub-provinces, divisions, sub-divisions, lands, districts and sub-districts so that in mountain areas the altitudinal belts of vegetation are equivalent to the districts. As can be seen, this system is closely analogous with the systems of physico-geographical regionalization and frequently makes use of the same

terms, but important differences also exist. Not only physical geographers, but also the Russian geo-botanists and soil experts use above all the concept of zones in systems of regionalization. Here the concept of "states" exists above all, it is on the other hand not used in physical geography. Further, the term "region" is not used in any geo-botanical division although it is very widely applied in geography. The taxonomic geobotanical ladder is built from "the top", that is from the most universal concept and not using the concept of basic units so that there are many sub-district and sub-provinces which we would call provinces or macroregions in a physico-geographical division.

W. Szafer writes [38, Vol. II, p. 3] that a geobotanical division "dependent on flora and vegetation throws light simultaneously on the complex of factors on which their existence is dependent; that means, on the specific features of the relief, climate, soils, on the genesis of plant associations or on the history of their evolution". Of this opinion there is not any substantial difference between physico-geographical and geo-botanical regions and both these sciences ought to be mutually complementary. The physical geographer from his knowledge of the non-biotic environment aspires to a synthetic classification of biogeographical differences, the botanist above all analyses flora and vegetation aspiring to explain their connections with the non-biotic environment and their spatial differentiations. From the Humboldt standpoint of the unity of the whole of nature one must accept the objective existence of certain territorial complexes which can be studied and understood by the methods of various sciences. We define such units as natural regions creating more or less complex unities. This does not mean however that the generalized taxonomic system of individual geographical sciences has to be that alone, because the units of higher order can be varied in their dependence on the accepted criteria. In geobotany we name these criteria "floral", in physical geography "environmental".

The geobotanic division of Poland by W. Szafer is dependent on a differentiation of flora and environment, it is a regional and not a typological division, and simultaneously is a concept in something of its own right, a physico-geographical division. The least of its units are the districts of which 80 can be distinguished in Poland. They would correspond to the proposed concept of mezo-regions or called "sub--districts" in Gvozdietski's scheme. The regional units are still smaller and these we call microregion. The floral peculiarities of larger geobotanical districts are still not proven, and their differentiation depends on the position also of the non-biotic elements of the environment which are better known overall. Geobotanical units of greater order are named lands. They correspond to the German *Grosslandschaft* (*Macrochor*) and

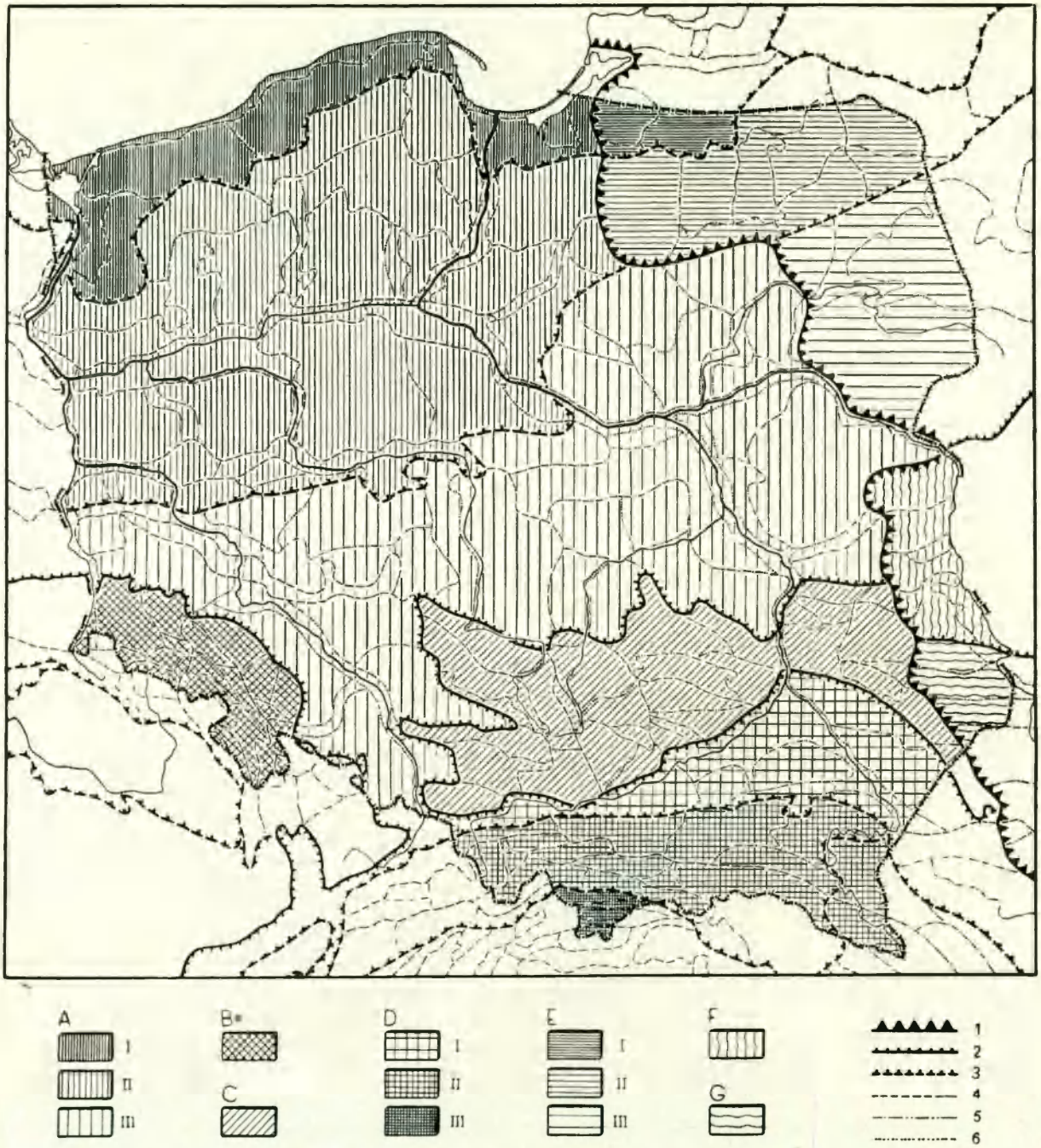

Fig. 2. Physico-geographical regionalization of Poland

Provinces and Subprovinces: (A) Middle European Lowland; I — South Baltic Coastland; II — South Baltic Lake District; III — Central Polish Plain; (B) Bohemian Massif; Subprovince of Sudety Mountains; (C) Lesser Poland Plateau; (D) Carpathians and Subcarpathians: I — Subcarpathian Basins; II — Outer Carpathians; III — Central West Carpathians; (E) East Baltic Lowland: I — East Baltic Coastland; II — East Baltic Lake District; III — Podlasie—White Russian Plain; (F) Polesie Plain; Subprovince West Polesie; (G) Black Sea Platform; Subprovince Volhynian Plateau. Boundaries: 1 — Between the areas of Western and Eastern Europe; 2 — of provinces; 3 — of subprovinces; 4 — of macroregions; 5 — of mezoregions; 6 — of microregions.

the Russian districts (*okrug*), and according to our proposals — to macro-regions. Outside the mountain areas W. Szafer distinguishes 25 such units. The last, largest geobotanical regional units in Poland, called by W. Szafer divisions (*działy*), do not have synonymous correspondents in physico-geographical regionalization, because the Baltic division, the northern, and Black Sea divisions are differentiated according to basic zonal features, while the Sudety and Carpathian divisions are differentiated by azonal provincial features and altitudenal differences. The feature of geographical zoning, although weakly visible in Poland, ought to be considered in any regional division, and what has hitherto escaped attention in doing so, geo-botanical and pedological criteria play an important role.

The typological viewpoint exists independently of regional divisions both in geobotany and in physical geography, and has special application in field research. The whole phytosociological system has a typological character but we can also classify the inorganic environment into types [19]. Geobotanical concept of facies as a complex of homogeneous vegetation and undifferentiated environmental conditions, is in the same time geographical unit, but the concept of associations and of *urochishtche* as units of higher degree than facies do not coincide with each other. Thus the basic levels of regional and typological division in both physical geography and in geobotany are in reality the same, but each of these specific science develops another system of integration into units of higher order. Regional and typological taxonomic systems in both these sciences can be compared in the following way:

TABLE 1. TYPOLOGICAL SYSTEM

Phytosociology [38]	Science of Landscapes [18]
Facies	Facies
Association	*Urochishtche*
Connection	Variety of landscape
Order	Genus of landscape
Class	Class of landscape

TABLE 2. REGIONAL SYSTEM

Plant Geography [38]	Regional Physical Geography [19]
Sub-district	Micro-region
District	Mezo-region
Land	Macro-region
Sub-division	Sub-province [sub-zone]
Division	Province
Province	Zone
Area	Area
State	Continent

We shall move now from these general considerations to the problems of a division of Poland into natural regions in connection with regionalization of neighbouring countries and of geobotanical regionalization of Poland [38].

A new physical regionalization of Poland has been made by utilizing the work of St. Pietkiewicz [31], some publications regarding northern

Poland [10], southern Poland [14], Lublin Voivodeship [6], the Nida Basin [9], the Greater Poland Lowland [23], and my own earlier and new research.

Above all it has been necessary to pay attention to marking through Poland the boundary running between the area of Western and that of Eastern Europe. The geobotanical northern and Black Sea divisions correspond to zonal units of Eastern Europe. The Lublin Polesie as a part of the large province of Polesie can also be included undoubtedly in the area of Eastern Europe. The boundary of the northern divison, having a climatologic-vegetational and therefore zonal character, is not distinct. The same impreciseness characterises the boundary of the Black Sea division, corresponding to the northern forest-steppe zone of the Volhynian-Plateau.

Then the physico-geographical boundary between Eastern and Western Europe leads from the east coast of Vistula Haff southwards, dividing the Mazurian Lake District from the Western Lake District, and the Mazovian Plain from the Podlasian. The boundary zone between Western and Eastern Europe has an overall geographical character because it finds its expression not only in mutual differences of climate and vegetation but also in paleo-geographical facts which themselves express the boundary between the east-European platform and the folded sedimentary rocks of western Europe. The difference goes further and marks out also facts of human geography with which one is not concerned here.

The zoning of climate, vegetation and soils does not find its expression in Poland because of the relatively limited extension of the land to the south. Until now, therefore, this geographical characteristic has been passed over.

However, using the given geobotanical interpretation we can speak of the entry into Poland of three zones: the subboreal forest zone, mixed central European type of forest and the forest-steppe. A certain zoning is preserved in the relief of the land under the influence of factors, which occured in the recent geological past but find their present expression in the existing young and old glacial and Tertiary forms. Less expressive is the zoning of soils. The disturbance of exogenic geographical zoning is caused by endogenic forces thanks to which southern Poland is a land of mountains and plateaus influencing the wind movements and local climatic peculiarities and expressed in a lowering of temperatures, an increase in rainfall, and vertical zoning of vegetation and soils.

The share of large physical units in the territorial structure of Poland can be presented in the following manner:

TABLE 3. REGIONAL DIVISION OF POLAND INTO LARGE PHYSICO-GEOGRAPHICAL UNITS

Area	Western European	Eastern European
Zones:	Provinces and sub-provinces	
Subboreal Mixed Forest	—	E. East Baltic Lowland I. East Baltic Coastland II. East Baltic Lake District III. Podlasie — White Russian Plain
Middle European Mixed Forest	A. Central European Plain I. South Baltic Coastland II. South Baltic Lake District III. Central Polish Plains B. Bohemian Massif I. Sudety and their Foreland C. Lesser Poland Plateau D. Carpathians and Subcarpathians I. Subcarpathian Basins II. Outer Carpathians III. Inner Carpathians	F. Polesie Plain
Forest-Steppe	—	G. Black Sea Platform I. Volhynian Plateau

In total there are within Poland two large geographical areas, three climatic-vegetational zones, and 7 structural provinces being divided in turn into sub-provinces according to geological and geomorphological characteristics. These in turn we divide into 39 macro-regions and 210 smaller units which embrace the specifity of diverse geographical positions, geological structure and relief, and linked with this, of hydrographic, climatic, vegetational, and soil features.

This latter regional division of Poland is not with any certainty devoid of doubtful and questionable problems, but it certainly approximates to a presentation of the country's entire natural features.

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GEOGRAPHIA POLONICA 1, 1964

POPULATION AND URBAN GEOGRAPHY IN POLAND

Leszek Kosiński

The geography of population and settlement since World War II has been considered in Poland as a part of economic geography just as the geography of industry, agriculture or transportation. Compared to the pre-war situation, when demographic and settlement problems belonged to human geography (anthropogeography) this represents a sharp change. The post-war reorientation was associated with methodological changes and, in particular, with introduction of a marxist methodology. Emphasis on the problems of production undoubtedly was justified in a country destroyed by the war and trying intensively to industrialize itself. Consequently there has been a tendency to emphasize the role of population as an element in the productive forces rather than in consumption.

However, this reorientation is not quite consistent, since population and settlement geography differs basically from other branches of economic geography. The specific nature of population and settlement geography is reflected in definitions proposed by K. Dziewoński in 1956 [2]. According to him: "The subject for research as regards the geography of population and settlement is the distribution and structure of historically developed spatial human communities, together with the material features of such settlements. Research should also include the study of the functions of settlements and use of land occupied for this purpose... And again: The aim of population and settlement geography is a critical appreciation of the rationality and efficiency of both the network and the internal structure of settlements. Such study should be undertaken from the point of view both of production and of living conditions in a given settlement, i.e. from the point of view of the needs and interests of the community."

In these definitions the problems of population were considered together with those of settlements, functions and land utilization forms having been emphasized. As a result of the pragmatic tendencies in post-war

Polish geography, an appreciation of the problems of existing patterns were stressed. However, Dziewoński's concepts were criticized by Mrs. M. Kiełczewska-Zaleska, who questioned the validity of linking both population and settlement geography into one discipline and argued against limiting it to economic aspects [19]. Newertheless, a common treatment of both elements was widely accepted in research, in teaching as well as in the institutional organization of geographic study and research in this country.

It does not mean, however, that post-war studies have fulfilled all of Dziewoński's demands. Their authors were attempting in essence to solve the problems which are important both from a social point of view as well as from the pragmatic. As far as the methods were concerned, a functional approach prevailed. Recently, however, the range of problems studied has widened beyond the purely economic aspects.

In this paper the main trends of Polish population and urban geography based essentially on selected recent publications will be discussed. The problems of rural settlement have been considered elsewhere.

1. Growth and distribution of population in Poland

Geographers, who participated in the demographic studies carried out by the Committee of Space Economy of the Polish Academy of Sciences, were charged with analyzing the problems relating to the distribution of population in Poland. At the same time Polish geographers have participated in the work on I.G.U. World Population Map. For these reasons special emphasis has been given in this country to population distribution problems.

Initialy an attempt was made to study the distribution of population in the 20th century over the present territory of Poland. K. Pudło-Palonka prepared a set of maps, where the distribution of concentrated urban population was combined with the density of dispersed rural population. Administrative divisions differed for different periods. Settlements were considered urban if they had the administrative status of towns [36].

More detailed maps of the distribution of population were based on data taken from the last two census of population — 1950 and 1960. The method used was that suggested by the I.G.U. World Population Map Commission. Population distribution was shown by dots and spheres or rather by projection of the spheres. To determine the arrangement of dots the general map of the built up areas was used [42].

Detailed maps of the distribution of population were used as a basis for density maps. In order to be free of the frequent changes of administrative divisions, which in fact made any comparison impossible,

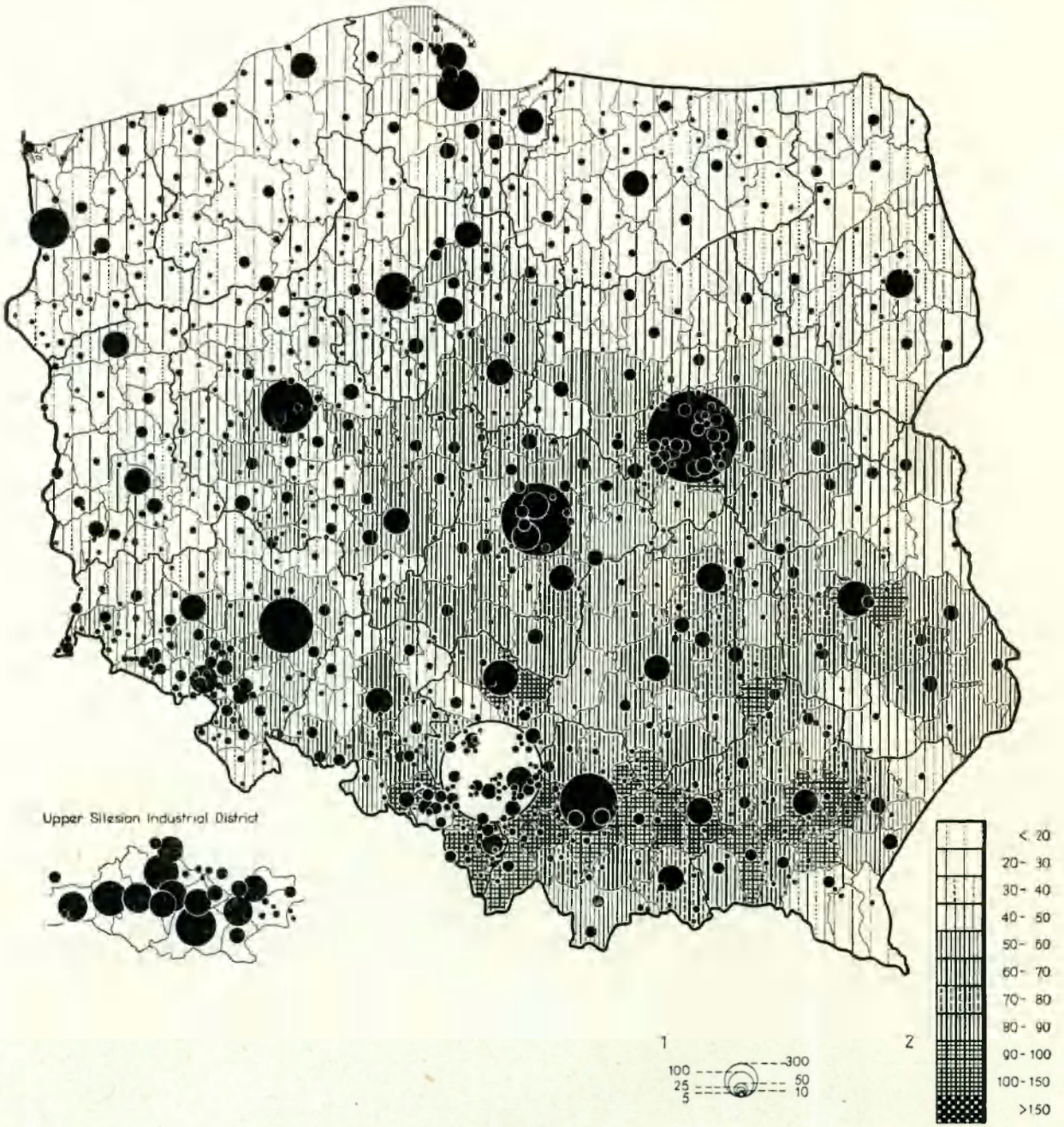

Fig. 1. Density of rural population and distribution of towns in Poland in 1960 (according to K. Pudło-Palonka)

1 — size of urban population, in thousands (circles for towns over 100,000 proportional to the number of inhabitants); 2 — density of rural population per square km

a special hexagonal network (3100 hexagons of 100 square km. each) was used. Thus, the density of population was computed for an *a priori* accepted permanent pattern of reference. Later a final map was prepared

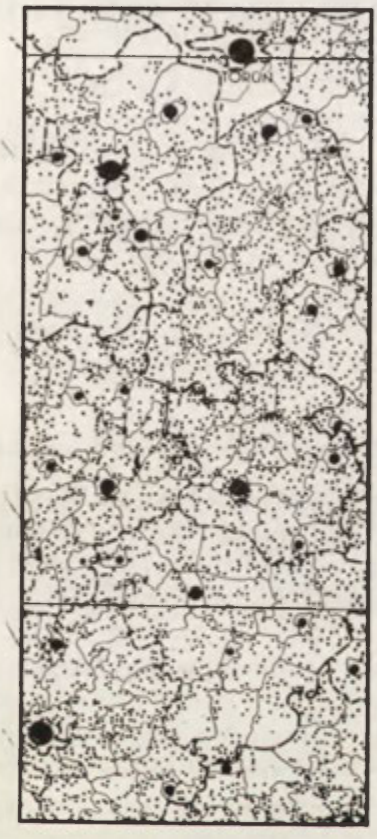

Fig. 2. Distribution of population in Toruń District in 1950

rural population represented by dots, each dot = 200 inhabitants, urban population represented by the spherical projections

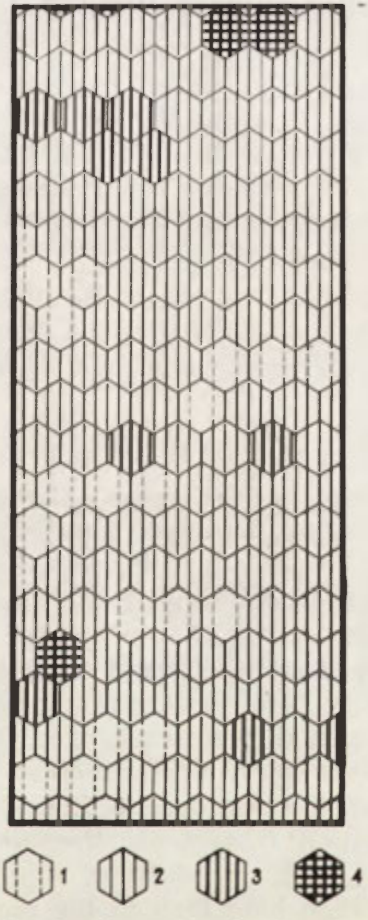

Fig. 3. Changes in the density of population in 1950—1960:

1 — losses of population; 2 — gains of less than 10%; 3 — gains of 10—25%; 4 — gains of over 25%

showing the changes in the density of population 1950–1960. Hexagons made the comparison fully possible.

Such a method of studying the density of population and its changes proved to be satisfactory and was consequently employed for the period 1900–1950. Since there exist no detailed dot maps of the distribution of population, the results were obviously less precise than for maps

prepared for later period. The method as well as the results of the study were discussed in detail elsewhere. Included in that study also are maps or sections of maps [6].

More recently R. Jedut gave an extensive analysis of the concentration of Polish population [47]. This is a continuation of similar studies by F. Uhorczak.

Demographic structure and migrations have been studied by several authors, including A. Jelonek [13, 14], whose work is most recent. The regional approach recently has become more popular too. Examples one might mention are the studies by A. Jelonek [15], W. Czarkowska and W. Leszczycka [1] for Krakow voivodeship and by E. Piasecki for the city of Wrocław [35].

Finally in connection with the preparation of population maps for the National Atlas of Poland, demographic cartography has been given considerable attention. These maps are to be published later.

2. Studies on the population problems of the western and northern territories

The territorial changes which occured as a result of World War II were followed by important demographic developments. The population over an area of more than 40,000 square miles or 1/3 of the present territory of Poland was almost completely exchanged. The present population of the area is about 8,000,000 as compared to 8,850,000 in 1939. Since there remained about 1,000,000 of the indigenous population (the former Polish minority in the eastern provinces of the German Reich) about 15,000,000 people in all were exchanged. This figure includes war losses and the exodus of German population on the one hand and the influx of Poles and natural increase on the other hand. As a result of these tremendous population movements the area under discussion possesses certain demographic peculiarities, since the age structure reveals a younger population here than in the remaining part of the country as well as extremely high ratios of natural increase.

Other special features of the area involve a higher degre of urbanization, faster industrialization and, as a consequence, a permanent in-migration of population as opposed to emigration which characterized this area even before 1939.

Thus, the northern and western territories of Poland have attracted many scholars, including geographers, as an extremely interesting area for research. Several studies were undertaken by the Institute of Geography of the Polish Academy of Sciences. In some of those existing statistical data were utilized (territorial origin of population and

migrations); others were based on field surveys (demographic problems and settlement structure of the selected areas).

Several detailed studies have already been published, i.e. the results of geographical study were included in a special publication of the Western Institute in Poznań [11]. The present author attempted to give a synthetic picture of the processes based upon detailed studies [27]. The demographic development of the western and northern territories of Poland were discussed in connection with the demographic processes for the country as a whole *vis-a-vis* the pre-war situation. Movements of population were compared with other contemporary migrations in Central Europe.

Present studies on population problems in Central Europe continue this type of studies.

3. Demographic problems of the foreign countries

Research on the demographic problems of foreign countries is relatively less developed in Poland. However, one should mention here the work of A. Maryański, who is the author of numerous detailed studies as well as of two larger volumes. He attempted to compare world population around 1950 with that of around 1930; he also discussed the main urban concentrations [33]. Another large study by the same author deals with the demographic problems of Asia and all the countries of that continent [34].

J. Staszewski has been interested in the vertical distribution of the world population [38] and his study provoked A. Zierhoffer to disagree [41]. More recently J. Staszewski has discussed the distribution of world population as measured by the distance from the sea [39].

In this same group on might include also a global study on the distribution of Poles or persons of Polish origin by M. Kiełczewska-Zaleska and A. Bonasewicz [20].

4. Studies on the economic stimulation of small towns

Small towns in Poland experienced, after the war, particular difficulties of development. The crisis was caused by war destruction, the extermination of the Jews who had formed the majority of the population in many small urban centers, changes in the trading system which eliminated to a large extent the intermediary position of small towns, and succesful competition of larger industry as well as of larger urban centers. Consequently due to the lack of prosperity, young pople began to leave the affected towns and frequently even the total population declined. The productive capacity of the towns was not fully utilized

and in many cases labour surplusses appeared. Sometimes municipal equipment and facilities decayed. The crisis of the small towns and in particular of small local centers has attracted the attention of geographers. Although the problem was essentially an economic one, geographers first undertook the analysis of the background of the crisis and the formulation of a program for economic improvement [22]. On the one hand research of a general character was carried out, based on an analysis of statistical materials but in addition geographers also embarked upon field research, conducted in the small towns according to a plan whereby students preparing diplomas and theses were employed. Since the large proportion of the graduates in geography ultimately went to work in economic planning offices, the studies they prepared were a very important element in their training. The completed work was eventually turned over to the planning bodies and selected studies have been published [7].

The crisis of the small towns took various forms in different parts of the country and remedial measures must accordingly differ, but in all cases local resources need to be utilized. Thus not only the towns themselves but their hinterland was also analyzed.

The majority of small towns will continue to serve as local centers and their prosperity will depend on the development of the agriculture. The programme for economic stimulation obviously could not embrace all centers that have declined and have lost their character and urban status. Inevitably some towns must decline to the level of villages, since the transformation of social and economic systems is bound to cause changes in the settlement mesh. The economic stimulation of some of the decayed towns, however, will form them into specialized towns (industrial, resorts, satelite towns, etc.).

Geographers continue to study small towns, although the problem of their decay has lost much of its importance [18]. In order to stimulate them special economic measures were introduced. Some of them have become capitals of newly created *powiats*, a development associated with the administrative reforms of 1956/57. Thus, they gained new administrative functions as well as commercial and service functions since, under existing conditions, the trade and service network organization is related also to the *powiat* divisions. A much larger proportion of small new industries were established in the medium-size and smaller towns. This latter trend was associated with the decentralization of economy.

As a result, the more acute forms of the crisis have been overcome and many of the small towns now fit into a changed economic situation. This does not mean, however, that all the difficulties have disappeared; the final adjustment of the problem remains a task for regional planners.

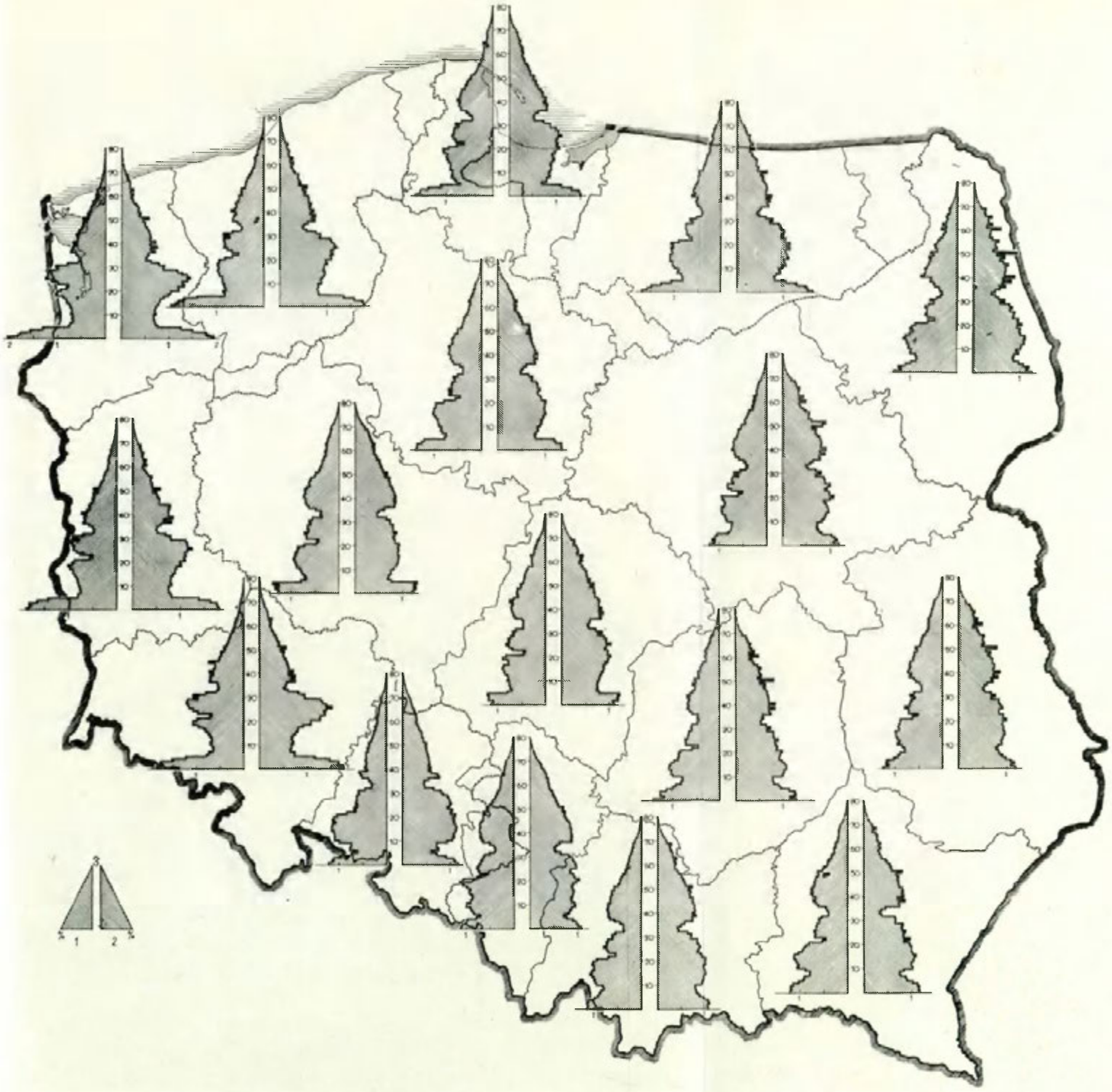

Fig. 4. Structure of population according to sex and age in 1950

1 — men; 2 — women; 3 — age; pre-war boundary marked by a dotted line.

5. A STUDY OF FUNCTIONAL STRUCTURE AS A BASIS FOR ANALYZING THE ECONOMIC FOUNDATIONS OF TOWNS

The term "functional structure" means the division of urban population into active (basic and non-basic) and inactive. The differentiation into basic and non-basic groups is determined by their contribution to the foundation and development of the town. The basic group includes the population employed in establishments and institutions where the activity reaches beyond the town and so reflects the position occupied by the town in the region. The population in the non-basic group serves only the population of the town itself, especially the basic group. The non-basic group thus has a secondary character and appears only when the proper stimuli exist.

The functional approach has been developed by the economists and town planners in the West (i.e. H. Hoyt in the U.S.A.) as well as in the East (i.e. P. Levtshenko in U.S.S.R.). Geographers have also adopted this concept especially in analytical studies. In Poland J. Kostrowicki introduced this approach at the beginning of 1950' [21]. Later numerous detailed studies were prepared based on the census data of 1950. The results were later published [28].

The crucial aspect of the concept is the distinction between the basic and non-basic groups. In order to make this distinction a special formula was prepared earlier. In the preparation of this formula the character of each establishment or each institution was taken into account. Under the conditions of a planned economy the problem was a relatively easy one, since each establishment has its tasks determined in advance. In certain cases, however, estimates had to be made. Since census data were used in the studies (at times even the primary sheets and the research was done by sampling) the results were applicable only to a resident population. The population employed outside the town was also included; they were considered basic, since their income contributes to the town economy irrespective of their occupation.

After the structure of the population of the various towns was established, a functional classification was prepared, based on an analysis of the basic group. Table 1 gives examples of different functional types of towns.

Studies of the functional structure of towns were used by town planners in two ways. A knowledge of the existing state of affairs enables the planner to assess the economic activity of the town (the size of the basic group) and its distinctive character (the structure of the basic group) as well as the level of services provided for the inhabitants (the size and structure of the non-basic group). Obviously a statistical analysis is an insufficient basis for a full evaluation and must be supplemented by an

TABLE 1. FUNCTIONAL STRUCTURE OF POPULATION IN SELECTED TOWNS IN 1950 (PERCENTAGE OF TOTAL POPULATION)

Towns	Population (in th)	Groups of population			Structure of basic group								Functional type of town
		Basic	Non-basic	Inactive	Manufacturing	Building	Transport	Trade	Cultural and Social Services	Administration	Others	People working outside the town	
Independent													
Bielsk Podlaski	7.3	30.8	14.3	54.9	4.2	2.5	0.4	4.7	3.2	7.5	7.7	0.6	Multifunctional (*powiat* seat)
Knyszyn	2.9	21.6	12.3	66.1	9.1	—	—	3.3	2.3	2.8	4.1	—	Multifunctional
Andrychów		42.9	7.6	49.5	27.2	1.3	0.5	4.1	1.0	0.4	4.0	4.4	Industrial
Ciechocinek	4.5	32.5	12.4	55.1	0.1	0.7	0.6	0.7	19.7*	—	5.7	5.0	Resort
Myszyniec	1.7	20.5	10.5	69.0	2.6	—	12.2	2.2	1.1	1.2	1.2	—	Transport-center
Dependent													
Milanówek	8.7	40.3	9.1	50.6	5.5	0.2	—	0.1	1.0	0	5.8	27.7	Satellite
Iłża	3.3	34.6	7.5	57.9	9.2	—	—	2.9	2.3	—	8.7	11.5	Industrialized satellite

* Including 18.4 employees of the resort establishments.

economic and social analysis, but it is nevertheless a valuable pointer, especially in comparative studies. Secondly, a knowledge of the balance between basic and non-basic groups can be used as o forecast with respect to the population of the town. With a knowledge of the forecasts made in the economic plan with respect to the expansion of certain main branches of the economy, and planning for the future contributions of the basic and non-basic groups, one can estimate the future population according to the following formula:

$$P = \frac{B \cdot 100}{100-(c+d)}$$

where P estimate of the total population
B estimate of the basic group
c estimate of the percentage of non-basic group
d estimate of the percentage of the inactive group

since

$$100-(c+d)=b$$

where b estimate of the percentage of the basic group then

$$P = \frac{B \cdot 100}{b}$$

Detailed studies have made it possible to establish the average proportions of the basic and non-basic group in each branch of the national economy. These ratios were used in the studies, based on available statistical material. As a result a functional classification of larger Polish towns was established [24]. Fig. 5 shows the distribution of the towns together with their spheres of influence, as established by A. Wróbel, who utilized data on railway passenger flows. An example of

Fig. 5. Functional types of larger towns in Poland in 1950 and their spheres of influence, as defined by passenger Flows

Key — see p. 87

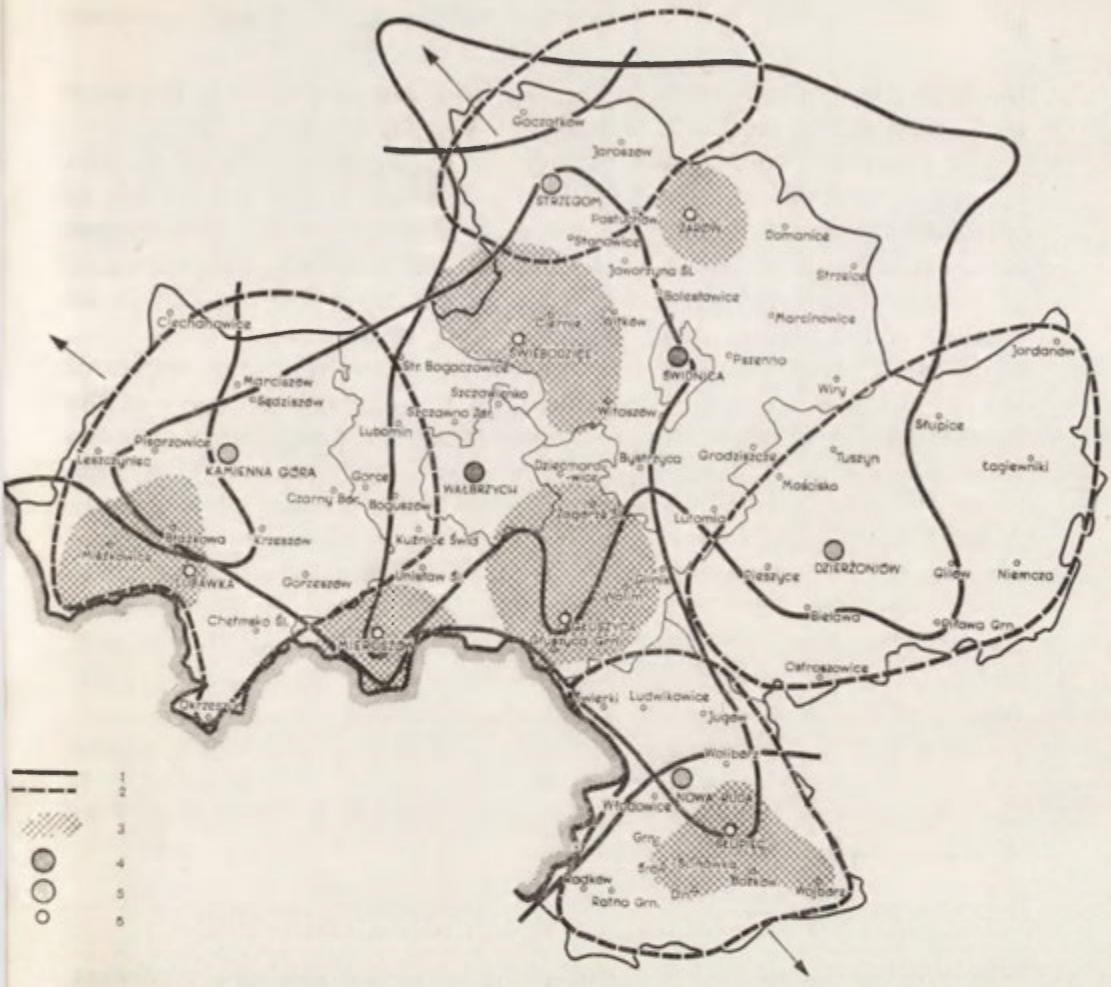

Fig. 6. Spheres of influence of some Lower Silesian towns (according to A. Werwicki)

1 — spheres of influence of sub-regional centers (above the *powiat* level); 2 — spheres of influence of *powiat* centres; 3 — spheres of influence of local centers; 4 — sub-regional centres (above *powiat* level); 5 — *powiat* centers; 6 — local centers

Key to Fig. 5.

