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The Character and Role of Scientific Centres in Poland

Introduction

The aim of the work is to define the character and role of scientific centres in Poland and the ultimate model of their development. Hence, it will present the diversification of science as a socio-cognitive system by distinguishing its subsystems — scientific centres forming spatial clusters of units carrying out scientific activity and associated with large cities. This is a system approach to science in its spatial dimension.¹

The work has four parts. Part one presents the state and kinds of scientific institutions in Poland. Part two outlines an empirical model of a scientific centre which provides a basis for the characterization of the Polish scientific centres given in part three. Part four, in turn, presents the ultimate model of the development of scientific centres in Poland.

1. The state and kinds of scientific institutions in Poland

In Poland scientific activity is carried out by three basic kinds of institutions: 1) higher schools, 2) institutions of the Polish Academy of Sciences (PAN), and 3) research and development (R&D) units.

Higher schools are engaged in scientific and didactic work. They include: universities, higher technical schools, agricultural, economic and medical academies, higher pedagogical schools, higher maritime schools, physical training academies, higher arts schools, and theological academies. They are subordinate to the Ministries of National Education, Health, Culture and Arts, the Office for Maritime Economy, and the Committee for Physical Culture and Tourism.

The institutions of the Polish Academy of Sciences (PAN) include independent scientific institutes and departments. They are affiliated to seven PAN Faculties: of Social Sciences, Biological Sciences, Mathematical, Physical and

¹ Chojnicki Z., *A Methodological Model of a Scientific Discipline*, [in:] Kukliński A. (ed.), *Transformation of Science in Poland*. Science and Government Series, Vol. 1. State Committee for Scientific Research. Warsaw, 1991.

Chemical Sciences, Technical Sciences, Agricultural and Forest Sciences, Medical Sciences, and Earth and Mining Sciences.

The R&D units embrace R&D institutes, R&D centres, and central laboratories. They are mostly subordinate to various ministries, but also to central offices.

There is a separate group of institutions providing scientific services: libraries, archives, information centres, computing centres, etc.

It is rather difficult to give a division of scientific units and institutions according to their engagement in basic or applied sciences. In principle, the division of sciences into basic and applied rests on the degree of concreteness of results and fulfilment of their practical functions. Traditionally, basic sciences are taken to include mathematics, physics, chemistry, biology, astronomy, Earth sciences, social sciences, and the humanities, while applied sciences — medical, technical, agricultural and economic sciences. However, this division is not disjunctive. Thus, the decision to ascribe particular scientific institutions to basic or applied sciences is arbitrary and rests on the following assumptions:

1) among higher schools universities are thought to belong to basic sciences, while higher technical schools and agricultural, economic and medical academies to applied sciences;

2) all PAN institutions are classified as belonging to basic sciences;

3) all R&D units are assumed to belong to applied sciences.

The above classification is reflected in the structure of the State Committee for Scientific Research (KBN).² It consists of the Committee for Basic Sciences, out of the 28 members of which 14 are university professors and 2 are PAN professors, and the Committee for Applied Sciences, whose activists are 14 polytechnic professors, 3 professors of an agricultural academy, 2 professors of a medical academy, and 11 professors of R&D units.

In terms of figures, scientific institutions in Poland look as follows: in 1989 there were 97 higher schools, 81 PAN institutions, and 297 R&D units.³ Among them they employed a total of 66,000 scientific workers, including 14,000 higher-ranking ones, i.e. professors and associate professors (*docents*). Higher schools had a share of 76% of scientific workers and as many as 80% of professors and associate professors. PAN institutions had 7% of scientific workers and 8% of higher-ranking ones. R&D units employed 16% of the total number of workers and 11% of professors and associate professors.

As the above data show, the highest scientific and research potential can be found in higher schools, which also fulfil educational functions.

² The KBN is a chief administrative body brought into existence by an Act of January 12, 1991. KBN members represent scientific circles of the country and jointly decide on the allocation of funds for scientific activity.

³ Data from *The 1990 Statistical Yearbook*, Central Statistical Office. According to *Informator Nauki Polskiej 1989/1990* (the guide-book of Polish science), the figures look as follows: 97 higher schools, 78 PAN institutions, and 310 R&D units.

2. The concept of a model of a scientific centre

A scientific centre is a spatial cluster of scientific units (departments, institutes, universities and other scientific institutions) within a single city or several cities.

A scientific centre comprises units representing each of the three organizational sections of science, viz. higher schools, PAN institutions and R&D units; the presence of a university is indispensable.

Polish scientific centres are clearly associated with the network of large cities and constitute an integral component of their spatial-functional structures.

Two points should be noted at this stage:

1) the presence of the main sections of science in each centre gives it a complex character and shows full scientific and educational activity to be carried out there;

2) the presence of a university, which is a scientific and academic institution of prime importance, is a necessary condition for the formation of a centre due to its dominant role in the training of the scientific staff and carrying out of basic research.

