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Kaczmarek, Z., Kindler, J. and Laski, A.

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Z. Kaczmarek, J. Kindler,
and A. Laski

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Research Proposal for the Water Resources Sub-Project

Z. Kaczmarek
J. Kindler
A. Laski

Introduction

Making optimum use of the water resources is a task which long has engaged human effort and which has, in recent decades, been studied within the framework of the integrated regional development plans. The "integrated development" of a region means the orderly marshalling of all its resources to promote human welfare. It is evident, however, that the influence of development of a given region upon the rest of the national economy is in most of the cases considerable. Moreover, the investment needs of any development scheme are closely linked to the needs of the whole economy. These introductory comments are especially relevant to the water resources development schemes. It is now widely recognized that individual water projects - whether single or multipurpose - cannot as a rule be undertaken with optimum benefit for the people affected before there is at least the broad outline of a plan for the entire drainage area.

In the Vistula River Basin, we are fortunate to have such a plan. The first long-term water resources development plan was drafted by the Polish Academy of Sciences in the years 1953-1956, for the time horizon of 1975. Then the plan was twice revised in the early 60's with the simultaneous extension of the time horizon to 1985. The most recent phase of comprehensive studies was completed in 1972, with the formulation of the "Vistula River Project, ('Planning Comprehensive Development of the Vistula River System'") carried out with the assistance of the United Nations Development Programme. As far as the methodology is concerned, the most significant conclusion of the Vistula River Project was that the approach conceived and tested within the Project framework has proven to be feasible and technologically workable. An attempt to incorporate in the planning process a specific computational capability to screen,

simulate and optimize alternative water resources development alternatives has demonstrated the merits of the "systems approach". This approach is to be understood here not merely as a technique or group of techniques such as mathematical programming, simulation, etc. Rather it should be thought of as a broad planning strategy that involves the use of various mathematical techniques for solving highly complex water problems. It is a framework of thought designed to help decision makers choose a desirable course of action.

Although the techniques applied in the Vistula River Project have already been shown to produce reasonable results, there is considerable potential for their further development, extension and refinement. Many elements of the planning strategy and the tools employed for water resources studies are subject to continuing development. The magnitude of the tasks ahead is still large and there is no doubt that at least some of them can be dealt with much more effectively in the context of international and multidisciplinary efforts of the International Institute for Applied Systems Analysis.

The direct source of inspiration for this paper is the recent proposal of a joint IIASA-Polish research program on the integrated development of the Lublin region in Poland. The Lublin study is proposed as a pilot project for the IIASA Integrated Regional Development Program. It should be recognized that the problem here is one of harmony between the development and utilization of resources - existing and potential - and the needs and requirements of the national economy and the population inhabiting the region. The water resources considerations are an important part of any regional planning effort. This is also true in the case of the Lublin region where local water resources are rather scarce and a considerable volume of water will have to be imported from outside the region. For that reason, consideration must also be given to the upstream storage facilities, and the water resources component of the Lublin Study must go beyond the physical boundaries of the region.

Although this paper concentrates on the Lublin region, some thoughts are also given to the related problems in the upper portion of the Vistula Basin. Information concerning the entire basin is problem-oriented. A description of the basin and its water resources is presented in some of the earlier IIASA documents. The paper ends with the formulation of a proposal for the Water Resources Sub-Project to be implemented within the framework of the Lublin-Vistula Research Program.