I — Structure of basic group: 1 — manufacturing; 2 — building; 3 — transportation; 4 — trade; 5 — cultural and social services; 6 — administration; 7 — others

II — 8 — voivodeship center; 9 — population of town 1950; 10 — growth of urban population 1950—1958; 11 — population of the region of II order in 1958

III — Size of population

IV — Functional types of towns: 12 — manufacturing towns; 13 — resorts; 14 — slightly industrialized multifunctional towns; 15 — highly industrialized multifunctional towns; 16 — slightly industrialized multifunctional towns with communications playing a subdominant role; 17 — highly industrialized multifunctional towns with communications playing a subdominant role; 18 satelite towns

V — 19 — boundary of the I rank region; 20 — boundary of the II rank region;

the application of the functional concept in a regional study is the work by L. Kosiński on the towns of Białystok voivodeship [26].

The functional method was further developed by A. Werwicki, who applied it in historical studies [43]. He was trying to use the concept to study the changes of functions and of their influence on the development of towns. In order to be able to compare the functional characteristics of towns at different periods of time he limited his discussion to an analysis of the percentage of the population whose income comes from: (a) manufacturing, (b) trade and transportation, and (c) other sources of income. Depending on the deviation from the average structure of the basic group (for different size groups separately) four main types of towns were established: industrial, transportation and commercial, service, multifunctional, as well as mixed (a combination of the previous four). A comparison of the functions of towns with their demographic development leads to a conclusion, that the contribution of different functions to urban growth is variable. As a consequence the author divided the basic functions into dynamic functions, which cause further population growth, and static functions, which support the existing concentration of population.

One should mention that A. Werwicki used in his study, among others, the data of the 1787 census, which had been kept in the German archives and which were first evaluated and published after World War II by W. Dziewulski [8], S. Golachowski as well as by T. Ładogórski [31].

6. Functional relations between town and region

Studies on the spheres of influence of towns are not very numerous. Such studies, however, were undertaken in connection with research on selected sections of the western territories. The research was in principle limited to studies of county (*powiat*) seats, whose sphere of influence was to a large extent determined by their administrative functions. Nevertheless, it was found that the reach of several functions did not coincide with administrative limits. This lack of coincidence would apply especially to the spheres of influence of fairs, which play an important part in rural life not only economically (delivery of agricultural products and purchasing of industrial goods) but also socially. In the studies villages as well as small towns below the *powiat* level were also considered.

During the research undertaken by the Institute of Geography of the Polish Academy of Sciences two basic methods, developed by other scholars in this field (i.e. A. E. Smailes and H. E. Bracey in Britain, O. Tuominen in Finland, R. Klöpper and K. Hottes in Germany), were

employed. The basic data were obtained by interviewing the responsible people in towns as well as by sending out questionnaries to the teachers of local schools. The results were mapped and maps were used as basis for establishing the catchment area of different institutions. Synthetic maps showed the extent of the immediate hinterlands of the towns as defined by trade connections, the purchase of agricultural produce, milk deliveries, catchment areas of health service centers and also the extent

Fig. 7. Distribution of local centers in *Opole Regierunsgbezirk* in 1939 (according to Cz. Kaniowna)

1 — local centers of lowest order; 2 — villages served by the lowest order service centers

of the wider hinterlands as expressed especially in trade relations, the influence of fairs and the influx of customers buing consumer goods.

Studies on spheres of influence of small towns, discussed more generally elsewhere [23, 29] were also used by local planning authorities, who also used the author's methods in their own research.

In the studies of the spheres of influence of towns some authors emphasized cultural relations. National research based on an analysis of residence of students of academic schools was done by K. Dziewoński and E. Iwanicka [5]. A paper by M. Jeśman, who utilized data on the commuting to the Opole schools is an example of the regional approach [14].

Studies on migration of urban population, done by L. Straszewicz in connection with his numerous works on Łódź Industrial District, only partially belong to this group [40].

In fact all the studies discussed here refer to towns as central places, as centers of nodal regions. The latter have been studied by A. Wróbel who has generally an interest in economic regions. In order to establish limits of nodal regions he used data on passenger flows [45]. Nevertheless, a general classification of the Polish towns as central places does not exist so far. An important exception may be found in the studies of M. Chilczuk on rural centers of socioeconomic linkage discussed elsewhere in this volume. Also included there is a discussion of the studies of social changes in the countryside under the influence of a city, carried on by M. Dobrowolska in Kraków.

A. Wróbel has attempted to combine a functional concept with studies on central places. He used earlier works on the functional structure of towns and cities and, by analysing the basic group (excluding industry), he astablished synthetic indices of the regional importance of towns [44].

An interesting study on German regional planning during the war in Silesia was published by C. Kaniówna [17]. The data which survived the war and are now kept in archives prove that the settlement network in this area was to be established according to central place theory. C. Kaniówna reconstructed the map of villages selected for further development (concentration of service establishments) as central places.

7. Spatial structure of towns and cities

The spatial aspects of towns have been emphasized in historical studies, undertaken especially in Wroclaw, by S. Golachowski [e.g. 9], H. Szulcówna [41], T. Ładogórski [last 32]. The first two authors [10] emphasize the necessity of considering the total "town area". This term refers to all the land granted to the town at the time of location, i.e.

including arable land, meadows, pastures, and so forth. In this way the influence of the functions on the landscape can be traced, thus combining a functional approach with a morphological one.

Numerous regional monographs of Silesian towns have also been published by H. Leonhard-Migaczowa [last 30] which have emphasized historical as well as the spatial aspects of towns.

Studies on urban land use, directed by K. Dziewoński were, at the beginning, connected with studies on land use in rural areas. The latter developed very succesfully; on the other hand studies on land use in towns were limited to half a dozen small towns [37]. The common feature of these studies was an attempt to summarize their results in the form of a balance for the urban area in which were included:

— residential areas (gros): divided into different zones;

— settlement areas: including residential areas as well as commercial, service, administrative, green spaces, streets and squares;

— invested areas: including settlement areas as well as industrial, municipal facilities, railway, cemeteries, etc.

Data were obtained during extensive field surveys, at which time the land use of each urban lot was registered on special forms.

A. Werwicki simplified the method in recent studies, but the results have not been published yet.

Recently K. Dziewoński proposed a new method of analysing the spatial structure of towns [4]. He suggested that the classification of towns should not be limited to socio-economic criteria but that they should also take into account "material" forms such as the territory of the town, its pattern of development and manner of utilization. The starting point for such a morphological classification of towns is as far as Dziewoński is concerned (a) the definition of the magnitude and the degre of complexity of the spatial pattern of a town (forms simple, complex and manifoldly complex); (b) a determination of the most important constituents of the spatial pattern of a town and especially of its predominant elements (i.e. elements strongly and distinctively developed); (c) the interrelation of the elements; (d) the definition of the relation of the spatial pattern of a town to its geographical environment; and finally, (e) the definition of the character of its dynamics of development, its growth within territory occupied.

8. General studies

Relatively numerous analytical studies are in principle not accompanied by general works of a synthetic character. Nevertheless there are some first attempts. A few years after general characteristics of urban de-

velopment in Poland were studied by A. Jelonek [12], K. Dziewoński published a more comprehensive study [3] wherein he attempted to sum up previous achievements. The latter reviewed the Polish publications on the subject and discussed the present intensity of urbanization, its

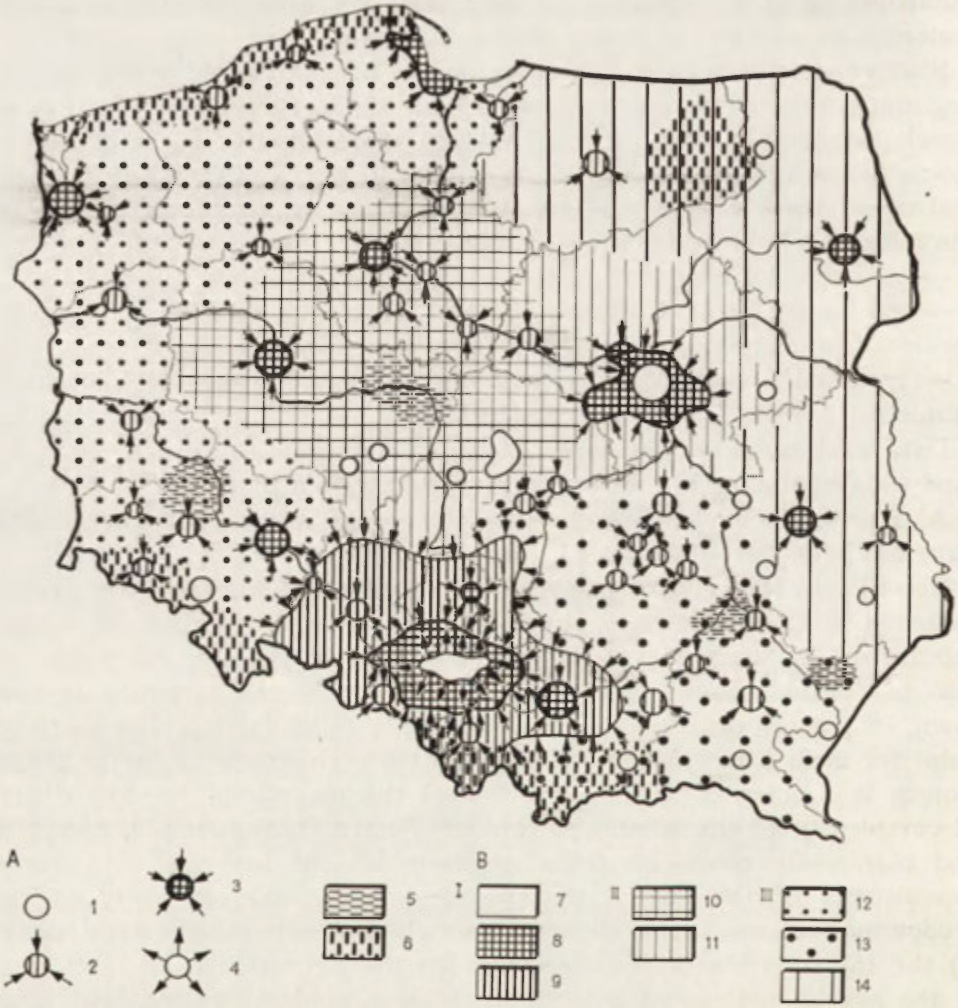

Fig. 8. Urbanization processes in Poland in 1950—1960 (according to K. Dziewoński)

A. Main Urban Centers and Areas

1 — limited growth; 2 — strong growth; 3 — very strong growth; 4 — signs of decentralization; 5 — new mining areas; 6 — areas of mass tourism

B. Zones of Urban Growth

I. Areas strongly urbanized: 7 — conurbations, metropolitan areas; 8 — areas of direct deglomeration; 9 — areas of indirect deglomeration

II. Areas of decreasing growth in urbanization: 10 — areas of balanced structure; 11 — areas of deformed structure

III. Areas of strong urbanization: 12 — areas of balanced structure; 13 — areas of growth of middle-size towns; 14 — areas of concentration in the largest town

spatial differentiation as well as its existing characteristics as a result of earlier complex population movements and changes.

Of several maps published by Dziewoński one such map gives a comprehensive picture of urbanization during the last ten years. In Dziewoński's opinion the intensive processes of urbanization developing within Poland's planned economy, are in the main outlines effectively directed. The development of big cities is, generally speaking, checked, middle size towns are developing at an increased rate, while small towns after a period of a transitional depression caused by war losses, socio-economic changes as well as by post-war resettlement movements, are developing either as industrial or administrative centers or else as centers supplying and servicing their agricultural hinterlands. Regional differences persist: alongside areas which went through an intensive urbanization process at the turn of a century and where further urbanization now depends on deglomeration and decentralization of the most densely populated and most industrialized areas (The Upper Silesian and Cracow Region etc.), there are some urbanized areas where the process is now slowing down (e.g. Industrial District of Łódź), followed by areas in which the urbanization process leads to the establishment of new industrial settlements (mainly in the new mining districts, e.g. Tarnobrzeg — sulphur, Konin and Turoszów — brown coal), or to the parallel development of middle-size towns (e.g. in Rzeszów or Kielce voivodeships or in the Lower Vistula valley), or else to the concentration of urban population in the largest town within the region (e.g. in the Lublin, Białystok or partly also Olsztyn voivodeships).

The respective chapters of the textbooks on economic geography of Poland should also be mentioned as ones of comprehensive character. The last attempt of this type is a chapter of a textbook published in 1963 [25].

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GEOGRAPHICAL STUDIES ON RURAL SETTLEMENT IN POLAND

Maria Kiełczewska-Zaleska

Rural settlement in Poland has been the subject of a variety of geographical studies. There are reasons for the widespread differences in methods in these studies. One of the reasons is a result of the evolving theoretical base underlying the approach to rural problems within geographical studies. In the inter-war period research on rural settlement involved the description and explanation of the exterior morphology of villages and village dwellings in their layout and relationships to the environment and so forth.

A newer emphasis in the conceptual framework of research in human geography treats the phenomena of settlement in a much broader and more comprehensive way.

According to Dziewoński, "the distribution and structure of historically developed human communities and associated material forms fall within the scope of research in the geography of settlement and population". Research should embrace, besides man and the material forms, the means whereby the latter are utilized and taken advantage of as well as the territory they occupy [15]. According to that definition, problems pertaining to building structures, to houses and other material forms, as well as to the population itself, have been introduced into the research on rural settlements. The way in which the population lives, its occupation and the changes in social structure may be the subject of research in much the same way as are building structures. Theoretical formulations have been developed in our country in a manner that approaches the point of view of the French geographers. Sorre's concept especially in his great synthesis contains these ideas. Sorre stresses that man and settlements are indivisible and that, in his opinion, one should not fail to analyse population characteristics when studying rural settlements. This analysis should proceed to the study of the distribution of rural houses [34].

There is, however, an original element in Dziewoński's work — it is the stressing of the tasks and aims of the study the geography of settlements. He sees these objectives from the point of view of the adaptation of settlement patterns and structure to social and economical needs and to social development. This concept is in harmony with the understanding of the role of geography in regional planning for which a knowledge and an analysis of settlements is of great importance.

The stressing of dynamic historical aspects as well as of the aims of research in settlement geography have influenced the conceptual development of studies on rural settlement. The most characteristic features of recent developments in research in Poland then, are on the one hand an increase in interest in the geographical and historical problems of rural settlement and, on the other, a growing interest in contemporary economic-geographic problems.

Historical geographical research shows a tendency toward an analysis of the past development and distribution of settlements, of the mutual interrelations of settlements and the geographical environment. Poland is a country whose physiography is of highly differentiated character. The geological and geomorphological structure creates contrasts, especially between the south and the north. Some latitudinal zones may be observed and they are distinguished by relief, soil and vegetation. Each of these zones has a rich relief with convex and concave forms whose value for man, his economy as well as for settlements is different. The spread of rural settlement and of the agricultural economy was a slow process and the influence of soil and relief on their formation was very great, especially in the early period, although the relationships are not yet fully known. Historical geographical research on this problem is closely connected with the development of the history of settlements. New discoveries of evidences of settlement in prehistoric times are very frequent. Research on settlement during the prewar period of the Polish state, intensified after World War II, led to the discovery of many hill-forts (*grody*) and the earliest foundations of towns and villages.

A knowledge of the geographical environment and an analysis of the topographical situation help in an understanding of the character and the functions of this type of settlement. The location of early historic settlements (shown by geographers) has demonstrated the defensive value of hill-forts based on topography and the various types have been classified according to different forms of relief [13]. These scientific works have drawn attention to the necessity of reconstructing the natural landscape with its marshes and waters which, in northern Poland, increased the defensive character of settlements. A location on an island or isolated among marshes, or on the steep slopes of a river encouraged the building

of the first fortified settlements. There are some analytical studies which deal in detail with this problem. These include Dylik's work on the situation of Łęczyca, one of the oldest settlement centers and the work of Zajchowska [41] on the hill-fort of Bonikowo, an ancient Polish site, and the description of the hill-fort of Jeziorko, a Prussian settlement in the Mazury region [20].

Another important problem to be studied is the development of settlement patterns. Two trends may be distinguished in this research. One of them is more historical, the other more geographical. The first is based mainly on the detailed analysis of historical sources. These are historical studies prepared chiefly by historians and devoted to the reconstruction of ancient settlement patterns [19, 27]. These studies attempt to locate such settlements and determine the character of the settlement pattern. In these studies there is little stress on relationships with the geographic environment and on questions of the layout and topographical situation of settlements.

The studies on the reconstruction of forest areas in the past, elaborated by Mochnacki [26] and Slaski [33], give a new view of the development of the settlement pattern. After the war historical studies on settlement development were elaborated for some regions i.e., the settlement of Warmia in Teutonic times [30], the settlement of the Wieluń region in the 12–16th centuries [32], and the settlements of the Upper Wiar basin in the 15th century [39], as well as others. These works differ considerably among each other. In the historical journals there is a discussion going on as to the methods and scope of such work, which is a proof that the interest in the history of settlements associated with geographical study is strong and increasing [2, 43].

The second, more geographical trend of research places more stress on the problem of the development of settlement patterns in connection with the respective elements of the geographical environment. This type of study tends to seek out that element of the environment which had the most distinct influence on the formation of the settlement pattern. Various points of view of the respective authors may be observed. The environment, as a complex of physical elements, is difficult to be defined as a whole. One or more elements may be selected and the relationships with the settlement pattern may be discussed. For instance in the study on the development of settlements around Łódź [14] the relationship to relief was the main problem. The author divided the territory under consideration into 45 regions by type of landscape. For each of the landscape units, he determined the ratio of settlements that had developed in different historic periods.

The results of this study were interesting and characteristic for Łódź region, where a distinct relationship between relief and the phases of settlement are evident. In the Middle Ages, at the end of the 15th century, more than 50 per cent of the settlements were built in the valleys and less than 25 per cent in the uplands. This study, therefore, has shown, as precisely as possible, the importance of glacial valleys in northern Poland in the development of settlements in mediaeval times.

The central area of the territory analysed, today the suburban Łódź region, unfavourably situated, was sparsely populated until the end of the 18th century. In the 19th century settlements of an industrial character developed rapidly and thus the role of this area, until then economically unimportant, changed suddenly.

"Antropogeographical inversion", as the author calls it, has occurred here. Two factors, relief and geographical situation, selected by the author from among the other elements of the environment, have had an influence on the period when settlements developed, while in fact the complex of various factors, which creates the geographical environment, influenced the forms of settlements. In the valleys the complex is created by the geomorphologic structure: soil, water conditions, vegetation, even the climate are affected by the valley. Therefore, through a study of the geomorphologic structure the characteristics of the whole environment are determined. Dylik's work has very rightly stressed the role of valleys in the settlement development of the early period.

In the uplands the respective elements are distinguished in another way. Thus, the studies of larger regions, first of all, analyse the influence of soil on the periods of settlement development.

The distribution of settlements in Pomorze in the 13-14th and 15th centuries shows that agriculture expanded and stabilised itself on better soils which assured good yields in the three-field rotation system [21]. Also for the Central Poznań region the same phenomenon was stated by Zajchowska [42] who observed in details the location of settlements arising in various periods, in connection with the soils. The new settlements of a manor type which arose in the 16th century are also found often in ancient settlement areas.

Until the 16th and 17th centuries settlements occupied areas which before had been waste-land or were utilized only to a small extent. These newly occupied lands belong to various physiographical regions. In the postglacial landscape of northern Poland there are various areas of sandy soils and valley terraces, parts of frontal moraines, the marshy bottoms of great valleys and of lake basins, which were occupied in this later period.

In the mountains and in the uplands, the settlements occupied first valleys and slopes and only later reached the watershed areas which for a long time had preserved their woody character. It is not an accident but a result of rational evolution that the greatest primeval forest in Poland and in Central Europe, Białowieża Forest, is situated on the Vistula watershed at the headwaters of the Narew.

The influence of the natural environment on the development of the settlement pattern and on the use of land for agriculture is outlined and analysed in historical-geographical works. The main features of these relationships were observed but the problem has not yet been fully solved [6].

Regional and synthetic studies may continue together with the development of research on the history of settlement.

One of the most important problems is connected with this research, which involves the problem of the origin of settlement forms and of relics of ancient agricultural landscape preserved until now. Poland, populated, as far as the rivers Odra and Nysa by Polish tribes (in the Middle Ages) and, from the 13th century on especially under the influence of the western states, was subject to German colonisation. The Slavonic and German population mixing in the border region created specific settlement forms which became subject to both German and Polish research. Thus, there is an extensive historical and geographical literature dealing with the origin of village forms [25]. Zaborski [40] contributed a synthetical elaboration on the distribution of various village forms in Poland. To a certain degree he based his study on historical terminology and he prepared a cartographic study of rural settlements as seen on contemporary topographic maps. This study is of importance with regard to certain types of villages, the character of which may be defined from purely exterior features. For the most of the villages, however, some control and deeper historical studies are required. The monographs of single villages and of smaller regions perform this task.

For the south of Poland, where the oldest settlement areas were found, K. Dobrowolski [11, 12] and M. Dobrowolska produced a number of interesting works which show a rich typology of villages and field patterns on the basis of ancient cadaster maps and of numerous relics of old settlement forms in this area. The latest summary of this research was presented by M. Dobrowolska in Vadstena in 1961 [8]. These studies reveal the great differentiation in field structure and in the ownership of and changes in dispersed fields. They also explain the period of origin of the layout of the fields and consider the difficult problem of the oldest field layout type.

Studies based on cadaster maps have also helped to reveal the development process of village layouts in other parts of Poland. For the territory of Central Poland, the neighbourhood of Łowicz, Warężak [38] gives examples of ancient village types and discusses the changes they have undergone. Piaścik [29] described the settlement of Kurpian Forest showing the oldest and newer settlement forms in a region most interesting from an ethnographical point of view. These studies have pointed out examples of older villages with a village green mainly of an oval shape; this tends to confirm the belief, more and more accepted, concerning the ancient origin of those villages in Poland.

Dziewoński [16] drew attention to the necessity of research in the countryside and of topographic analysis in connection with historical studies.

He discussed the settlement of Ujazd Trzebnicki, one of the oldest monastery foundations of the 11th century in Silesia, in a territory where there is a number of interesting villages with village greens.

Studies of villages based on an interpretation of cadaster maps and on detailed historical research were organised in Pomorze Gdańskie and presented in M. Kiełczewska-Zaleska's work [21]. About 2000 villages were analysed and the following data were determined for them: earliest historic mention, ownership relations, the size according to the quantity of arable land in *Hufen* (*łany*) and the number of farmsteads and their legal status in the Middle Ages. Thus, possibly complete historic documents for Pomeranian villages have been obtained. These data have permitted a distinguishing of various groups of settlements in the Middle Ages. Settlements organised on Polish law made one group of villages [1], the other group consisted of villages founded on rent law, the so-called German law of the 13-14th centuries. There were considerable differences between these two kinds of settlements as far as the organisation of economic life was concerned. The first group was based on an older law which had been in use previously. An analysis of village plans and of field layouts on cadaster and other maps has permitted a determination of the differences in agrarian structures and layouts between these two types of villages. The most interesting fact observed was that among villages under Polish law there were layouts with various types of central squares. They belonged to smaller villages which in the 16th century consisted of, less than 20 *Hufen* (*łany*) with a socially differentiated population. Farmsteads were of various sizes and underwent many changes. They had belonged for the most part to the small gentry families and have not changed under the influence of manors in the 19th century. These settlements are found mainly in the lake regions,

on less fertile areas and are relics of former, older settlement forms in Pomorze.

On the other hand there are settlements situated on moraine plains with better soils suitable to a more intensive agriculture. They are relics of settlements founded on the so-called German law. The foundation of these settlements and the introduction of rent law, called German law, were accompanied by the uniting of some smaller settlements into one and the creating of large villages. These new villages had an area of about 40–60 *Hufen*, farmsteads of almost equal size and a regular layout. They had a regular field structure adapted to three field rotation. The village common consisted usually of a large square of oval or rectangular shape forming the centre of the village.

The existence of villages with a central square among smaller settlements of the hamlet type, founded on the Polish law, points to an ancients origin of this type. A. Krenzlin [24] has found similar types of village layouts in the area between the Elbe and Odra and explains their origin by reference to various systems of economy. She relates small villages of hamlet type to the meadow-field type of agriculture (*Feldgrasswirtschaft*). As evident from research in Pomorze, it does not seem probable that such great economical differences should exist between two groups of settlements which differed only in their legal status. The culture of cereals was perhaps less intensive in the villages on Polish law but it created the chief reason of their existence already in the Middle Ages. This is proven by the fact that the basis for fixing the natural rent in these villages was *radło* i.e. an art of hoe. On the other hand, one can assume that the two types of villages are the expression of various morphogenetic processes. Small villages are the result of a slow evolution and spontaneous development of the settlement, while large regular villages were founded on a plan and were the result of a regulatory action of great landowners.

Studies on settlements situated near Wroclaw were also based on ancient cadaster maps. They revealed villages in early 19th century which grew vegetables and which had a different layout than neighbouring agricultural villages. The plans of these villages become comprehensible only in terms of the occupation of their inhabitants. It was a Wroclaw suburban zone and vegetables and fruit growing was developed on a large scale, there. These villages were absorbed by the town in 1867 and today they are an urbanised part of Wrocław [35].

The studies of ancient cadaster maps have allowed also an understanding of the most recent changes in rural settlements, which within the last hundred years have had a decisive influence on their actual state. Poland which, as late as the beginning of the 19th century, still

had villages of concentrated feudal type, introduced during the first half of that century major agrarian reforms, which created new social and ownership relations and which destroyed ancient forms.

Peasants were granted the right of ownership of the land and were released from work on the manor's fields. Progress in the technique of cultivation accompanied the reforms and this was favourable to the development of capitalist manors and separate individual peasant farms. These great changes, breaking the social and economic unity of the feudal village were reflected in the forms of rural settlement [22]. The villages and the situation of farmsteads underwent changes and the ancient field layouts with their numerous dispersed strips were regulated and remeasured. Frequently village buildings were transferred to new places on newly united fields. Rural settlements were built on an individual farm system. Thus the number of dispersed settlements increased. This process was quite different in the different parts of Poland. Geographical research in the interwar period drew attention to the forms of dispersion of rural settlement in Poland. Such studies were undertaken under the influence of Demangeon and of the International Committee of Rural Settlements of the I.G.U. and showed the degree of dispersion of settlement in the different regions of Poland. There was even a synthesis of the findings of these studies undertaken for the whole territory of Poland [28]. These studies dealt with the settlement question by means of static methods and they attempted a rather formal description of the problem of dispersion and concentration. They did not afford an insight either into the development processes or into their reasons. They dealt with the characteristics of settlements as far as their physiognomy and the system of distribution of settlement over the landscape was concerned. This trend of research was abandoned after World War II.

One study of this problem, however, was made after World War II, which characterised the distribution of settlements in a detailed way. It consisted of a map of settlements made on the basis of land utilization by joint inter-university research project directed by F. Uhorczak [37]. This map was made first on the scale of 1 : 100,000 and showed all settlements, even isolated farms. The entire settlement design was increased by surrounding each building with a circle of 0.7 mm radius. Then the map was reduced by photographic process to 1 : 300,000 and 1 : 1,000,000 scale. Even at a scale of 1 : 1,000,000 differences between various forms of concentration of settlement remained visible. This map gives a real picture of settlement forms and is not a schematic presentation of types. Such a map may serve to further studies. It has stressed clearly the great settlement concentration in the mountain valleys. Various

types of ancient villages may be distinguished on it. Most of all, however, the uneven degree of dispersion of settlements is visible. This map is based on more modern material than Zaborski's work. Thus when comparing these two maps one can see an interesting process which has taken place in Poland.

At the beginning of the 20th century, Wielkopolska (Poznań region) showed the greatest dispersion of settlement. It was a dispersion of secondary origin connected with the agrarian reform and the regulation of field ownership and enfranchisement. On the other hand central and eastern Poland on Zaborowski's map showed few dispersed settlement areas. The consolidation of dispersed fields, undertaken during the 20 years between the wars, introduced new field measurements and caused far reaching changes in Mazowsze, in the Lublin region and in other parts of central Poland. New dispersed settlements arose because the buildings were transported to newly measured fields. Uhorczak's map shows the state of the distribution of settlements for a later period than Zaborski's or Pawlowski's studies and shows how the process developed in Poland.

The development of scaterred settlements has been going on in Poland until recent years. The agrarian reform after World War II also caused the parcelling of land and an increase in the number of isolated small farms. Only from 1959, was the establishment of separate farmsteads forbidden.

Polish rural settlements are little adapted to modern forms of economy. A considerable division of rural ownership is characteristic for Polish agriculture. Farms of 2–10 hectares are most frequent since they represent 62 per cent of the total number of farms. Dwarf farms of less than 2 hectares represent 19.6 per cent and those over 10 hectares only 12 per cent of the total number of farms. The peasants have their small plots scattered in several places, sometimes in other villages. The tendency to build homesteads in the vicinity of fields has been the cause of the dispersing of settlements. It was this form that was best adapted to the individual agricultural economy on a small scale in the capitalist system. This pattern of ownership and farm distribution makes difficult a mechanized socialist economy. It does not create possibilities for equipping the villages in communal and service installations, either. The development of an electrical network, the supply of water, the organization of shops, cinemas, club rooms, require concentration of investments which are more economic in larger centres. Thus, there is a tendency to hamper the spontaneous dispersal of settlements and to encourage a network of larger better invested villages. Geographers have joined in the discussions of this problem.

The newest changes the rural settlements have undergone are the subject of research on a very large scale. Studies of social and economic problems were introduced i.e. on the demographic structure of migrations, on the ownership system, on the social stratification of rural population and on the productive relations which are transforming the village under the influence of urbanization, and so forth.

Changes in this respect have been great in Poland in the last 18 years especially in the south-western regions where heavy industry has developed. Research on this part of Poland under the direction of M. Dobrowolska have contributed valuable insights [9, 10]. The Kraków voivodeship was, before the war, part of the most overpopulated area in Poland, where the standard of living was very low. Even on fertile soils in the northern part of the voivodeship the villages, as result of overpopulation, possessed no sufficient basis for existence. On 100 hectares of arable land in this region there were on average over 100 persons dependent on agriculture. Studies effected in Kraków have proved that after World War II the problem of overpopulation has partly been liquidated thanks to migration from the villages either to the western recovered territories or to towns where new factories were established. Examples quoted in these studies show that the villages lost one fourth to one third of their population by migration during the first four years after World War II. It was mainly the poorest landless population that left the country. Moreover, a large part of the inhabitants from the overpopulated villages found new employement in the neighbourhood.

As shown in the research on the industrial centres of the Kraków–Chrzanów Coal Basin, the majority of the industrial settlements draw their man-power from villages. In many instances the rural population constitutes $^3/_4$ of the total number of workers employed in new large industrial plants. They inhabit former villages and travel to work. Travels to work have become very common in many *powiats* of Kraków voivodeship as well as in other industrial regions in Poland [18]. This development has resulted in the formation of a new social group of peasant-workers. Small farmers become industrial workers wherever the transport facilities enable them to travel to work. This population is still strongly linked to the land since their wives and the older members of families still work in agriculture. Living on what the land produce and on their earnings in industry these peasant-workers are well off. Housing investments and a high standard of life in these villages are sufficient evidence of it. However, it is unfortunate that agriculture, even if only the additional occupation of the family, is not intensified. The number of exclusively agricultural farms in regions, where people travel to work

in industry, constantly decreases. The division of farmsteads and at the same time the increased density of population is the result [31]. Physionomical changes in these villages and the formation of a new socio-economic group of peasant-workers are the subject of new research which has thrown a light on these problems, a specific feature of Poland's industralisation combined with her settlement and social structure. The transformation of villages under the influence of industry is the subject of geographical research in many other countries. A comparison of these studies will furnish interesting conclusions based on analogous but very different situations. In Belgium [5] in the Ardennes mountains the industrialization of the population was accompanied by steady migrations to town of people who, however, did not give up their land in the country. Unable to cultivate the land they leased it or covered it with forest. In this way the land lay under forest, contrary to its agricultural value and potential. The forest grows often on the best soils. Other changes have taken place in the Rheinland and Westfalen. The intensification of agriculture and especially the production of vegetables and fruit may be observed in many regions there [36], where a part of the population is engaged exclusively in this profitable trade.

In our country the situation in agriculture does not favour such possibilities. It is clear, however, that the processes of industrialization cause various changes adapted to the social structure and to the actual economic situation of the country.

Research on rural settlements involves also the study of the problems of the functional structure of the settlement. The links that formerly existed between town and country, when the village was essentially an agrarian settlement and the town contained all other occupations, have been dissolved.

Actually the urban functions have now been assumed by the villages where the population has increased due to an in-migration of landless farmers from the countryside. Agricultural purchasing agencies and stores which distribute industrial goods, health and culture services, are located in larger villages which have taken over a part of urban function.

Studies concerned with the links between town and country [23] have drawn attention to these new relations. Such studies have developed a new hierarchy of stettlements where the types of villages are differentiated according to their role and their importance. Those villages which have become small local centres call for special attention. Research has been undertaken, which will serve as a basis for planning the transformation and reorganization of the rural settlement network. These problems are treated most fully in M. Chilczuk's studies [3, 4] who analysed the distribution of different services, schools, institutions in

villages and small local centres throughout Poland. On this basis he presented a typology of settlements.

The problems mentioned in this article as the subject of geographical research in Poland are only a part of the geographical study of rural settlements. The aim of this article has been to stress the main problems and to present the main trends of development. As can be seen from this short review the research continues in some fields and while there is no special increase in interest in rural settlements, the extended scope of study is obvious. It resulted in determining the theoretical definitions as well as the development of research methods. New methods of cartographic analysis of ancient maps and plans have been introduced to geographical and historical studies. Problems pertaining to the social and demographic transformation of the village and the hierarchy of the rural settlement network have been raised.

Geographical research on problems of rural settlement important for planning has been introduced. It reveals the processes taking place and furnish data for planning concepts.

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GEOGRAPHICAL TYPOLOGY OF AGRICULTURE IN POLAND METHODS AND PROBLEMS

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All over the world economic geography is a subject now undergoing a serious transformation. Agricultural geography which developed to a certain degree of independence by a common effort of both geographers and agricultural economists is also subject to a similar metamorphosis. As has already been pointed out in details elsewhere [27, 32, 24] formerly agricultural geography was concerned mainly with statistical descriptions of the distribution of different agricultural products. In most cases it either did not attempt to synthesize various elements of agriculture, or when it did so it was mostly by forming agricultural regions in an intuitively descriptive way. This old geography is being transformed into a subject of more synthetic and generalizing approach where the geography of agriculture is treated as geography of different types of agriculture defined at first also intuitively, and described qualitatively. Recently however objective and selective criteria such as quantitative indices and measures are being applied more frequently.

During the last 20–30 years, there have appeared in many countries a considerable number of studies concerning types of agriculture elaborated both by geographers and agricultural economists. These studies reflect a growing interest in a more synthetic approach to the geography of agriculture.

Several years ago it was already pointed out [51] that the results of these studies cannot be compared since the criteria for defining the types differ greatly from country to country and even from author to author in one country. The confusion extends from terminology through criteria and bases, to methods and techniques of those classifications. The confusion does not seem very severe when one works within national boundaries of a small or even medium sized country or region. Ultimately one can always come back to the basic source material. But when one wants to make a larger synthesis, covering several countries or regions, or the

whole world the difficulties are almost insurmountable, since the results of regional studies do not give an adequate basis for such a synthesis. No wonder that most of the larger typological syntheses are still based on general experience and intuition rather than on precisely determined scientific criteria.

At the same time there is a growing demand for such a typology of agriculture. The development of geographical science requires more and more syntheses established on more and more exact data. The need for food and other agricultural products of the growing world population requires planning of more rational use of land. Good, effective planning however requires a good knowledge of both — existing natural resources and conditions and how they are used, which are forms, ways, and effects of their utilization i.e. of all, what contributes to the notion of types of agriculture.

Because of the great diversity of world agriculture, the elaboration of its typology or even of the criteria of such typology is beyond the capacity of a single student or even a single scientific institute. To achieve it the experience and effort of a group of experts in agricultural geography of various countries and zones should be joined eventually within the International Geographical Union. The aims, tasks and bases of such typology have been generally discussed by the author in the articles published in Poland [24, 29] and then presented at the XIXth International Congress of Geography in Stockholm [26].

Simultaneously, the same problem was raised by N. Helburn [13] with reference to earlier American works, where he emphasized the need of such typology and outlined its bases.

The aim of this article is to contribute towards the establishment of criteria for such a typology. The methods of a geographical typology of agriculture discussed here are those applied by Polish geographers. Obviously, these methods will not solve the whole of the problem, nor even will they show its whole extent and complexity, since they are based mainly on research done only in Poland and several neighbouring countries, on literature and on the author's own observations in Western Europe, U.S.A., Brazil, the Pacific Islands and Java. This is evidently an insufficient basis. However it is believed that, despite these deficiencies the formulation and presentation, of these experiences and concepts will contribute towards the clarification of this important problem.

1. Types of agriculture

As it has already been said there are great divergencies in the terminology applied in a typology and classification of agriculture. It is therefore

necessary to explain at each occasion what is to be understood by a certain term.