To characterize scientific centres, their following properties should be considered:

- In the internal structure of a centre there is a specific pattern of factual links and dependences determined by the scientific potential of its scientific units.
- The position of the three sections of science in a centre determines its functional properties and shapes its scientific structure and profile. The scientific structure is formed by the share and role of basic and applied sciences as well as education in the activity of the centre. Associated with its scientific structure is its profile, which can be specialized or multidirectional and which means involvement in selected disciplines.
- Internal relations in a centre holding among scientific units or sections define the functioning of the centre as a spatial whole.
- The size of a centre and its rank in the set of scientific centres is determined by its total potential measured as the number of professors and associate professors employed.

The division of scientific centres rests on four criteria.

The first division is made on the basis of the spatial organization, and distinguishes two classes: 1) scientific centres embracing a single city, or *monocentres*, and 2) those embracing several cities, or *polycentres*. In comparison with a monocentre, a scientific polycentre is a more complex and expansive form of spatial organization of scientific units. A monocentre is associated with the settlement system of an urban agglomeration with a single, dominant city in which socio-economic functions concentrate, not excepting scientific and educational ones. A polycentre can be found in the settlement system of an urban agglomeration with two or more equal (or almost equal) cities which divide socio-economic

functions, including scientific and educational ones, between themselves in a complementary way.

The **second** division of scientific centres, by size, carried out on the basis of their scientific potential as measured by the number of higher-ranking scientific workers, distinguishes centres of various hierarchical orders.

By superimposing these two divisions on each other we obtain two-dimensional classes of scientific centres which answer to the following descriptions: a highest-order scientific monocentre, a low-order scientific polycentre, etc. Thus, the two-dimensional classification assumes that in an empirical distribution of scientific centres a monocentre can be of a higher order than a polycentre.

The **third** division of scientific centres is one based on their functional properties. It yields three classes:

- 1) with the dominance of academic functions;
- 2) with a balance between academic and purely scientific functions;
- 3) with the dominance of purely scientific functions.

The **fourth** division gives classes of centres by their impact range. The social impact of a centre, or its relations with the outside, depends on its functional properties and size. By the character and spatial range of impact, the centres are grouped in two classes: regional and national.

3. The characterization of scientific centres in Poland

3.1. The identification of scientific centres

By the adopted criteria of a scientific centre, ten of them can be distinguished in the Polish spatial network of scientific units (Fig. 1): the Warsaw, Cracow, Poznań, Wrocław, Łódź, Lublin, Szczecin, Upper Silesian, Tri-City, and Toruń-Bydgoszcz ones. The incomplete description of the Szczecin and Toruń-Bydgoszcz centres only results from lack of full information. Table 1 presents no figures for the PAN institutions in these two centres and for R&D units in Szczecin. Both centres have units of these two sectors, but they are branches, departments, workshops, teams or stations subordinate to institutions with the seats in other cities, and hence appear in the statistics of those other cities.⁴

Among the ten scientific centres, seven belong to the class of monocentres associated with single large cities (from 1.7 million to 350,000 inhabitants). These are the centres of Warsaw, Cracow, Wrocław, Poznań, Łódź, Szczecin and Lublin. The remaining three are polycentres, each of which embraces two or more towns. The Toruń-Bydgoszcz centre is associated with two towns: Toruń (200,000 population) and Bydgoszcz (380,000), which have strong functional links of a complementary character. The Tri-City centre spreads over Gdańsk (470,000), Gdynia (251,000) and Sopot (48,000), which are spatially and functionally integrated. The Upper Silesian centre embraces five functionally integrated towns: Katowice (370,000), Sosnowiec, Bytom, Gliwice and Zabrze (260,000–200,000).

⁴ Unfortunately, *Informator nauki polskiej* (The Polish Science Reference Book) does not provide separate data on subordinate institutions.