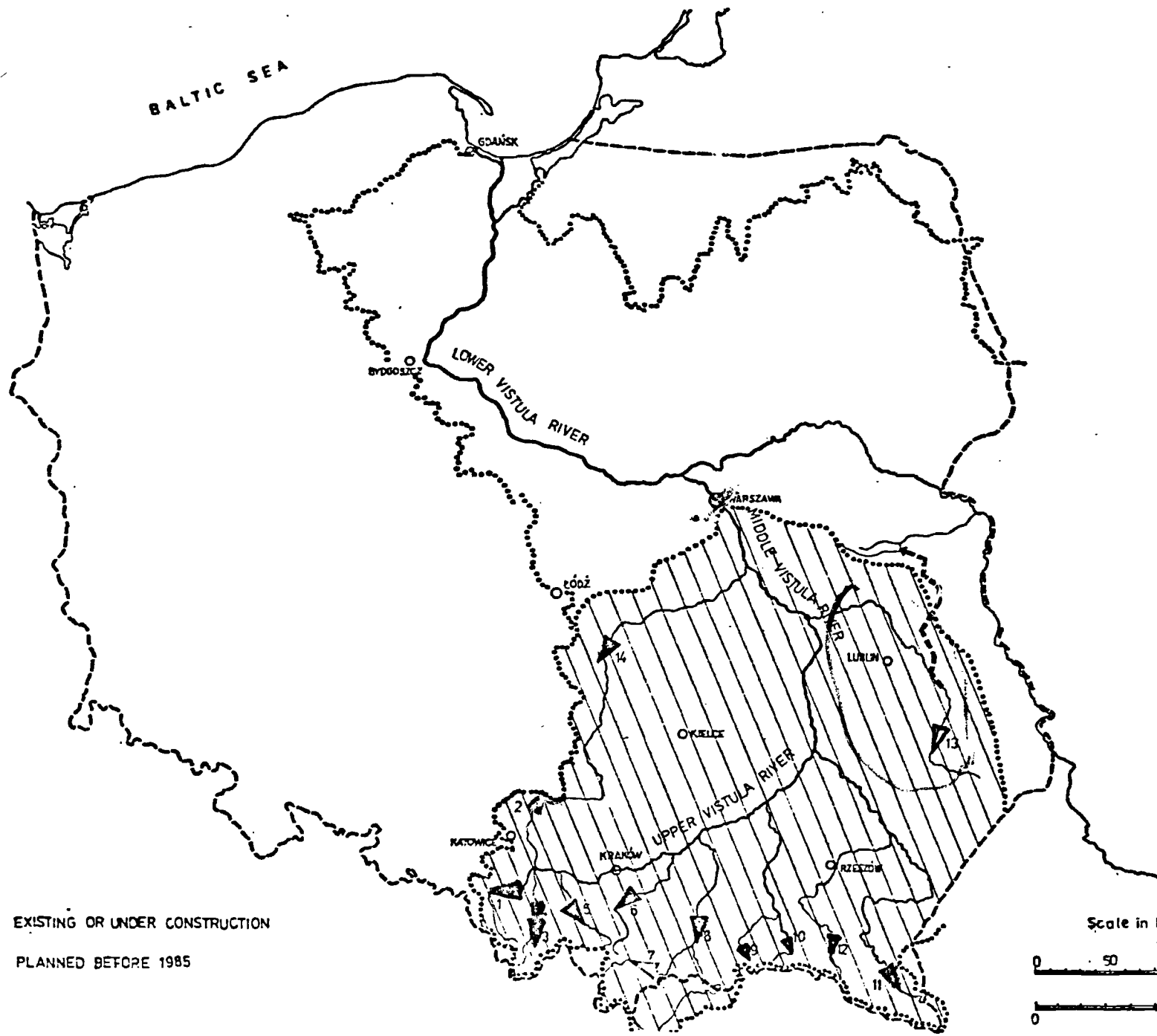
General Description of Water Resources Problems in the Vistula River Basin

The upper and middle portions of the Vistula River basin related to the Lublin region (see Figure 1), cover an area of about 85,000 sq. km., that is, 44% of the entire basin. The southern part of the basin lies in the Carpathian Mountains and the highest point of the basin is at 2,660 m. above sea level. The drainage area of the mountainous tributaries amounts to 23% of the system considered, that is, to about 10% of the entire basin. These tributaries exert a decisive influence on the regime of the Upper and Middle Vistula.

Two flood periods are observed in the basin. First, one is due to snow melting which occurs in March and April (11% and 17% of the total annual runoff, respectively), and another in June and July as the result of intensive rainfall. The typical low-flow months extend from August to February.

The following figures may characterize the upper and middle portions of the Vistula River system:

- 65% of the basin's population,
- 38% of the total population of Poland,
- 56% of the industrial water requirements in the entire basin, including the cooling water,
- 76% of the municipal water requirements in the entire basin, and
- 40% of the agricultural requirements in the entire basin.