The notion of type of agriculture (type of farming, *type de culture et d'elevage, Wirtschaftstypus, tip selskogo khozyaistva*) is considered to be the most general and also of the highest order embracing all typological features of agriculture. For some, mainly the French and earlier German authors the notion of the highest order is the economic and agricultural system, whereas in the studies of mainly the American agricultural economists the type of farming is distinguished mainly or exclusively based on the commercial part of agricultural production.

In Polish agricultural geography the type of farming is also understood to be an idea of the highest order. According to the author's definition [24, 26, 28, 31] the type of agriculture is understood as being shaped under given natural conditions by particular social and economic processes; an ensemble of characteristic ways, orientations and effects of farming applied or achieved in agricultural establishments of definite land tenure conditions. The features which define the type of farming are the following internal features:

1) The conditions of land tenure.

2) The ways of farming together with its intensity.

3) The effects of farming i.e. its productivity, effectiveness, marketability and orientations in production.

Natural environment is the basis and background of man's agricultural activities. However, it does not define the type of agriculture. In the same or similar geographic conditions different types of farming are developed depending on the standard of techniques applied and on both social and economical conditions.

Nor will the external economical, social or technical conditions define the type of farming, because on the same territories and under the same social and economic conditions different types of farming will evolve in different natural conditions.

External, natural, economic and social or technical conditions help to explain, however, why a certain type of agriculture had been formed on a certain territory.

The pattern of features which form the type of agriculture is a dynamic one. Its different elements are subject to continuous changes whereas the speed of changes in these features is different. In territories of old traditions of agriculture it results in the stratification of different features of both the former and present farming patterns which consequently result in the formation of highly complex types of agriculture. Where agriculture was introduced more recently, then the types are, of course, much simpler.

Some of the features defining the type of agriculture are measurable quantitatively while others are not, but all should be taken into consideration when classifying farming into types [1].

2. Conditions of land tenure

The conditions of land tenure comprise all forms of social relations in the agricultural production process i.e.: forms of property (common, individual and social property); relations between property and labour, that is different forms of land tenancy and labour supply; relation between agricultural establishment and land, that is size and configuration of farm land, the size of single fields, their fragmentation and dispersion. This is more or less what the French call *la structure agraire*.

Although the problem of land property in geographical research does not cause any methodical difficulties it is often omitted in geographical studies, though, depending on the type of property, land tenure and the size of farms, the remaining typological features such as ways of farming, its intensity, the results, orientations and particularly the marketability and effectiveness of agriculture develop differently even on the same territory.

In Polish geography investigations of social conditions and property rights are mainly concerned with the proportion in number or area between state farms, collective farms and private holdings, their distribution and the differences between them as to the ways and orientations in farming [29, 22]. Then comes the differentiation of size and structure of farms i.e. proportions of different size farms [2] and finally classification on family farms and those based on hired labour, and lately also the problem of farms owned by peasant-workers i.e. part-time farmers or

[1] As I have already emphasized in my review of C. F. Jones' and G. G. Darkenwald's textbook on economic geography (*Przegl. Geogr.* 29, 1957, 1, pp. 194–197) it seems to be wrong to classify various forms of agriculture as one type simply because the same kinds of crops are grown there, while all other features are entirely different. I was particularly intent on pointing out the difference between mediterranean agriculture and that of California and certain regions in Chile or Australia. N. Helburn [13] took the same attitude when he wrote "Wheat farming in North Dakota... is much more closely related to cotton farming in West Texas than to wheat farming in Manchuria..." On the other hand, types of farming which differ from one another in many ways should not be considered to be of the same type only because they are situated on the territory of the same state and are therefore subject to the same economic policy.

[2] By applying the so-called *quadratraster* method of cartographic representation taken from German geography [4] good results have also been achieved in that respect in analysing the forms of property and size of farms on the whole territory of the country in the period 1938 and 1958, and with more details on the territory of the voivodeship of Białystok for the year 1958. Respective maps worked out by the Institute of Geography of the Polish Academy of Science have already been prepared for publishing.

even weekend farmers coming back to their farms at peak-season time [25]. The only synthetic spatial study of this problem is the study of social and economic regions of agriculture made by agricultural economists [12].

More popular among Polish geographers, though to a smaller degree than in French or German geography, are investigations on the patterns, shape and dispersion of fields, i.e. on what is sometimes called agricultural morphology and when taken from the genetic point of view, the morphogenesis of agricultural landscape. These investigations in Poland have encountered difficulties arising from the transformation of the former configuration of fields owing to land reforms in the 19th and 20th century. In most regions in Poland there are also no documents from which one can reconstruct the original pattern of fields or else these documents once made have never been actualized; many of these documents were lost during the past wars. This type of investigations has been commenced between the World War I and II. After World War II, owing to the trend of directing human geography to serve more practical purposes such investigations have been almost given up. Only recently they have been recommenced in some geographical research centres [3].

No matter what could be said about the importance of such research, it would certainly be unreasonable not to take into account the present pattern and especially the fragmentation of farms in the agricultural geographical studies. The configuration and dispersion of fields influences greatly the farming systems applied, the productivity, and above all, the labour efficiency in agriculture.

Therefore, not going deeper into the genesis of the present pattern of fields, the Polish Land Utilization Survey, since the beginning of its investigations was interested in both the division of land into farms and the fragmentation of their land presenting it on the land use map [23, 29].

Research on the relation between fragmentation of farmland and the maintenance of the relic three-field system and their effects on agricultural production have been studied by W. Biegajło in the region of Białystok [1, 2, 3].

3. System of farming

The system of farming is one of the most controversial and most differently interpreted notions in agricultural economics and geography.

[3] The only more important study of this kind is by M. Kiełczewska-Zaleska [16]. Some papers by Polish geographers concerned with these problems were presented at the Symposium on Morphogenesis of Rural Landscape in Vadstena, Sweden, after the XIXth Intern. Geogr. Congress.

Some authors understand the concept of the farming systems as superior, almost the same as what has been called above the type of agriculture, while others take the economic or production system as the proportions between different branches of farming i.e. what in other studies and here has been defined as the orientation in agricultural production or that of farming. Many authors distinguish the differences between economic or farming systems (*Wirtschaftsysteme, Betriebsysteme, sistema selskogo khozyaistva*) and the systems of production (*système de production*), and also the difference between these and the agricultural systems (*Landwirtschaftsysteme, système d'agriculture*) and the system of utilization of land (*Bodennutzung-* or *Bodenbenutzungsysteme*), distinguishing apart from above mentioned, systems of cultivation or vegetal production (*système de culture, sistema zemledelia*) including systems of field farming, systems of grassland use, horticultural systems etc. as well as livestock raising or animal production systems (*système d'élevage*) including cattle, sheep, pigs etc. raising systems, industrial production systems i.e. those of manufacturing of agricultural products etc. etc.

Very frequently the terms system of farming or livestock raising, as well as the type of farming (type of agriculture) are used without exactly defining their meaning.

Along with the development of this concept in science and with the very meaning of the word "system" which stands for „a coordinated body of methods, an orderly way of getting things done" [53] which would rather answer the question "how?" (farming is performed) than "what?" (is produced), the system of farming (system of agriculture) is taken by the author as a complex of means and ways aiming at the obtaining an agricultural production together with methods of maintaining the fertility of soil. In that way of thinking the system of farming is not of a superior category but only a partial one, defining quantitatively and qualitatively a certain set of features of agriculture of a mainly organizational and technical character.

Among these the most important are the three following categories:

(a) Organization of agricultural land,

(b) Ways of farming i.e. organizational and technical means and methods undertaken in order to obtain the effects of production and to maintain the fertility of soil,

(c) Intensity of the applied means and ways i.e. intensity of farming.

(a) Organization of agricultural land

The organization of agricultural land mainly consists of its division into the chief uses of land, and then its division according to its further

designation. The methods of research in that line are relatively simple and easily give numerical results. The only difficulty in studies aiming to compare regions greater than one country consists in the divergency of agricultural statistics. The distribution of the main uses of land is shown on all the maps of land utilization. In Poland is has been shown on general land use maps edited under the direction of F. Uhorczak, on maps worked out for the particular regional plans and also on detailed maps of land utilization survey [24, 30].

Statistical research into the proportion of various land uses between different regions may also lead to a certain typology based on the dominance or coexistence of various land uses and using definite indices: arable, arable with pasture, pasture with arable, arable with orchards etc. areas. The study in that respect was made by W. Ormicki in 1932 [4] but was not continued.

With regard to the division of main land uses according to its further designation the most frequent kinds of studies are concerned with the analysis of participation of different crops with regard to either a more general category e.g. arable fields applying either cartograms or isolines or their distributions shown by dot maps. In Poland such analytical studies are numerous and although they offer no methodological novelties, they have great scientific and practical importance. Experiments in synthesizing these elements were commenced a long time ago. In 1932 J. Ernst had already applied the so-colled privilege and defficiency method as one of the criteria for agricultural regionalisation of the country [5].

Another attempt at more synthetical approach was contained in the maps of participation of different groups of crops in the sown area in

[4] All we know about his paper comes from the summary of W. Ormicki's report which was given at the meeting of the Geographical Section of the Polish Academy of Sciences and Letters (*PAU*) held in Cracow the 6th of December 1932. In this report author gives a quantative method for classyfying types of land utilisation based on the share of the main land uses (calling them — cultures) by means of a sliding scale distinguishing: the dominating cultures covering more than 50 per cent of the total area, relatively prevalent cultures (at least 40 per cent of the area), and secondary cultures (25–40 per cent of the area). On this basis the author distinguishes monouse areas (A) and multiuse areas including the following types: (B), where secondary "culture" appears along with the dominating "culture"; (C), one relatively prevalent and one secondary "culture"; (D) one relatively prevalent and two secondary "cultures"; (E) one relatively prevalent; (F) two secondary "cultures"; (G) three secondary cultures. Maps in that respect can be worked out by either the spatial or the isoline method [41].

[5] Based on the average share of the 5 principal crops in Poland he calculated the average deviation for each county. Then, applying the scale for every 10 per cent off the average he worked out maps of deviation for each crop and marked areas where they reached positive (priviledged) and negative (defficient) deviations which he accepted to be one of the bases for regionalization of agriculture in Poland [9]. He also repeated this method in his latter study [8].

Poland[6], based on the grouping of crops commonly used in the Polish statistics. However further research has proved that all groupings used in statistics, textbooks and research works were inconsequent and based on heterogenous criteria therefore of no use for typological research[7]. As long as the research was concerned with particular crops treated individually the grouping of elements was of no greater importance. When grouping of crops however became the basis for quantitative handling of typological criteria it turned out that the criteria for grouping the crops had to be both uniform and universal.

This is why the author has worked out two new interrelated groupings of crops to serve the purpose of geographical typology of agriculture.

These groupings may be used alternately according to the aim of the work. The first one is based on mainly agrotechnical means applied, on the role of the given crop in the rotation and on the intensity of its cultivation; the second one is based on the economic reasons i.e. the purpose of the cultivation of a given crop. The first group divides all field crops into: intensifying (or intensive) crops, structure-building crops, and the group that could be called either extractive, extensive, exhausting or soil-degrading crops. Besides, the division also distinguishes perennial crops and permanent grasslands.

According to this terminology the group of intensifying crops includes crops requiring greater input of labour, careful cultivation and fertilizing, thus enriching the soil, increasing subsequent crop production. The structure-building crops do not require such means but they enrich the soils' content of nitrogen and maintain its crumb structure; therefore they also make good forecrop. The third group includes soil-exhausting crops; after such crops the soil must be given some regenerative treatement or a special rotation of crops must be applied. This division encounters no special difficulties in handling although there are certain crops of a transitory character which may be included in either the first or the third group.

Among the permanent crops also semi-permanent ones have been distinguished (strawberries, rhubarb, hop, pineapples etc.) cultivated generally for several years on the same field but not included in the rotation.

[6] See maps by R. Szczęsny showing the shares of grain crops, root crops, fodder crops and industrial crops presented and analyzed in the present author's paper [22].

[7] Polish statistics distinguish cereal crops, pod crops, hilled crops, fodder crops, industrial crops and vegetables. This division mixes the agrotechnical cryteria of ways of cultivation (hilled crops) with the economic criteria concerned in the purpose of cultivation (fodder, industrial crops etc). The fact, that several of the crops cultivated may be arranged simultaneously under different groups — basing on accepted criteria — shows the lack of consequence of this division. Sugar beet may be grouped for example under industrial and hilled crops as well; maize is both a cereal and hilled crop, mangold is hilled and fodder crop, lupine and field pea are both pod and fodder plants etc.

Somehow greater difficulties will be encountered when applying the grouping based on economic criteria. Although the division of crops into: alimentary, industrial and fodder is all the more evident, because some of the plants are utilized in different countries or in the one country for various purposes[8], certain difficulties arise. It is concerned particularly with macroscopic studies based only on statistical data where from it is not easy to define the designation of a given crop and usually calls for additional research and where there are no data it must be based on estimates.

(b) Ways of farming

Investigations into the ways of farming i.e. into the means and ways applied are more difficult and can hardly be given quantitatively. In geographical investigations, among these means are considered the way of tilling land (hoeing, ploughing, machine ploughing etc.), systems of crop rotation (shifting, fallow, non-follow, irregular, regular, monocultural, free), water regulation systems (drainage, irrigation, full regulation), systems of propagation (vegetative, by seeds), the method of harvesting (by hand-using the hoe, sickle, scythe; by machinery-using, the harvester, the mower, the combine etc. — drawn by animals or engines, etc.).

The features mentioned above have different typological significance. Some of them, as for instance, the distinction between hoeing and ploughing or between vegetative and seed propagation are of greater typological importance when concerned with primitive systems, where these methods practically exclude themselves. In more advanced systems they generally go together, depending on the plant cultivated. On the other hand the methods of harvesting, or crop cultivation are usually of a lesser typological importance because of their variety and close relation with different kinds or groups of cultivated plants. Of all the features mentioned, the rotation of crops is often said to be of the most significant typological importance because it unites the features of all other categories. Therefore in chiefly French and Russian works on agricultural geography, the rotation of crops is often treated as the

[8] Rye being the staple bread crop in Middle and Eastern Europe is cultivated mainly for fodder in West Europa and North America. Moreover in mountain regions in South-East Europe rye is cultivated for bread-making in highlands and for fodder mainly in the warmer lowlands. Oats widely cultivated in England and also in Scotland for alimentary purposes is used in Poland almost only for horse feeding. Barley is used in Poland for alimentary, fodder and industrial purposes, whereas proportion of use for either of these purposes varies in different regions. Likewise potatoes are cultivated in various proportions to serve the alimentary, fodder and industrial purposes.

principal feature which defines the agricultural system, provided that the remaining features lead to further differentiation of the selected systems. Investigations of crop-rotation systems is however a rather tedious task, since no statistics furnish the adequate data and thus macroscopic investigations may sometimes obtain them through investigations into the relative proportion of particular groups of crops (and fallow) in the structure of arable land utilisation. This allows one to establish a somewhat approximate picture of a division of land into the elementary rotation fields which gives way to the recognition of the system of crop rotation.

Investigations on the rotation of crops as a feature which defines the system of farming have been undertaken from the early beginning by the Polish Land Utilization Survey, even by recording the rotation of crops on the map [9]. Based on these investigations and some studies by agricultural economists namely Z. Mścichowski and S. Schmidt [35,36,45], the author has worked out the preliminary systematics of systems of crop-rotation applied in Poland [22, 29].

On the basis of detailed field investigations of crop-rotation systems supported by numerous interviews and an enquiry W. Biegajło [1] performed his study of ways of farming in the voivodeship of Białystok. In this study he had given all the passing stages from the three-field system through four-year crop-rotations similar to the Norfolk system applied by peasant farmers to the modern long term crop rotation used in the state farms. In his work the crop-rotation systems were the ordering element around which he grouped the remaining features of the farming systems.

It is not certain however, if crop-rotation systems would make a sufficiently good sample element of the farming system or only of the ways of farming in regions with a higher and more commercial agriculture. This calls for further studies.

(c) Intensity of farming

The term "intensity of farming" is not always interpreted in the same way. It is sometimes used — mostly in American studies to define the volume of crop and livestock production per acre which in this work is called the productivity; it sometimes means the cost of production, the level of productive forces, the expenditure on labour and capital invested per unit area or labour. Following most of the Polish agricultural

[9] For details see [15]. For some information in English see also J. Kostrowicki [23] as well as some other publications already quoted by this author and concerned with the methods of the Polish Land Use Survey.

economists this term is meant here as the amount of labour and means of production used per unit area, whereas not only the extent but also the structure of intensity and particularly the proportion between labour and means of production are of importance in this respect.

Although the definition of the intensity of farming by using quantitative methods is easier than for example ways of farming, the research into the intensity of farming on a macroscopic scale always remains a difficult task.

There are many methods of measuring intensity. The most exact but also most difficult (and impossible to perform in geographic research of larger territories) is the direct method consisting in checking expenditures on labour and capital per unit of area calculated in either money or conventional units. Therefore some authors have tried to measure the intensity using results of production per unit area which is in fact the way of checking the productivity. This is an easier method which might be applied in any mass investigations research but by the same definition of intensity it is a wrong method. Although there is an undoubted relation between intensity and productivity these relations are not at all simple; since the productivity also depends on natural features of the environment. The more they influence productivity, the smaller will be the intensity of farming. Therefore measuring intensity by the productivity upsets the logical way of thinking and is likely to give false results.

As it is difficult to apply the unique index to depict all inputs and means on agriculture, sometimes in agricultural economics and geography mainly in the Soviet Union, intensity is checked by means of several selected, easily measurable, accepted as representative, indices.

J. Okuniewski, the Polish agricultural economist, basing his results on research performed in Greater Poland stated that the best index of intensity is the amount of labour in man-days ratio and the expenditures on turnover means per unit area [37]. However in large-scale geographical research it is often either difficult or impossible to apply such indices and therefore they must be substituted by more simple ones depicting approximately similar features [10].

[10] The following may be accepted to be the indices: 1) outlays on manual labour given in man-hours (or man-days) per unit area, 2) value of the means of production per unit area, 3) outlays of animal draft-power in work-days (work-hours) per unit area, 4) outlays on mechanised labour (tractor) in work-days per unit area, 5) amount of manure used per unit area, 6) amount of fertilizers used per unit area, 7) number of productive animals per unit area etc.

Provided these indices may prove to be either difficult or else impossible to apply for any comparative research of larger areas, they may be substituted by simpler ones, reflecting approximately the similar features: 1) number of actively employed in agriculture per unit area, 2) number of draft animals per unit area, 3) number

Establishing intensity by means of several indices leads to another method, namely establishing symptoms of intensity such as participation of these elements of agricultural production which require more labour or means i.e. the intensive elements of agriculture [11].

Seeking for a common comparable measure for different symptoms of intensity led as a result to establishing the so called method of evaluating in points.

Two methods of evaluation should be distinguished. One, which was introduced by Laur [34], evaluated the importance of different features of intensity according to a uniform five-point scale. The sum of points thus obtained was supposed to define the level of intensity. This method, summing up elements of varied importance, expressed in different values, by means of a table of subjectively established points, is mentioned here because some time ago it influenced Polish geographers who used to apply it for different purposes [12].

The second method, mainly developed by German scientists consisted in evaluating in points different elements of agriculture, different crops

of tractors per unit area, or if tractors are hired from outside the farm, the share of the tractor ploughed land in the total of arable land, 4) number of farm animals, in conventional (manure producing) units per unit area, 5) amount of fertilizers per unit area. Using the indices given above one should be aware of the fact that not all people, animals and tractors fit for the work may be used and that there may be surpluses of these working powers.

[11] Thus the intensity of farming can be estimated according to 1) share of arable land in the total of agricultural land, 2) share of irrigated land in the total agricultural land, 3) share of sown land in the total of arable land, 4) share of intensive crops in the total of cultivated land, 5) number of produotive animals in conventional units per unit area or per area used for fodder.

[12] J. Ernst likewise endeavoured to define both the "degree of suitability of natural conditions for cropping" according to a 6-point scale, the "suitability of the relief" and the quality of soil and then according to a 5-points scale "the degree of the utilization of natural conditions" for cropping using as a basis the percentage of land sown with the 5 main crops in the total area as well as the average yields of the 5 main crops per 1 hectare. The author did not take into consideration that the influence or the importance of the relief and that of the soil etc. for agriculture are not the same and cannot be compared in any kind of units, nor can they lead to any positive scientific results when arbitrary evaluated elements are summed up without finding their common denominator [9, 10].

In his later study on Podole [8] the author followed the same method. In order to define agricultural similarities of different *powiats* he put into the formula of average differences so unequivalent, heterogenous values expressed in varied units as e.g. relative elevation, yields per ha, the share of particular crops in the total of arable land etc., although this formula worked out by an eminent anthropologist J. Czekanowski, widely applied in anthropology, phytosociology and other disciplines requires in principle, comparability of data compiled. Obviously, considering the level of agricultural geography in Poland in those days, this attempt to give some more precise expression to the results of investigations meant certain progress with regard to the description commonly applied at that time. It is astonishing however that this method could find some followers nowadays who regardless of obvious methodical incomparability of elements as natural conditions, percentage of various crops, yields per 1 hectare etc. tried to apply that method anew for defining agricultural regions (see [11] and other works of this author).

and items of animal production according to their average intensity. This method is undoubtedly more exact and objective, but because the intensity of different crops cultivation or of animal production may also be different, these indices only approximate to reality.

Research on the regional differentation of agricultural intensity in Poland has mostly been carried out using the latter method. This is how W. Schramm [46] performed his studies involving the whole country with regard only to crop production applying his own measures of intensity. This study has given little positive results since it showed greater intensity in some of the underdeveloped eastern regions of the country than in Greater Poland. This probably resulted from applying indices representing rather the amount of manual labour than the total of outlays on all means and forces.

Using Schramm's method T. Olszewski [38] treated separately the intensity of main forms of land utilization and the intensity of crop cultivation for which he applied Schramm's indices with slight alternations in different points.

Based on the German examples B. Kopeć [13] worked out and applied in his research a method of defining the intensity of farming which he bound with the definition of system of farming. In order to establish a level of intensity B. Kopeć applied the following formula:

$$I_R = \Sigma(p \cdot s) + \Sigma(q \cdot t)$$

where:

- p the percentage of land under fields and permanent grassland in the total area of farmed land,
- s the coefficient of intensity of groups of crops based on input of labour and effective means of production per hectare of a given crop compared with the input per hectare of the four main cereals (rye, wheat, barley, oats),
- q the number of livestock of different kinds in big animal units (500 kg) per 100 ha. of agricultural land,
- t the coefficient of intensity of groups of livestock raising also based on the input on labour and effective means per big animal unit, compared with 1 ha. of cereals.

Although this simple and easily applied method has already been used in various areal studies by geographers [14], historians [47, 49] [15] and lately also by agricultural economists [33] it should be experimented with in regard to other territories and compared with the results achieved by other methods.

[13] A method has been presented several times. See among others [19, 18, 20, 17].
[14] W. Biegajło applied this formula to compare the intensity of different systems of farming in the voivodeship of Białystok.
[15] I. Kostrowicka used the same method to evaluate the intensity of croping in the Kingdom of Poland between 1863 and 1865 [21].

(d) Agricultural systems

The research on agricultural systems not always treated in the same meaning than is given here has occupied much place in the areal studies of Polish agriculture. That research has been based either on only some of the above mentioned elements e.g. structure of agricultural land, structure or intensity of cropped land, or it tried to bind together those different elements. Numerous efforts at defining systems of farming (systems of agricultural land utilization) refer mainly to the interwar years [7, 42]. Following the numerous German works of these years, Polish research used rather complicated and varied divisions defining the system of agricultural land use based on the participation of particular crops in the structure of the sown area.

Similar methods have also been applied in some post-war studies [5]. The most consequent system of defining systems of farming has been worked out by B. Kopeć [16]. He treats a system of farming as a supreme typological notion which in his opinion is "the final stage of development in the possibilities of synthetizing" and within its framework he distinguishes such part-systems as that of vegetable production with field crops, permanent grassland, horticultural production etc. and that of animal production including cattle, pigs etc. raising systems. In order to define systems of farming in that way the author assumes the following supposition. Animal production is the main branch of agriculture provided it exercises sufficient influence upon the fertility of soil by an adequate supply of manure. According to the author this is so only if the farmed land is manured at least every four years with 250 q per 1 ha. when 1/4 of the farmed land is manured each year. This requires approximately 60 big animal units per 100 ha of arable land; this is the minimum limit of the animal inclination in farm production. Everything below this, no matter the proportion of vegetable and animal production is, the author considers to be inclined mainly towards plant production. An additional criterion to establish the intensity of agricultural production is the proportion of animal to plant production $\frac{I_Z}{I_R}$ defined according to the above shown formula. The author based "the vegetal orientation in agricultural production" on very complicated principles — different for each group of crops. No less complicated methods are also applied to define the orientation in animal production. As a whole, in spite of

[16] Accordingly to B. Kopeć cereals are the chief division of crop production provided they take up more than 60 per cent of arable land, hilled crops if they take up 25 per cent of arable land and fodder crops (including meadows and pastures) when over 35 per cent of agricultural land. In livestock raising the main group

certain deficiences the method worked out by B. Kopeć being a firm and uniform concept contributed much to an undoubted increase of the possibilities of synthesis in areal research of the Polish agriculture.

In his recent work B. Kopeć applying the above method has also classified the systems of farming in Poland [17]. As this classification was not based on detailed studies involving the whole country, it should be treated as preliminary and hypothetical one. Geographers have also tried to apply the methods of B. Kopeć in defining farming systems but with little positive results in so far. Fully using this method to measure the intensity of farming W. Stola [47] tried to define systems of farming not according to the divisions suggested by the author but by applying uniform divisions based on the participation of different crops and items of livestock raising, in a sum of conventional units applied for the formula of intensity, assuming that different elements of agriculture have already been reduced to a common denominator in uniform comparable units by the coefficients of intensity thus making the application of differentiated divisions unnecessary.

Such an attitude seems to be reasonable and logical. If we assume that the coefficients of intensity give an adequate image of differences between the input of labour and means for different kinds and elements of farming (which, as had already been said, should be checked) then the proportions resulting from this calculation depict the structure of such intensity based on which we can define the organizational and technical inclination of farming, directing the efforts of a farmer to achieve the determined purposes of production.

Certain elements for defining systems of farmings with regard to arable lands have also been introduced by the Polish Land Use Survey since earliest works, determining both of system of rotation applied on the territory under investigation and the so called orientation in land utilization. At first [14, 43, 50] this used to be defined according to the percentage shares in a sown area of four main groups of crops namely: cereals, root crops, fodder crops and edible pod crops and a relative preponderance in each group of particular crops. The following shares

is cattle when the number of head of cattle exceeds 2/3 (66.6 per cent) of the total calculated in big animal units (excluding draft horses) pigs when they exceed 20 and sheep 10 per cent. If two or three groups of crop or animal production simultaneously comply with all above given conditions the group which exceeds the given standard by the largest extent is accepted by the author as a chief division. If, on the other hand none of them reaches the required standard the orientation is said to be a mixed one. Priority among the cultivated crops in a given group is defined on the basis of the relative prevalence of their sown area.

[17] By applying the method described above 32 so-called farming systems are distinguished and arranged into the four following groups: 1) animal inclination (11 orientations), 2) crop-animal (11), 3) crop (4), 4) special (6 orientations).

(in percentages) have been taken as limits — 10, 20 and 30 per cent for root crops but 20, 40 and 60 per cent for the remaining groups provided that the share above 60 per cent (root crops, 30 per cent) has been taken as dominant the rest, 40–60 per cent (root crops are 20–30 per cent) as of equal rank and 20–40 per cent as secondary. A privilege given to the root crops was explained not by their intensity but not very rightly by their productivity. Based on the above utilization of arable land was said as being oriented towards cereals, rye with potatoes, while cereals with a prevailing share of rye have taken over 60 per cent of sown land and the root crops with a prevailing share of potatoes 10–20 per cent and other groups less than 20 per cent of sown land; as a cereal — root crop, wheat–sugar beet orientation with lucerne, when grains with prevailing wheat amounted to 40–60 per cent, the root crop with sugar beet prevailing — 20–40 per cent, and fodder crop with lucerne prevailing were 20–40 per cent. This is how the orientation of arable land utilization has been defined on maps demonstrated at the Stockholm Congress and published in various periodicals [26, 28, 29].

In the instruction of the Polish Land Utilization Survey issued in 1962 [15] certain changes have been introduced aiming at establishing the definition of the orientation in arable land use on the discussed above (see page 118) grouping of crops based on agrotechnical criteria. Crops were grouped into intensifying, structure building and extractive; the nomenclature used until now and the technique of defining orientations have been sustained but in determining them they have been given symbols. The above given method was also applied by W. Stola to determine the orientation of utilizing of arable land in the voivodeship of Białystok. Using this method she first distinguished 61 different crop combinations applied on this territory. Then she reduced them according to similarity to 12 orientations [18]. The areal distribution of these orientations offered an interesting basis to examine the spatial relations between orientations in the utilization of arable land and the size of farms and such external factors as distribution of market centres, communication network etc.

[18] Among the 61 crop combinations distinguished, 24 composed of two elements have occured in 405 villages while 37 with three elements in 177 villages. Among the most frequent are the following combinations [48]:

$E_2r\ I_1p$ the rye with potato orientation (107 villages)
$E_3r\ I_2p$ the rye and potato orientation (106 villages) and then
$E_2r\ I_3p$ strong potato and rye orientation (54 villages)
$E_2r\ I_1p$ strong rye with potato orientation (35 villages)
and only one combination of three elements namely
$E_2rI_2pS_1l$ rye-potatoe with lupine orientation (39 villages).

E extractive, *I* intensive, *S* structure forming groups (see p. 118).

Research undertaken in 1960 on land utilization outside Poland has spoken against doubling the value of intensifying crops. As it was proved the relation of prevailing crops in this group i.e. maize to other groups from the point of view of both intensity and productivity is by far different from the coefficient used in Poland where potatoes prevail in this group. This is why the studies on selected villages in East Central European countries do not privilege any more any of the groups concerned and treat the proportions between them in areal units. For a better distinction of the intensifying group in Poland it has proved necessary to introduce an additional division on the level of 30 per cent of the sown area.

Returning to the problem of farming systems which specify the amount and character of means and ways applied in farming one could agree with many of the authors who treat separately these means and ways in particular branches of agriculture as systems of crop growing and animal breeding and then within the framework of these they discuss the various partial systems of lower order. As the crop cultivation and animal breeding are nearly always more or less related to each other and both history and geography do not know many systems of farming based exclusively on either crop cultivation or animal breeding it seems reasonable to consider besides the partial systems also systems of farming understood as a whole i.e. as many (mainly Russian) authors have done by distinguishing systems of farming as particular stages of the whole evolutionary process of the development of technology, organization and agricultural science applied at different times and in different places. This allows us for a better understanding of the place of farming systems applied on a given, closer area, being of greater interest to us in the whole process of development of farming systems.

4. Effects of farming

Agricultural production is the effect of farming. It also provides the basis for defining further typological features of agriculture such as productivity, labour and capital efficiency, marketability, and also orientation in production.

(a) *Productivity of agriculture*

Although the notion of productivity (*productivité, efficacité d'agriculture, Produktivität*) or that of the level of agricultural production is not as controversial as the notion of intensity, it is sometimes also differently understood and its precise measurement yields certain difficulties. Alt-

hough productivity is generally considered as a total output per unit area (*rendement à l'unite de surface*), some authors use this term to define the productivity of labour or capital, which is called here efficiency (of labour) or effectiveness of capital input.

The simplest and most primitive idea about the agricultural productivity of a particular area is given by yields per unit area which are the subject of numerous analytical geographical research. As the yield of any crop only defines its own productivity, which in turn is different with regard to other crops attempts have been made since long ago to reduce them to homogenous comparable measures.

Among Polish geographers J. Ernst [9] in his work on agricultural regions in Poland published in 1932 summed up the yields of the four main cereals and $^1/_{10}$ of the potatoe yields, and by dividing it by 5 obtained something like an integrated average yield for the 5 main crops in Poland.

W. Ormicki's [39] method was more sophisticated. In order to define the average yield (which he improperly called intensity) he introduced the following formula:

$$I = \frac{k_1 z_1 + k_2 z_2 + \ldots k_n z_n}{n}$$

where

$z_1 z_2 \ldots z_n$	yield of a particular crop in q per/ha,
n	number of crops under investigation,
$k_1 k_2 \ldots k_n$	integrating coefficient based on the caloric value of crops as compared to the value of 1 q of rye.

Taking thus obtained the highest "intensity" achieved in Poland (county of Leszno 28.45 kg of rye per 1 ha) for 100, he worked out a cartogram illustrating the relation between the crop productivity calculated per value of rye in different counties of Poland.

Productivity [40] was the term used by this author to define the relation of the obtained integrated yield of the 5 principal crops to the total area which he calculated using the following formula:

$$P = I \,.\, p$$

where

P	agricultural productivity,
I	intensity of farming (in the author's terminology),
p	area under investigated 5 crops in percent of the total area.

Although only 5 main crops have been investigated and animal production was entirely omitted, both cartograms worked out according to this method give a most interesting, although only approximate, picture of

spatial differentiation of agricultural production in Poland at that time. A similar method of reducing the yields of various crops to their value in cereal, by means of the specially elaborated multipliers was applied by W. Schramm [46], in his research on spatial differentiation of productivity of agriculture in Poland. In spite of having applied several estimations the results of the work in the form of a cartogram based on these calculations are less doubtful than the already discussed analysis of intensity of agriculture (123). Nevertheless it gives only an approximate picture of the problem. All studies mentioned above have been concerned only with vegetal production. Defining the animal production is a very difficult task. The statistical data give usually little information as to the amount of produced meat, milk, wool, etc. the average weight of a livestock unit, the average milking capacity of cows, the average egg-laying capacity of hens etc. being the corresponding data to those of yields per ha. seldom are compiled for smaller administrative units. In many geographical studies however, mainly by Russian authors these single indices per unit area illustrate the productivity of animal husbandry. To determine a full animal production in comparable units yields further difficulties.

Since statistical data concerning agricultural production are usually far from being complete the establishing of a complete productivity of agriculture in comparable units required working out several estimates. Although statistics provide data concerning the basic elements of mainly vegetable production, and partly of animal production, there are several other often secondary though not unimportant elements of this production, for which there is generally no or only incomplete data (e.g. production of straw, chaff, sugar-beet leaves, pasture grass, skins, feather, manure etc., as well as the amount and value of sold animals, and those growing from natural increase). Another difficulty is the fact that some part of vegetal production is fed on the spot to livestock and so transformed into animal production. So if accepting for the evaluation of agricultural production of both of them it causes that some elements of agricultural production may be counted twice. In view of the above agricultural economics created such notions as — gross production, gross output, gross income on one hand, and net production, net output, net income on the other which involves the gross production less the products used for reproduction purposes on the farm (fodder, seeds, manure etc.).

It has not been settled yet whether the gross or net production gives a more suitable basis for defining agricultural productivity, efficiency of labour or the marketability of agriculture. Net production seems to be more suitable for defining productivity and therefore also the orientation

in agricultural production; applying it to define the labour efficiency would be however wrong because, the production of fodder given to livestock and grain used for sowing etc. require also separate outlays in labour. Leaving out either of these elements when taking net production as a base will cause diminishing of real outlays on the total of agricultural production.

Anyhow it appears that if the investigations concern the particular effects of farming, different bases of calculation may be applied, but if typology of agriculture is the aim of investigations — common base of calculations is indispensable and in this case only gross production may serve that purpose. Besides gross production is generally easier to calculate, because although it requires several estimates, it is easier to perform than establishing a part of the agricultural production used on the farm e.g. fed by livestock. This is particularly difficult with some crops as for instance potatoes, barley or oats that usually serve different purpose. Then there is also the problem of homogenous and comparable measure of the whole of agricultural production. Some scholars use in their investigations monetary units, other use conventional units based on natural foundations. The use of monetary units is advantageous since it is a common denominator widely known and applied in economic life and it also permits calculation of the rentability or income of either a particular farm or of agriculture in general. The disadvantageous feature of applying monetary units is the need to base estimates on prices which are subject to changes in time and space. Consequently any comparisons of the results obtained are very difficult. Even omitting changes arising as a result of time, the application of money as a comparable unit, be it within the limits of the territory of the country, will provide difficulties owing to local differences of prices [19]. All the more difficult will be a comparison of effects of agricultural production of two or more countries even in the existing currency rates allowing one to find the right relation of the monetary unit to another. The point is that even in capitalistic countries market prices of agricultural products do not reflect the costs of production. It must be considered that in the most countries prices are not a result of a free interplay of supply and demand; as they are either protected by customs tariffs or they are established as a result of subsidies offered by the state. Although in socialist countries changes of prices in time are slower, in most of them, however, there are several prices for agricultural products

[19] In spite of this, many authors apply this index in their geographic investigations. Among the Polish authors I. Kostrowicka [21] has given the areal differentiation of crop productivity in the Kingdom of Poland for the years 1842–1864/65 based on the available data of that period concerning volume of production and prices.

none of which gives a real picture of the costs of production nor do they offer a basis for comparisons between different countries.

In this situation is seems therefore to be more appropriate to accept conventional units as measures which are not subject to any changes in time or space. There are several such units applied for that purpose. In Central Europe the most popular is so-called grain unit [44, 52] based on the starch and protein content in various agricultural products calculated in caloric value as related to the four cereals. As units of measure they also have their disadvantages because the contents of both starch and protein cannot be a suitable measure for products which are not alimentary goods (i.e. fiber crops, tobacco etc) and besides, several food crops are cultivated not because of their protein or starch contents (i.e. fruits) but for the other reasons. The common comparable measure for these crops has been established on the basis of other criteria, mainly on their input-output comparison. In spite of such or other disadvantages, grain units as measures of the effects of farming are more and more widely applied in both economic and geographic studies.

The productivity of agriculture as a starting point for defining the orientations of the Polish farming in 1938 and 1958 was the subject of a not yet published study by R. Szczęsny carried out in the Department of the Agricultural Geography of the Institute of Geography of the Polish Academy of Sciences. For the definition of productivity he applied a special formula which is a development and also a simplification of following formula worked out by the present author for the purpose of geographic agricultural research

$$P_g = \frac{z[p_1+p_2+\ldots p_n]+z[(m\cdot n\cdot im)+(l\cdot il)+(w\cdot iw)+(d\cdot id)+\ldots (x\cdot ix)]}{A}$$

where:

P_g productivity of agriculture i.e. the total production per unit area in grain units

z units

p production of different crops

m number of heads of livestock of particular sort producing meat (cattle, calves, pigs, sheep, poultry etc.)

n slaughter index, different for each kind of livestock, giving the proportion of livestock destined for slaughter during investigated period out of the total number of livestock

im average gross weight of meat stock animal, different for particular sort of animals (cattle, pigs, calves, sheep)

l number of heads of milk-producing livestock (cows, goats, sheep etc.)

il milking capacity per head; different for particular sort of milk animals (cows, goats etc.)

w number of heads of wool producing animals

iw wool output index per head
d number of egg-laying poultry
id egg laying capacity — according to kind of poultry
x number of livestock yielding other products (e.g. skins, manure, furs, bristles etc.)
ix index of the output of these products
A area of agricultural land.