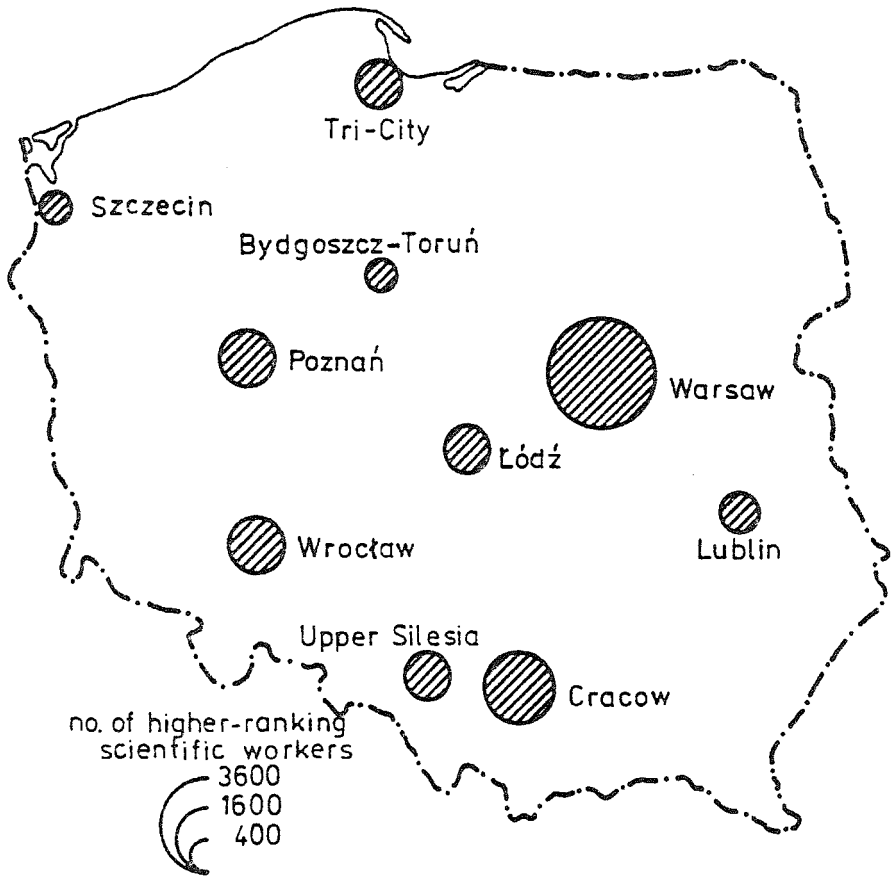


Figure 1. The distribution of scientific centres in Poland

Apart from the ten scientific centres, scientific units are located in 55 localities (43 towns and 12 villages). They include:

- 11 towns with higher schools,
- 1 town and 4 villages in which PAN institutions are located,
- 39 towns and 8 villages with R&D units.

Out of this set of 55 localities, 42 (including the 12 villages) have one scientific unit, 4 towns have two, 6 towns have three, and 3 towns have four or five units.

3.2. The scientific potential of the centres

The ten scientific centres have 79 higher schools (81% of the total), 73 PAN institutions (94%), and 252 R&D units (81%). The concentration of high-ranking scientific workers is even higher and amounts to 90%, or 90%, 95% and 85%, respectively, in the three organizational sections (cf. Table 1).

Table 1. Scientific centres

Centre	Higher schools		PAN institutions		R&D units		Total
	A	B	A	B	A	B	B
Warsaw	14	2,193	40	967	137	1,642	4,802
Cracow	13	1,578	11	127	16	161	1,866
Poznań	9	1,127	6	54	22	126	1,307
Wrocław	9	1,099	4	61	10	22	1,182
Upper Silesia	6	742	6	36	27	196	974
Tri-City	7	696	3	45	9	59	800
Łódź	6	736	2	18	22	90	844
Lublin	5	728	1	7	3	17	752
Szczecin	5	434	–	–	–	–	434
Toruń-Bydgoszcz	5	383	–	–	5	3	386
Total	79	9,716	73	1,315	251	2,316	13,347
Poland	97	10,798	78	1,390	310	2,720	14,908

A – Number of units

B – Number of higher-ranking scientific workers employed

Sources: *Rocznik Statystyczny 1990* (The 1990 Statistical Yearbook), GUS, Warszawa; *Informator Nauki Polskiej 1989/90* (The 1989/90 Polish Science Reference Book), Warszawa.

The particular scientific centres have different potentials as measured by the number of higher-ranking workers (Table 1, Fig. 1). An analysis of the distribution and gradient of this index in the set of the 10 centres allows four size classes to be distinguished:

- I — Warsaw
- II — Cracow, Poznań, Wrocław
- III — Upper Silesian centre, Łódź, Tri-City, Lublin
- IV — Szczecin, Toruń-Bydgoszcz

On the basis of the analysis of the share of higher-ranking workers of the centres in the national total, we can find four hierarchical orders corresponding to the four size classes (Table 2). Worth noting is the fact that the scientific centres of the highest, first and second orders, are monocentres.

An additional criterion of the scientific position of a centre is the number of its PAN members. Out of the total number of 316 PAN members, 306 come from the ten centres, most of whom from Warsaw, then from Cracow, Poznań, Wrocław and Upper Silesia (Table 3).

Table 2. The potential of the scientific centres

Scientific centres	Higher-ranking scientific workers	% of national total
Warsaw	4,802	32.2
Cracow	1,866	12.5
Poznań	1,307	8.8
Wrocław	1,182	7.9
Upper Silesia	974	6.5
Łódź	844	5.7
Tri-City	800	5.4
Lublin	752	5.0
Szczecin	434	2.9
Toruń-Bydgoszcz	386	2.6
Total	13,347	89.5

Table 3. Members of the Polish Academy of Sciences (PAN)

Scientific centres	Number of members
Warsaw	157
Cracow	59
Poznań	26
Wrocław	22
Upper Silesia	16
Łódź	9
Tri-City	9
Lublin	3
Szczecin	2
Toruń-Bydgoszcz	3
Total	306

Another index of the position of a centre is the number of members of the State Committee for Scientific Research (KBN) coming from the particular centres and elected by the scientific circles of the country for their scientific authority (Table 4). The centres have 56 representatives in the KBN (for the total of 58 elected members). They mainly represent the Warsaw centre, with Cracow, Wrocław and Upper Silesia occupying farther but equal position.