- ▼ EXISTING OR UNDER CONSTRUCTION
- ◻ PLANNED BEFORE 1985

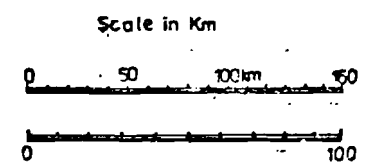


FIGURE 1

In the years 1980-1985, fourteen multi-purpose reservoirs, (see Table 1) will operate in the system - eight of them already exist and three are presently under construction. The total active capacity of these 14 reservoirs will amount to about 1500 million cu.m., that is, about 9% of the mean annual runoff of the Vistula in Warsaw. Additionally, a number of small reservoirs serving predominantly agricultural purposes operate in the system. By the end of 1985, seven major water transfer canals will be in operation.

The mean annual runoff from the upper and middle portion of the Vistula amounts to 17 billion cu.m. During the dry years, it may drop down to about 10 billion cu.m. The monthly variances of Vistula flows are very high and spatial distribution of water resources is very uneven. The ground water resources are rather limited and they may serve only local purposes.

The mean annual water requirements in 1985 are estimated as follows:

Industry (including cooling water)	- 6.60 billion cu.m.
Municipalities	- 2.10 " "
Agriculture	- 1.30/0.50 " "
Total	:10.00 - 9.30 billion cu.m.

These are concentrated mainly in the urban areas, (Silesia, Krakow, Warsaw, Lodz, Lublin, etc.). This creates difficulties in meeting all water requirements, at least in some regions and in dry periods. In Silesia, critical water deficits may amount to about 20% of the total 1985 industrial and municipal requirements.

The quality of water in the Vistula basin is unsatisfactory. The highest rate of pollution is observed in the Upper Vistula and some of its tributaries (Przemsza, Nida, Lower San). The situation will be much worse in the future if drastic measures limiting the discharge of polluted water into streams and lakes are not undertaken. It should also be mentioned that in the

TABLE 1

List of Reservoirs

1. Goczalkowice (144 mln cu.m.)	Existing
2. Przeczyce (19 mln cu.m.)	Existing
3. Tresna (87 mln cu.m.)	Existing
4. Porabka (18 mln cu.m.)	Existing
5. Swinna Poreba (140 mln cu.m.)	To be built before 1985
6. Dobczyce (113 mln cu.m.)	Under construction
7. Czorsztyn (198 mln cu.m.)	Under construction
8. Roznow (139 mln cu.m.)	Existing
9. Klimkowka (33 mln cu.m.)	Under construction
10. Katy (42 mln cu.m.)	To be built before 1985
11. Solina (362 mln cu.m.)	Existing
12. Besko (15 mln cu.m.)	Existing
13. Izbica (60 mln cu.m.)	To be built before 1985
14. Sulejow (95 mln cu.m.)	Existing

middle part of the Vistula, thermal pollution will create serious problems.

Although most of the Vistula river valley and majority of the river tributaries are already protected against flooding by means of levees, there is still a risk of flood damage by overtopping the levee crest.

The main objectives of water management in the Vistula river basin are as follows:

- a) the optimal storing and allocation of available water resources to minimize deficits and the consequent economic and social losses;
- b) improvement and maintenance of the desired water quality, including thermal pollution control;
- c) flood control; and
- d) other control objectives such as recreation, navigation, hydropower generation, etc.

General Description of Water Resources Problems in the Lublin Region

While analyzing the results of the planning studies implemented within the framework of the "Vistula River Project", special consideration was given to the possibility of serious water shortages in the Lublin Upland. This region of about 10,000 sq.km. roughly corresponds to the basin of the River Wieprz, the right hand tributary of the Middle Vistula. Until recently, the Wieprz river basin was considered to be one of those characterized by a comparatively well-balanced water management situation. Except for some deterioration of water quality, no special problems were encountered in this region. Occasionally, in dry years, some difficulties are experienced in the supply of the required volume of water to the Wieprz-Krzna Canal. Maintenance of the minimum acceptance flow in the Wieprz River is also sometimes difficult.

The situation has changed in 1975, with the decision concerning development of the local coal deposits. They are estimated at about 20 milliard tons of anthracite and semi-

anthracite which will provide the primary energy for a number of steam-electric power plants and industrial undertakings. To reduce the transportation costs, some of the new power and industrial developments will be located right in the mining region which is predominantly agricultural. The agriculture, however, will remain important in the region. Because of the excellent soil resources, it is traditionally one of the most important agricultural centers in Poland. A few years ago, the construction of the Wieprz-Krzna irrigation canal (140 km. long, 33 m³/s capacity), and the irrigation based development of 70,000 hectares of pasture land have additionally increased agricultural production in the region.