When establishing the number of productive animals, corrections should be assumed for natural decrease, temporarily unmilky cows etc.

The formula given above includes only real gross production either calculated or estimated; it does not include, however, the increase in the weight of livestock or new born living animals which will be taken into consideration in animal production as meat, milk etc, but not necessarily in the same year.

Because of lack of adequate materials or small significance of certain elements of production R. Szczęsny left some items of productivity as fruit, poultry and bee-keeping production as well as some minor products which finally reduces to a certain extent the defined productivity. In spite of that his work gives a most interesting picture of the differentiation in agricultural productivity on the whole area of Poland and the changes in that respect during the past twenty years. This was achieved for the first time using uniform and comparable criteria.

A similar method, but in a more detailed scale has been applied by W. Biegajło in the agricultural section of the Economic Geography of the Białystok voivodeship which is now under preparation. This method has also been tested in several other studies on smaller territories among which was also the analysis on land utilization and farming in selected villages in Bulgaria, Yugoslavia, Hungary and Poland based on the land use field works and carried out in cooperation with geographers of these countries. As these last studies concern small territories and much information (which was not in the available statistical publications) could be collected by means of observations and interviews, the estimate of productivity of agriculture was more precisely worked out.

(b) The orientation in agricultural production

The notion of orientation of production (*orientation, Produktionsrichtung, Erzeugungsrichtung, Wirtschaftsrichtung, napravlenie selskogo khozyaistva*) is also not always understood in the same way, hence different bases are taken for the purpose of defining orientations. According to some of them orientation should only mean an intention or aim of the farmers' efforts and therefore the structure of sown area and the number

of livestock should be taken as a criterion for that purpose [20]. In some countries, mainly U.S.A. and U.S.S.R. the orientation of agriculture is based on only the commercial part of production which is acceptable in countries where marketed produce constitutes all or most of the output. In most countries of the world, however, including Poland, where small farms prevail, disposing of a varied, often small range of commercial production such a method is not sufficient. Certainly the spatial structure of commercial production may be investigated and its orientations defined on this base. This, however, is a different problem.

The most appropriate seems to be the attitude of those authors who are of the opinion that orientation in agricultural production should reflect neither the aims nor intentions of the producers but the results obtained by them, no matter whether the production was consumed on the spot or sold and therefore, that agricultural productivity should be a base for defining orientations in agricultural production.

Most essential in the definition of the orientation in agricultural production according to this point of view is the establishment of proportions between first the vegetal and animal production and then between particular branches of each of these groups.

We have then to face another problem: should different elements of agricultural production be grouped, to achieve this aim or should they not, and if so — how should the groups be formed. As for the vegetable production forming groups according to the above suggested model (see page 119) based on the economic criteria seems to be the most appropriate. Where livestock production is concerned the situation is more complicated. Here the division most frequently encountered is that according to the species of animals. We therefore speak of the orientation in raising cattle, pigs, sheep etc. It seems that as in crop production, grouping should consider above all the economic aim. Therefore we should speak of the orientation in producing milk, meat, wool, furs, eggs etc, either independently of the animals which furnish these products or, as we do not always have to deal with exactly the same products — one may distinguish for example orientations in breeding dairy or beef cattle, wool, sheepskin or meat sheep, bacon, lard or meat hogs etc. Although this corresponds with the division of animals into so-called productive types it is most difficult to establish their share in the total number of heads of particular kinds of animals using statistical data only.

The studies on the orientations in production along the lines presented above were commenced by agricultural geography not long ago. Among

[20] This is how orientation of farming is understood by B. Kopeć (footnote 13).

Polish authors J. Okuniewski [21] studied the orientation of production on selected farms of Greater Poland on the basis of the structure of net production calculated in grain units. A similar method using monetary units was applied by Z. Grochowski in his studies on some one hundred collective farms [22]. R. Szczęsny in his above mentioned work (see page 131) on orientations in agricultural production in Poland based his studies on the structure of gross production calculated in grain units. Feeling the inadequacy of grouping applied ordinary in statistics to the study regarding effects of production and yet not daring to break of with them he followed the example of some German and Russian works and applied partly modified grouping which tends towards a more economic treatment of crops by distinguishing the four following categories

(1) grains, namely the cereals and edible pod crops,

(2) edible root-crops, namely potatoes and vegetables,

(3) industrial crops, including root-crops such as sugar-beet, oleaginous, fibres, herbs, etc.

(4) fodder crops including both root-crops and those cultivated for silage, hay or green-fodder, straw as well as a meadow and pastures production.

With regard to livestock products he applied the mixed method for defining orientation finding in Poland only the dairy cattle orientation, the meat orientation with pig rearing prevailing and a mixed meat-milk or milk-meat orientation where either dairy cattle or pigs prevail.

Following the Polish land utilization survey R. Szczęsny has also applied as a method of distinguishing the orientation of agricultural production a constant and multidivisional scale. A predominant orientation must account for over 60 per cent of the gross production, a mixed one 40–60 per cent and the accompanying orientation 20–40 per cent of the total production. Using this base he established first the ratio between crop and livestock production and then using the same divisions he distinguished within the framework of each, different orientations of production. Applying these indices he found in Poland 21 orientations

[21] He defined farms, on which one branch of production e.g. of cereals, hilled crops industrial crops, vegetables, the breeding of cattle or pigs, give more than 50 per cent of net production to be singly oriented; farms on which two major branches of agricultural production make a total of over 50 per cent of net production (one of them over 25 per cent) he acknowledged to be dual-oriented; the last group are farms on which no one branch of production prevails and two main orientations do not constitute more than 50 per cent, were acknowledged as being of a mixed orientation.

[22] As a criterion for defining orientations he assumed that a given division or branch of production (the author only admits 4 orientations: cereals, industrial crops, vegetables, livestock breeding) comprises at least 30 per cent of the value of net production. On this basis cereal orientation was found on 47 collective farms, cereal-livestock orientation on 40, livestock on 30, and finally vegetables orientation on 7 cooperative farms.

of agricultural production [23]. Of these 15 were noted in 1938 and 18 in 1958, 3 have disappeared and 6 new orientations developed. In spite of some minor methodical deficiences in his work, the image of changes in the spatial pattern of Polish agriculture given by the author is most interesting and points out several essential transformations occuring during the years 1938–1958. These are namely changes from vegetable, mainly grain crops orientations with dairy cattle prevailing in animal production to the mixed vegetable-animal or animal-vegetable orientations. In this case among crops wheat, sugar beet, potatoe and vegetable orientations gain importance along with mixed meat-milk livestock raising with growing importance of pig breeding.

The task for the nearest future given to the Department of Agricultural Geography in the Institute of Geography of the Polish Academy of Sciences is to test their own methods of establishing productivity and orientations of agricultural production on the materials concerning the past of Polish agriculture, by the more detailed research of small territorial units and then to apply them to the studies outside Poland.

(c) Efficiency of agriculture

The concept of efficiency in agriculture embraces both the labour efficiency and capital effectiveness. While the first one may easily be defined by dividing the total production by the number of man-hours worked in agriculture or less precisely by dividing it by the numbers of employed in agriculture — the definition of efficiency of outlays i.e. of their effectiveness is so complicated that till now it cannot be applied in large-scale mass research.

Different measures of the efficiency of labour have been applied. Besides the most frequently applied index of the total of production calculated in monetary or natural units per man-day, man-hour or per employee [24], also a reverse index is applied where total of labour per

[23] Using this method R. Szczęsny distinguished 21 orientations in agricultural production in Poland in 15 of which crop production prevailed (namely 4–grain, 1-grain-root, 4-grain-fodder, 1-grain-root-fodder, 3-root crop and 2-fodder orientations) and 6 mixed ones vegetable-animal namely 4 grain livestock, 1 root crop-livestock and 1 fodder-livestock breeding orientation. Three of these orientations (mainly crop ones) have disappeared in the period of years 1938—1958; 1 orientation (also a crop one) the author has found to be disappearing; 3–crop orientations as stabilized; 8 (6 crop orientations and 2 mixed ones) as developing and 6 (2 crop and 4 mixed ones) which only appeared after the war.

[24] In the latter case it must be noted that labour might be not fully employed and therefore the result will not give a real image of labour efficiency in agriculture i.e. the relation of production to the outlay on labour but the relation of production to the number of workers employed. This will also show the eventual influence of the labour surpluses in agriculture which is both interesting and important but connected more with the problem of intensity of farming than with an efficiency.

unit of product is considered. This may refer to the amount of labour required to produce either a certain output of a particular kind of product or the whole production.

The efficiency of labour in agriculture is a most essential typological feature. It shows the labour outlay necessary to achieve a given level of productivity. This allows one to distinguish between the so-called intensive types of farming where high productivity per unit area will be achieved by large inputs of labour or capital from the extensive types of farming where the production per unit area may only be small although it may be high per unit of labour. Also farms where despite large labour outlays, the productivity is low, may be distinguished from those where low productivity is the result of low inputs. It is unfortunate that these problems have escaped the attention of Polish geographers and therefore more emphasis must be put on developing research in that direction.

(d) Marketability of agricultural production

The marketability of production is another important typological feature of agriculture. It is namely the quantity of market products delivered outside the farm either in relation to the total production or per unit area. In the first case the marketability of agricultural production is defined as a percentage; it expresses the degree of commercialization (marketability). In the second case it is defined in monetary or conventional units per unit area (ha) and expresses the dimension of commercial production. Both these methods serve to complement each other and should be applied jointly.

In geographical research besides the degree and intensity of commercialization also its structure may be investigated, i.e. the share of different agricultural products in the total commercial production. When grouping them properly also the orientations of commercial production may be defined.

The marketability of production is the subject of numerous geographical studies mainly in U.S.A. and U.S.S.R. In Poland there are only few such works mainly because of difficulties in distinguishing the commercial part of production of small peasant holdings. The only study of importance concerns the areal differentiation of marketability of peasant holdings in Poland. It was worked out at the Institute of Agricultural Economics (under the supervision of F. Dziedzic). Based on incomplete data of purchases, the dimension of commercial production in different counties was first established, calculated in grain units per ha of agricultural land and then according to the structure of commercial production — the

orientation (using constant divisions) in marketability of egriculture have been defined. Numerous cartograms worked out based on this method give a most interesting picture of both the dimension of the commercial production and its bases in different parts of the country [25]. Using the reports of Russian governors, an attempt was made by I. Kostrowicka [26] at defining the commercial production both in relation to the gross production and in silver rubles per hectare for the territories of the Kingdom of Poland in the middle of the 19th century.

5. Typology of agriculture

The methods of geographical typology of agriculture presented above on the one hand do not exhaust many problems while on the other hand the features and indices shown in the investigations executed elsewhere may prove to be either too numerous or else inapplicable.

A certain set of established features or indices should only constitute a starting point which would guarantee that nothing important has been omitted. The final choice of features and indices may be different in every work depending on the range of the work, circumstances specific to different countries or regions and the availability of the basic data —

[25] This work is known from the report of P. Dąbrowski [6]. Using the following indices the main crop or livestock-rearing orientations have been established:

Main orientation		Share of commercial animal productions in the total commercial production
strong livestock	*H*	80—100
moderate livestock	*h*	60—80
mixed with livestock prevailing	*hr*	50—60
mixed with crop production prevailing	*rh*	40—50
moderate crop	*r*	20—40
strong crop	*R*	0—20

If animal breeding is the main orientation, (*H*, *h*, *hr*) various orientations (*B* — cattle, *T* — pigs, *O* — sheep, *D* — poultry) production have been accepted as the leading ones if they cover more than 75 per cent of animal production, as prevailing if 50–75 per cent and relatively prevailing or accompanying if they cover 25–50 per cent. In each of the orientations for livestock production, assuming the same scale, inclinations have been distiguished according to the production of definite products such as meat or milk where cattle is concerned, bacon or lard and meat when pigs etc. If crop production is the main orientation by applying the same divisions, orientations have been distinguished according to particular kinds of crops except cereals which have been grouped together. Within the framework of these orientations, less consequently, inclinations connected with either species or purpose of a given plant have also been distinguished.

[26] Marketability in crop production varied in different countries of the Kingdom of Poland between 30–60 per cent of the total, varying from approximately 6 to 20 silver rubles per 1 hectare. First of all sugar- beet and then, wheat, barley, potatoes and rye [21] were the basic commercial products.

provided that the following three principal sides or aspects of the problem will be respected, namely: that of social and land tenure, technico-organizational and economic. Conserving always for comparability the initial uniform bases — it should be made a rule that in going from larger to smaller areas one applies increasingly more precise and subtle measures and indices as far as material allows.

The need of always respecting all the most essential aspects of the problem on any grade of typology requires consideration of the problem of the method of the final synthesis of these features and indices. Such a method of synthesis has not been worked out so far. In the majority of typological works mainly concerning larger areas, even if they used the quantitative methods and indices of different types the final synthesis is being made by means of either a rather intuitive choice of factors, which — in the opinion of the author of a given work — are of a decisive importance or by cartographic superposition of individual elements and ascribing the decisive role to coincidence of the limits of range of these elements.

Similarly, on the basis of the results of the land utilization survey of selected areas and various statistical data the present author has distinguished 7 main types of farming in Poland [22, 29, 31] giving their general characteristics and also their specific features taking examples of selected villages and agricultural units.

This sole attempt at a complete typological synthesis of Polish agriculture is from the methodical point of view unsatisfactory and it probably only partly reflects the real situation in that respect. Distinguishing farming types was not based sufficiently on the results of syntheses of particular categories of typological features which did not at all exist, while the choice of features decisive for the distinguishing of particular types of farming was based rather on experience and intuition than on strict and precise methods of distinguishing and integration of features important from the point of view of typology, because neither did these exist. It seems that besides establishing the most essential typological features and indices the next important problem to be considered is that of establishing strict methods of integrating them. This is also one of these problems which may best be solved through international co-operation.

CLASSIFICATION OF CROPS

I. Rotated crops			II. Perennial crops		
A. Intensifying	B. Structure--building	C. Extractive	A. Semi-perennial	B. Perennial	
				Bushy and Creeping Plants	Tree Crops
1	2	3	4	5	6
A. FOOD CROPS					
1. Supplying chiefly protein and starch (predominantly pod crops)					
Green Pea Beans Broad Beans (as garden crops)	Peas Beans Broad Beans Lentils Chick Pea Soya Beans Cow Pea (*Vigna*) Sword Beans (*Canavalia*) Pigeon Peas (*Cajanus*) Velvet Beans (*Stizolobium*) Hyacinth Beans (*Dolichos*)				
2. Supplying starch and protein (predominatly cereals)					
Maize	Wheat Rye Barley Oats Buckwheat Millet Sorghum Rice Quinoa				
3. Chiefly starch (mainly root and tuber crops)					
Potatoes Vegetable Root Crops (beet roots carrots, swedes, radishes, horse-radish, parsley, celery, rutabaga turnip, salsify) Sweet Potatoes Manioc (Cassava) Yam Taro Jerusalem artichoke Arrowroots Ulluco (*Ullucus*) Oca (*Oxalis tuberosa*) Anu (*Tropaeolum*) Coleus			Bananas		Bread-fruit Sago Palm

1	2	3	4	5	6
4. Chiefly oils and protein					
Poppy Chufa (*Cyperus esculentus*)	Soya Beans Peanuts Bambarra Nut (*Voandzeya*) Potato Bean (*Apios americana*)			Pistachio-nuts Various nuts	Brazil Nut Almond Pistachio--nuts Walnut Avocado Sweet Chestnut Hazel Nuts
5. Chiefly sugar and protein					
					Coconut Locust Tree Fig Tree Date Palm
6. Chiefly mineral and vitamin contents (predominantly vegetables)					
Pumpkin (Squash) Cucumber Tomato Sweet Paprika Egg Plant Calabash Endive Lettuce Watercress Artichoke Spinach Sorrel Asparagus Onion Leek Garlic Cabbage Cauliflower Kohl-rabi Broccoli Brussel Sprouts					
7. Chiefly mineral, vitamin and sugar contents (predominantly fruit plants)					
Melon Watermelon			Strawberries Rhubarb Pineapple Bananas	Rasperry Blackberry (Brambles) Currant Gooseberry Grapes Quince Nedlar Hawthorn Rose Cornel Fig Tree Pomegranate Passion-fruits Fijoa	Apple Tree Pear Plum Apricot Peach Bitter Cherry Cherry Mulberry Lemon Grapefruit Orange Mandarin Kumquat Mango Avocado Litchi Annonas Persimmons Pawpaw Guava Date Palm Durian
B. INDUSTRIAL 1. Supplying food products (a) Sugar					
Sugar Beet Potatoes (for syrup) Maize (for sugar)		Sweet Sorghum	Sugar Cane		Sugar Palm (Arenga)

1	2	3	4	5	6
(b) Beverages					
Chicory				Tea Coffee Maté	Cacao Coca Cola Maté
2. Supplying partly food products (a) Starch and alcohol					
Potatoes Manioc (cassava) Sweet potato Taro Yam Arrowroots		Malting Barley Rye Oats Sorghum Rice	Sugar Cane		Apple Plum Vine Mulberry
(b) Oils and fats					
Rape Colza Flax Hemp Sesame Poppy Oil Pumpkin Sunflower Mustard	Soya Peanut	Rape Colza Flax False Flax (*Camelina sativa*)	Castor Oil Plant	Castor Oil Plant Cotton	Olive Tree Oil Palm Coconut Tung (*Aleurites*)
(c) Spices. Seasoning and medical products					
Bitter Paprika (red pepper) Cummin Caraway Parsnip Fennel Coriander Anise Mustard Laurel Marjoram Ginger Poppy Turmeric Pepper-mint Various Medical Herbs			Hops	Pepper Vanilla	Quinine Camphor Coca Cola Eucalyptus Cinnamon Clove Tree Nutmeg Tree Pimento Tree Various Medical Trees
3. Non food products (a) Essential oils and decorative articles					
Lavender Thyme Hyssop Rosemary Peppermint Sage Balm Various cultivated Flowers				Roses and other Cultivated Flowering and Decorative Bushes	Various Cultivated Flowering and Decorative Trees
(b) Narcotics					
Tobacco Opium Poppy					Betel (Areca) Coca
(c) Fibres					
Flax Hemp Jute Ketmia Ramie		Flax	Cotton Abaca (Manilla Hemp) Sisal Hemp	Cotton	

1	2	3	4	5	6
(d) Dyes					
Madder Saffron Turmeric etc.				Indigo	
(e) Other industrial products					
Kok-saghyz				Osier	Para Rubber (*Hevea*) Panama Rubber (*Castilloa*) Assam Rubber (*Ficus elastica*) Cork Oak Bamboo Eucomia
C. FODDER					
1. Supplying concentrated foods (chiefly pods and cereals)					
Maize	Serradella Vetch Field Bean Sweet Lupin Field Pea Chick Pea	Oats Barley Rye Millet			
2. Supplying bulky and succulent foods (chiefly roots and silage fodders)					
Maize Mangold Swedes Turnip Kale Pumpkin Sunflower					
3. Supplying hay and green fodder (chiefly rough forage)					
	Clover Lucerne (Alfalfa) Sainfoin Serradella Vetch Field Pea Melilot Trefoil	Green Rye Millet Sorghum Green Maize Various Cultivated Grasses		Mulberry	
4. Mellifluent					
Phacelia *Echium vulgare* Hyssop *Echinops* *Borrago oficinalis* *Dracocephalum* Coriander White Mustard	White Clover Sainfoin Broad Bean Melilot	Buckwheat Rape	Mulberry		Apple Pear Vine Plum Cherry
D. GREEN MANURES					
Ploughed-in Serradella Lupin etc.					

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GEOGRAPHIA POLONICA 1, 1964

MAIN RESEARCH PROBLEMS IN POLISH INDUSTRIAL GEOGRAPHY

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The Conference at Osieczna, which took place in 1955, determined the main lines relating to the further development of industrial geography. From that date the number of published studies dealing with these problems became quite important. These studies referred to various problems, as stated below. The research works were carried out by geographers, as well as by economists, statisticians, historians and so on. Sometimes they were conceived in a similar way. It is very difficult to determine a substantial boundary line between the studies which should be considered as relating to problems of industrial geography, and those which should not be so considered. However, in order not to increase unduly the achievements of Polish geographers by works carried out by other specialists, the present paper has been in the main lines limited to discussing those studies which were prepared by geographers. It was not always possible to carry out such limitation in a consistent way. The paper thus gives some notions of the matters with which geographers are dealing within the sphere of industrial geography, but on the other hand it does not state the full achievements of Polish science in this respect. This review comprises studies published since 1955. Works which appeared before this date have been reviewed by A. Wrzosek in the paper "Review of the previous achievements of Polish industrial geography" published in 1956 [71].

The works of geographers, relating to industrial geography, embrace quite an extensive range of themes. As in the present paper it is not possible to discuss fully all published works; the paper thus deals only with the most typical problems considered. The works can be divided into nine groups.

General descriptions

The first group consists of studies dealing with the general problems of industrial geography. These refer to the nature of the problems, research methods, trends of development, as well as to programmes of studies on industrial geography in the universities [25, 35, 39, 45]. A Kukliński [35] singles out and characterizes the main trends of development in industrial geography as follows: 1) landscape, 2) historico-geographical, 3) technico-economic, 4) physiographic, and 5) econometric. The same author is of the opinion [39] that research referring to industrial geography may be divided — depending on the starting point of a given investigation — into four groups, namely: (a) systematic, (b) regional, (c) topical and (d) cartographic.

Besides research dealing with general themes, descriptions stating the distribution of industry, contained in textbooks on Poland's economic geography — for the use of universities — should be reckoned as belonging to the first group. Publications presenting data giving a statistical and cartographic picture of the distribution of industry in Poland, especially those prepared in collaboration with geographers [23, 58], are also included into this group.

Studies on particular industrial plants

Geographical investigations also dealt with large individual industrial plants. Programmes of this type have been worked out by S. M. Zawadzki [78] and I. Fierla [19]. They consist mostly of monographs dealing with the plant's production considered with reference to its location, the sources of raw-materials supply and semi-manufactured products which are forwarded from other localitites, site conditions (water), the supply of electric power, labour (commuting) and the markets for finished goods. The main stress is laid on the spatial connections which have a bearing on the production. In some of the studies more attention is being paid to the historical development of the plant, in others, to the technological and economic problems. The achievements of geographers in the sphere of monographs on particular industrial plants are, however, not so important. The studies which should be mentioned are: A. Blok-Iwińska [6] on the Lenin Ironworks in Nowa Huta, I. Fierla [18] on the Metalworks at Starachowice, S. M. Zawadzki [76] on commuting to specially selected industrial plants.

Factors in the location of industrial plants

Problems of industrial plant location are mainly the concern of economists: they are, however, also elaborated by geographers. The problems of location were investigated in the first place from the point

of view of raw materials, describing their supply for particular branches of industry, for example for the building materials industry [22, 26, 65]. Sometimes the characteristics of raw-material resources in the particular areas [3] or in the whole of Poland [33] are given. They were studied but mainly in qualitative or quantitative terms. However, some analyses of the costs of exploiting raw materials were introduced as a factor in total production costs, and therefore as a plant location factor. Studies prepared by Z. Zajda and S. M. Zawadzki [73, 74], investigating the economic effectivness of industrial plants located after the World War II, went much further. These studies give an analysis of the total complex of locational factors.

The spatial distribution of particular industries

Most studies in industrial geography refer to the spatial structure of particular industrial branches. These studies chiefly deal with the whole of Poland, and exceptionally only with particular parts of Poland. They present analyses of the distribution of industrial plants classified according to various criteria such as: employment, equipment, complex of the production cycle, dimensions and quality of production, quantity of electric power used, raw materials, water, and so on. Numerous indices are therefore being used to facilitate comparisons within a particular branch of industry. When considering the magnitude of production and local consumption, the studies state the economic links existing between the investigated areas (mostly administrative units, for which statistical data exist) where a definite kind of industry is being concentrated, they state local balances i.e. areas with surpluses and/or deficits, as well as the main centres and districts which play a dominant role in the national production in a particular industry.

These studies are very interesting, among others, from the methodological point of view. They contribute to the development and improvement of research methods within the range of indices available, means of quantitative comparison (statistical), cartographic settings and so on. Several such investigations are being prepared as theses for Master's or Doctor's degrees; few of these are being published, however.

The main body of the studies published refers to the building-materials industry, and chiefly to brickworks [37, 38, 51, 52], cement plants [31, 40–42], gravel pits and limekilns etc.

The second-most important studies relate to the food industry. Among others studies of the sugar industry [21, 56], fish industry [34], dairy industry [10], and meat industry [14] should be mentioned. A study of

the food industry in Białystok voivodeship has been prepared by M. Chilczuk [8].

Studies of metallurgical industries [77], those relating to textile industry by L. Straszewicz: in Poland [61], in France [63] and in Bulgaria [62], as well as the studies by A. Werwicki, dealing with textile industry in Białystok voivodeship [67, 68] are worth mentioning. Separate mention should be made of the paper by A. Kukliński [44] refering to the methods of research on the particular branches of industry.

Sites of industrial plants

Studies have been started on physiographic conditions relating to the topographical position of a particular plant, that is studies on the influence of the morphology, geological structure, sources of raw materials, water, climate etc., on the choice of the site of the plant. At the same time studies were started investigating the influence of the natural environment on the production process. Yet other studies have been begun to ascertain the degree, kind and scope of transformations in the natural environment caused by an industrial plant and its relevant production.

The building materials industry has been chosen for these purposes, and especially brickworks [26] and cement plants [22, 32]. By extending the investigations on a number of plants belonging to the same kind of industry it has been possible to make a series of generalizations relating to reciprocal connections between an industry and the natural environment, and to introduce — for certain investigated phenomenona — quantitative indices, which are mostly used in the calculations of production costs, or costs of recultivating destroyed areas.

Industrial districts

Another type of investigations is represented by studies on the industrial districts in Poland. These investigations deal with definite territorial complexes of production, which can be separated from the remaining areas. The investigations have a multiple character. They embrace the analysis and characteristics of all branches of industry and of all plants situated in the given area. The subject is treated mainly from a historical approach since investigation of the causes of the emergence of an industrial district and of the dynamics of its development is indispensable for obtaining certain guiding lines for the future.

The best papers refer to the Warsaw Industrial District [48, 49]. A similar work has been started for the Łódź Industrial District [59, 60] and Upper Silesian Industrial District [79].

Industrial problems in geographical monographs

In textbooks dealing with Poland's economic geography, there may be found — as already mentioned — chapters referring to industry. In these chapters we may find: the distribution of industry according to particular branches; statistics of particular plants, employed persons or production (sometimes treated dynamically) and only occasionally a statement and characteristic of the industrial districts. In economico-geographical monographs dealing with smaller areas, especially particular parts of Poland such as voivodeships, counties and so on, chapters relating to industry are written according to a similar scheme. In some monographs, however, investigations into industrial questions are more penetrating, taking account of the circumstance that a particular industry plays a special role in the regional economy and shows strong dynamics of development which have a decisive influence on the whole economic development of the area.

Most of the monographs dealing with particular counties have not been published. Many monographs describing particular voivodeships have a popular-scientific character, special emphasis being put on the informative part. In the present paper the last two groups of monographs are disregarded; so are monographs relating to towns, since these have a different character. Only such monographs of voivodeships have been considered in which the chapter dealing with industry has some scientific importance, as well as those monographs which deal only with matters relating to industry in a given area. Of the former monographs dealing with the following voivodeships should be mentioned: Białystok [2], Gdańsk [17], Katowice [20], Kielce [30], Opole [64], Poznań [15, 16, 24, 75], Rzeszów [9], Warszawa [70] and Zielona Góra [4, 7]. The papers prepared by L. Pakuła [53, 54] on the development of industrial centres in the Kraków voivodeship and especially in the Chrzanów county should also be mentioned. A very interesting paper is that prepared by S. Smoliński, H. Przedpełski and B. Gruchman on the industrial structure of the Western Territories in the years 1939–1959 [57].

The process of industrialization in Poland

One of the most characteristic manifestations of the development of national economy in Poland is to be found in the high rate of Poland's industrialization after the World War II. From the spatial point of view the process had a different course in various periods of time. The first years after the war are characterized by the reconstruction of destroyed

industry; during succeeding years we note the development of the already existing industry and the construction of new industrial plants. It is to be noted that although the industrial plants constructed in the old industrial districts are — as a rule — more profitable, it has been decided, from the social point of view, in order to level the standard of life of the inhabitants of the total country to build new industrial plants on areas which up to now were weakly industrialized or lacked industry.

The main assumption of studies related to the process of Poland's industrialization, is the historical handling of the subject. Similarly to the studies on industrial districts, the investigations should embrace also the dynamic analysis of the industrial development in the past and present times, as well as to determine the prospects for this development. In order to create possibilities of investigations consistent with the above stated demands, adequate indices of comparison had to be determined. The number of persons employed in industry has been recognized as the most suitable index, allowing the classification of the plants according to their size, at the same time permitting computations with reference to the number of inhabitants and surface of the area. The indices determined in this manner served to carry out investigations on the historical process of industrialization starting in 1946 and in certain case from the beginning of the 20th century, or even from the middle of the 19th century [36].

The program of studies on Poland's industrialization after the World War II has been worked out by K. Secomski [55]. The industrialization process in the above period has been analyzed by: A. Kukliński [43], A. Wrzosek [72], B. Wełpa [66]. Changes in the industrialization within the years 1946–1956 have been investigated by J. Kantor and A. Kukliński [27]. These problems were in the fullest manner presented by T. Mrzygłód [50].

On the basis of the index of the number of persons employed in industry, an attempt has been made to determine within the territory of Poland the existence of actual industrial districts. For the determination of industrial districts the following bases have been adopted:

(1) the absolute number of persons employed in industry and handicrafts,

(2) the index of the number of persons employed in industry and handicrafts calculated per 100 inhabitants and the occurrence of deviations when compared to the average index for the whole of Poland,

(3) the index of the number of persons employed, calculated per square kilometer of surface according to the above mentioned rules.

Thirteen industrial areal units have been determined which were divided into three categories:

(a) industrial districts with indices three times as high as the average index for the whole of Poland (Silesia-Cracow, Łódź, Warsaw, Sudety Piedmont);

(b) industrial areas with indices twice as high as the average index (Gdańsk-Sopot-Gdynia, Bydgoszcz, Wrocław, Opole, Old Polish Industrial Area);

(c) industrial areas where indices are a little higher than the average (Tarnów-Rzeszów, Greater Poland, Zgorzelec-Zielona Góra, Carpathian Piedmont).

This work has been prepared jointly by S. Leszczycki, A. Kukliński, M. Najgrakowski and J. Grzeszczak [47].

The localization of new or developed industrial plants in the plans for the years 1961–1965 have been analysed — from the spatial point of view — by W. Kawalec [28, 29] and E. Witkowski [69]. This problem is extremely complex. The localization principles are evident only in relation to extractive industries, and on the other hand quite open to discussion in relation to all other kinds of industry. The development of old industrial districts and centres is more profitable, and the modernization of old plants cheaper. However, in old industrial agglomerations difficulties arise as regards: transport, social services, deteriorating health conditions and the deficiences of water and open spaces make themselves felt. Investments in new localities are more expensive since additional investments are necessary (such as transport, living quarters, social services) and the deficiency of teams of qualified workers. In non-industrialized areas it is easier to locate small or middle-sized industrial plants connected with local supplies of raw materials, i.e. those not requiring highly qualified manpower.

Further industrial development in Poland requires very thorough studies. The economists undertook, therefore, works determining indices for the programme of development and distribution of the industry, and the possibilities of taking advantage of the mathematic model when investigating spatial connections. These methods were introduced into the works prepared by geographers, first by A. Kukliński [42] when analyzing the development of the cement industry in Poland up to the year 1980.

In the sphere of investigations on industrialization processes the papers should be mentioned prepared by M. Dobrowolska [11, 12] dealing with the creation of new centres and small industrial districts, as well as studies on the spatial structure of Poland's economy [13], as industry plays a decisive role in this structure.

Atlas of Polish Industries

To prepare the edition of the Atlas of Polish Industries a Committee has been appointed composed of representatives of the Planning Commission of the Council of Ministers, Central Statistical Office and Institute of Geography of the Polish Academy of Sciences. S. Leszczycki was apointed as Chairman of the Committee [46]. Teamwork on the Atlas has lasted for four years and was concluded in 1960. The Atlas contains almost 100 maps grouped on 70 plates, and consists of several kinds of maps. The initial part of the Atlas deals with general industrialization. It contains maps illustrating the state of industrialization of various areas of Poland, worked out according to indices of industrialization of the particular counties (refered to above), and the map of changes in the distribution of industrial plants within the years 1946–1956. The census of industrial plants prepared in 1956, using as a main criterion the number of persons employed in industry and handicrafts, serves as a basis for other maps. Industry has been divided into eight groups. For each group a map of the employment structure by counties was drawn marking with circles of different sizes, the number of employed persons and divided into sectors to show the part played by particular industrial branches within a definite group. The basic maps of the Atlas, maps of the distribution of particular industries have been executed with reference to individual plants, differentiating them according to qualitative and quantitative indices, chiefly using the number of persons employed in a particular plant. These maps permit a further analysis of the spatial structure of particular industries. On certain maps background symbols were introduced depicting the sources of raw materials or outlet markets (population) or other features connected with the production processes of a particular industry. These maps serve, among other things, as base for an analysis of the directions of transport of various goods. A certain number of maps have a different character, being related to the size of production, installed power etc. A defect of the Atlas lies in its static character (the Atlas shows the conditions existing at the end of 1956), and also in that there is no precise differentiation between handicraft and small industrial plants.

The Atlas of Polish Industries [1] has been duplicated in 70 items, by means of coloured photographs. The copies have been bought by interested offices and institutions. As the first edition was completly sold work has begun on issuing a second edition which will have a more dynamic character and will allow one to avoid the inaccuracies and gaps which crept into the first edition.

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SOME PROBLEMS OF TRANSPORTATION GEOGRAPHY IN POLAND

Teofil Lijewski

Among the problems dealt with in transportation geography in Poland some have particular significance since they are connected with the specific conditions of economic development in Poland.
These are:

— communication and transportation facilities and their regional differentiation,

— historical development of the communication network,

— flows of goods and their significance for geographic and economic regionalization,

— passenger traffic and its requirements,

— commuter traffic.

Transportation and communication facilities on Polish territory are very unequally distributed. These disparities are due to political division of the area during the period of partitions in the 19th century, and to the different levels of economic development of the respective areas. There are fundamental differences between western and eastern Poland, and differences of lesser importance between the North and South. Some of these differences are shown in table 1.

TABLE 1. DENSITY OF TRANSPORTATION NETWORK IN SELECTED AREAS

Voivodeships	Railroad Network	Bus Lines Network	Improved Roads
	in km. per 100 sq. km.		
Szczecin (NW)	11.2	17	36.2
Wrocław (SW)	14.0	29	56.8
Białystok (NE)	4.7	14	21.4
Rzeszów (SE)	4.7	14	25.5
Average	8.6	19	34.2

The most populated and industrialized south-western voivodeships are the best equipped. They are followed by the western voivodes-

hips — Poznań, Bydgoszcz and Gdańsk — which formed part of Poland before the World War II, then come the remaining western voivodeships, the central voivodeships and finally the eastern voivodeships. The greatest differences exist in the railroad networks which were established mainly before World War I, i.e. at a time when Polish territory was divided and under foreign rule. After the war and even more so after World War II, the development of the railroad network was limited, due to the increasing role of road transportation and its taking over part of the traffic from the railroads. Thus the differences in the railroad network density which arose during the 19th century have never been equalized.

The differences in the density of the hard surface roads in various regions are of less degree, since their development has run parallel with the considerable development of motor transportation during the inter-war and especially the postwar periods. Over the period 1938 — 1961 the number of motor vehicles in Poland increased 24 times, of which the increase in cars amounted to 5 times, in trucks to 15 times and in motorcycles and scooters to 77 times. This increase required an adequate development of a roads network and the modernization of surfacing, which caused certain adjustments to be made in the inequalities of distribution inherited from the 19th century.

Among the geographic monographs surveying the problems of the network of transportation and communication in Poland, attention should be drawn to the studies on the road network by W. Kaczmarek [15] and R. Domański [8], on the waterways by T. Tillinger [11] and by J. Mikołajski [24], to the article on the transportation network in Poland (as compared with other European countries) by M. Madeyski [20] and to the study on transport accessibility of Poland by W. Barczuk [1].

As mentioned above the main cause of the disparities in the development of transportation and communication facilities in Poland lies in the historical past. Throughout the whole of the 19th century as well as in the early years of the 20th century, when a modern network of railroads and roads with hard surfacing was established, the territory of Poland was divided between three separate states: Russia, Germany and Austria. Each of them — within its boundaries—developed a network of transportation and communication according to its own needs and political tendencies. This became fully apparent after the re-union of the three formerly annexed areas within the boundaries of the Polish State in 1918. Considerable investments were needed in the communication network of the earlier border-line areas, whereas previous arterial roads — leading to the capitals of the three partitioning po-

wers — lost their importance. To a smaller degree this occured again in 1945 after the second readjustment in political frontiers.

TABLE 2. PRE-II WORLD WAR DIFFERENCES BETWEEN THE DENSITY OF TRANSPORT AND COMMUNICATION NETWORKS IN 3 PROVINCES OF POLAND

Territory annexed by:	Railroads in 1912	Improved Roads in 1911
	in km. per 100 sq. km.	
Russia (Congress Kingdom)	2.6	6.9
Austria (Galitzia)	5.3	19.4
Germany (Poznań)	9.5	24.3

These differences were by no means related to the density of population or to the level of industrialization in the respective provinces. The territory annexed by Russia was highly industrialized and the city of Łódź — which even now is handicapped as far as transportation is concerned — formed one of the biggest industrial centres. Fig. 1 gives a cartographical illustration of the state of the railroad network in 1914 on present Polish territory.

It shows that there were but a few links between the railroad network of the territories annexed by Russia and those annexed by Germany and Austria. The borderline area on the Russian side was practically devoid of railroads and of improved roads as well. This was due to a policy of the tsarist governement which, fearing aggression by the neighbouring states considered a zone of trackless territory. A defense measure of German policy was directly opposite and resulted in a maximum number of railroads and improved roads being advanced toward the Russian border. This was consistent with Germany's intention should war break out, of crossing the Russian border at the earliest moment and carrying the war onto enemy territory.