The scientific centres are also academic ones and fulfil an educational function. Their educational performance is measured by the number of students (Table 5). Noteworthy is the fact that the ordering of the centres on the scale of scientific potential is the same as that on the scale of educational activity. An exception is Lublin, which has a higher position as a university centre than as a scientific one.

**Table 4. Members of the State Committee
for Scientific Research (KBN)**

Scientific centres	Number of members
Warsaw	19
Cracow	9
Poznań	5
Wrocław	9
Upper Silesia	9
Łódź	3
Tri-City	2
Lublin	—
Szczecin	—
Toruń-Bydgoszcz	—
Total	56

Table 5. Scientific centres by the number of students

Scientific centres	Students		% of total
	total	intramural	
Warsaw	67,516	51,301	18
Cracow	48,344	38,650	13
Poznań	33,816	26,379	9
Wrocław	33,613	27,393	9
Łódź	22,084	18,815	6
Lublin	29,560	22,752	8
Tri-City	23,783	18,864	6
Upper Silesia	31,396	25,320	8
Toruń-Bydgoszcz	18,064	12,119	5
Szczecin	15,196	11,304	2

Source: *Rocznik Statystyczny 1990* (The 1990 Statistical Yearbook), Warszawa, GUS.

3.3. The structure of the scientific centres

The centres are highly diversified with respect to the number of units in the particular sections. Thus, they have from 5 to 14 higher schools, 1 to 40 PAN institutions, and 3 to 137 R&D units.

The most extensive academic sections are in the centres of Warsaw and Cracow (14 and 13 higher schools) as well as Poznań and Wrocław (9). They all share the same recurrent pattern of schools: a university, a polytechnic, an agricultural academy, an economic academy, a medical academy, a physical training academy, a music academy, a higher arts school, and a papal theological faculty. The recurrent pattern in the remaining centres only includes a university and a medical academy.

The academic section in the centres employs from 383 (Toruń-Bydgoszcz) to 2,193 higher-ranking scientific workers (Warsaw), which gives an average of 972. The Warsaw and Cracow schools employ 23% and 16%, respectively, of all higher-school professors and associate professors working in the centres, while the share of the Toruń-Bydgoszcz centre is only 4%. Higher schools employ a considerable percentage of these workers in the particular centres: in 8 of them in excess of 84%, relatively the least in Warsaw — 46% and Upper Silesia — 76%.

Among the higher schools of a centre the greatest scientific potential is concentrated at the university. An exception is Wrocław, where the university has a slightly lower position than the polytechnic.

A state university employs an average of 316 higher-ranking scientific workers. The largest in the Warsaw University with its 715 professors and associate professors. The smallest in the Lublin Catholic University (118 professors and associate professors), which exists in the Lublin centre along with the state university (254 higher-ranking workers).

The universities in the various centres differ not only in the absolute numbers of workers, but also in the didactic level as expressed by the number intermural students per higher-ranking scientific worker. This index is the lowest at the universities of the Cracow, Warsaw and Poznań centres (23–25 students), which indicates the highest scientific-educational level. For the universities in 6 centres the indices range from 29 to 36 students, and the Upper Silesian university has the highest index — 40 students per higher-ranking worker.

In a scientific centre the university has a 26% (Cracow) to 53% (Toruń-Bydgoszcz) share in the higher school potential.

In a few scientific centres the university meets competition on the part of the polytechnic or another technical school. This especially holds for Cracow with its Academy of Mining and Metallurgy and Polytechnic (30% of the academic potential of this centre), and for Łódź, Wrocław and Gdańsk.

A good university and a good polytechnic have a strong influence on the image of the given centre. For instance, Cracow is associated mostly with the Jagellonian University, while Gdańsk with its Polytechnic.

The most extensive section of PAN institutions is in the Warsaw centre — there are 40 of them, or 55% of their total number in the scientific centres.

There are 28 PAN institutes in Warsaw out of the total of 46 located in the centres, including all the 8 largest ones (with over 100 workers). As a result, the Warsaw centre has 74% of all higher-ranking scientific workers employed in PAN institutions in all the centres of the country. In the centres of Cracow, Poznań, Upper Silesia, Wrocław, Gdańsk, Łódź and Lublin there are from 11 to 1 PAN institutions employing 10–0,5% of the total number of PAN professors and associate professors working in the centres.

However, the degree of concentration of PAN scientific staff in the Warsaw centre is overestimated, because the figures embrace institutions having the capital as their main seat. In reality, a lot of institutes have their branches outside the seat of the parent institution. To grasp the magnitude of this overestimation, let us consider some data obtained from the PAN Branch in Poznań. The Branch embraces 28 small scientific units (departments, workshops, branches, teams) subordinate to independent PAN institutions located in Warsaw (with the exception of 2 units associated with the Cracow institute). They employed a total of 40 higher-ranking scientific workers, while the 6 independent PAN institutions situated in the Poznań centre employed 54.