At present, municipal and industrial water demands are, in most part, covered from the groundwater resources. There are no deficits by now, but taking into consideration the expected growth of these demands, the assessed groundwater resources would be sufficient just for a few years. Such a situation calls for the intensive development of the surface water resources. Comparison of the present level of water supply in the dry hydrological year with the water demand projections made for 1990, indicate the possibility of water shortages in the range of 300 million cu.m.

It should be underlined, however, that in spite of rapid urbanization and industrialization of the Lublin region, agriculture will remain as the most important water user. The agricultural water demands will continue to be much higher than the combined municipal, industrial and thermal-power cooling demands.

Taking into account that the unsatisfactory water management situation may seriously affect the overall development of the Lublin region, the "Vistula River Project" has already indicated some of the necessary water control works. Construction of one or a few large storage reservoirs on the Wieprz River is forseen. Furthermore, a proposal has been made to build a canal to transfer water from the Middle Vistula to the upper

reaches of the Wieprz River. Another alternative under consideration is the diversion of water from the San River via the storage reservoir on the Tanew River. These structures will render possible the complete utilization of the local water resources augmented by water transferred from outside the region. Because of the comparatively small resources of the Wieprz River, a major role will be played by the water transfer facility.

The studies on the final scheme of water management in the Lublin region have been recently initiated by "Hydroprojekt" and other organizations concerned. All are being closely coordinated with the regional planning units involved. It is generally believed that complex problems in water development and management must be dealt with if the water resource is to make its full contribution to the planned development of the region.

Increased water usage places greater emphasis upon the management of the water system to protect water quality. In addition to industrial wastes and municipal sewage, thermal pollution requires attention. The ecological effect of increased stream temperatures must be studied to determine acceptable temperature changes. Anticipated water quality problems which must be prevented or minimized by advanced planning also include the increase of agricultural chemicals and total dissolved solids in the surface runoff (non-point pollution sources) and in the irrigation return flows.

Providing water-based recreation, either as part of multiple use developments or as independent recreation facilities will be a problem of great magnitude. The projected expanding population and attendant increased economic growth in the region especially emphasizes the need for high quality water resources available for all types of recreational uses.

Water transportation as a part of the overall transportation system in the Lublin region also needs serious consideration. The navigation canal linking the Vistula with the mining region could facilitate coal transportation to steam-electric

power plants situated along the Vistula River. This canal would become part of the international East-West waterway, if extended to the Bug River, which forms a boundary between Poland and the Soviet Union.

The complexity of the Lublin water system calls for an imaginative approach to its organizational problems. The type of organization must be determined and certainly, there is no single correct way to organize and administer a regional water scheme. The organization of water management must be fitted into the general organizational framework and unit of control must be observed to avoid waste of natural, capital and human resources. The scope of the powers to be conferred upon the water authority is an open question, and the way it is decided may depend on the organization as well.

On the whole, the Lublin region is characterized by a rapidly developing economy with a large number and variety of problems confronting water management. The most important of them seems to be water supply for population, agriculture and industry as well as water pollution control.

General Outline of the Sub-Project Proposal

It is proposed that in the two-year period from 1976-1977, the following problems be studied within the framework of collaboration between IIASA and the Polish organizations assigned to the water resources component of the Lublin study:

- 1) Analysis of water resources development alternatives as the background of various hypotheses concerning economic development of the region with due consideration given to the spatial aspects of the problem (water management as an element of the regional infrastructure).
- 2) Staging of the water resources development program. Optimal sequence of implementation adapted to the dynamics of the overall economic development of the region.

- 3) Development of operational rules for comprehensive management of water resources in the region.
- 4) Organization of the system-oriented management of water resources in relation to the general organizational framework in the Lublin region.
- 5) Resolution of regional water conflicts (upstream uses versus the downstream uses), which will be exemplified by the Lublin study as well as by some conflicting situations in the upper portion of the Vistula River basin.

By water management, we always mean management of water quantity and quality. It is felt that the Lublin study offers an excellent opportunity for real-life testing of a number of methods and ideas already developed at IIASA, as well as in the NMO countries. There is an abundance of all types of models available, the process of their development will continue and demonstrations of how they can be effectively used within the framework of a regional development will be of great interest to many countries in the world. It is expected that more detailed programs of implementation of these ideas will be developed during the Lublin-Vistula workshop to be organized by the IIASA Water Project in the near future.