These historical facts point to the necessity and importance of historical and geographical research on the development of the transport and communication network in Poland. Research involving earlier historical periods, is being carried out by historians, while more recent periods (the 19th and 20th centuries) have been investigated by geographers. Among the postwar studies on this subject the following should be mentioned: the history of the railroad network by J. Jankowski [14] and T. Lijewski [18], the monographs on the development of transportation networks of particular regions by T. Lijewski [17, 19] or of particular means of transport by R. Domański [10].

Surveys of the flows of goods have so far dealt mainly with railroad traffic in the first place because the railways, as well as shipping, are keeping accurate statistics of the transported goods, of their kind and geographical distribution. In Poland transport by rail occupies a posi-

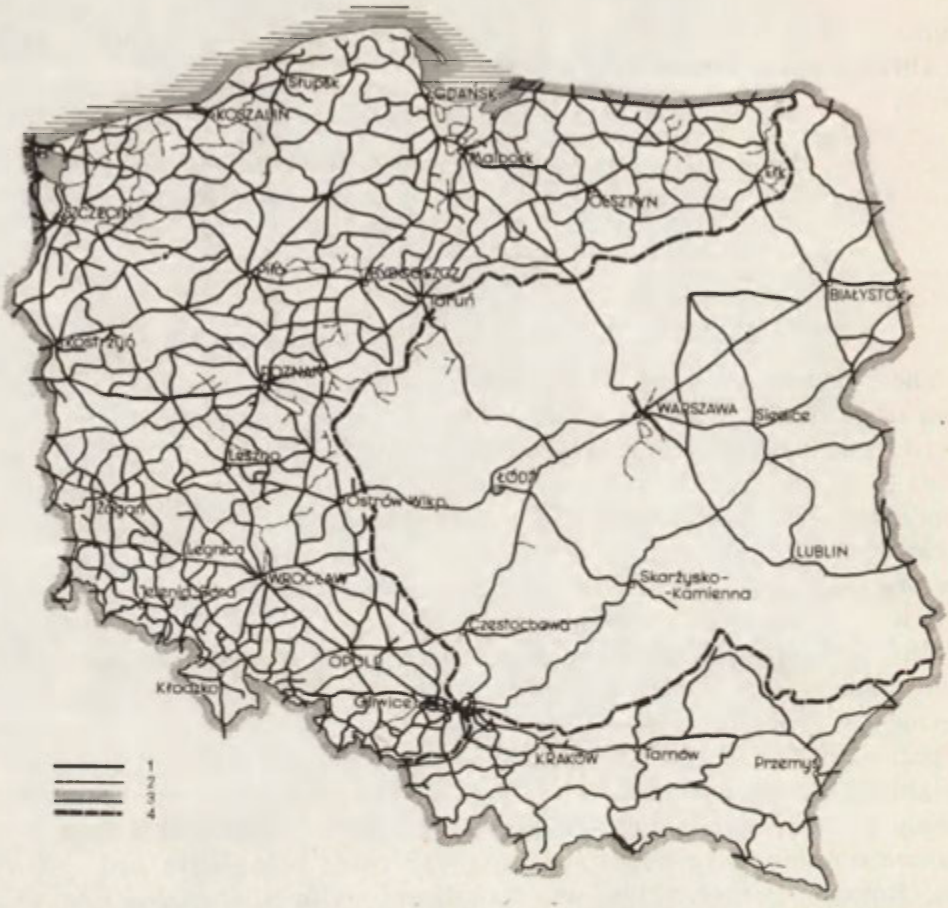

Fig. 1. Railroad network in 1914 on the present territory of Poland
1 — standard and broad-gauge lines; 2 — narrow-gauge lines; 3 — present boundary of Poland; 4 — boundaries of partition-powers in 1914

tion of the greatest importance: in 1961 the railroads carried 85.6 per cent of the total goods transported by public means of conveyance. The participation of railroad in the interregional exchange of goods is still higher, for motor transportation is in principle restricted to short distance hauls. As regards the transport of goods on the rail — taken in tonkilometres — the volume in 1961 amounted to 96.9 per cent of the total goods conveyed by public transport. It should, however, be noted that these data do not include goods transported by trucks not run as a public service. The latter is in fact even more developed than public truck sevice, but restricted mainly to local exchange and not fully registered by statistics.

It should also be pointed out that in terms of total freight goods Polish railroads hold a leading position in the world. In Europe, excluding

the Soviet Union, Polish railroads occupied in 1961 the first place both in total freight hauled goods (297.7 millions tons) as well as in freight hauled per tonkilometres (69.7 billions).

In Poland the transportation of goods by railroads plays an important role in the formation of geographic and economic regions, the more so because this transport takes place mostly between the particular regions. In 1961 70 per cent of the freight transported by standard-gauge railroads was carried beyond the boundaries of voivodeships while only 30 per cent were carried within the voivodeships, nearly half of which were carried within the Katowice voivodeship. In 1961 the average distance on which goods were transported amounted in Poland to 244 km. This is due not only to the great distances on which coal has to be transported from the excentrically placed Upper Silesian Coal Basin, but also to the considerable distances for which such goods as constructing materials (i.e. stones — 214 km., bricks — 203 km., cement — 293 km.), agricultural commodities (i.e. grain — 211 km., potatoes — 262 km.) and timber (239 km.) are transported.

Some scholars used transportation statistics in order to determine economic regions in Poland. Z. Chojnicki [5] did it for the whole of Poland, T. Hoff's study [13] is limited to the south-eastern part of Poland. Special mention should be made of monographs dealing with some particular aspects of transportation such as i.e. its role in the location of industry [9] or in supplying the towns [23].

Much less has been written on passenger traffic and the meeting of the transport needs of the population. Statistical data, supplied by transport companies, reveal only the number of transported persons and the distances only without taking into account the geographical distribution. Certain indices may be found in the number of passenger trains and buses running on particular lines.

As regards passenger traffic Polish railroads also play the most important role although the predominance of the railroad over buses and automobiles is not so considerable as in the case of the transport of goods; moreover it is rapidly decreasing. In 1961 the railroads transported 67.4 per cent of the total of passengers who used public means of transport. The share of the railroads in the transport of passengers expressed in passenger/kilometres, amounted to 77 per cent. The transport of passengers by buses amounted to 32.4 per cent of all passengers carried, but only to 22.7% as regards passenger/kilometres. The average distance of transportation of a passenger amounted to 37.7 km. for the railroads and to 22.6 km. for buses. As regards the number of transported passengers Polish National Railroads may be considered one of the largest transport companies in the world. In Europe only

such countries as the Soviet Union, the German Federal Republic, Great Britain and France show a larger volume of railroad passenger/kilometres. During the period 1955–1958, in fact Poland even surpassed Great Britain and France in this respect. The large role played by rail transport is the result of the still small number of motor cars in Poland. The number of motor cars in Poland amounted to over 136 000 in 1961, i.e. 4.5 car per 1000 inhabitants.

The apparent mobility of the inhabitants of Poland results from the fact that places of work do not often coincide with places of residence especially in the new industrial areas; it is also due to the existence of a considerable percentage of peasants-workers, i. e. of the persons who maintain their farms while engaging in nonagricultural trade, as well as to the centralization of the management of state-controlled economy in administrative centres, low railroad and bus fares — especially as regards commuter tickets — and finally to the considerable devastation of the country in the last war and the subsequent changes of boundaries, which caused a considerable shift in the population.

The transport of passengers and the meeting the transport needs of the population are studied in monographs on transport and communication of particular regions. i.e. by J. Warszyńska [26], in Kraków voivodeship. An interesting attempt to delineate regions of operation, i.e. nodal regions of major town centres, based on the passenger traffic (excluding commuters) has been undertaken by A. Wróbel first for the Warsaw voivodeship [27] and later for the whole of Poland [28].

The largest group of passengers in public transport involves commuters travelling daily between their place of work and their residence. On the railroads alone commuters represented in 1961 about 650,000 of persons daily, i.e. 44.4 per cent of the total number of passengers. The exact number of people working away from their places of residence is unknown, as this problem has so far not been covered by Polish statistics. Nevertheles it is known, that at the end of 1960 about 900,000 persons (6.7 per cent of the working population) were working in counties (*powiats*) other than those in which they lived. Trips made within the *powiat* boundaries not included into statistics may be just as numerous.

The divergence between places of work and places of residence on such mass scale is a new phenomenon in postwar Poland. Before the war commuter traffic occured only locally (i.e. to Warszawa) and on a much smaller scale. The present increase is caused, in the first place, by the industrialization of the country after the war. The development and construction of new centres of industry was not always accompanied by housing development in adequate proportions and this imposed

the necessity, for people employed in the new industrial centres, to travel to their place of work from other localities. The fact that quite a number of people working in industry are also engaged in agriculture hinder their transfer for a permanent stay in town. Also difficulties encountered in the exchange of dwellings in the towns, caused by living space restrictions and state control, are yet another factor towards the increase in the number of commuters.

Travelling to work as a phenomenon — with implications not only in the domain of transport but also with a considerable influence on settlements, agriculture, social structure etc. — very quickly attracted the attention of Polish geographers. Careful consideration of this matter was given in the Kraków centre since Southern Poland is a region of most intense commutation between places of employment and homes. Under the direction of M. Dobrowolska a number of monographs have been written investigating this problem in particular industrial centres and settlements. The papers by J. Herma [12] and S. Mańkowska [21, 22] give a more synthetic view of the problem in Kraków voivodeship. Research done in the Kraków region permitted conclusions to be reached as to the socioeconomical structure of the villages [6] and the formation of geographic-economic regions [7].

In other regions of Poland investigations of commutation problems have been carried out only occasionally. These surveys refered either to restricted areas (f.e. the Łódź Industrial Area [25]) or particular industrial establishments (f.e. the Works in Ostrowiec [29]). Data, collected in 1959 by the Planning Commissions, have allowed fuller conclusions to be reached with respect to the problem of commutation in Poland.

One should also mention a textbook on the transportation geography written by S. Berezowski [2], which appeared recently in Poland. Apart from a study of transport problems in various countries, the textbook contains a methodological introduction and an extensive chapter on transport in Poland. The theoretic and economic problems of transportation geography have been discussed also by W. Krzyżanowski [16] and Z. Chojnicki [3]. Full review of the Polish literature on transportation geography up to 1956 was given by Z. Chojnicki [4].

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ECONOMIC REGIONALIZATION

Kazimierz Dziewoński

The term "region" belongs to a small group of geographical terms which are universally used in most of the basic languages of the world. In everyday use the term involves, however, two different connotations of its generally accepted meaning. This leads to many misunderstandings and difficulties in its use as a scientific term, especially as one connotation is in most cases forgotten while the other is stressed and developed. A region is a part of some area, of a space in general. At the same time it is not some part but a definite part which in contradistinction to the remaining area or space is characterized by certain common features, by some degree of unity or integration. In other words, it is a sub-area or a subspace. In result a region is limited by some kind of boundaries. The determination whether there are any distinct parts in an area or space, what are their specific characteristics, how large they are or what is their delimitation — these are problems for research. In consequence a derivative term was recently developed and this is "regionalization". It denotes either a division of some area or space into parts (regions), or the action leading to the establishment of such a division. In the latter case the action may mean a study of the spatial structure of reality. Then it is scientific research. But it may also mean the working out of a scheme for a division of some area, which will in the future involve further action. Then it is planning.

Obviously "economic region" and "economic regionalization" deal with economic problems and divisions of a space or, to put it more precisely with problems and divisions of an economic space. But what is an economic space? Generally speaking all economic activities may be considered as a specific manifold, n-dimensional space. But considering that human economy is so far uniquely connected with the earth, specially with its surface, i.e. with geographical space, it is possible to limit the concept of economic space to the economic activities considered

as a space corresponding one way or another, at least partly, to geographical space[1]. To stress the social character of man's economic activities, the term "socio-economic space" will be used in this paper.

In consequence it may be stated that economic regionalization deals with the regionalization of economic activity as expressed in the structure and divisions of the socio-economic space. An economic region may be defined therefore as an economic or socio-economic subspace.

After these introductory remarks, dealing in a rather abstract way with the basic terms, as they are used in this article, let us turn to the problems of economic regionalization in Polish geography. Meeting the needs and demands of regional planning these problems were reintroduced in geographical research about thirty years ago. The difficulties involved in planning and in the advancement of planning methods stimulated the development of theoretical studies. They will be discussed here under five main headings: [1] regional and administrative divisions; [2] differing opinions on existing regional divisions; [3] natural and economic regions; [4] delimitation of economic regions and [5] application in economic regionalization of statistical methods of analysis, of econometric methods in particular.

1. Regional and administrative divisions

The first problem which confronts regional planners, among them geographers, is the delimitation of the area to be covered by the proposed scheme for regional development. It is fairly obvious that in reality two different areas, sometimes strongly varying in both size and shape, are then involved: (a) the area in which the basic problems of a planning scheme may find a satisfactory solution and (b) the area for which the given authority does or may possess planning powers. The boundaries of the first area depend on the specific problems to be solved, while those of the second are related in one way or another to the administrative divisions of the country. The real problem, therefore is contained in the question to what degree it is possible and convenient to adjust administrative boundaries to the demands of future development and future needs — often quite distant in time. It is comparatively easy to revise and enlarge the boundaries in case when the land is used

[1] A French economist F. Perroux in his recent book *L'économie du XX-me siècle* (Paris 1961, p. 27 a.o.) writes about the geonomic in his opinion, a banal space (*l'espace geonomique*) in contrast to the economic or abstract spaces (*les espaces économiques*). But surely this banal space plays an important, specific role in the human economy and only an economic space including by transformation features of the geographical (I prefer this term to geonomic) environment is the proper domain of the economic geography.

rather extensively and much more difficult when the proposed changes include subtle adjustments and sometimes serious limitations of the land actually intensively used. Even in the first case new social and economic problems may be confronting the administrative authorities enlarging their area and extending their boundaries. In result the task of bringing complete coincidence of planned and planning areas (or regions) becomes quite a problem to be in time solved as an element of planning and of economic policies.

But even with the acceptance of present administrative boundaries as a basis for planning activity, some adjustments have to be undertaken in practice. There are cases when the present spatial economic structure and activities do not exactly conform to the administrative divisions. This creates special difficulties in all the countries where administrative organization plays an outstanding role in economic life. Such is the case with the socialist countries. A change in administrative boundaries becomes then necessary, even inevitable. Obviously regional planning offices must participate in such a reform. Usually they are asked for studies and proposals, ar at least for an opinion on the intended modifications. Then a definite amount of konwledge of the spatial structure [2], of the regional structure of the national economy in particular is needed, and geographers are expected to provide it. This has happened in Poland as well as in other socialist countries [10]. The concept of an economic region as an entity by definition different from the administrative one has proved a useful differentiation. The studies organized for the purpose of reforming the administrative boundaries covered an analysis of the problems of the spheres of economic and cultural influences of major urban centres as well as the problem of their accessibility. Later, other problems, such as those involved in industrial complexes and agricultural zones of production were undertaken in addition to the former ones. A new administrative division of the country was finally suggested and with some modifications, approved. But in the following years the division was several times re-adjusted [3].

[2] The difference between spatial and regional structure may be defined as follows: the regional structure is limited to those elements of spatial structure which are significant for regional divisions of the socio-economic space; it is, therefore, a term more restricted in meaning.

[3] The first major changes of the administrative boundaries took place in 1947 (enlargement of the area of the Capital City of Warsaw) and in 1949 (creation of 3 new voivodeships, changes in the boundaries of almost all voivodeships as well as a radical redrawing of the administrative divisions of the Upper Silesian conurbation). The next major changes took place in 1954 when the *gmina* (parish) was superseded by the smaller *gromada* (commune) (in place of 3001 *gminas* 8789 *gromadas* were created), and in 1955 when many new *powiats* (counties) were created. Further changes were introduced in 1956, 1957, 1959, 1960 and 1961 when, among others, the number of *gromadas* was successively diminished (from 8789 in 1955 to 5245 in 1962).

At that time geographers engaged in the preparation of these studies clearly realized that a complete coincidence of administrative and economic regional division can never be obtained because in each case different elements, problems and criteria have to be taken into account. The tendency for administrative purposes is to split the whole area into parts of the same of at least similar size. This is of primary importance for the organization of any administration. The criteria of size may vary (e.g. area, population, taxes and economic strength, etc). Sometimes different criteria may be combined but the division on the same hierarchic level always tends towards units of similar size. On the other hand, in economic regionalization, divisions are based on the structure of economic life. Criteria here cannot be preconceived, they are inherent in reality and inductively defined, subsequently they vary from case to case. In fact there is no rule or tendency towards the establishment of units of the same size. The size of an economic region may grow with time, it may be easily connected with various periods and stages of socio-economic development. At higher stages of the development of human societies the size of a characteristic region and its complexity are liable to grow following the general intensification and diversification of the entire economic and social life. A full realization of the phenomenon led to a further theoretical analysis and a new formula. A distinction was established between the abstract, legal character of the administrative divisions (even when they serve directly economic purposes) and the material, physical character of divisions of economic activity, in the first place of production, or, as already stated, of the economic space. In terms of the Marxist theory of economic and social development, this means that administrative divisions form part of the economic and social superstructure, while economic regionalization belongs to the characteristics of the whole complex of the material basis of human society. This formula leaves room for a more sophisticated, a more precise definition of the mutual relations between economic regions and administrative units, including the advantages of their correlation and the disadvantages of their variance.

There exist some additional reasons for the persisting mix-up of concepts of economic regions and administrative units. All statistical data are grouped together and published by administrative units. In this way the use of economic or social statistics for studies of regionalization involves at least in this respect some administrative units. To make matters worse, it is very often necessary, if only for convenience purposes, to integrate data related to very numerous and small administrative units into some larger units. Some units established for *ad hoc* use, are later treated as permanent ones and of specific meaning and importance. In

fact some leading economists and also geographers tried to limit problems of economic regionalization to a straight grouping of administrative units for statistical purposes. However, in view of the remarks, such a position has no serious foundation, except for herein mentioned temporary utilitarian advantages.

To sum up: the different concepts implied in general administrative division, economic administrative division and economic regional division have to be accurately defined, used and observed in geographical research, lest regional analysis should lead to muddled findings.

2. Differing opinions on existing regional divisions

One of the very disturbing features of all the studies in economic regionalization is the extreme diversity of opinions on what is the actual, regional division of any area of the world. This had led some geographers to a complete negation of the very concept of economic region [4], and others to questioning the existence, i.e. the "objectivity" of economic regions [7, 11]. To overcome these difficulties American geographers have developed a whole theory of the concept of a region as a tool of geographical research and analysis. According to this theory the terms and criteria defining "region" depend on the accepted aims and chosen tools of a specific study. In result certain elements of subjective judgement have by definition been introduced into the concept itself. In Poland the reaction has not been as sharp as that, nevertheless a very deep dissatisfaction with the existing state of affairs has been widely felt. Generally speaking, a majority of Polish geographers — the Marxist ones for the ideological reasons — do not want to abandon the concept of an economic region as part of an objective reality, nor as an object of geographical research. Without going into even more involved epistemological questions it will be enough to say that the objective existence of an economic region is in this paper understood as a relatively stabilized division of the socio-economic space into smaller areas, each being internally more or less uniform or integrated and externally distinct from the remaining area and other regions, all forming an organic whole, a set, or in other words — the space. Hence the formalized definition of the economic region as a subspace of the socio-economic time-space. This division may be a subject of research by scientific methods and the outcome of the entire analysis should be the same whatever the undertakings of the research worker.

[4] See for example the well known sarcastic article of G. H. T. Kimble "The Inadequacy of the Regional Concept" in *London Essays in Geography*, London 1951, pp. 151–174.

The differences existing between various geographers are, therefore, differences of opinion, the sequel to the varying and limited extent of their studies and the difficulties to make a full analysis because of the application of different criteria in studies of regionalization. But the variance of criteria is not only due to the differences of approach and the unsufficiently developed complexity of analysis. In fact, the reasons are deeper. This was obviously realized by American geographers when they had differentiated between uniform and nodal regions [11] and described them by different ways of approach and selection of criteria [11]. However, a region is by definition at the same time a part of a larger area (or space) and in itself some kind of a complete whole. Taken together these two facets of a region are somewhat baffling the analyst and often lead him to some contradictions. In result he usually abandons or treats as secondary one or the other of the two aspects. To overcome the difficulty this author tried once to evolve the idea of a dialectic development of a region [3]. To-day it seems that this idea was too schematic. A more sophisticated approach is necessary. It seems better to define each region as a specific, historically formed union of the two elements here mentioned — their integration and balance when well established, even if temporary, define the existence of a region. All changes achieving a new balance mark the evolution of regional structure, a new integration, perhaps on different level or in a different area, and in this way the emergence of a new regional division. Thus an economic region is considered as a fluctuating, historical spatial entity. For this reason, too, the term "time-space" was used in the afore-mentioned definition.

All these reflections may serve as a foundation for the formulation of the theory of regional development. Certain simple primary forms and types of economic regions may be distinguished partly by deduction, partly by induction [4]; more mature forms are more difficult to define. A detailed and serious study of concrete cases and regions prepared on a comparative basis is here necessary before a clear theory of regional development in history may be fully evolved. A systematic formalization of terms may be then necessary for making comparisons and for establishing basic typology. At present the following terms seem to be useful: all regions as are met in the study of socio-economic spaces, may on the basis of their similarities [5] be classified into groups which we may call regions of the same m o d e l. When such a model, perhaps with

[5] These similarities being connected with the criteria used for their characterization and delimitation.

some additional traits, may be identified with a form or forms typical for certain social and economic formations then we may speak of the t y p e of a region. Within the same model and type there may be regions of varying size hierarchically related with one another. Then we may speak of regions of various r a n k. In some cases the ranking of regions may also involve hierarchical ordering of the regions of varying models. Then the type will be defined not only for a certain model, but also for a group hierarchically interconnected models.

Altogether we have provisionally defined three basic terms: model, type and rank. We will return later to the problems of the concept of a model.

3. Natural and economic regions

However, it was not recently that the terms "region" and "regional", irrespective of what we said earlier were introduced into geography, nor was it made by the planners. Indeed these terms are as old as geographical sciences themselves. In reality many difficulties and misunderstandings in their use arise from the dual character of geographical sciences. Should systematic or regional geography be developed? Topical or regional methods should be used? — these are the questions discussed already by classical geographers (as for example by Strabo), and since his time by nearly all (and every) eminent geographers of the subsequent pe riods. An interesting presentation of the problem is given in the basic work on the development of geographical concepts by R. Hartshorne [5] who, having returned after twenty years to the discussion of main methodological problems of geography [6] paid great attention to the problem of overcoming these immanent dichotomies. Hartshorne assumes correctly that none of the two should be abandoned and always the proper fusion of both should be searched for and obtained from the analysis of area and phenomena under scrutiny. However, this pragmatic approach, comparatively easy in the monographical analysis, becomes really difficult when the study is more general and in particular when we are trying to obtain a unified classification of geographical sciences.

Another intrinsic and characteristic dichotomy in geographical sciences is connected with its division into physical and human (or in the Marxist terminology — economic) geographies. All efforts to overcome this division (among them by Hartshorne himself, and in the U.S.S.R. by W. A. Anuchin [1]) have not been so far very successful. As evidently there exist some very obvious and fundamental differences between natural and social laws of development, these differences have to find their reflection in geographical sciences dealing both with changes in

geographical environment and with those in human society. In relation to regional problems and a regional analysis this inevitably leads to the recognition of separate sets of physical and human, or economic regions. However the temptation to identify these two sets has for many geographers been irresistible [8]. Hence the popularity of the concept of so-called "geographical region" which in some rather miraculous although undefined way is to express at the same time the basic spatial divisions of the earth's surface and of human society and its economy. But as the Polish experience shows clearly, all such efforts are vain. The coincidence of natural and human or economic regions, even when found in reality — and this happens very rarely — is in fact more or less accidental or at least very specific. Again a correct description of relations between these two kinds of phenomena calls for a much more sophisticated approach. One of them may be found in the concept of the transformation of geographical into economic space. Such theory should point out which elements, features and relations characteristic for one space remain invariant under and after transforming into another one. Tentatively it may be said that all elements of metric character, without any serious changes, may not necessarily be subject to a continuous transformation, and this is the case with such areal units as regions are. However boundaries and barriers impeding the movement and transfer of physical bodies preserve their role in the transformation. Hence in research the finding of the correlation between natural frontiers and boundaries of an economic region is of great importance. Through such a study — in my opinion — a majority of coincidences between natural and human or economic regions may be easily established and explained.

4. Delimitation of economic regions

To use properly the concept of the economic region both in geographical research and in economic and physical planning we should be able either to check on and subsequently correct certain already established regional division or to find out by study the number and boundaries of regions, existing in the socio-economic reality. Some methods for the delimitation of regional units should be clearly evolved, defined and agreed upon. But this involves the development of some unified theory of an economic region. On the basis of the experience obtained, efforts at formulating such a theory are made by a group of Polish geographers working in the Institute of Geography of the Polish Academy of Sciences in Warszawa. In fact elements of such a theory are presented in the earlier parts and statements of this paper.

Let us look now closer at this theory. To explain its basic assumptions let us once more turn to the mathematical and logical concept of transformation. If an economic region is a sub-space of the socio-economic time-space, i. e. it is at the same time a part of this larger set and a separate set itself, then we should describe such a region first in terms of the whole space, and then as a regional entity or, in other words, we should define first the transformation of the socio-economic space into or on the region and the transformation in other direction of the region into the space, as well as the self-induced transformation of the region into itself. While the first transformations will serve for defining both the existence and the basic and significant characteristics of a region, the last one may form the basis for its delimitation.

What meaning may be connected exactly with the expression: "self-induced transformation of the economic region into or on itself"? If we consider an economic region as a set of socio-economic activities (operations) within a certain area, it may be easily observed that some activities are closed within the area, others are open, i.e. their closure takes place in a much wider space, involving the use of exterior areas. We define therefore self-induced transformation of the economic activities into or on itself as a closure of economic activities within the regional area. Incidentally a model of an economic region, as formerly described, may also be defined by the kinds of economic activities closed within its area.

We are able to define now the boundaries of a region as lines or areas of the local maximalization for closure of socio-economic activities. The whole problem seems easy to apprehend in case when the regional area is considered as one growing in size. A greater area obviously contains a greater number of activities closed within. Is it however possible to diminish the regional area and to increase the closure? The answer is in the affirmative because by increasing area we may include new additional activities whose closure will involve still wider areas, and by diminishing the area we are able to eliminate those activities whose closure would involve too large an inflation of the regional area. The study of local maximalization of closure allows therefore for a correct delimitation of an economic region without resorting to outside criteria unconnected with regional socio-economic activities. In case where there is no maximalization of closure the correct conclusion is that serious doubts about the existence of the region itself are liable to emerge. In such cases at least the concept of its model or of its whole area must be completely revised.

The importance of distinct physical or administrative boundaries, forming serious obstacles to traffic is within this conceptual framework

very easily explained. In transformation of these boundaries they remain invariant and become, therefore, significant lines for local maximalization of closure for various economic activities and, in consequence, they seriously influence the delimitation of economic regions.

Many methods used so far in practice for the delimitation of economic regions may be treated as simpler cases of the maximalization of closure, which generalizes their basic rules. Among such methods those connected with the study of urban spheres of influence (hinterlands) or of commuting areas or of market areas should be mentioned. Indeed the whole theory of central places, especially in its latest development [2] or even of economic landscape (*Wirtschaftliche Landschaft*) as developed by A. Lösch [9] may be treated as special cases of this theoretical construction.

5. Application of statistical and econometric methods of analysis in economic regionalization

Lately, in the same way and for the same reasons as in the whole world, the attention of Polish geographers turned towards the application of mathematical, statistical and in particular econometric methods in geographical research in general and in regional studies in particular. For the first time indeed geographers are faced with a definite and farreaching possibility of the quantification of their observations and analysis. The development of statistical theory, of mathematical logic and of all kinds of mathematical machines, permits us to deal with large quantities of miscellaneous data, connected or not by involved correlations, difficult to apprehend by intuition and impossible to work out without some mechanical aid. Moreover these data need not to be limited to simple elements but may be integrated into general economic indices and quantities, such as gross national (or regional) product, income or others. A global picture of the areal economy may in this way be obtained. However, the application of these new methods meets with some very serious obstacles. Among them three should be discussed now. These are: lack of proper statistical data, difficulties in the use for research purposes of the most developed econometric methods aiming at the programming of economic activities and finally, the lack of properly defined concepts and theories of socio-economic spatial phenomena.

For purposeful use of mathematical and statistical methods detailed series of data are obviously necessary. Their compilation involves clearly established needs for specific information and, in most cases, the existence of comparable data for succeding periods of time which in turn implicates some continuity in the processes of evolution, if not a certain

stabilization of basic conditions of socio-economic development. Even in case when the second condition is somewhat weakened, or even completely disregarded, the fulfilment of the first postulate of a clear understanding of the nature and extent of indispensable data surely demands some theoretical conception of the means and ends of our research. But here the real difficulties begin. The techniques of programming so-far developed may be easily used for planning purposes, i.e. for the establishment of what, when, where and how certain things should be done so that the maximum effect for the socio-economic development may be obtained. The application of the same methods in the analysis of present conditions, however, is not so easy. True it may be stated that by a comparison of the optimal solution with the actual conditions we are able to judge what is wrong in them and how they are to be improved. But such a statement implies that (1) we know all causes, factors and elements involved in the present conditions, and that (2) the mechanism and models implicitly included in our analytical techniques are the correct ones. However, the results do not support such a claim.

There are other ways open. One of them is to work out some hypothetical model, to calculate on this basis characteristic indices and distributions and then to check whether they conform to reality. The results obtained again are not so far very helpful.

In a paper on research frontier in urban geography prepared in the spring of 1961 for the Committee on Urbanization of the Social Science Research Council B. J. L. Berry gave a review of progress achieved by the use of new techniques in the field of urban geography. Berry is an eminent specialist and an enthusiast of the new methods, but on the basis of his review it may be concluded that although urban geography with its theoretical concepts (including among them the theory of central places) belongs to the better developed branches of human (economic) geography and is comparatively well prepared for application of the various mathematical methods of analysis, yet the results so far obtained are in most cases — when critically appreciated — tautological, trivial or negative. The greatest successes were achieved in those studies where the use of probabilistic calculus had been possible, i.e. when the assumption of stochastic background had been in fact realistic. But this clearly indicates that the whole body of our theoretical concepts and conceptions is unsatisfactory indeed.

The efforts aiming at the formalization and development of the theory of economic region may be developed in several directions. Those which define the economic region as a specific part of the socio-economic time-space seem to be promising. The whole theory may be built up on the

basis of concepts used in the mathematical theories of sets (region being a subset of the set of economic activities or a subspace of the socio-economic time-space).

In such treatment a problem — or indeed the problem — arises what dimensions should be ascribed to the analysed spaces. There are two principal possibilities to be explored. One indicated by Perroux is to treat all independent factors influencing the location of economic activities as separate dimensions of the socio-economic space. This may lead us to a new formulation of the theory of location. The difficulty lies here in the analysis of multi-dimensional cases of concrete situations. To simplify our problem an elimination of secondary insignificant factors and the grouping together of the significant ones, may be necessary. However, the approach would create possibilities for calculating mutual deformations, caused by factors acting, generally speaking, from varying directions and varying conditions.

The second approach (as already stated at the beginning) is based on the correlation which obviously does exist between the geographical or natural (physical) environment or space and the socio-economic one. Here the concept of dimensions must be limited to the three traditional — length, latitude and height (depth) complemented by the fourth one — that of time. If some simplification would be necessary the third traditional dimension of height (depth) may be bypassed. In human social and economic life it still plays only a secondary role and in comparison to others it is diminutive. In a modified form it may be included in our reasonings under the first two traditional dimensions of length and latitude, in the analogy to the way which is used for instance in reducing temperature at various levels to the standard temperature at the sea level. In result we would have to deal only with three dimensions, those of length, latitude and time.

Both these directions may lead us to the use of the tensor calculus — rather an interesting possibility, as it would allow us to analyse not only influences of separate factors on the location of given socio-economic activity but also the interdependence of these influences resulting from their impact on the same activity, modifying not only the final result — the location of the activity — but also these factors, themselves. This interdependence which so far has not been taken into account may arise both in the case of factors acting simultaneously (in one cross-section of time) or even better and in a more realistic way when acting in varying periods of time. This would be an enormous improvement and at the same time an important generalization of the present already classical Weberian approach (using vectorial calculus).

There still is another road for sophistication in our locational and especially regional analysis. This is in the development of the field theory of the socio-economic space (as well as of the geographical space). Such a theory would form a good basis for a purposeful and rationalized use of the so-called gravity models in the regional analysis, a problem which has so-far been rather difficult to apprehend and to explain. The field theory would treat the socio-economic space as the one created by the existence and activities of man and human societies. Within the terms of such a theory the intensity of space (to use this expression rather loosely) would grow along with the number, density and activity of men (by definition social animals). This statement alone gives a good view and perspective of the possibilities of such a theory and its relatively good convergence with the socio-economic reality.

However, in the analysis of the relations (by transformation) between the socio-economic and geographical space the field theory of the socio-economic space would lead us into some serious difficulties. Evidently the diversification of geographical space finds its complementation and expression in the socio-economic space only by its usefulness to human society (the obstacles created by elements of geographical environment to man and his needs being included in the form of negative usefulness) — variances in usefulness (both in space and in time) adding to the complexity of fields. But the geographical space possesses its own fields, which, however, are not necessarily reflected in the socio-economic space. In result — within the field theories of both spaces their metrical values are not always preserved in transformation of one into another. They are equivalent topologically but not metrically.

A specific difficulty is created by the many possible uses of natural resources. An extension of the concept of transformation may give here a proper solution. We may develop our analysis of the transformation of the geographical into the socio-economic space in form of one-many transformation for future and one-one transformation for the present situation. On the other hand problems of the geographical environment as influenced and changed by activities of man would take form of another many–one transformation.

The next step in the development of the formal theory of socio-economic space and in particular of economic region should include a closer definition and analyisis of the concept "tranformation" — of one space on or into another or of a space on or into itself or its part. This involves efforts to express such transformations in mathematical terms and forms and in particular as functions.

Problems of transformations within the socio-economic space involves also a closer definition of the concept "economic relations and activities". Obviously the choice of algebras and geometries which are to be used both in theoretical constructions and practical research depends on detailed concepts included in this very general class. It is not possible to name and to ennumerate here all relations and activities which may and finally will be taken into account. But some indication of at least more important ones seems to be necessary. The first and the most basic ones are the complex relations connecting together the whole processes of production and consumption. Obviously their analysis has to follow already developed economic theories. The Marxist approach to the problems of global product and national income seems in this case to be specially useful. On the mathematical side the treatment of this problem involves in principle no more than the introduction of primary operations of addition and substraction. However, in dealing with the elements of production and consumption within socio-economic time-space the introduction of tensorial approach will probably be necessary. Tensorial approach, as already stated, contains tremendous possibilities, both from the theoretical and practical point of view, but it also involves some very serious study as to what meaning and position should be ascribed to various elements and factors of both production and consumption.

Beside basic processes of production and consumption there are other perhaps less important and less extensive or more limited social and economic relations and activities which nevertheless are significant for the nature and structure of socio-economic time-space and for economic regions. In some cases they probably also are easier for study and analysis. Among them I would like to mention specially such relations as between personal incomes and expenses structurally aggregated for the whole population and the problems of relations between places of work, dwelling and leisure, i.e. of travelling to work and for recreation. As an example of partial relations the analysis of which is of great importance in regional studies we may cite the problem of the so called "production cycles". A production cycle for some group of goods forms naturally part of the larger cycle of production and consumption. But with the lack of many data necessary for the full establishment of the larger cycle in quantitative terms and in regional cross-sections, the partial one may play the role of *pars pro toto* giving significant results for the definition of regional structure and economic region. Moreover the limited cycle may be closed within the region while the larger one will remain open. Finally the analysis of limited problems allows for a more detailed study, deeper probing into the reality.

A very long road has taken us from the practical problems of regional planning to the most formal and abstract theories of economic region. It indicates very clearly the importance of studies in applied geography for the development of geography as a pure science. It is hoped that the progress obtained in theory and general knowledge will be equally useful for planning purposes and for a better development of the national economy as well as for a more efficient and rational use of our natural resources.

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THE KARST RELIEF OF THE KUEILIN AREA (SOUTH CHINA)

Mieczysław Klimaszewski

Recent studies of the karst relief pay heed to the part played by climate in its formation. The karst landforms, karst processes and karst phenomena occuring in different climatic zones have been the subject of numerous works. They are also the subject of the Commission on Karst Phenomena of the I.G.U.

Special attention is given to karst features developed in the tropical and subtropical regions which have their focus in the characteristic hills, resembling haystacks, which are called "mogotes". These rise steeply above the flat floors of either the marginal or central poljes. This curious karst relief is known in Cuba, Jamaica, Guadaloupe, Puerto Rico, Mexico, Java and on the isle of Celebes. It is also of widespread occurence in the southern part of China, in the province of Kuangsi. During my stay (together with Professor S. Leszczycki) in the Chinese People's Republic in October and November, 1958 I wanted, therefore, to pay a visit to this karst region. Our Chinese colleagues, especially Professor Huan Bin Wej, the Director of the Chinese Academy of Sciences, enabled me to incorporate this visit in the programme of my two-month journey through East China. I spent in the Kueilin area just a few days. For that reason the present remarks are only a contribution to our knowledge of the mogotes in the Kueilin area.

The area

The town of Kueilin lies in the province of Kuangsi on the Liu Kiang River ab. 150 m. above sea-level, along the railway leading from Hengyang to Hanoi. The Kueilin area is situated on Devonian and Lower Carboniferous limestones interbedded with sandy shales af the Lower and Upper Devonian. These Palaeozoic rocks are preserved in a syncline which is bordered by mountains consisting of Algoncian metamor-

phic rocks (Fig. 1). On the outcrops of the impermeable rocks there developed either broad or narrow ridges rising to 2000 m. The lime-stones form the wide floors of the poljes as well as the narrow and steep-sided ridges and mogotes rising above these plains to heights of between 200 and 500 m.