The rank of the centres as far as the PAN section is concerned is also reflected in the internal organization of the PAN. Warsaw is the seat of the PAN Presidium, and PAN branches are situated in Cracow, Wrocław, Poznań, Katowice, Gdańsk and Łódź. Out of the total of 14 Scientific Committees affiliated with the Presidium, 13 have the seat in Warsaw and 1 in Cracow. Out of 99 Scientific Committees affiliated with the seven PAN Faculties, 72 operate in Warsaw, 11 in Cracow, 5 in Wrocław, 4 in Poznań, 3 in Katowice, 2 in Lublin, 1 in Gdańsk, and 1 in Olsztyn.

The research profile in PAN institutes in some centres is closely connected with the specialized socio-economic functions of their parent city (the Institute of the State and Law in Warsaw, the Institute of Hydro-Engineering and the Institute of Fluid-Flow Machines in Gdańsk, the Institute of Metallurgy in Cracow, the Institute of Agrophysics in Lublin, the Institute of Rock Mass Mechanics and the Institute of Pharmacology in Cracow).

The section of R&D units is also the strongest in Warsaw with its 137 units, i.e. 55% of their total number operating in the scientific centre network. It also employs 1,642 higher-ranking scientific workers, i.e. 70% of all professors and associate professors working in those units in all the centres. In the remaining centres this section is much less powerful. The four centres of Upper Silesia, Poznań, Łódź and Cracow have from 27 to 16 R&D units, with a total of 87 (35%) units employing 573 (25%) higher-ranking scientific workers.

Warsaw has a high concentration of the largest units, i.e. R&D institutes. There are 80 such institutes (out of the total of 140) operating there, including 5 of those employing over 100 scientific workers. The Warsaw centre has a higher concentration of scientific workers than R&D units.⁵ The R&D institutes of the Warsaw centre also have a high scientific standing: 40% of them have the

⁵ It should be noted, however, that the largest R&D institute in the country, the Teacher Training Institute (649 scientific workers, including 590 doctors), has its seat in Warsaw and its branches in several other towns. But all its workers are formally employed in Warsaw.

right to confer the degree of a doctor. In the four remaining centres mentioned above there are 34 R&D institutes.

The main factor of the location of R&D units is the organizational one. Its effect is the concentration of R&D units in Warsaw, which is the seat of ministries. In the other scientific centres the locational factor is the level and specialization of industry (Upper Silesia, Łódź, Cracow) and agriculture (Poznań).

The relations among the three kinds of scientific units representing the main organizational sections of science: higher schools, PAN institutions and R&D units, are determined by the functional properties of the centres.

**Table 6. The internal structure of the scientific centres
by section and number of higher-ranking scientific workers employed (in %)**

scientific centres	higher schools	PAN institutions	R&D units
Warsaw	46	20	34
Cracow	84	7	9
Wrocław	93	5	2
Poznań	86	4	10
Upper Silesia	76	4	20
Łódź	87	2	11
Tri-City	87	6	7
Lublin	97	1	2
Toruń-Bydgoszcz	99	—	1
Szczecin	100	—	—

As above table indicates, the principal function of all the ten scientific centres is an academic one. The proportion of the PAN section and that of R&D units to the section of higher schools shows that it is only in Warsaw that first two sections play a significant role in the scientific potential of the centre, comparable with the role of its higher schools. In the remaining 9 centres the non-academic units only complement their basically academic position. The only outstanding centre is the Upper Silesian one in which R&D units play a secondary, but quite significant role.

Thus, the scientific centres can be divided into three classes:

- I — Lublin, Szczecin, Toruń-Bydgoszcz — centres created almost exclusively by higher schools;
- II — Warsaw — with a large share of PAN institutions and R&D units, though with a slight dominaton of higher schools; and
- III — the remaining centres — strongly dominated by higher schools and with a modest share of PAN institutions and R&D units in their structures.

A centre with a well developed, full scientific and didactic activity has a variety of higher schools as well as PAN institutions and R&D units of different scientific and research scope. It creates a favourable environment for the educational work of its higher schools, the training of the scientific staff, and R&D activity. The neighbourhood of various academic schools and R&D institutions is highly desirable for the development of co-operation and conditions integrating steps in science.

A highly complex scientific centre is that of Warsaw. Here there are all types of higher schools to be found in Poland (except unique ones). There are PAN institutions representing all the 7 PAN Faculties, and R&D units are associated with all the 17 ministries and central offices.

The well-developed Cracow centre definitely yields precedence over Warsaw as far as the scale and diversity of scientific and educational activity are concerned. Cracow has a set of higher schools and a number of PAN institutions, but R&D units only represented 4 ministries (of industry, agriculture, national education and justice) and some central offices. Also Wrocław and Poznań have relatively well developed scientific and educational profiles. In the successive centres down the size scale, viz. Upper Silesia, Łódź and Tri-City, there is a tendency for scientific and research activity to be specialized as adjusted to the R&D units located there.

Scientific centres with a wide scope of activity are mainly those which have a strongly developed academic function and good, old universities ensuring a high education level (Cracow, Warsaw, Poznań and Wrocław), which may suggest that a university attracts other scientific institutions. Those centres which have been created by a reverse process, i.e. in which at first there were specialized higher schools and R&D units which stimulated the foundation of a university, are weaker (new universities are in the centres of Upper Silesia, Tri-City and Szczecin).