The limestones are light grey in colour, well bedded, and often include quartz grains (*silica* secretions). The limestones are subject to attack

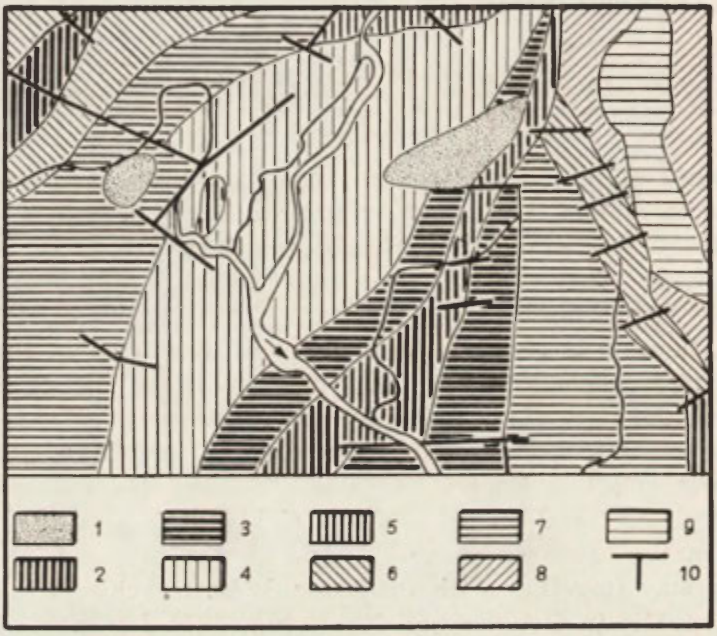

Fig. 1. Geological map of the Kuelin area after Chen-Shu-Phen

1 — Quaternary red clay; 2 — Lower Carboniferous series with coal strata; 3 — Lower Carboniferous limestones; 4—5 — Upper Devonian limestones; 6 — Upper Devonian sandy shales; 7 — Mid Devonian limestones; 8 — Lower Devonian sandy shales; 9 — Lower Devonian shales; 10 — Fault lines

of karst processes and of mechanical weathering which tend to be concentrated along fault lines and joint fissures occuring in N–S and E–W trending series. A brief examination of the karst features shows that they are polycyclic and polygenetic forms.

Previous views

The relief of Kueilin and its vicinity has long been famous as a scenic wonder in China and both scientists and artists have taken great interest in it. The caves of the Kueilin area were described in detail by Sü-sia-ke,

an explorer and traveller, in 1641, and the fantastic rock-forms depictured by many Chinese painters. People unaware of the existence of such a curious landscape believed that these landforms were a creation of the imagination. The fancy of many emperors and Chinese magnates for building rock gardens has also had its roots in the bewitching relief of the Kueilin area.

Recently interesting references on the karst features of this area have been published by H. Wissmann [17] and Czen-Szu-phen [2, 3].

H. Wissmann recognized that the curious relief of the Kueilin area developed by karst processes operative under humid-tropical climatic conditions. He termed it the *Kegelkarst* according to H. Lehmann. Vertical-walled hills, resembling towers (*turmkarst*), are dominant in this area. They rise to 200 m. above the karst planation surfaces. H. Wissmann has reported the presence of active plains still developing by lateral erosion of periodical waters and of inactive plains which do not develop because floods are absent. Vertical-walled hills occuring within these plains are being transformed. Gravity slopes develop at their foot. Their further development produces conical forms. H. Wissmann has also discussed both the extent of the *Kegelkarst* and its development conditions. He took the line running north of the Tai Hu lake and south of Nanking in the Lower Yangtze-Kiang basin as the northern limit of the *Kegelkarst* region. He believed that its development is dependent upon the high rainfall occuring all the year round, the high temperatures (especially in summer) and the rareness of frost.

On the basis of examination of the karst landforms and of the cave explorations Czen-Szu-Phen from Nanking has recognized the following stages in the development of the Kueilin karst region:

1) Formation of the Upper Cretaceous planation surface; its remnants are preserved in the summits of the mogotes rising to between 400 and 500 m. above sea-level.

2) Dissection of the older surface and formation of the younger planation surface at the close of the Cretaceous and at the beginning of the Tertiary; its remnants are preserved in the summits of the mogotes rising to between 250 and 300 m. above sea-level.

3) Dissection of the area to the upper cave level today occuring at an altitude of 180 m. above sea-level; formation of the upper caves.

4) Dissection to the middle cave level, today occuring at an altitude of 170 m. above sea-level; formation of the middle caves and of the corresponding terrace plain and karst planation surface.

5) Dissection to the present river level; formation of the lower caves at 150 m. above sea-level.

The same author suggests that the 250-300 m. surface was dissected in Tertiary times, whereas the 170 m. surface was formed during the Lower Pleistocene. The criteria of dating, however, are seen to be unsatisfactory and doubtful.

The problem

In all work on karst features which has been published up to now certain types of relief were attributed to defined climatic conditions but little attention was given to the climatic changes and their morphogenetic role. Kueilin lies on the border of the subtropical and tropical zones. It may be presumed that the climatic conditions were very often changing in this region, i.e. the tropical zone alternated with the temperate and even cold zone. We are faced with the very interesting problem of what share and what influence did the climatic changes have upon the course of fashioning this karst region?

The description of landforms and relief types

During my stay in this region I was able to examine both the karst landforms and karst phenomena which occur in Kueilin and in the area between Kueilin and Yangso, a town lying c. 67 km. south-east of the former.

I. The Kueilin karst region

In the east and west, the Kueilin karst region is surrounded by mountains composed of Devonian and Carboniferous sandstones and shales. The karst region itself is situated on Devonian and Carboniferous limestones. The *Kegelkarst* relief type is dominant in this area (Fig. 2). Numerous hills which vary in form and size surmount the wide plains cutting across different series of the Devonian and Carboniferous limestones. These plains occur at c. 20 m. above the present Liu Kiang River level. Hills are arranged in certain zones (Fig. 3). In the western part along the mountain front consisting of sandstones and shales, there occurs a wide 170 m. karst plain with numerous mogotes within it. This plain has the aspect of a marginal polje. The next zone is represented by two limestone ranges with a fairly notched crest line; their sharp summits rising to 450 m. above sea-level. The third zone contains asymmetrical limestone hills of between 250 and 300 m. above sea-level. Their asymmetrical profile is dependent upon the dip of strata toward the SE. The middle and east parts of the area are also occupied by the

Fig. 2. Geomorphological sketch of the Kueilin area after Chen-Shu-Phen

1 — Mountains rising to 800 m. composed of Lower Devonian shales and sandstones; 2 — Hills rising to 200 m. composed of Devonian and Carboniferous sandstones and shales; 3 — Karst ridges rising to 450 m. composed of Middle and Upper Devonian limestones; 4 — Asymmetrical mountains and hills rising to between 250 and 300 m. consisting of Upper Devonian limestones; 5 — Mountains and hills rising to between 250 and 300 m. composed of Devonian and Carboniferous limestones; 6 — Mogotes rising to between 180 and 190 m. composed of limestones; 7 — Limestone plateau rising to between 250 and 300 m.; 8 — Promontory consisting of sandstones and shales; 9 — 190 m. karst plain blanketed with red clay, 10 — 155 m. flood plain

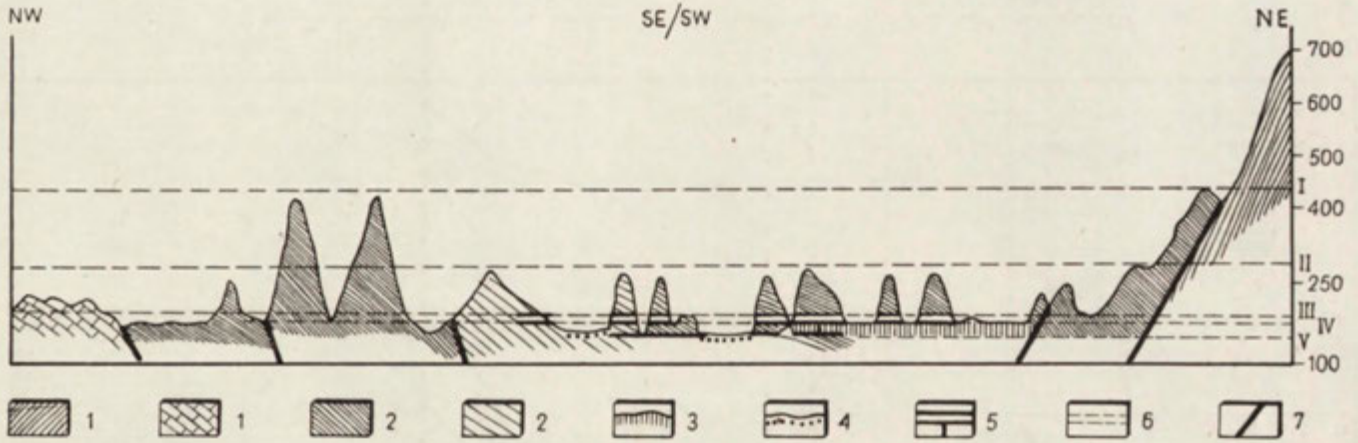

Fig. 3. Geological-geomorphological section across the Kueilin area after Shu-Phen

1 — Devonian sandstones and shales; 2 — Devonian limestones; 3 — Red clay; 4 — Old gravel; 5 — Cave levels; 6 — I—V surfaces due to karst planation; 7 — Fault lines

wide 170 m. karst plain and the flood plain lying at c. 155 m. Numerous hills of more symmetrical and regular shapes (Fig. 4) rise above these plains. The areal distribution of the hills is shown on the map and on the photographs taken from the hills A and C. During the stay in Kueilin I was able to examine in detail four karst hills, marked with A, B, C, D on the map. The hill A lies in the center of the town (Photo 1).

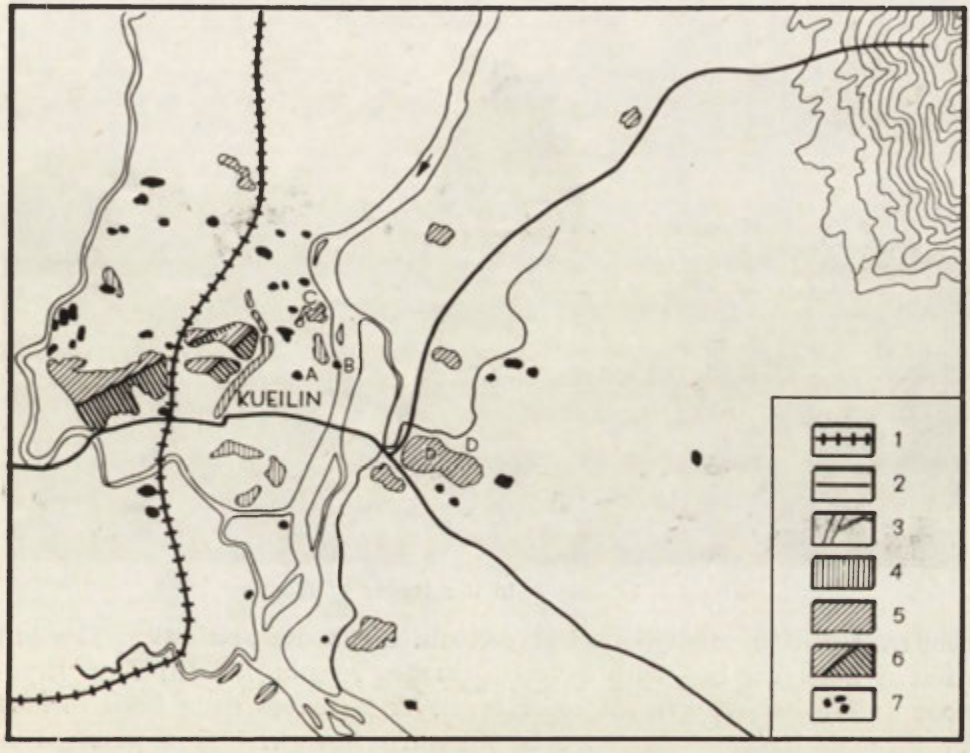

Fig. 4. Distribution of karst mountains and mogotes in the Kueilin area

1 — Railway; 2 — Main roads; 3 — Streams; 4 — Ponds; 5 — Karst mountains and hills; 6 — Asymmetrical mountains; 7 — Mogotes

The hill is 40 m. high, its sides are steep and have both shallow rillenkarren aligned with the fissure system and small hollows, resembling pocks, being to 0,5 cm. deep. Its summit plain is pitted with jamas and shafts which attain a depth of 5 m. At the foot of the hill in the lower part of the rock walls there are corrosion notches. They occur at three different levels seperated from one another by horizontal ledges. The corrosion notches are c. 1 m. deep, from 30 do 80 cm. wide and rise to 2,5 m. above the Kueilin alluvial plain. Small galleries and open fissu-

res lead from these notches into the hill's interior. This fact indicates that the dome-like hill is honeycombed at its base.

The Fu-Pu-san hill (B) rises above the Liu Kiang River to an altitude of 40 m. Many jamas and open fissures which are sometimes filled with rock fragments may be found on its rock sides. Where barren limestone is exposed, its surface tends to develop either circular or elongated pocks being to 2 cm. in diameter and to 0,5 cm, deep. Their occurence is de-

Photo 1. Mogote A in the center of Kueilin

pendent upon the distribution of calcium carbonate and silica. The hill itself is honeycombed with cavern passages running in different directions at 2 m. above present river level. These caves have been formed by through streams. Evidence of pressure flow in closed passages is found in the fact that their side-walls have well developed scallops and cut-banks, and evorsion hollows occur on their roof. The caves are periodically inundated during the floods. Galleries may be from 2 to 5 m. high.

Vertical fissures and horizontal joint planes are seen on the side-walls of the cavern passages. Vertical fissures are filled with a porous travertine, whereas the joints are open. Bedding planes show many roof hollows being indicative of pressure flow of the cave waters. Travertine deposits also occur at the opposite outlet of the main cavern passage. A staircase leading to the Kueilin terrace plain was carved out of this travertine. The terrace plain quoted is at higher level (4 m.) than the cave floor and occurs at 6 m. above present river level.

The third isolated hill C occurs north of the two hills described above. It is 100 m. high and has three summits, resembling haystacks, separated by depressions with sink hollows within them. These are up to 5 m. in diameter. Rock surfaces barren of vegetation have well developed karst features. All of the fissures are widely open, and deep jamas developed where joint planes intersect. The most common directions are 40°, 110° and 175°. Little inclined surfaces have many karren which vary in form and size. The gently winding *rillenkarren* may be up to

Photo 2. *Rillenkarren* with grooves separated by knife-edge ridges

20 m. deep. Their slope along their lengths is slight, their sides incline between 50° and 60°. On the steep sides of the *rillenkarren* there occur many small grooves being from 3 to 5 cm. wide and to 0.5 cm. deep (Photo 2). These grooves are separated from one another by knife-edge ridges. Thus the barren limestone surfaces are fairly dissected by karren, jamas and widened joints.

The hill itself is also honeycombed with horizontal cavern passages and vertical shafts. The lower cave system occurs at 10 m. above present river level, the higher one at c. 40 m. The upper caves are partly or completely filled with travertine, whereas the walls of the shafts were smoothed by great masses of water.

On the opposite left bank of the Liu Kiang River there occurs the mountain Ye-Ya san ("mountain of the crooked moon"). It rises to 100 m. above present river level and has several summits separated from one

another by sink holes. In the north and west, the mountain is steep-sided, often vertical-walled because it was undercut by the Liu Kiang River with its eastern tributary.

The mountain's surface has well developed karst features. It containes the Ci sing jan cave system which has been described by Czen Szu Phen [2]. Both the cavern passages and the chambers occur at three different levels connected by vertical shafts and chasms. In general these caves are to 1700 m. long.

The lower cave floor level corresponds in height with the river level and its abandoned loops. The passage being c. 160 m. long falls from c. 8 m. at its outlet to 4 m. in the interior of the mountain. The cave floor is covered with gravel and often wet. In summer it is drained by a subterranean stream. The cave has been changed into a temple at its outlet as deduced from the sculptures carved out of limestone. A few metres away travertine deposits up to 2 m. thick cover the limestone walls. The cavern roof is decorated with stalactite curtains. Both the side-walls and the roof have been fairly smoothed by powerful through streams before sculptures were carved. The small stalactites are recent phenomena.

The middle cave system occurs at 25 m. and the upper one at 40 m. above present river level. The smaller passages at both levels are either completely or partly filled with yellow travertine. Bones of animals which are considered to be Pleistocene in age have been found in it. Both the main passages being to 10 m. high and the great chambers being to 70 m. wide and 20 m. high contain a great variety of stalactites, stalagmites and stalagnates. Stalactites are usually shorter (1–2 m.) than stalagmites (2–3 m.). These formations show some variation in colour. Single stalactites are associated with stalactite curtains. Many different types of stalactites also occur on the side-walls. Horizontal passages at different levels (sometimes waterfilled) may be connected by vertical shafts which open out from the upper cave floor.

II. The karst region between Kueilin and Yangso

During an excursion from Kueilin to Yangso on the Liu Kiang River about 67 km. S.E. of Kueilin, I was also able to examine the karst landforms of this area.

Both small and great assemblages of mogotes can be traced along the road leading to Yangso. A small group of mogotes rises from a karst plain immediately adjoining the township of Kueilin 3 km. south of Kueilin, numerous mogotes stand out in marked relief and the road follows a wide depression separating the asymmetrical mogotes in the

Photo 3. Asymmetrical hills dependent upon structure

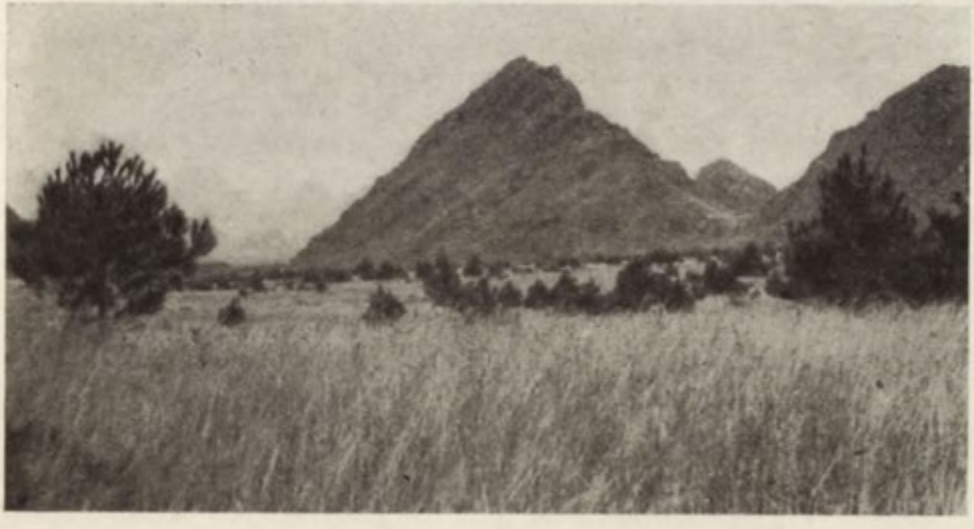

Photo 4. Conical hill dependent upon structure

west from the symmetrical mogotes in the east (Photo 3). A sedimentary infill of red clay blankets the limestones and levels the floor of the depression. Asymmetrical mogotes, resembling haystacks, surmount the karst plain. These steep-sided hills have rounded summits and attain heights of 20–30 m. and 100–200 m. above the plain (Photo 4,5). Rock fragments are noted at the base of the mogotes.

The profile of the asymmetrical mogotes is dependent upon the structure. They consist of limestone beds dipping eastwards at about 30° (25°–35°). The dip slopes are less inclined, whereas the opposite slopes which cut across the dip are steep (about 80°) and usually rocky (Photo 3). Those hills have the profile of structural hills. Huge talus heaps occur at the foot of the frontal slopes. Sometimes the inclination of the frontal slope is similar to that of the dip slope. In that case the hills seen from one side resemble a rightangled triangle and have the aspect of monoclinal structural ridges (Photo 4). This variation in form of the mogotes is indicative of the important part played by structure in the karst relief. Even in limestone regions the process cannot be overvalued.

Rounded hills also occur in the central part of the *Kegelkarst* region. The hills are from 20 to 60 m. high. Their sides with slopes of 20° are mantled with a clayey waste and dissected by small valleys of periodical streams. These rounded hills consist of insoluble sandstones and shales dating for the most part from the Lower Carboniferous.

Midway between Kueilin and Yangso, the mogotes range in form from triangular and asymmetrical domes to hills, resembling tables and rounded haystacks. Their bases covered with talus (Photo 6) vary in height and size. Viz. in those areas lying off the river, the mogotes rise from rocky conical bases covered with limestone debris and blocks being to 8 m. in diameter. The height of the conical base is three times that of the steep-sided dome. Sometimes this proportion is like 2 to 2 or even 3 to 1. The talus slopes usually incline about 30° and may be covered with vegetation (Photo 5,6). A few hundred metres away there occurs a karst plain with several mogotes within it, whereas many mogotes surround this extensive central polje, especially in the east (Photo 7). Heaps composed of huge limestone blocks are also found here. They are to 10 m. high and developed by the complete destruction of the small mogotes.

Completely rounded limestone hills also occur. Their sides inclined about 40° are grass-grown or left under shrubs. The hills attain heights of 100 m. The waste mantle is composed of red clays including sharp-edge limestone fragments. What struck me was the absence of recent karst forms on the fallen blocks.

Photo 5. Karst plain with a mogote rising from a conical base, today undercut.

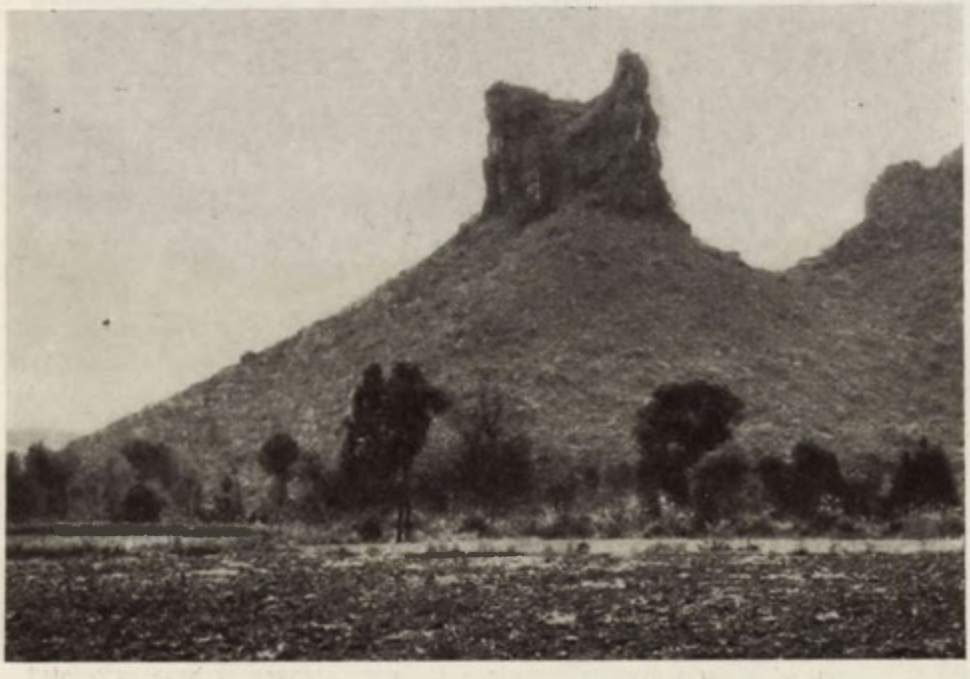

Photo 6. Mogote rising from a high conical base

Photo 7. Assemblages of different mogotes

Photo 8. Wall of a karst mountain, note entrances to caves at base associated with the karst plain

Photo 9. Fragment of a central polje surrounded by karst mountains; mogotes surmount its flat floor

The mogotes themselves are honeycombed with caves. Entrances to caves may be seen at the foot of the mogotes and at between 20 and 30 m. above the polje floor (Photo 5). Corrosion notches and cave outlets undermine much of one of the mogotes (Photo 8). These notches may be to 8 m. high. Their bottom lies c. 2 m. below the polje floor. They have well developed roof hollows and massif curtains, their sidewalls show evidence of scalloping by streams. Collapse of part of the cavern roof has clogged the entrance to caves with rock fragments. The cave floor is inundated during periods of heavy rainfall. The bottom of the notches lies below the karst plain. This fact indicates that the mogotes are undermined not merely by laterial corrosion [8] but also by d o w n w a r d c o r r o s i o n operative below the polje floor up to the time when it becomes covered with insoluble residue.

Near by Yangso the mogotes increase both in height and number. In this area there occur flat-floored poljes surrounded by limestone mountains which are moderately dissected. Mogotes occuring in the marginal part of the poljes show evidence of recent erosion by periodical waters at their base. Poljes vary in size, one of them being to 1000 m. long and c. 500 m. wide.

III. The Yangso karst region

The town of Yangso lies on the right bank of the Liu Kiang River on a terrace plain rising to 6 m. above the river. This terrace plain gradually merges into karst plains constituting the floor of the central poljes. The poljes around Yangso are drained by the Liu Kiang River. Several poljes which open into the river valley may be seen from a mogote rising to 200 m. above the town of Yangso. The flat floors of the

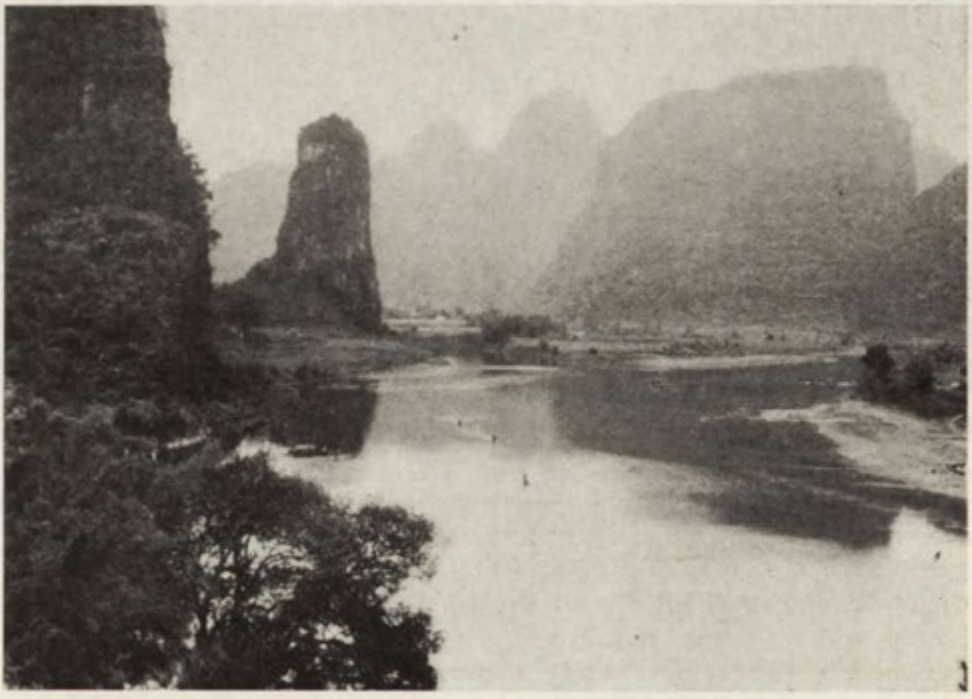

Photo 10. High karst mountain and isolated mogote south of Yangso

poljes are surrounded by limestone mountains whose summits resemble haystacks. Their heights exceed 200 m. above present river level. Isolated mogotes rise to heights of between 20 and 100 m. above the floors of the poljes (Photo 9). These mogotes contain numerous caves.

The mogote that towers above the town is 200 m. high and has steep sides with slopes of between 50° and 65°. An exposure at its base reveales a red residual clay filling both the joints and the solution hollows. Vertical fissures contain crystal calcite attributed to an older phase of fissure infilling. The same red clay is noted to fill the jamas, solution hollows and fissures developed on the steep sides of the mogote. An

analysis of the red clay from samples taken from these hollows shows that caollinite is dominant in the clayey waste.

A staircase carved out of limestone leads to the top of the mogote. Its summit is rocky and has well developed karst features. The most common forms are jamas and small solution hollows following the fissures. Hollows are filled with the red residual clay.

A boat trip of several kilometres from Yangso downstream permitted observation of the karst landforms occuring on the Liu Kiang River's bank, viz. isolated and grown together hills, resembling haystacks, of different height (most common 100 m.) and of very fantastic forms (Photo 10). These mogotes also have conical bases (with slopes of between 25° and 35°) covered with rock fragments. The river tends to undercut some of the mogotes producing erosion notches at 1.5 m. above normal river level. The streamwater also penetrates into the rock through fissures. Near the curve of the river there occur two terrace plains. The lower plain of 5–6 m. consists of limestone gravel with a veneer of clay. The higher 25 m. terrace plain is composed of gravel. Quartz gravel predominates. The present river channel has limestone gravel in it and huge parts of its bottom are covered with water plants.

The characteristics and classification of the karst landforms

The karst relief around Yangso has the aspect of the tropical karst which has been described by H. Lehmann [8, 10] and termed the *Kegelkarst*. The main elements of the *Kegelkarst* relief are found here, viz. karst plains developing by lateral corrosion through flowing waters as well as the residual mountains, hills and isolated rocks or mogotes. These plains have a veneer of red clay which rests upon the karst surface of the limestone bedrock. Residual mountains, hills and mogotes are honeycombed with caves occuring both at their bases and at upper levels (hanging entrances to caves). The degree of dissection of the landforms is different. In general they are dissected in a high degree.

The residual summits range in size and form:

(a) k a r s t "s e r r a" rising to an altitude of 300 m. above present river level; they have steep sides and a notched crest line consisting of sharp peaks separated by deep passes, those ridges occur west of Kueilin;

(b) k a r s t m o u n t a i n s to 100–200 m. high; they are dissected in a high degree and have, therefore, several summits, resembling haystacks and towers;

(c) k a r s t h i l l s with several domes or sharp peaks rising from a common rock base;

(d) isolated rocks or mogotes of different form rising to 200 m. There may be distinguished (1) steep-sided mogotes, resembling haystacks — their summit is either rounded or flat (Photo 9), (2) steep-sided karst towers having a sharp summit (Photo 1,7), (3) symmetrical karst cones of right-angled triangular outline (Photo 4), (4) asymmetrical karst cones with sides differently inclined (Photo 3), (5) karst tables (mesa) having steep sides and a flat summit (Photo 5,6).

Those forms of the mogotes and of numerous hills are dependent upon the dip of strata (symmetrical and asymmetrical cones, mesa) and the stage in development of the karst relief ("haystacks", towers).

The karst landforms of the Kueilin area differ from those of the Yangso area. High and notched karst ridges aligned northeastwards according to the strike of the rock occur west and southeast of Kueilin, whereas high and fairly dissected karst mountains separated from one another by the flat floors of the central poljes dominate in the Yangso area. The poljes themselves are either surrounded by steep-sided karst mountains on all sides or open into the Liu Kiang River valley on one side. Single mogotes surmount the flat-floored poljes. Mogotes also occur in the Liu Kiang River valley. A karst plain with isolated mogotes of different form and size within it dominates between Kueilin and Yangso. Thus different types of relief occur in the Kueilin-Yangso region. Although this region has been formed in the same space of time, the following types of relief occur next to each other:

(a) mogotes, J. Corbel [1] regarded them as the result of karst processes which have been operative since the Cretaceous,

(b) "sera", and

(c) mountains and poljes, being regarded as the product of karst processes which have been operative since the Miocene [1].

Karst landforms occuring in this region are not the expression of regional age difference. In my opinion the different stages in the development of karst relief are the consequence of the petrographic-structural differences and of the position of the karst landforms in relation to the controlling base level (*Vorfluter*) of the Liu Kiang River rather than that of a longer period of development.

The development of the karst landforms

Most of the mogotes of the Kueilin-Yangso region bear the impress of polygenesis. The mogotes are of three types:

A. Mogotes steeply rising above the karst plain being periodically flooded. These mogotes are steep-sided, often vertical-walled and have

characteristic notches at their base (Photo 1,7). The mogotes are honeycombed with caves occuring both at their base and at higher levels. These are the monogenetical developing mogotes.

B. Mogotes rising from conical rock bases covered with fallen rock. Their sides incline 30°–35°, whereas the sides of the mogotes slope at about 55–85°. The steep slopes ("*Steilhang*" according to W. Penck) were destroyed and consequently caused to retreat by outward slumping of the weathered material. The talus slopes (*Haldenhang*) developed, and are developing by gravity processes. These rock surfaces have the aspect of pediments. The proportion of the height of the conical base to the total height of the mogote is like 1 : 5 to 4 : 5. Isolated limestone hills also occur. They resemble rounded cones and represent the stage of the complete transformation of the mogotes by mechanical weathering and gravity processes. The forms described above are regarded as polygenetic vanishing mogotes (Photo 6,7).

C. Mogotes with a conical rock base being undercut by periodical waters which inundate the impermeable karst plains blanketed with the red residual clay. The talus slope inclines toward the karst plain 30°–35°. These forms represent the polygenetic rejuvenated mogotes (Photo 5).

The monogenetic mogotes (A) are typical of the tropical karst [1, 4, 7–10, 11, 13, 14, 17] and develop by the undermining action of waters. In the Kueilin area, they occur both within the flood plains and the depressions of the 20 m. surface.

The polygenetic vanishing mogotes (B) result from different alternating processes. Mogotes of the tropical type have developed first by karst processes. They were successively changed into mogotes with conical bases both by mechanical weathering and intensive gravity processes. Those landforms are found among the hills which rise above the dry karst plains and have been described by H. Wissmann [17].

The polygenetic rejuvenated mogotes (C) are of similar origin. They occur within the depressions of the karst plains and, therefore, they are undercut by periodical waters in recent time.

The development of the karst relief

On the basis of examination of the karst landforms of the Kueilin-Yangso region several phases in development of its relief may be distinguished. These phases reflect different climatic circumstances. Tropical karst landforms, i.e. karst plains, mountains and

mogotes rising above these plains, developed under warm and humid (tropical) climatic conditions. Chemical weathering was prominent during this period. Mogotes were undermined by waters flooding the karst plains (covered with impermeable deposits) and by superficial and subterranean streams as deduced from cavern passages which occur at about 20 m. above and at present river level. These cavern passages are more or less accordant in height with the extensive karst plain.

The transformation of the karst landforms (mogotes) by the weathering of their walls and by the formation of conical bases covered with talus was due to different climatic circumstances, i.e. drier and probably cold climatic conditions favouring mechanical weathering.

But not all forms have been transformed. Mogotes always affected by periodical floods have developed without hindrance ever since, whereas mogotes towering above the dry 20 m. plain have been changed. Since some of these forms are undercut today, it can be concluded that the present climatic conditions favour the development of tropical karst landforms (the precipitation's total leads 1500–1750 mm. annually).

All these facts indicate that phases of humid climate favouring the development of the *Kegelkarst* were subsequently followed by phases of dry climate unfavourable for karst processes [6, 11] but causing the tropical landforms to be transformed. In my opinion conditions favouring the development of both the planated surfaces and the mogotes prevailed in Tertiary times, in interglacial periods and in recent time. Destruction of the mogotes occured during phases of dry and cold climate. These existed here during the glacial periods. According to H. Wissmann [15, 16] the snow-line was depressed to 900 m. above sea-level during the maximal glaciation (Riss ?) in the Lower Yangtze River basin. Since Kueilin lies c. 600 km. south of it, a cold climate must have prevailed at this time in the Kueilin area. Sinking of the sea- and ocean-level at about 100 m. caused the shore line to move seaward in the glacial periods. As a result the smoothing climatic influence of the ocean was reduced and the monsoon zone displaced southwards.

At present the Kueilin karst region lies on the border of the subtropical zone but it has been fashioned by processes operative under humid-tropical conditions (chemical weathering, solution, undermining) which alternated with processes operative under dry and cold climatic conditions (mechanical weathering, outward slumping, creep). The especially rapid destruction of this

area is due to recurrent climatic changes. The rate of destruction was here greater than that in other karst regions where the climatic changes were less expressed. This conclusion may be drawn when the degree of dissection of the subtropical Kueilin-Yangso region is compared with that of karst regions in the humid tropics (Cuba, Hispaniola, Guadeloupe, Mexico, Java, Celebes) and in the temperate zone (Chunking area, structural ridges near Canton, limestone mesa near Hangchou). I am of the opinion that these climatic circumstances must be taken into account when reconstructing and dating the stages in development of the karst relief. Karst regions whose evolution was initiated during the Tertiary that have suffered great climatic changes in Pleistocene times are more dissected (mogotes stage) than those regions where there have been little climatic changes throughout the whole period of karst relief formation.

The sequence of morphological events

The analysis of the karst relief in the vicinity of Kueilin and Yangso permits its development in Tertiary and Quaternary times to be reconstructed. In travelling across this area one can note that the summits of the ridges, mountains, hills and mogotes rise to 400–500 m., 250–300 m. and 180–190 m. above sea-level. The even planes preserved in the summits which are accordant in height and have well developed karst features are interpreted as being remnants of three planation surfaces. These surfaces recognized by Czen Szu Phen [2, 3] may be attributed to the karst processes at the following heights:

400–500 m. above sea-level (250–300 m. above present river) — I surface,

250–300 m. above sea-level (100–150 m. above present river) — II surface,

180–190 m. above sea-level (30–40 m. above present river) — III surface,

170 m. above sea-level (20 m. above present river) — IV surface.

The wide 170 m karst plain above which tower the ranges, mountains, hills and mogotes merges into a terrace of similar height near Kueilin. This terrace is capped with gravel. Terrace remnants at c. 5–6 m. above present river level (V surface) are found below the 170 m. surface, while the present Liu Kiang River flows at a height of 150 m. above sea-level.

Mountains, hills and mogotes which rise immediately above the river and surmount the V and IV surfaces are honeycombed with caves

formed by through streams. The caves occur at different constant levels. Well developed cave systems are associated with the III planation surface (30–40 m. above present river level), with the IV planation surface (20 m. above present river level) and with the present Liu Kiang River level. The occurence of several cave levels being accordant in height with the planation surfaces confirms Czen's contention that several karst planation surfaces may be found in this region. Above these surfaces there were always rising mogotes with through cavern passages at their base.

Dating of the surfaces appears to be very difficult. Chen Shu Phen [2, 3] regarded both the "S surface" of 400–500 m. above sea-level and the "S_1 surface" of 250–300 m. above sea-level as having been formed at the close of the Cretaceous and at the beginning of the Tertiary. The "S_{3b} surface" of 170 above sea-level was formed at the close of the Tertiary or at the beginning of the Quaternary. The dissection of this surface has been referred to Pleistocene times.

There is, however, no justification for dating the Tertiary and Quaternary surfaces (the latter bearing morainic and glacio-fluvial deposits). But within the IV surface there occur mogotes transformed by processes operative under dry and cold climatic conditions, i.e. prevailing in Pleistocene glacial periods. This fact may confirm the validity of Chen's suggestion that this surface existed well back into Pleistocene times. Nevertheless, this surface antedates the last cold period in this area. At this time or during those periods the mogotes were subjected to mechanical destruction. Weathering, outward slumping of the debris and the formation of conical bases covered with talus caused the steep sides of the mogotes to retreat. The fallen rock fragments were not removed by streams because these were flowing at a lower level to accumulate the gravel covering of the 5–6 m. terrace. Thus the dissection of the 20 m. surface must be referred to Pleistocene times rather than to the Holocene [2]. The relation of the terrace deposits to the lower caves associated with the present river level indicates that valleys were cut deeper and caves formed prior to the accumulation of these deposits probably during the last interglacial period at which time humid tropical climatic conditions prevailed.

The pre-Holocene age of the lowermost cavern passages in Kueilin is also indicated by travertine covering the side-walls at their outlet. This travertine postdates the cave formation. It is suggested that travertine accumulated during a warm and humid period because travertine is deposited by water flowing through a cool environment (in the interior of the caves) into a warm environment (outside of the caves). In Kueilin, the travertine was deposited at the outlet of the cavern passages, i.e. on the bor-

der of the two environments. The occurence of roof hollows, corrosion curtains and scallops in the lower caves is indicative of powerful streams that were held in contact with all the rock surface of the tube through which they moved. In recent times deposits are being removed from the caves. Periodical waters undercut only their side-walls.

The higher caves associated with the III and IV surfaces are also filled with travertine. It does not occur at their outlets but at great depths. The greater cavern passages and chambers contain a great variety of dripstone formations (e.g., the Cisingjan and other caves). The dripstone is of epigenetic origin. It was deposited when the caves were dry. This fact indicates a lowering of the karst water table of the *Vorfluter*. The travertine is of syngenetic origin. It was deposited by subterranean streams flowing through the cavern passages that were associated with the extensive karst plains. Supposing the bones of animals found in the travertine in the Cisingjan cave (at 40 m. above present river level — III surface) were indeed of Pleistocene age this karst planation surface also would date from Pleistocene times. The occurence of travertine in the deeper parts of the caves can be explained as the result of deposition of *calcium carbonate* by cool water disappearing underground in the deep caves which were warmer during the cold Pleistocene periods.

Karst processes continue to operate in the Holocene because the climatic conditions favour their development. At present the total amount of precipitation is 1500–1700 mm. annually. Rain occurs mainly in summer. The temperatures are high, the sum of the active temperatures amounts to between 5000° and 6000°, the mean temperatures during July are 28°–30°C, the mean temperatures during January are 10°–12°C. Occasionally a slight frost and snow fall occur. Mogotes are undercut by stream water and floods associated with periods of heavy rainfall in summer time while underground moisture is falling and dripstone is accumulated in the caves. Chemical weathering produces a red clayey waste in which caollinite is dominant.

The rate of recent karst processes is difficult to establish. The barren rock surfaces are dissected by numerous jamas, solution hollows and different types of karren. These developed only within the old summit planes where they tend to be enlarged and rejuvenated. No karren could be found on the limestone blocks which became detached from the mogotes in Pleistocene times, though karren are a common occurence both on the blocks and the smoothed surfaces of similar age in the Tatra Mts. Hence the conclusion may be drawn in agreement with J. Corbel's conception [1] that the rate of karst processes under cold climatic circumstances exceeds that under subtropical climatic conditions.

Final remarks

The examination of the karst relief of the Kueilin area shows that it is a polycyclic and polygenetic relief. Several karst planation surfaces with mogotes (undermined by caves at their base) within them have been recognized in this area: this indicates that features characteristic of the tropical karst have been formed here in Tertiary times accompanied with the lowering of the controlling karst stream (*Vorfluter*) level. Moreover, the Kueilin area is situated within the subtropical zone

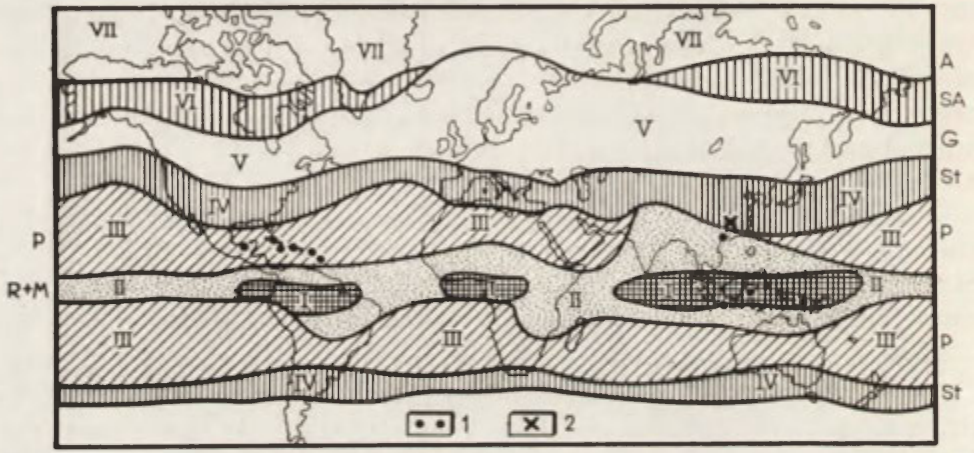

Fig. 5. Distribution of *Kegelkarst* regions in different climatic zones

1 — *Kegelkarst* regions; 2 — Kueilin karst region
Zone of tropical climates: I — equatorial; II — monsoon; III — passates
Zone of subtropical climates: IV — subtropical
Zone of temperate climates: V — temperate
Frigid climates: VI — subarctic; VII — arctic

between the humid tropics to the south and the drier temperate zone to the north (Fig. 5). As a consequence rythmical climatic changes have occured here in Tertiary and Quaternary times [5, 12] and the area has suffered from humid tropical and temperate climatic conditions alternating with cool and drier climatic circumstances. Thus we have in the Kueilin area (enclosed between the parallels of latitude c. 28°–23°N.) different landforms which developed by extremely different morphogenetic processes under extremely different climatic conditions. These climatic changes are responsible for the formation of the karst relief described above. It includes both tropical elements (*Kegelkarst*) and polar elements (conical bases and talus heaps). Tropical elements extended as far as the parallel of latitude 28°N., whereas the Tropic of Can-

cer is the limit of the polar (cool) elements. The karst relief in the vicinity of Peipei (limestone ridges), Nanking (limestone structural escarpments) and Hangchou (limestone table mountains) belongs to another type than the *Kegelkarst* of the Kueilin area. The conclusion is that the parallel of latitude 28° N. is the northern limit of the *Kegelkarst* relief. It extends thus beyond the souther limit marked out by H. Wissmann [17]. The intense dissection of the karst relief of the Kueilin area (mogotes stage) is the consequence not merely of a long period of evolution [1] but for the most part of the d i f f e r e n t mode of fashioning.

None of the areas lying within other climatic zones has suffered from climatic and morphogenetic changes as great as those in the Kueilin area during the Cenozoic Era. It must be observed, however, that the question is concerned with the subtropical regions that border directly on the humid tropics.

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THE STRUCTURE OF ECONOMIC REGIONS IN POLAND ANALYZED BY COMMODITY FLOWS

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1

Between the elements of spatial economic structure there are various types of linkage. Among these, of particular areal significance are those revealing the spatial links which occur between various phases of the production process, as well as between production and consumption. These are expressed above all in the exchange of all kinds of goods and services. That exchange is reflected most strikingly in commodity flows. These establish a basic measure of the links, ie. inter-regional links, binding the fundamental elements of the structure of space economy; these elements are the economic regions. That the phenomenon of commodity flows is a measure of inter-regional connections is substantiated by the fact that such flows reveal the magnitude of goods exchange which, in turn, expresses a geographical division of labour seen in the specialization and complexity of individual economic regions.

So far economic geography has been concerned to only a limited degree with the problem of commodity flows. Yet from the results of spatial analysis of these phenomena, the possibility arises of investigating inter-regional connections as well as determining the characteristics of the structure of economic regions. N. N. Baranski has drawn attention to this possibility, writing: "In the transportation connections between countries and between regions of individual countries is summed up the whole pattern of complex geographical division of labour; maps of commodity flows reveal perfectly the regions of surpluses and deficits, as well as the links existing between them" [1].

The break-through in research on inter-regional connections (based on commodity flows) was achieved by E. Ullman who worked out for the U.S.A. the pattern of commodity flows between the states, and

presented the characteristics of certain states from an interpretation of flow phenomena [13]. However, it was only later through W. Isard that the theoretical conclusions resulting from such analyses were applied to the investigation of regional pattern [8, 9]. According to W. Isard, investigations of commodity flows establish the essential contents of inter-regional dependence which are not taken into account in the model of economic region of A. Losch [10]. They also throw light on the existence of regions of different order in a hierarchical arrangement of regional structure.

Any attempt at presenting the structural pattern of Poland's economic regions in the light of commodity flows depends on the relevant statistical material for railway freight haulage in 1958. This gives statistics for movements arranged in 16 classified freight groups between the 17 voivodeships[1].

It is possible to achieve a valuable analytical estimate of the pattern of commodity flows using railway freight statistics since in Poland the railways share the largest part of the total freight tonnage moved (84.7 per cent) and of all transportation movements (96.7 per cent). This justifies to a high degree the representative character of railway transport as an indicator of commodity flows. However, the value of commodity flows based on the statistics of railway freight haulage, from the point of view of their application to regional analysis, is limited with respect to the following:

1. The voivodeships as the consigning-receiving units provide too little spatial detail and permit an analysis of commodity flows only on a macro-regional scale. It thus limits analysis to regions of higher order only.

2. There is insufficient differentation in the generic grouping of freight in 16 classified groups. From the economic point of view these do not have homogeneous character and make impossible any differentation in the individual types of raw materials and finished products. This also applies for any introduction of economic accounting in terms of monetary value.

3. Other limitations result from the existence of crosshauls, extenuated hauls and back-hauls which do not represent true economic links.

[1] The statistics of the National Statistical Office for freight hauls by railway in Poland in 1958 are the sources for obtaining the pattern of commodity flows. These are given in the form of chequerboard tables of freight hauled between all voivodeships including the city-voivodeships according to the following freight groups: 1) bituminous coal (2) brown coal and coke, (3) ores and pyrites, (4) stones, (5) sands and gravels, (6) crude and refined petroleum, (7) metals and metal manufactures, (8) bricks, (9) cement, (10) artificial fertilizers, (11) chemical products, (12) grains, (13) potatoes, (14) sugar beets, (15) other crops and processed agricultural produce, (16) timber and timber manufactures.

Despite this, however, a comparison of railway freight flows on the inter-regional scale does show the existence of basic regional contrasts which, from the point of view of regional analysis, possess fundamental significance: they permit one to grasp the chief inequalities in the distribution of the output of raw materials and mass products, and they reflect the major elements of the geographical division of labour.

The definition of Poland's regional structure on the basis of the statistical material characterized above is limited to the existing voivodeship framework. There is no possibility of achieving a correction of this division and as a result, one can only approximate in reality.

Recognition of this limits the investigation of regional structure to the voivodeships as the basic elements, establishing therefore the administrative-economic units as the economic regions. It must be emphasized that the degree to which such an analysis is adequate is closely defined by the suitability of this initial system; only to that degree can one accept this analysis of regional economic structure of the country. Verification of the system, however, falls outside the scope of the present work, and has been considered by K. Secomski [12], K. Dziewoński [6, 7], St. Berezowski [2], B. Rychłowski [11], and A. Wróbel [15].

Analysing the structure of the system of economic regions in this form is an exercise in definition based on flows, types of commodities of the economic regions, as well as on the links occurring between them[2]. This establishes a substitute for research on regional structure for it permits one to recognise the whole feature of these structural elements as well as the existing relations between them. This emerges only from investigation of regional peculiarities, and results from the individual features which distinguish one region from other regions.

Referring the investigation of regional structure to that of the spatial regional structure as given, the analysis can proceed to the first important problem, that of the c o m p l e x i t y of the system of economic regions regarding their character as elements of that system, and the links between them.

The definition of the scope of the d i f f e r e n t i a t i o n and i n t e g r a t i o n lie in its fundamental peculiarities, which, from the point of view of the aims of regional analysis, remain to be studied.

The aim of investigating regional differentiation is to define the character of the commodities of the regional elements by means of separating the types of these elements. It is necessary, however, to seek criteria which can define the type of economic region; of prime impor-

[2] Investigation of the system's structure depends on the working out of the kind of relationships arising between the system's elements. The complex of these relationships can be named according to the nature of the connecting elements.

tance here is its economic productive-market function, and secondarily the intensity and character of exchange within and between regions. This may be done according, above all, to the size and character of the contribution of its products to the national economy as defined by the nature of goods dispatched, the range of specialized commodities, as well as the regions commodity balance.

An investigation of the system's integration aims at defining the degree of linkage arising between elements of the system regarding the intensity and character of its binding connections and the type of regional elements.

2

The role of the economic region in the geographical division of labour within a country, as well as the character and type of economic region, are reflected in the share and contribution of that region to the national economy. Thus the differentiation in the productive-market character of the regional elements in the geographical division of labour of the country permits definition of the economic region's profile according to the character and intensity of its commodity exchange. One should take into account as basic criteria:

(A) The character of commodities dispatched from the region.
(B) The degree of goods specialization of the region.
(C) The degree of commodity balance in the region.

(A) The character of goods dispatched from the region can be understood according to the structure of commodities dispatched in the individual groups of freight. The following grouping of goods has been made in order to separate the basic raw materials and products which determine the chief sources of mass commodities. The percentage division of railway freights is given below.

1. Raw materials for fuel and power, as well as ores and pyrites. These include bituminous coal, brown coal and coke, crude and refined petroleum, metal ores, and pyrites	53.7
2. Raw materials for building purposes including building stone, sands and gravels	15.1
3. Industrial products among which metals and metal manufacture, bricks, cement, artificial fertilizers, and other chemical products may be mentioned	15.6
4. Agricultural crops: grains, potatoes, sugar beet, other crops as well as processed produce	9.0
5. Timber and timber manufactures	6.6
	100.0

Although this classification does not provide groups with homogeneous characteristics, it nevertheless permits division of the chief commodity groups according to their commodity destination.

The dispatch of goods from individual regions was established on the basis of the above classification. However, it must be observed that such a five-fold classification of commodities compared with the 16 classified groups of freight does not permit a division into groups homogeneous from the economic viewpoint. It is less detailed and precise and this limits its importance to the major sources of mass commodities.

The structural pattern of freight dispatched from individual regions is presented in the table below.

TABLE 1. THE STRUCTURE OF RAILWAY FREIGHTS DISPATCHED BY VOIVODESHIPS 1958*

Voivodeships including city-voivodeships	Dispatches in percentages for respective voivodeships					Total
	E	B	I	A	T	
Warszawa	7.7	21.5	27.9	30.5	12.4	100
Bydgoszcz	1.6	23.0	21.7	37.2	16.5	100
Poznań	7.1	6.4	22.5	45.9	18.1	100
Łódź	5.3	23.3	20.0	36.2	15.2	100
Kielce	10.5	57.2	21.0	4.9	6.4	100
Lublin	4.2	10.5	27.4	40.2	17.7	100
Białystok	0.7	36.1	6.8	15.8	40.6	100
Olsztyn	0.3	24.5	10.8	24.6	39.8	100
Gdańsk	3.2	28.8	22.2	25.2	20.6	100
Koszalin	0.2	11.9	12.5	24.9	50.5	100
Szczecin	2.7	8.8	34.7	31.8	22.0	100
Zielona Góra	15.6	15.0	19.4	18.0	32.0	100
Wrocław	30.8	33.5	13.9	14.7	7.1	100
Opole	19.4	30.2	30.8	13.3	6.3	100
Katowice	82.2	5.1	11.3	0.4	1.0	100
Kraków	44.4	32.5	18.2	1.6	3.3	100
Rzeszów	21.1	28.0	15.3	13.8	21.8	100

* The following symbols denote individual commodity groups:
E,e,e' — Raw materials for fuel and power, and ores
B,b,b' — Raw materials for building purposes
I,i,i' — Industrial products
A,a,a' — Agricultural produce
T,t,t' — Timber and timber products

To establish the structural characteristics of freight dispatched from individual regions it is necessary to combine the method of standard deviation with a simple method adopted by J. C. Weaver to define the character of crop region [14]. The adaption of standard deviation for showing type characteristics of freight dispatched by a region depends upon the discovery, for each region, of that combination of average commodity dispatches which gives least standard deviation $\Sigma d^2/n$ (4).

Calculations of standard deviations have thus been made for all the combinations of averaged groups of dispatched freight. By defining the least deviation for individual combinations, the following characteristics of the commodities of individual regions can be given:

TABLE 2. THE CHARACTERISTICS OF COMMODITIES DISPATCHED BY VOIVODESHIPS 1958*

Voivodeships including city-voivodeships	Characteristic commodities				
Warszawa	A	I	B	T	
Bydgoszcz	A	B	I	T	
Poznań	A	I	T		
Łódź	A	B	I	T	
Kielce	B	I	E		
Lublin	A	I	T		
Białystok	T	B	A		
Olsztyn	T	A	B		
Gdańsk	B	A	I	T	
Koszalin	T	A	I	B	
Szczecin	I	A	T		
Zielona Góra	T	I	A	E	B
Wrocław	B	E	A	I	
Opole	I	B	E	A	
Katowice	E				
Kraków	E	B	I		
Rzeszów	B	T	E	I	A

* For explanation of symbols see table 1

The table establishes a basis defining commodity types of regions. It is a means for expressing the contribution of each economic region to the national economy.

Any attempt at defining the commodity type of regions must be based throughout upon the similarity of qualitative features which characterize the marketability of the region. The complex of features of commodities dispatched from the individual regions makes possible a division into groups of regions or single regions which are distinguished by the complex of their own features or by one feature. This group feature or features distinguishes the commodity type of region. In order to define these features it is essential to classify the regions so that regions possesing the same features throughout are put into the same group identified by a given complex of features.

The following groups of features create individual commodity types of regions:

B,T,E,I,A — Rzeszów and Zielona Góra
B,E,A,I — Wrocław and Opole
A,B,I,T — Bydgoszcz, Łódź, Gdańsk, Warszawa and Koszalin
A,I,T — Poznań, Lublin and Szczecin
T,A,B — Olsztyn and Białystok
E,B,I — Kraków and Kielce
E — Katowice

B) The degree of commodity specialization of a region is an expression of the differentiation of regional structure. It thus has a similar basic significance for recognising the complexities of the regional system as do the characteristics of commodities dispatched. The process of differentiation in regional structure is manifest in regional commodity specialization. This in turn expresses the individuality of the regions. It is necessary to detect such individuality in order to understand the degree of complexity in the regional system under investigation.

A basic measure of a region's specialization will be the product of the region's share in a given commodity group as a percentage of the total of that group divided by the population of the region as a percentage of the country's population. This product is called the coefficient of commodity specialization of the region. If one denotes the population of region i as S_i, the country's population as ΣS_i, with a_i as the sum of the region's sare in a given commodity group, and Σa_i as the sum of total freight in that group, then:

$$\text{Coefficient of commodity specialization of the region} = \frac{a_i}{\Sigma a_i} \Big/ \frac{S_i}{\Sigma S_i}$$

The definition of commodity specialization according to this coefficient is given in the table below. This presents coefficients formed for the chief commodity groups for the voivodeships.

TABLE 3. THE COEFFICIENTS OF COMMODITY SPECIALIZATION BY VOIVODESHIPS 1958*

Voivodeships including city-voivodeships	Coefficients of commodity specialization				
	e	b	i	a	t
Warszawa	0.02	0.18	0.24	0.48	0.24
Bydgoszcz	0.02	0.72	0.70	2.29	1.18
Poznań	0.04	0.14	0.52	1.87	0.93
Łódź	0.01	0.17	0.16	0.51	0.27
Kielce	0.09	1.77	0.66	0.26	0.46
Lublin	0.01	0.14	0.40	1.04	0.58
Białystok	0.00	0.60	0.10	0.47	1.57
Olsztyn	0.00	0.83	0.40	1.53	4.13
Gdańsk	0.02	0.78	0.60	1.24	1.26
Koszalin	0.04	0.39	0.43	1.47	3.73
Szczecin	0.04	0.36	1.44	2.28	2.00
Zielona Góra	0.23	0.69	0.92	1.46	3.34
Wrocław	0.72	2.53	1.09	2.04	1.23
Opole	0.67	3.38	3.54	2.70	1.61
Katowice	7.47	1.49	3.47	0.21	0.69
Kraków	0.94	2.24	1.30	0.22	0.52
Rzeszów	0.10	0.46	0.26	0.42	0.85

* For explanation of symbols see tab le 1

The coefficients greater than 1 qualify given groups for inclusion as groups specialized in the region eg. groups (e), (b) and (i) in Katowice voivodeship.

The sphere of commodity specialization formed on the basis of this coefficient is presented as follows:

TABLE 4. THE SPHERE OF COMMODITY SPECIALIZATION BY REGIONS, 1958*

Voivodeships including city-voivodeships	Commodity specialization by groups			
Warszawa		—		
Bydgoszcz	a	t		
Poznań	a			
Łódź		—		
Kielce	b			
Lublin	a			
Białystok •	t			
Olsztyn	t	a		
Gdańsk	t	a		
Koszalin	t	a		
Szczecin	a	t	i	
Zielona Góra	t	a		
Wrocław	b	a	t	i
Opole	i	b	a	t
Katowice	e	i	b	
Kraków	b	i		
Rzeszów		—		

* For explanation of symbols see table 1

This examination of the sphere of commodity specialization permits a division of the regions into four groups:

1) The first type includes those voivodeships specialized in one group. These are: Poznań and Lublin in agricultural produce (a). Białystok in timber and timber products (t). Kielce in building materials (b).

2) The second group is characterized by specialization in two commodity groups: Bydgoszcz, Olsztyn, Gdańsk, Koszalin and Zielona Góra (t and a). Kraków in building materials (b) and industrial products (i).

3) The third type specializes in three commodity groups. These are: Katowice in e, i, b, and Szczecin in a, t, and i.

4) The fourth type is distinguished by specialization in four commodity groups: Wrocław and Opole in groups b, a, t, i.

It will be noticed that three voivodeships — Warszawa, Łódź, and Rzeszów do not specialize in any of the basic commodity groups.

(C) The degree of balance in a region's commodities permits definition of the complexities of regional structure, since it takes into account differentiation in the character of regional economy regarding the balance between intra-regional and inter-regional flows [3]. The criterion of flow balance for individual regions is contained in the distinction between regions with a closed economy and those with an open econo-

my. This principle of distinction was introduced by K. Dziewoński. It is based on the contention that a region with a closed economy is separated from other regions to the degree that its economy is balanced. It is this balance which establishes a region's character. According to K. Dziewoński, however, this balance need not be complete; a region is not self-sufficient in a given sphere. Additional inter-regional flows exist within the sphere of balanced phenomena, for the quantities being balanced in a particular region are determined also by fulfilling their true role in the regional economy. On the other hand, balance is not such an important feature in region with an open economy [5].

If one accepts, as a measure of the commodity balance of the economic region, the index of the regional balance of commodity flows, one must accept it as a measure of the balancing of these commodity flows within individual regions. By this measure the relationship is the sum of the intra-regional flows of individual commodities to the sum of the inter-regional flows of the same goods. If I_i is the index of regional balance and x_{ii} is the sum of freight in a given commodity group dispatched in region i to region i, then:

$$I_r = \frac{x_{ii}}{a_i - x_{ii}}$$

This index can be treated as a means for singling out the highly balanced regional units, ie. the closed regions, from the open regions. The size of the indices of regional balance so formed are presented in the table 5.

TABLE 5. INDICES OF THE REGIONAL BALANCE OF COMMODITY FLOWS BY VOIVODESHIPS, 1958*

Voivodeships including city-voivodeships	Indices of regional balance in relation to dispatches				
	e'	b'	i'	a'	t'
Warszawa	0.07	2.30	0.47	0.65	1.05
Bydgoszcz	0.28	3.84	0.51	2.16	1.10
Poznań	0.35	1.90	0.70	1.75	1.29
Łódź	0.65	5.00	0.43	1.18	0.89
Kielce	0.18	0.26	0.25	0.57	1.19
Lublin	0.27	6.39	0.20	0.59	1.30
Białystok	2.30	0.42	0.63	0.16	0.34
Olsztyn	0.28	0.25	0.66	0.72	0.38
Gdańsk	1.39	4.96	0.74	1.86	1.19
Koszalin	1.67	0.48	0.76	0.64	0.17
Szczecin	0.39	2.70	0.15	1.91	0.31
Zielona Góra	0.49	0.32	0.10	1.34	0.15
Wrocław	0.64	0.24	0.35	3.23	1.19
Opole	1.65	0.25	0.14	1.45	0.75
Katowice	0.33	4.34	1.10	1.41	2.51
Kraków	0.45	0.92	0.25	1.21	3.40
Rzeszów	0.41	1.53	0.41	1.19	0.62

* For explanation of symbols see table 1

The size of this index is important for dividing the highly balanced regional units (the closed region) from the poorly balanced (open) regions. The closed region will be one in which intra-regional flows are greater than the inter-regional flows, giving an index greater than 1, and separating these from the open regions with an index of less than one. Since the principle of balance relates to only the important freight groups (which have real significance for the respective region), the examination of regional balance will take into account only those commodity groups which are characteristic for the region and which thus define its commodity type; for example, groups a, i, b and t for Warszawa.

TABLE 6. THE INCIDENCE OF INDICES OF REGIONAL BALANCE GREATER THAN 1 FOR DEFINED COMMODITY GROUPS, THE COMMODITY TYPES OF REGIONS

Voivodeships including city-voivodeships	Indices of regional balance characteristic for the respective region		
Warszawa	b' (2.30)	t' (1.05)	
Bydgoszcz	b' (3.84)	a' (2.16)	d' (1.10)
Poznań	a' (1.75)	t' (1.29)	
Łódź	b' (5.00)	a' (1.18)	
Kielce			
Lublin	t' (1.30)		
Białystok			
Olsztyn			
Gdańsk	b'(4.96)	a' (1.86)	d' (1.19)
Koszalin			
Szczecin	a' (1.91)		
Zielona Góra	a' (1.34)		
Wroclaw	a' (3.23)		
Opole	e' (1.65)	a' (1.45)	
Katowice			
Kraków			
Rzeszów	b' (1.53)	a' (1.19)	

In parentheses the size of the index of balance for respective goods.

These indices confirm that the following regions can be defined as closed types of region: Warszawa, Bydgoszcz, Poznań, Łódź, Lublin, Gdańsk, Szczecin, Zielona Góra, Wroclaw, Opole, and Rzeszów. The regions with open-type economies are thus the voivodeships of Kielce, Białystok, Olsztyn, Koszalin, Katowice, and Kraków.

3

The foregoing analysis emphasizes the existence of considerable differentiation between the character of these regional elements regarding their commodity type, their specialization and degree of regional balance.

A definition of the character of the system's regional elements has fundamental importance for recognising regional structure. However, the study of relationships is expressed in terms of the spatio-economic linkages between these elements. Such investigations permit the definition of the degree of linkage in the system, and thus also of the degree and character of its integration. The nature and strength of the links resulting from commodity flows binding the regional elements express directly the economic links in the system under examination; these spatial links throw light on the pattern of the spatial structure of the regional system. The consolidation of this structure is of prime importance for studying the spatial structure of the national economy, for it opens the way for analysis also of the spatial aspect of economic activities.

Examination of economic links is of prime importance in analysing regional structure, since these reflect the move objective existence of complex economic activities. They arise from the reciprocal dependence of regional elements which itself results in commodity flows between them.

The pattern of intensity of inter-regional freight flows is set out in table 10. This serves for estimating the degree of integration between the regional elements. The measure of inter-regional flows between two regions is conceived as the sum of freight dispatches and receipts between them. Thus the measure of the intensity of flows between region i and region j is equal to the sum of inflows and outflows from region i to region j. Such a measure is reversible. The following classification of flow intensities can be introduced based on the sizes of measure used in the analysis:

TABLE 7. CLASSIFICATION OF THE SIZE OF FLOW INTENSITY

Group number	The size of flow intensity (in tons)	The definition of the intensity of flows of the group
I	over 600,000	high
II	300–600,000	average
III	150–300,000	low
IV	under 150,000	very low

Such a measure of the magnitude of connections shows that, the greater the intensity of flow between a given regions, the stronger is their linkage. The pattern of flow intensity thus defines the scope and degree of linkage between the regional elements of the system in terms of the size of those connections.

Linkage in the regional system, however depends not only on the strength of these links but also on their character and on the type of dependence. The basic formula defining these in terms of flow intensity is the coefficient of dependence. The coefficient of dependence between region i and region j is the relation between the volume of flows from region i to region j and from region j to region i. If W, is the coefficient of dependence, this can be expressed in the formula:

$$W_{ij} = \frac{X_{ij}}{X_{ji}}$$

The size of this coefficient determines the type of dependence.

In this example, when W_{ij} is greater than unity, region j is more dependent upon region i than *vice-versa;* when W_{ij} is less than unity than region i is more dependent on region j. When W_{ij} is near or at unity then mutual dependence of the two regions is indicated, and this can be considered as occuring within the range $W_{ij} = 0.90$ and to $W_{ij} = 1.10$. The type of dependence of regions i and j can thus be classified as follows:

TABLE 8. CLASSIFICATION OF THE TYPE OF DEPENDENCE

Coefficient of dependence	Type of dependence
0 to 0.90	passive (P)
0.90 to 1.10	mutual (M)
over 1.10	active (A)

Definition of the quantitative nature of the links rests on the same principle as the definition of the type of dependence, and also on the size of the coefficient of dependence. It follows that the relation between the volume of outflows to inflows from one region to another is the means for calculating the quantitative aspect of links between the two regions. Such a relationship is called a unilateral connection when either inflows of outflows dominate between two regions; but when the relationship is one of quantitative equilibrium between inflows and outflows from one region to another it is called bilateral linkage. The quantitative character of links may be classified as follows:

TABLE 9. THE CHARACTER OF LINKS CLASSIFIED QUANTITATIVELY

Coefficient of dependence	Character of connection
0 to 0.50	unilateral (u)
0.50 to 2.00	bilateral (b)
over 2.00	unilateral (u)

Table 10 contains a description of the system of inter-voivodeship links in terms of their character, the types of dependence, and above all, the types of economic region. The degree of integration which results from inter-regional connections is expressed in the characteristics and types of their dependence and defines the relationships between the regional elements. These relations are of a diverse nature. Two relationships, however — equivalents and subordinates — must be mentioned as being important in the degree of integration of the regional system. These however. do not exhaust all the possible combinations which characterize the various connections and dependence between types of economic region.

Relationships of equivalent character signify bilateral connections of a mutual kind between regional units of the same economic type. The mutual nature of these relations gives a uniformity.

Relationships of subordinate character denote unilateral connections and passive or active dependence. They occur between units of the same kind as well as between those of a different type. Such relations express the subordination of one regional element to others, leading to the development of a nodal organization.

4

The pattern of connections presented in table 10 establishes a synthetic description of the complexities of the country's regional structure in terms of voivodeships from the point of view of regional analysis. That complexity is expressed in the differentation of fundamental types of regional elements as well as in various forces integrating the inter-regional links.

An examination of this synthetic description emphasizes the preponderance of relationships of subordinate character compared with those of equivalent character. This preponderance, expressed in unilateral and active or passive dependence and in highly intensive interregional flows, serves to confirm that the dominating feature of the country's regional structure is its focal character.

The focal character of individual elements is determined by an analysis of the intensity and type of dependence of unilateral links. Such an analysis opens the way for defining the regions with the greatest intensity of commodity flows, linking them with other regions. The pattern of interregional flow intensity indicates that such a region is Katowice.

The connections with Katowice occupy first place in the inter-regional flows of all other regions, endowing Katowice with a focal chara-

TABLE 10. THE DEGREE OF INTENSITY OF INTER-REGIONAL FLOWS, THE CHARACTER OF THEIR LINKS, DEPENDENCE, AND THE TYPE OF ECONOMIC REGION

Voivodeships including city-voivodeships	Warszawa	Bydgoszcz	Poznań	Łódź	Kielce	Lublin	Białystok	Olsztyn	Gdańsk	Koszalin	Szczecin	Zielona Góra	Wrocław	Opole	Katowice	Kraków	Rzeszów
Warszawa	c	IIPb	IIPb	IIIAb	IIPu	IIMb	IPu	IPu	IIIPu	IIIPu	IIIPu	IIPu	IPu	IIPu	IPu	IPu	IVPb
Bydgoszcz	IIAb	c	IIMb	IIIAu	IIIPu	IVPb	IVPb	IIPu	IIMb	IIIPu	IIIPb	IVPu	IIPu	IIPu	IPu	IIPu	IVPb
Poznań	IIAb	IIMb	c	IIAb	IIIPb	IIIPu	IVAb	IVPb	IIIAb	IIPu	IIPu	IPu	IPu	IIAb	IPu	IPu	IVPu
Łódź	IIIPb	IIIPu	IIPb	c	IIPu	IVPu	IVPu	IVPu	IVPu	IVPu	IIIPu	IVPu	IPu	IIPu	IPu	IIPu	IVPu
Kielce	IIAu	IIIAu	IIIAb	IIAu	o	IIAu	IVPu	IVPb	IVAu	IVPu	IVPu	IVMb	IPb	IIIPu	IPb	IMb	IIAb
Lublin	IIMb	IVAb	IIIAu	IVAu	IIPu	c	IIIPu	IIIPu	IVAu	IVAu	IVMb	IVAu	IIPu	IIIPu	IPu	IPu	IIPb
Białystok	IAu	IVAb	IVPb	IVAu	IVAu	IIIAu	o	IIIPb	IVPb	IVPb	IVAb	IVPb	IVPb	IVPu	IPu	IIIPb	IVAb
Olsztyn	IAu	IIAu	IVAb	IVAu	IVAb	IIIAu	IIIAb	o	IIAb	IVAu	IVAb	IVPu	IVPu	IVAb	IPu	IIIPu	IVPu
Gdańsk	IIIAu	IIMb	IIIPb	IVAu	IVPu	IVPu	IVAb	IIPb	c	IIIPb	IVPu	IVPu	IIIPu	IIIPu	IPu	IIIPu	IVPb
Koszalin	IIIAu	IIAu	IIAu	IVAu	IVAu	IVPb	IVAb	IVPu	IIAb	o	IIAb	IVMb	IIIPu	IVPu	IPb	IVPu	IVPb
Szczecin	IIIAu	IIIAb	IIAu	IIIAu	IVAb	IVMb	IVAb	IVAb	IVAu	IIIPb	c	IIIMb	IIPu	IIPu	IPu	IIIPu	IVAb
Zielona Góra	IIAu	IVAu	IAu	IVPu	IVMb	IVPu	IVAb	IVPu	IVPu	IVMb	IIIMb	c	IAu	IIIPu	IPu	IIIPb	IVAb
Wrocław	IAu	IIAu	IAu	IAu	IAb	IIAu	IVAb	IAAu	IIIAu	IIIAu	IIAu	IPu	c	IAb	IPu	IAu	IIAu
Opole	IIAu	IIAu	IIAu	IIAu	IIIAb	IIIAu	IVAu	IVAu	IIIAu	IVAu	IIAu	IIIAu	IPb	c	IPb	IMb	IIIAu
Katowice	IAu	IAu	IAu	IAu	IAb	IAu	IAu	IAu	IAu	IAb	IAu	IAu	IAu	IAb	o	IAu	IAu
Kraków	IAu	IIAu	IAu	IIAu	IMb	IAu	IIIAb	IIIAb	IIAu	IVAu	IIIAu	IIIAb	IPu	IMb	IPu	o	IPu
Rzeszów	IVAb	IVAb	IVAu	IVAu	IIPb	IIAb	IVAb	IVAb	IVAb	IVAb	IVAb	IVPb	IIPu	IIIPu	IPu	IPu	c

The symbols given in this table are explained in the tables: (1) The degree of intensity of commodity flows in table 7, (2) The type of dependence in table 8, (3) The character of the connections in table 9, (4) The type of economic region is defined as open (o) or closed (c).

ter on the national scale. This defines the role of Katowice (the Upper Silesian Industrial District) as that area upon which are focussed the productive-industrial activities of the country, the basic sections of heavy industry: coal-mining, metallurgy, engineering, and chemicals. The high degree of its specialization links it with a wide area, and, as a result, gives a unity which is the functional basis of its ability for full complex economic development; thus simultaneously it also establishes its own inner coherence. The high intensity of the commodity flows of Katowice, the uniformity of its links, the active type of dependence and its character as an open economic region reflect the predominant role played by the raw materials and industry of this region in the structure of the national economy. As a result of its nodal organization, therefore, Katowice can be considered as the focal economic region in the national system.

Having accepted the highest intensity of inter-regional flows and the unilateral character of links as defining nodal elements of the first order one can proceed to stipulate similar elements of a lower order. Two such regional elements exist — Wrocław and Kraków voivodeships. After Katowice they dominate the connections with other regions.

Wrocław establishes a closed region of wide market specialization and a wide range of dispatched commodities. It is preponderantly active in the character of its dependence and has unilateral connections. On the other hand Kraków is an open region showing less specialization and a narrower range of commodities dispatched, though with a greater intensity of flow (than Wrocław). Likewise, however, it has active unilateral connections.

This division od Poland into parts, one linked with Wrocław, the other with Kraków as nodal regions, indicates that those are definite spatial units of higher order (above voivodeships level). Yet in those units spatial integration is weak.

Upon the basis of flow intensity binding individual regions with Wrocław and Kraków one can make the following division. The most intense flows of the Wrocław region are with Opole, Poznań, Zielona Góra, Łódź, Bydgoszcz, Szczecin and Koszalin; those of Kraków with Rzeszów, Kielce, Lublin, Warszawa, Gdańsk, Białystok and Olsztyn.

Yet further differentation of these units is possible using criteria which approximate more closely to their functions. If one recognizes as such a criterion the integration of the units according to the nature of their connections and dependence, then the following division into regional complexes may be made; active, unilateral links bind Wrocław with Poznań and Łódź (IAu), Szczecin and Bydgoszcz (IIAu), as well as with Koszalin (IIIAu); unilateral connections of passive character link

Wrocław with Zielona Góra (IPu), while an active bilateral connection exists between Wrocław and Opole (IAb). This arrangement introduces a certain hierarchy since more intensive flows occur between Koszalin and Poznań than between Koszalin and Wrocław. The relationships between Koszalin and Poznań can be classified as a secondary complex therefore. This secondary complex, moreover, shows a different structural character resulting from its economic type. Differentiation of the region of higher order (Wrocław) according to the simple economic model shows that it has uniform closed character with the exception of Koszalin which is of open type.