The scientific centres differ in their structure. The basis for its analysis is provided by the division into basic and applied sciences. The proportions between units representing these two types of science determine the scientific structure of the centres (Table 7).

Although each centre in Poland has a university, considered the mainstay of basic sciences, in all of them applied sciences are developed better. An exception is the Lublin centre with its two universities, and the Toruń-Bydgoszcz centre created mainly by its university. The scientific centres of both higher and lower orders in which applied sciences predominate differ in the degree of this domination. It is the most pronounced in the centres of Upper Silesia, Wrocław, Szczecin and Cracow. Hence, it is characteristic of both those with old, well-established universities (Cracow, Wrocław) and those with new, weak ones (Szczecin, Upper Silesia). The domination of applied sciences is due to the technical schools and R&D units (Upper Silesia, Cracow, Wrocław) or a poor development of the university in comparison with other academies in the case of lower-order centres (Szczecin).

In five scientific centres there is a tendency to balance basic and applied sciences. It appears at various levels of their development: the highest in Warsaw,

Table 7. Basic and applied sciences by the number of high-ranking scientific workers

Scientific centres	Higher schools					PAN institutions	R&D units	Basic sciences	Applied sciences
	univ.	techn.	agri.	econ.	med.				
Warsaw	715	451	256	142	190	967	1,642	1,682	2,681
Cracow	407	482	147	74	153	127	161	534	1,017
Poznań	421	164	174	70	177	54	126	475	711
Wrocław	301	327	149	78	155	61	22	362	731
Upper Silesia	221	267	-	55	148	36	196	257	666
Łódź	264	239	-	-	129	18	90	282	458
Tri-City	241	205	-	-	131	45	59	286	395
Lublin	372	50	151	-	155	7	17	379	373
Szczecin	132	96	92	-	82	.	.	132	270
Toruń-Bydgoszcz	204	75	-	-	34	.	3	204	112

a high one in Poznań, and an average one in the centres of Łódź, Lublin and Tri-City.

An additional feature of the scientific centres is their specialization in particular disciplines. In the multi-disciplinary centre of Warsaw a prominent position has been achieved by the humanities, social sciences, mathematics, physics, chemistry, technical sciences, and medical sciences. The Cracow centre specializes in the humanities, mathematical-physical sciences, geological and mining sciences, and biological sciences; Wrocław — in mathematics, physics and chemistry; Upper Silesia — in technical sciences; and Poznań — in biological and agricultural sciences.

3.4. The impact of the scientific centres

The impact of a scientific centres is defined by its external relations holding between the centre and its surroundings. It is expressed as social links of various spatial scales: regional or national. The regional scale of impact is the clearest and results from the centres' educational function. The scientific centres distinguished are simultaneously academic centres. An academic centre is mainly created by a university, but it is also composed of specialized higher schools. Academic centres associated with the ten scientific centres are the nodes of 10 academic regions. An academic region embraces:

- 1) the voivodeship containing the centre,
- 2) the first (possibly also the second) ring of its neighbouring voivodeships which compose the region in their totality or part (if they are influenced by several centres) (Fig. 2).

It can be observed that the pattern of the academic regions closely resembles the proposal for the division of the country into socio-economic regions. The

convergence of these regional pattern proves the claim that one of the factors shaping the regional structure of the country is the spatial organization of the academic activity.