The inter-regional flows of Kraków bring this region into the category of a developing unit of higher order. The character of its connections and dependence are presented as follows: unilateral active connections link Kraków with Rzeszów, Warszawa, and Lublin (IAu) and with Gdańsk (IIAu); bilateral connections with mutual dependence exist between Kraków and Kielce (IMb), and of active type with Białystok and Olsztyn (IIIAb). Simultanously, however, an analysis of flows shows more intense flows from Olsztyn and Białystok to Warszawa than to Kraków. This provides a subdivision of the regional unit of higher order of which the nodal area is Warszawa with Białystok and Olsztyn as regional elements. The connections linking Warszawa with these two regions are unilateral (IPu) and passive. According to the simple economic model this system can be divided into the closed type of economic region including Rzeszów, Lublin, and Warszawa, and the open type represented by Kielce, Białystok and Olsztyn.

Despite the preponderance of subordinate relationships in the system's structure, the role played by relationships of equivalent character does come to the forefront. These relations permit one to find certain elements for division into structures of uniform regional organization. The existence of these should be interpreted as a shift from the subordinate to the equivalent relationships as well as from nodal organization to the uniform. If one accepts the assumption that bilateral links where both sides are mutually dependent in the exchange of goods are dependent on, and tie, the regional elements more strongly than unilateral links with active or passive characteristics, then one should accept the role of uniform complexes as being parallel to those of nodal organization in the regional structure.

Bilateral connections of mutual type occur only between those types of economic region which feature equivalent relationships. These occur between the following regional units: Warszawa and Lublin (IIMb); Bydgoszcz, Gdańsk, and Poznań (IIMb); Kielce and Kraków (IMb); and between Zielona Góra and Szczecin (IVMb). It should be pointed out

that only one complex (Bydgoszcz–Gdańsk–Poznań) cuts across the regional units of higher order and nodal organization. This group, which has intense links and relationships, cuts across the existing nodal organization since it includes units of both the nodal regions of Wrocław (Bydgoszcz and Poznań) and Kraków (Gdańsk). This introduces a uniform element, emphasizing a different hierarchy of the regions of higher order as bases for the internal spatial division of the country.

In the analysis of the complexity of the regional system for purpose of organization into a hierarchy one must emphasize that the linkage of regional structure on a scale lower than the national scale is too weak to be a basis for a division into economic regions of higher order and consequently compels one to treat the regional system as the basic economic region. The attempt at differentiating the system into units of higher order demonstrates that two such units (Wrocław and Kraków) become apparent, yet these regions cannot be treated as basic regions, not even regions of higher order. This is because of the small differences occuring in the character of their connections, the type of dependence, as well as the intensity of flows. Differentiating the character of regional organization in this system shows that the uniform elements are close to the nodal organization which should be considered as parallel. As a result of the connections between the regional elements resulting from economic function of the regions give a varied organization, and one which is insufficiently integrated to establish the clearly diverse regions of higher order as bases for the internal spatial division of the country.

*

The foregoing attempt at defining the complexities of regional structure based on the criterion of commodity flows can have only an introductory character. Further research on the same methodological lines as the present work must not only be based on more exhaustive and conclusive methods of regional analysis in more homogeneous units, but should dispose of detailed statistical material (in terms of reality and space) giving also the monetary values of flows.

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SOME OBSERVATIONS ON THE REGIONAL CONCEPT

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The aims of this article are twofold. In the first part the author elaborates the criteria for defining the hierarchy of nodal regions and aims to prove that such a system is inconsistent with certain basic characteristics of regions as defined by Whittlesey. In the second part, the author points out that these inconsistencies are of general character and calls for explicit recognition of two different approaches to the delimitation of regions, this being the necessary step towards clarifying the logic of the regional concept as applied both in geographic research and practical activities.

I

In the technical sense proposed by Whittlesey the region is an area in which accordant areal relations produce some form of cohesion; it is defined by specific criteria and is homogeneous only in terms of these criteria[1].

For our present purposes we shall pay particular attention to the second part of this definition. Accordingly, we shall try to elaborate the criteria for delimiting the hierarchy of nodal regions in more detail and also to check the results with the basic characteristics of the concept of regional hierarchy. These are defined by Whittlesey [3] as follows: "The region occupies a fixed position in a hierarchy of regions of the same category, in which those of each successively higher rank consist of aggregations of regions of the next lower rank (for example: minor civil divisions, counties, states, the United States). Conversely, a given region may be one subdivision of a region of higher rank... No region can belong to more than one rank... In order to

[1] The term "homogeneous" is used here in the sense used by Whittlesey, i.e. covering both "uniformity" and "unity of interconnections".

keep in view these two equally useful approaches to the construction of regions, this concept of hierarchies will be designated by the term aggregation-subdivision".

In our discussion we shall assume that the nodal region consists of phenomena studied by economic (human) geography, resulting from the fact that certain places (nodal centres) perform certain functions *vis à vis* the areas surrounding them — an assumption fully justified in view of the widely popular usage of the term "functional" to denote such regions.

The concept of the hierarchy of such regions is obviously linked (and most probably genetically related) to the concept of the hierarchy of central places.

Indeed the very possibility that a hierarchy of nodal regions can be constructed on the basis of defined criteria, depends on the validity of the basic assumptions of the central place theory

(a) that there exists a hierarchy of central places which are the regional centres,

(b) that the intensity of their interconnections with the surrounding area varies inversely to distance.

T w o n o t i o n s o f h i e r a r c h y. The notion of a hierarchy of regional centres is often linked with the existence of relationships of domination and subordination between them. Using the concept of hierarchy in this relative sense we speak of regions of higher rank when — and only when — such regions are subdivided into regions of lower rank.

Yet, the essential meaning of hierarchical arrangement of regional centres is connected with the differentiation of their functions; the centres of the higher order perform the same functions as centres of lower order (all lower orders) plus certain specific, "higher order" functions; all centres of higher order are therefore *ipso facto* also centres of lower order (all lower orders).

Recognition of this fact leads to another possible way of understanding hierarchy — as a hierarchy in absolute sense, based only on the differentiation of functions. The existence of the hierarchy in a relative sense implies the existence of the hierarchy also in the absolute sense — but not necessarily *vice-versa.*

When the notion of hierarchy is used in the absolute sense (which is logical from the point of view of the "functional approach"), there often arises a situation in which some centres of higher order in a given system have no centres of the next lower order subordinated to them.

In such cases the region of higher order is also a region of lower order. This statement contradicts one of the characteristics of the hie-

rarchical system of regions as presented by Whittlesey: "no region can belong to more than one rank".

The criteria for delimiting any nodal region must always define two elements: (a) areal features expressing the fact of some kind of interconnections, and (b) regional centres which are foci for this kind of interconnections.

In the case of delimiting the hierarchy of nodal regions, these criteria may refer to: (1) various phenomena correspoding to various functions for various ranks of the system e.g. wholesale and retail trade, (2) one phenomenon, expressing the interconnections arising jointly from various functions (flows of passengers, flows of money, etc.).

If the criteria for delimiting nodal regions have to define given regional centres, then in case of the hierarchy of such regions they must refer to centres of a defined order. Therefore in this case the problem of delimitation contains also the question of defining the rank of the regional centres.

Defining the rank of regional centres. When the areal features used as criteria for delimiting the hierarchy of regions refer to various phenomena, then the classification of regional centres into different ranks, in principle, does not involve major difficulties. In this case one either ranks the centres on the basis of their performing given functions (which, as assumed, define their rank) or one starts with investigating the whole set of places (or basic areal units) for which subordination in the sphere of given phenomena expressing functional interconnections of various ranks is subsequently defined. In both cases the rank of functions defines the rank of centres; this procedure is theoretically easy, provided that such a classification of functions is known.

In the case when the features used as criteria refer to one phenomenon only, defining the rank of regional centres is more difficult. Two methods could be applied here: defining the rank in advance, or defining it simultaneously with the study of interconnections.

According to the first method the goal could be achieved (1) by the use of an index expressing for various centres the intensity of the phenomenon investigated (e.g. in case of investigating the telephone-calls between localities — the index of the number of extra-local calls), (2) by using data additional to that taken into account in the criteria of delimitation.

According to the second method, the rank of the centres is defined by analysing interconnections only. In this case, however, we cannot go beyond the relative notion of hierarchy; and thus we can rely only on the first of the two procedures for delimitation described below.

Procedures of delimitation. Two procedures for delimiting the hierarchy of nodal regions could be applied. In the first procedure, after definition of the regions of lower order, further investigations would analyse only their centres. Using this method one can define for each centre of higher order the pattern of its interconnections only with the regional centres of the next lower order.

According to the second procedure, in delimiting the regions of higher order, one takes into account all places (or basic areal units) investigated by the delimitation of the regions of lower order.

The decision as to the use of either of these methods in a given case would depend on the one hand on the actual arrangement of the interconnections studied, and on the other, on the degree of generalization assumed as necessary and satisfactory.

In choosing the first method, which is much more convenient and less time-consuming, one has to remember that whereas the factual result of the study refers to the subordination of centres, delimitation of the boundaries of higher-order regions on this basis will include in such regions whole areas of given lower order regions. This is a generalization carrying an implication which could be the further from reality the greater the range of interconnections which, in the sphere of the phenomena investigated, may arise directly between individual places and the regional centre of the higher order.

In many cases, therefore, the use of the second method of delimitation might be necessary for obtaining meaningful results. By use of this method, however, it often happens, and this is the very reason for applying this method, that the boundary of the region of higher order intersects the area of lower-order regions, and it contradicts Whittlesey's other rule that "regions of each successively higher rank consist of aggregations of regions of the next lower rank" (the principle of "aggregation-subdivision").

The discontinuity of regions. While delimiting nodal regions one has to take into account the occurrence of the "unequal attractive power" of regional centres. This tends to be most pronounced when general indices, expressing the performance of wider groups of functions by regional centres (e.g. volume of traffic), are used in delimitation. It also exists, however, when the criteria of delimitation refer to specific functions, since any "single function" differentiated consists in reality of a certain group of functions (e.g. the function of retail trade denotes a great number of functions consisting of selling various commodities). This phenomenon of "unequal attractive power" — traditionally associated with the size of cities — is of general character and

has to be reckoned with in every delimitation of nodal regions. Yet it has special importance in the case of delimiting regions of the same order of two cities, one of which is also a regional centre of higher order, and hence has supposed much greater "attractive power".

The simple gravitational model — based on the assumption that the influence of the regional centre is proportional to its size and varies inversely with distance — indicates that the geometric place of all points of equal influence of two centres of "unequal attractive power" is a circle, encompassing the smaller centre. This model explains that the frequent occurrence of discontinuous nodal regions is quite logical even in conditions conforming to the basic assumptions of the central place concept, which, as stated above, are involved in the concept of the hierarchy of nodal regions as such. Yet, this discontinuity contradicts the very definition of a region as a continuous area.

II

The above statements as to the hierarchy of nodal regions challenging in several respects Whittlesey's concept of universal characteristics of regions point to certain basic inconsistencies in his formulations of the concept of region. Analogical inconsistencies could be proved to exist in the concept of hierarchy in general for the very reason that this concept involves the notion of region as a unit of areal division, which is logically quite different than the elaborated by Whitt--lesey concept of region as an area homogeneous in terms of specific criteria. Although this last concept is of great value to geography, it has its limitations and cannot be considered as the only valid one.

It has been clearly demonstrated by Hartshorne in his discussion on systematic and regional geography [2] that Whittlesey's concept of region covers only one field of the term's usage, a term which in fact denotes several different concepts. "The concept of an area homogeneous in particular categories, the formal region, and the concept of an area coherently organized in particular ways, the functional region, are concepts of partial integration — the topical approach. For the concept of a unit of areal division in regional study, we use the word 'region' in essentially its original and common meaning" [2, p. 142].

The distinction, however, is not one between "region" in regional and in topical geographic studies; it is the more general distinction between two approaches to the delimitation of regions.

The first one starts with the aim of revealing of patterns of areal homogeneity in the phenomena studied. These patterns, called "regional" patterns, are defined i f and w h e n the actual arrangement of

given elements or element-complexes on the surface of the Earth makes them suitable for this kind of generalization.

The other approach starts from the need for areal division. "In regional geography — says Hartshorne — it is necessary to divide the total area under study allotting every place to some region". This type of approach is characteristic, however, for delimiting of regions not only for purposes of regional geography, but also for various purely topical studies, as well as for practical purposes (administration, planning etc.).

Only according to the first approach could the region be considered as an "areal generalization"; according to the second approach it is a "unit of areal division". In both cases it is an analytical device, and in both cases the criteria of delimitation should be chosen in view of the problem under study. However, it is only in the first case that the criteria refer to specific areal features defining the regional boundaries.

The logic of the second type of approach could be best expressed with a statement of the underlying principle: "a n y regional division better the none". In most cases, however, the need for areal division is accompanied by certain requirements which even the intuitive division made by a layman will meet better than a completely haphazard one. When we speak therefore, about "criteria of delimitation", the term denotes here a certain set of requirements to be met by a system of areal division. These requirements are, generally speaking, twofold:

(a) the requirements as to the correspondence of the areal division with regional patterns of some areal features (criteria which are "endogeneous" with respect to the mapped patterns);

(b) other requirements, "exogeneous" in the same respect.

For the purposes of study in regional geography, these two sets of conditions are very loosely defined, and almost never stated explicitly. As to the first type of requirement we have here only one condition: that the given regional division should be based for each region on some outstanding areal features — the importance of which is judged by the author — so "that each (region) has s o m e d e g r e e (spacing A. W.) of formal and functional unity, or both, with respect to some categories, at the sacrifice of formal and functional unity in respect to other categories" [2, p. 141]. This requirement is usually paired with only one "exogeneous" condition pertaining to the approximate number of regions into which the given area is to be divided. This approximate number depends of course on the detail elaborated in the study and its destination; in most cases, it rarely exceeds the number of — say — ten units of regional division of a given area. Where a study requires a more

detailed regional framework, hierarchical division into regions of higher and lower order is used; this enables one to meet the demand both for more detailed analysis and for synthetic generalization.

In the case of divisions made for more restricted topical purposes (including practical ones), these two types of conditions to be met by the regional division vary both in the degree of their precision as well as in their relative importance.

For certain types of problems the basic requirement is that the regional division should correspond as closely as possible to certain defined areal patterns of homogeneity. In such cases the exogeneous requirements will dictate only the choice of conventions used in delimiting the regional boundaries of areas, where the features studied do not form continuous patterns. In such cases it may be possible to construct a system of division based exclusively upon precisely defined areal features, so that formally the regions will conform to the definition of region according to the first approach. The criteria of such a division however will be a kind of compromise between the need for division and the significance of these criteria for the problem studied — at the expense of the latter.

At the other extreme we find such studies for which the requirements to be met by the system of a division are so loose that proper delimitation is not treated at all as a problem; usually some divisions constructed for other purposes — most often administrative divisions — are considered, therefore, as quite satisfactory for the needs of a given study. Although the requirement of some correspondence of the regional divisions with some patterns of homogeneity is inherent in the basic original meaning of the very term "region", in many cases the term is used even if no such correspondence could be claimed. This is the case, for example, with studies of "interregional commodity-flows" where useful results are being obtained by using any system of division into a sufficiently large number of areal units; for example, as the division of the U.S.A. into States, which cannot be considered at all as homogeneous units. In many other cases this requirement could be reduced to the implied rule that the regional division should not intersect patterns of particularly intensive interconnections or marked areal uniformities that are considered important for the problem under study.

When regions are delimited for practical purposes, in simple cases (e.g. defining of most rational service areas for a number of wholesale trade stores) the criteria of delimitation have purely "exogenous" character; they are determined by an equation designed to find the extreme values of some kind, such as costs of transport, sum of distances etc.

Where the purposes of such division are of more complex character, the criteria of delimitation, from the purely theoretical abstract point of view, may be similarly formulated. In practice, however, these criteria form a set of requirements, some of which are of "endogenous" and some of "exogeneous" character.

As an example of such a set of requirements let us take the six "axioms" formulated by C. B. Fawcett (1917) in his proposal for the new administrative division in England and Wales [1]:

1. The provincial boundaries should be so chosen as to interfere as little as possible with the ordinary movements and activities of the people.

2. There should be in each province a definite capital, which should be the real focus of regional life. This implies, further, that the area and communications of the province should be such that the capital is easily accessible from every part of it.

3. The least of the provinces should contain a population sufficiently large to justify self-government.

4. No one province should be so populous as to be able to dominate the Federation.

5. The provincial boundaries should be drawn near the watersheds rather then across the valleys and very rarely along streams.

6. The grouping of areas must pay regard to local patriotism and to tradition.

Among these six principles, the third and fourth ones are typically exogenous requirements, whereas the remaining ones are endogenous requirements which formulate (or lead to formulation of) the criteria of the correspondence of the division with specific areal features. It should be noted that such a set of criteria does not determine the division uniquely, but leave a certain margin of choice.

In the present conditions of planned economy determining different and more complex goals of such a regional division, the formulations as the one quoted above, seem very general and even naive. The accumulated experience and existing state of knowledge enables us to state a set of much more substantial requirements with much greater precision. Yet the logic of the procedure of delimitation remains the same and should not be confused by the statements frequently repeated from the end of 19th century up to this time, that the regions of planning and administration should correspond to certain regions "existing in reality", and that the delimitation of such regions could be the task of geography.

The essential task of the latter in this field is to reveal and analyse the patterns of uniformities and interconnections significant for the

functioning and development of the national economy which together form a certain regional (or spatial) structure. Proceeding from this regional structure to a regional division for the purposes of administration or planning one must always apply premises which cannot be infered solely from the analysis of this structure.

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PERSONAL INDEX

Compiled by *J. Grzeszczak* and *T. Jeżewska*

LIST OF CURRENT GEOGRAPHICAL PERIODICALS IN POLAND

This list does not include all the journals and publications where one might find geographic works but only those of predominantly geographical character. Thus, the general university series in which separate volumes or subseries deal with geography, and only those regional publications where there are separate geographical series and so forth were included. The list does not include journals on geology, meteorology, geodesy, economics, town planning, nor those regional journals of more comprehensive character, although they might sometimes contain articles of geographic character or interest.

On the list regular geographical journals were treated separately, while all the others were divided according to their editors into publications of the Polish Academy of Sciences, those of Universities, Academic Schools, Scientific Societies and finally some regional series.

Each journal or series was characterized in following way: original title and its English translation, frequency, editor (in English) and the adress of the editorial office, year of the first volume published, publisher (in Polish), average no. of copies issued, format, average no. of pages per year, occurence of figures, maps, tables, language of summaries if any, price per volume in Polish Złoties.

There is also a short description of each publication.

Journals

Czasopismo Geograficzne (Geographical Journal), Quarterly. Julian Czyżewski, editor. Editorial office: Wrocław, Pl. Uniwersytecki 1. Vol. 1–(1923–). Państwowe Wydawnictwo Naukowe. 2500 copies. 8° pp. 400, figures, maps, tables, bibliography English or French and Russian summaries. 60 zł each vol.

Articles on all aspects of geography but principally on physical and regional geography. Geographical news, critical reviews of books and maps, and Society news.

Geografia w Szkole (Geography in the School). 5 vols a year. Józef Barbag, editor. Editorial office: Warszawa, Pl. Dąbrowskiego 8. Vol. 1-(1948-). Państwowe Zakłady Wydawnictw Szkolnych. 15 000 copies. 8° pp. 325, figures, maps, tables, bibliography. 4 zł each copy.

Devoted to problems of teaching geography in primary and secondary schools. Articles on different aspects of geography. Teaching programmes and school practice. Notes on geographical events in Poland and abroad. Chronicle.

Geographia Polonica. Annual. Institute of Geography. Polish Academy of Sciences. Stanisław Leszczycki, editor. Editorial office: Warszawa 64, Krakowskie Przedmieście 30. Vol. 1–(1963–). Państwowe Wydawnictwo Naukowe. 1000 copies. 8° pp. ca 300, figures, maps, tables. In English or French.

The journal contains articles about the results of geographic research carried out in Poland, with emphasis on the methods of study and philosophy of geography. There are original works as well as translations or summaries of studies published earlier in Polish. In this journal papers prepared by Polish geographes for international congresses are also published as well as proceedings of international conferences held in Poland.

Poznaj świat (Know the World). Monthly. Polish Geographical Society. Edited by the Committee of the Praesidium of PGS. Editorial office: Warszawa, Nowy Świat 49. Vol. 1–(1948–). Państwowe Wydawnictwo Naukowe. 110 000 copies. 4° pp. 500, figures, maps. 5 zł a copy.

A popular well illustrated geographical magazine of very wide circulation. Articles on Poland and foreign countries. Numerous coloured and black-and-white photographs, usually with one coloured map on the cover. Short book reviews, statistical data and a conceise information concerning one country or continent, geographical news and other matters.

Przegląd Geograficzny (Polish Geographical Review). Quarterly. Institute of Geography. Polish Academy of Sciences. Stanisław Leszczycki, editor. Editorial office: Warszawa 64, Krakowskie Przedmieście 30. Vol. 1–(1918–). Państwowe Wydawnictwo Naukowe. 2000 copies. 8° pp. ca 800, figures, maps, tables, bibliography. English (or French or German) and Russian summaries. 25 zł a copy.

The leading Polish geographical journal. Contains: articles, notes, reports, discussions, critical book reviews. Research studies of Polish and foreign geographers as well as of other scholars covering all fields of geography. Emphasis on theoretical problems, methods of study; original research reports. Some issues deal with special subjects. English supplements to volume 28 (1956), 31 ((1959) and 32 (1960).

Publications of the Polish Academy of Sciences

Institute of Geography

Bibliografia Geografii Polskiej (Bibliography of Polish Geography). Irregular. Institute of Geography. Polish Academy of Sciences. Stanisław Leszczycki, editor. Editorial office: Warszawa 64, Krakowskie Przedmieście 30. 1956–. Państwowe Wydawnictwo Naukowe. 8° pp. varied. Arrangement by subjects and regions. Each volume priced separately.

Till now 4 volumes have been issued with 9249 entries covering the period 1936—1954.
Notice: There are 5 volumes of the Geographical Series of the Polish Analytical Bibliography covering the period 1953—1957. It will not be continued.

Dokumentacja Geograficzna (Geographical Documentation). Predecessor from 1952 was the Biuletyn Geograficzny Polskiego Towarzystwa Geograficznego. Irregular. Institute of Geography. Polish Academy of Sciences. Kazimierz Dziewoński, edi-

tor. Editorial office: Warszawa 64. Krakowskie Przedmieście 30. Vol. 1–(1955–). Instytut Geografii PAN. 500 copies. 8° pp. varied, figures, maps, tables, bibliography. Mimeographed. 7 zł each copy.

Contains results of geographical investigations (including preliminary ones) of different research centres in Poland as well as scientific documentation, explanations of geomorphologicl aand hydrographical maps, instructions, doctoral dissertations, bibliographies.

Prace Geograficzne (Geographical Studies). Irregular. Institute of Geography. Polish Academy of Sciences. Stanisław Leszczycki, editor. Editorial office: Warszawa 64, Krakowskie Przedmieście 30. Vol. 1–(1954–). Państwowe Wydawnictwo Naukowe or Wydawnictwa Geologiczne. 8° pp. varied, figures, maps, tables, bibliography. English, French or German, and Russian summaries. Each volume priced separately.

Monographs prepared by separate authors (often doctoral dissertations) or teams on various aspects of physical, economic, historical, applied geography and history of geography. Till now 40 numbers including 6 in English were published; among others proceedings of international conferences organized by the Institute of Geography eg. Vol. 25 — Problems of Applied Geography, Vol. 27 — Problems of Economic Region, Vol. 31 — Land Utilization. Methods and Problems of Research.

Przegląd Zagranicznej Literatury Geograficznej (Review of Foreign Geographical Literature). Predecessor from 1950 was Przegląd Radzieckiej Literatury Geograficznej. Quarterly. Institute of Geography. Polish Academy of Sciences. Jerzy Kostrowicki, editor. Editorial office: Warszawa 64, Krakowskie Przedmieście 30. Vol. 1–(1955–). Instytut Geografii PAN. 500 copies. 8° pp. ca 800, figures, tables, bibliography. Mimeographed. 10 zł each volume.

Contains translations of foreign publications (articles, sections of books) ranging from physical to economic geography, reports on travels abroad and on literature. Each volume deals with one topic. Mainly for junior scientific workers and students in Poland.

OTHER PUBLICATIONS CONTAINING GEOGRAPHICAL STUDIES

Biuletyn. Komitet Przestrzennego Zagospodarowania Kraju (Bulletin. Committee for Space Economy and Regional Planning). Irregular. Polish Academy of Sciences. Kazimierz Dziewoński, editor. Editorial office: Warszawa, Pałac Kultury i Nauki. Vol. 1–(1960–). Komitet Przestrzennego Zagospodarowania Kraju PAN. 8° pp. 100, bibliography. Mimeographed, manuscript.

A periodical presenting studies made under the auspices of the Committee. It provides a basis for internal discussion on the results of more important studies. Contains detailed studies covering demography, settlement, transport, spatial distribution of industry, industrialization, regionalization etc. Till now 19 volumes were published.

Bulletin de l'Académie Polonaise des Sciences. Sér. des Sciences Géologiques et Géographiques. Quarterly. Polish Academy of Sciences. Kazimierz Smulikowski, editor. Editorial office: Warszawa, Pałac Kultury i Nauki. Vol. 1–(1960–). Państwowe Wydawnictwo Naukowe. 8° pp. varied, figures, maps, tables, bibliography. In French with Russian summaries. 20 zł each volume.

Short communications giving original research results without full scientific documentation.

Studia i materiały z dziejów nauki polskiej (Studies and Documents from the History of Polish Science). *Ser. C. Historia nauk matematycznych, fizyko-chemicznych i geologiczno-geograficznych* (History of Mathematics, Physics, Chemistry, Geology and Geography). Irregular. Polish Academy of Sciences, Department of History of Science and Technology. Bolesław Olszewicz, editor. [Editorial office: Warszawa, Pałac Kultury i Nauki]. Vol. 1–(1957–). Państwowe Wydawnictwo Naukowe. 8° pp. varied, figures, bibliography. Each volume priced separately.

Dissertations devoted to the history of science including geography.

Publication of the universities and academic schools

Gdańsk

Zeszyty Geograficzne (Geographical Papers). Yearbook. Teachers' Training College in Gdańsk. Geographical Department. Józef Staszewski, editor. Editorial office: Gdańsk—Wrzeszcz, Sobieskiego 18. Vol. 1–(1959–). Wydawnictwo Morskie. 8° pp. varied, figures, maps, tables. English summaries. 15 zł a volume.

Contains research reports on physical, economic and regional geography of the costal region.

Kraków

Prace Geograficzne. Seria Nowa (Geographical Studies. New Series). Irregular. *Zeszyty Naukowe Uniwersytetu Jagiellońskiego. Prace Instytutu Geograficznego U. J.* (Scientific Papers of the Jagellonian University. Works of the Geographical Institute). Mieczysław Klimaszewski, editor. [Editorial office: Kraków, Grodzka 64]. Vol. 1-(1960-). Uniwersytet Jagielloński. 8° pp. varied, figures, maps, tables, bibliography. English and Russian summaries.

Each number is a serial dealing with physical geography only.

Prace z Geografii Ekonomicznej (Studies on Economic Geography). Irregular. *Zeszyty Naukowe Uniwersytetu Jagiellońskiego.* (Scientific Papers of the Jagellonian University). Antoni Wrzosek, editor. [Editorial office: Kraków, Grodzka 64]. Vol. 1–(1960–). Uniwersytet Jagielloński. 8° pp. varied, figures, maps, tables, bibliography. French and Russian summaries. Each volume priced separately.

Contains articles relating to studies carried out mainly in the Kraków region by junior scientific workers at the Department of Economic Geography.

Rocznik Naukowo-Dydaktyczny. Geografia (Scientific and Didactic Yearbook Geography). Irregular. Teachers' Training College in Kraków. Maria Dobrowolska, editor. [Editorial office: Kraków, Straszewskiego 22.] Vol. 1–(1951–). Państwowe Wydawnictwo Naukowe. 8° pp. varied, figures, maps, tables, bibliography. English and Russian summaries. Each number priced separately.

Some volumes of this series are devoted to geography (4, 8, 10). They contain articles which give research reports prepared by the scientific workers dealing with economic, regional and physical geography.

Lublin

Annales Universitatis Mariae Curie-Sklodowska. Sectio B. Geographia, Geologia, Mineralogia et Petrographia. Yearbook. Adam Malicki, editor. Editorial office: Lublin, Pl. Litewski 5. Vol. 1–(1946–). Uniwersytet im. Marii Curie-Skłodowskiej. 4° pp. varied, figures, maps, tables, bibliography. English, French, German, and Russian summaries. 30 zł each volume.

Articles on different aspects of geography. Emphasis on physical geography. Vol. 15 devoted to the VI-th Congress of INQUA dealing with problems of the loess. Till now 16 volumes were published.

Poznań

Zeszyty Naukowe (Scientific Papers). College of Economics in Poznań. Ser. I. Irregular. Seweryn Kruszczyński, editor. [Editorial office: Poznań, Marchlewskiego 146/150]. Vol. 1–(1961–). Wyższa Szkoła Ekonomiczna. 8° pp. 200, maps, tables. English and Russian summaries. Mimeographed.

In this series some volumes (1, 4, 5) are devoted to economic geography: they were prepared on the Institute for Regional Economy in the College of Economics in Poznań.

Zeszyty Naukowe Uniwersytetu im. Adama Mickiewicza w Poznaniu (Scientific Papers of the Adam Mickiewicz University in Poznań). *Geografia.* Irregular. Florian Barciński, editor. [Editorial office: Poznań, Fredry 10.] Vol 1–(1957–). 8° pp. varied, figures, maps, tables, bibliography. English, French, German and Russian summaries. Each volume priced separately.

Reports on studies prepared at the Department of Geography, mainly geomorphology.

Sopot

Zeszyty Naukowe Wyższej Szkoły Ekonomicznej w Sopocie (Scientific Papers of the College of Economics in Sopot). *Ser. B.* Irregular. Zbigniew Jaśkiewicz, editor. [Editorial office: Sopot, Czerwonej Armii 101/103]. Vol. 1–(1953–). Wyższa Szkoła Ekonomiczna. 8° pp. varied, figures, maps, tables, bibliography. English and Russian summaries.

Volume 9 contains a monograph, while in other numbers articles are published covering economic gography.

Toruń

Zeszyty Naukowe Uniwersytetu Mikołaja Kopernika w Toruniu. Nauki Matematyczno-Przyrodnicze. Geografia (Scientific Papers of the Mikołaj Kopernik University in Toruń. Natural Science. Geography). Irregular. Rajmund Galon, editor. [Editorial office: Toruń, Fredry 8.] Vol. 1–(1956–). Państwowe Wydawnictwo Naukowe. 8° pp. varied, figures, maps, tables, bibliography. French summaries.

Till now only one volume (4) devoted to geomorphology.

Wrocław

Prace Zakładu i Obserwatorium Meteorologii i Klimatologii Uniwersytetu Wrocławskiego im. Bolesława Bieruta (Reports of the Meteorological and Climatological Institute and Observatory of the Bolesław Bierut University in Wrocław). Irregular. Wrocławskie Towarzystwo Naukowe. Aleksander Kosiba, editor. [Editorial office: Wrocław, Cmentarna 11/13]. Vol. 1–(1947–). Wrocławskie Towarzystwo Naukowe. 8° pp. varied, figures, tables. English summaries.

Till now 10 volumes have been issued on the climate of Wrocław during 1946—1955 based on the surveys of the observatory.

Acta Universitatis Wratislaviensis. Ser. Studia Geograficzne (Geographical Studies). Predecessor since 1956 was the Zeszyty Naukowe Uniwersytetu Wrocławskiego Ser. B. Nauki Przyrodnicze. Seria Nauka o Ziemi (Papers of the Wrocław University Ser. B. — Natural Sciences. Ser.: Earth Sciences). Irregular. Józef Wąsowicz, editor. [Editorial office: Wrocław, Pl. Uniwersytecki 1.] Vol. 1–(1963–). Państwowe Wydawnictwo Naukowe. 4° pp. varied, figures, maps, tables, bibliography. Summaries in foreign languages. 10 zł a volume.

Articles on different aspects of geography.

Warszawa

Zeszyty Naukowe Szkoły Głównej Planowania i Statystyki (Scientific Papers of the College of Planning and Statistics). Irregular. Vol. 1–(1953–). Szkoła Główna Planowania i Statystyki. 4° pp. varied, figures, maps, tables. English and Russian summaries. Mimeographed.

Some volumes (7, 17, 41) are dealing with economic geography only. They are prepared by the members of the staff at the Department of Economic Geography under the chairmanship S. Berezowski.

Scientific societies

Łódź

Acta Geographica Lodziendzia (Predecessor till 1962 was Acta Geographica Universitatis Lodziensis). Irregular. Societas Scientiarum Lodziensis (Scientific Society of Łódź). Sec. III. Jan Dylik, editor. Editorial office: Łódź, Sienkiewicza 29. Vol. 1–(1948–). Państwowe Wydawnictwo Naukowe. 8° pp. varied, figures, maps, tables, bibliography. English, French or German and Russian summaries. Each volume priced separately.

The volumes of this series (until now 15 vols have been published) deal with geomorphology, geology, agricultural geography and history of settlement. Mainly reports from investigations in Poland; vol. 9 and 11 give the results of field observations in China and on Spitsbergen. The authors are members of the staff of the Section of General Geomorphology (Institute of Geography. Polish Academy of Sciences) and of the Geographical Institute of the Łódź University.

Biuletyn Peryglacjalny (Periglacial Bulletin). Irregular. Societas Scientiarum Lodziensis (Scientific Society of Łódź). Sec. III. Jan Dylik, editor. Editorial office: Łódź, Skłodowskiej-Curie 11. Vol. 1–(1954–). Łódzkie Towarzystwo Naukowe. 8° pp.

varied, figures, maps, bibliography. English, French and Russian summaries. Each number priced separately.

The leading Polish periodical devoted to periglacial topics only. Articles by Polish as well as foreign authors. Contains articles, terminological studies, notes and book reviews. Many figures and photographs.

Bulletin de la Société des Sciences et des Lettres de Łódź. Cl. III. De Sciences Mathématiques et Naturelles. Irregular. Łódź Scientific Society. Editorial office: Łódź, Sienkiewicza 29. Vol. 1–(1947–). Państwowe Wydawnictwo Naukowe. 8° pp. varied, figures, maps, bibliography.

A periodical in foreign languages devoted to physical geography.

Poznań

Badania Fizjograficzne nad Polską Zachodnią (Physiographical Studies on Western Poland). Irregular. Society of the Friends of Science. Department of Natural Science and Mathematics. Physiographic Committee. Bogumił Krygowski, editor. [Editorial office: Poznań, Fredry 10]. Vol. 1–(1948–). Państwowe Wydawnictwo Naukowe. 8° pp. varied, figures, maps, tables, bibliography. English, French or German, and Russian summaries. Each volume priced separately.

Dissertations, articles, communiqués, reports on studies of the geographical environment of Western Poland.

Prace Komisji Geograficzno-Geologicznej (Studies of the Geographical and Geological Commission). Irregular. Poznań Society of the Friends of Science). Department of Natural Science and Mathematics). Tadeusz Bartkowski, editor. [Editorial office: Poznań, Fredry 10]. Vol. 1 : 1936–1938, Vol. 2–(1956–). Państwowe Wydawnictwo Naukowe. 8° pp. varied, figures, maps, tables, bibliography. English and French summaries. Mimeographed. Each volume priced separately.

Each volume is a serial. Till now 11 vols have been issued (7 after World War II), covering physical geography.

Toruń

Studia Societatis Scientiarum Torunensis. Sec. C. Geographia et Geologia. Irregular. Scientific Society in Toruń. Rajmund Galon, editor. [Editorial office: Toruń, Fredry 8]. Vol. 1–(1951–). Państwowe Wydawnictwo Naukowe. 4° pp. varied, figures, maps, tables, bibliography. English, French and Russian summaries. Each volume priced separately.

Selected regional publications

Katowice

Górnośląskie Prace i Materiały Geograficzne (Upper Silesian Studies and Geographical Documents). Irregular. Silesian Scientific Institute in Katowice. Antoni Wrzosek, editor. [Editorial office: Katowice, Francuska 12]. Vol. 1–(1962–). Wydawnictwo „Śląsk". 8° pp. varied, figures, maps, tables, bibliography. English and Russian summaries. Mimeographed.

So far only one volume dealing with the settlement geography of Upper Silesia.

Opole

Materiały i Studia Opolskie (Documents and Studies on Opole District). Half-yearly. Scientific Economic Council at the Voivodeship Planning Commission; Polish Economic Society in Opole. Editorial Board. Editorial office: Opole, Piastowska 14. Vol. 1–(1958–). Wydawnictwo „Śląsk". 8° pp. varied, figures, maps, tables, Mimeographed. 20 zł a volume.

Articles, communiqués nad reports on economico-geographical investigations in the Opole voivodeship.

Poznań

Prace Geograficzno-Ekonomiczne (Economico-geographical Studies). Irregular. Western Institute. Stanisława Zajchowska, editor. [Editorial office: Poznań, Stary Rynek, Waga.] Vol. 1–(1961–). Instytut Zachodni. 8° pp. varied, figures, maps, tables, bibliography. Each volume priced separately.

Vol. I the only one published so far in this series contains a monograph on Zielona Góra voivodeship.

Compiled by *Barbara Kawecka*

Errata

Page/Line		*For*	*Read*
24/25	Fig. 1. Title		(according to E. Tomaszewski)
63[18]		psysiocoenose	physiocoenose
67	Fig. 1. Key	between 3-15;	between 3-15^0;
68[21]		T. Bartowski	T. Bartkowski
131$_{13}$		*z* units	*z* grain units
219[18]		region's sare	region's share

Geographia Polonica 1, 1964

Cena zł 57.—

Next volumes of
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will contain

VOL. 2

34 papers prepared by Polish geographers for the XXth International Geographical Congress in London, July 1964. They represent various fields in geography and are dealing mainly with geographical problems of Poland. C. 280 pp., c. 100 Figures. (in print).

VOL. 3

Problems of Applied Geography II. Proceedings of the Second Anglo-Polish Seminar at Keele — Great Britain, September 9 — 20, 1962. Co-edited by the Institute of British Geographers (co-editor of the volume Professor Stanley H. Beaver). 21 papers by British and Polish geographers, c. 260 pp., c. 70 Figures. (in print).

VOL. 4

Methods of Economic Regionalization. Materials of the Second General Meeting of the Commission on Methods of Economic Regionalization, International Geographical Union, Jabłonna-Poland, September 9 — 14, 1963. Editor of the volume Professor Kazimierz Dziewoński. Reports, communications and discussion. C. 260 pp., c. 20 Figures. (in print).

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