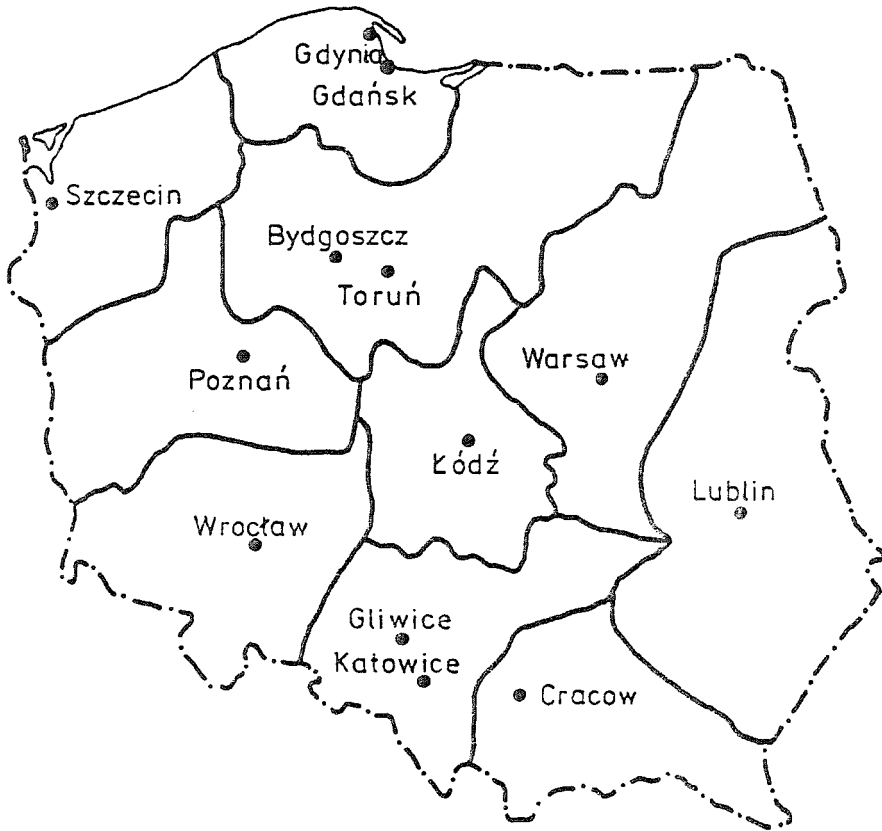


Figure 2. Academic regions in Poland

Only some of the academic centres have a national impact due to:

- their high scientific level and authority (the academic centres of Warsaw and Cracow),
- their unique or rare higher schools (Cracow, Szczecin, Tri-City, Łódź, Warsaw and Lublin), or
- the unique courses of study they offer (Warsaw, Cracow, Upper Silesia, Toruń, Tri-City, Łódź and Lublin).

The supra-regional function of the academic centres can be measured by the number of consultation points, faculties and branches run by their higher schools in other towns. Most prominent in this supra-regional educational function are the centre in Cracow, Warsaw, Wrocław and Poznań.

PAN institutions are those components of the scientific centres which are unique at the national scale due to their highly specialized profile. Hence they have a national impact, and, through them, so do the scientific centres. The impact is the strongest in the case of those centres that have the highest concentration of PAN institutions, viz. Warsaw, Cracow, Wrocław and Poznań.

Because of their similar features, R&D units concentrated in the scientific centres also reinforce or create the national impact of their parent centres: Warsaw, Upper Silesia, Cracow, Poznań and Łódź.

4. An ultimate model of the development of the scientific centres in Poland

Changes in politics, the economy and culture that have been taking place in Poland are creating totally new conditions for the development of science. Because of the socio-economic crisis, this development must take the form of an accelerated transformation of science.⁶

The programme of the transformation of Polish science accommodates both, aspects of its survival and development, and aspects of its role in the restructuring of the society, economy and state.

The programme of changes in Polish science must have a spatial dimension and be reflected in the modelling of the activity of scientific centres. The latter should rest on the following assumptions:

- in the conditions of the crisis, with science in a difficult financial situation, action should be taken to prevent an excessive spatial scattering of scientific institutions, because it involves the menace of additional losses resulting from the fragmentation of the means;
- changes in science should be closely related with the restructuring of already existing, strong scientific centres;
- the main effect of the restructuring should be an increase in the effectiveness of scientific research activities of a centre in the field of innovation promotion;
- the organizational and scientific restructuring of the centres should reinforce their regional function in the field of tasks connected with the character, specificity and needs of the region, and shape a specialized national function of a centre resulting from its participation in the national programme of research and educational development.

Let us elaborate on these assumptions.

The development of science in the period of crisis should be based on the existing scientific centres. Because of financial difficulties, it is undesirable to expand the spatial network of scientific units. The one element that could be added to it is Białystok, which does not meet all the conditions of a scientific centre, but is counted among cities creating scientific centres due to its demographic and economic potential as well as its position in the east of the country.

⁶ Kukliński A., *Nauka polska. Doświadczenia i perspektywy* (Polish science. Experiences and prospects). Biuletyn KBN No. 2, Warsaw, 1991.

The spatial concentration of the outlays for science in the 11 centres opens up the possibility of making them scientific research complexes. The scale of a complex, especially the composition and numbers of its staff and its research equipment, will ensure minimum conditions for effective scientific activity.

The restructuring of the scientific centres must embrace institutional and organizational changes, as well as transformations of employment and scientific and educational profiles.

An institutional restructuring of a centre requires:

1) a reform of the internal structure of scientific institutions operating in the centre in order to increase the effectiveness of their scientific and educational activities;

2) the winding up of weak scientific institutions unnecessary in the present political, social and economic conditions;

3) the transformation of some scientific units into innovation-promoting ones and centres for the diffusion of advances in world science;

4) rationalization of co-operation among scientific units of the three organizational sections of science located in the centre;

5) the introduction of new courses of study and the creation of post-graduate colleges in the centre (e.g. a college for managers, for local-government workers, a telecommunications college, etc.);

6) joining the centre's university with its other higher schools; the proposed integration means rationalization of activity by introducing complementary scientific and educational cycles.

A necessary move in the restructuring will be increasing the number of sources from which a centre's scientific institutions are financed. In the process of the market orientation of science, its financing should be decentralized and the sources of money should extend to embrace not only the State budget, but also regional funds, financial means from enterprises, including private ones, and the financial backing from abroad.

Changes in the scientific staff of a centre should aim at the rationalization of employment. They should result in a proper use of the centre's intellectual potential. This means, on the one hand, the elimination of scientific mediocrity, and on the other, acclaim for high scientific qualifications and outstanding scientific personalities, and opening up opportunities for talented, creative individuals.

An important task in the improvement of the teaching staff of the higher schools of a centre so as to prepare them for the training of scientific elites. Without elites educated at good higher schools, there will be no increase in the scientific level of the centre as a whole and no change in the group mentality of its community, which in turn conditions the success of socio-economic reforms.

Changes in the profile of scientific and educational activity of a scientific centre should take place *via* determination of its priorities, which is not identical, however, with the primitive assignment of research tasks. The centre should establish its priorities in applied sciences from the perspective of the regional and national demand for science. The starting-point is selecting those disciplines which most need technical, economic and social progress, and establishing which directions of research would give the best support to the economic policy of

the region and the country. In the scientific centres with national functions priority should be given to the problems of advanced technologies (alternative sources of energy, new materials, microelectronics, biotechnologies) related to the directions of development of world science, and to scientific problems associated with the socio-economic situation in Poland and concerning ecology, economy, management, social science, and political science.

After these changes have been made, all the scientific centres in Poland can fulfil the functions of regional centres, organized in the following way.

A regional scientific centre consists of two integrated parts: an academic centre and a scientific research centre. The existence and operation of the latter is closely associated with the restructuring of the former. A scientific research centre is a complex of new and adapted R&D units (research teams, laboratories). It consists of units engaged in region-oriented innovative activity, and hence can be called a regional innovation centre (RIC). It provides a basis for the formation of a regional technopolis. The idea of the formation of a technopolis is a result of a regional initiative. An RIC is a form of stimulating technological progress and the regional economy, as well as solving social problems (e.g. unemployment).

RICs can be divided into the following types:

1) units specializing in technological, service, organizational and legal innovations, so-called small-scale innovations made continuously and aiming at adjusting a product or service to a more demanding and changing market;

2) units engaged in the transfer of advanced world technologies suiting the region's economic profile;

3) units specializing in consulting and expert surveys;

4) industrial and service incubators that are the nuclei of new small and medium-sized businesses creating new jobs in the region.⁷

Units of innovation progress in a regional centre are State, private or regionally-financed units.

The organization and stimulation of the centre's network of internal links between scientific activity (higher schools), innovative activity (RIC) and the regional economy should be the task of a council appointed by the regional authorities. The council suggests forms of co-operation, guarantees complementarity of activities, organizes a permanent information service, informs interested parties about the demand on the regional scientific market, organizes scientific exchanges, is concerned with the introduction of results to the process of the region's development.

Only a few scientific centres can perform the function of national ones. **National scientific centres** carry out research in those basic and applied sciences that are especially important for the development of Polish science and the socio-economic development of the country. They embrace State scientific institutes (i.e. those financed from the central budget) which include PAN institutes (after

⁷ Jałowicki B., *Nowe przestrzenie produkcji jako czynnik rozwoju regionalnego i lokalnego* (New production spaces as a factor of regional and local development). *Studia Regionalne i Lokalne* (Regional and Local Studies) No. 1 (34). University of Warsaw, 1991.

their verification and reduction of their number) as representatives of basic sciences, and nationally unique R&D institutes engaged in applied sciences.

National scientific centres should be divided into two groups:

1) Complex centres in which research institutions and higher schools of a high scientific level and potential represent all disciplines in a full scientific cycle embracing basic and applied sciences and technologies. There are only two such centres: Warsaw and Cracow. They play a creative role in the development of science in Poland. Because they also perform political and cultural functions, they are naturally fit to conduct scientific activity oriented towards the solution of problems entailed by the reform of the country. The programme of this pragmatic scientific activity of the centres includes:

- in the field of economic sciences — the working out of an effective model of the economy in transition to a market one and the control of the process of the restructuring of industry;
- in the field of political sciences — issues concerning the improvement of State activity and the organization of administration and local governments;
- in the field of social sciences — issues involving the transformation of society consisting of the change in the role and position of social groups and their influence on social life and participation in the social costs of the reforms.

2) Specialized centres with a big scientific research potential, representing regions at the extremes of the scale of adaptability, i.e. those of the highest adaptability on the national scale and those whose land development resembles a Skansen museum on the European scale.⁸ These centres attain the rank of national ones since they specialize in international co-operation and the diffusion of world technologies and ideas. They work on the possible uses of world achievements in the socio-economic activities of the country. Their organizational form is provided by State scientific institutes (adapted or new) and laboratories making large-scale innovations, subsidized by European or even international organizations. The centres of this category include Poznań, Wrocław and Upper Silesia. Poznań may perform the function of a centre making and diffusing innovations in agriculture by utilizing world achievements; Wrocław may be an innovation centre in the field of transformation of industrial technologies *vis-à-vis* world technologies; and the Upper Silesian centre may play a role in the transformation of ecology, i.e. the halting of environmental degradation, related to the restructuring of industry.

⁸ Kukliński A., *Restrukturyzacja polskich regionów jako problem współpracy europejskiej. Uwagi dyskusyjne* (The restructuring of the Polish regions as a problem in European co-operation. Remarks for discussion). *Studia Regionalne i Lokalne* (Regional and Local Studies) No. 1 (34), University of Warsaw, 1991.