

THE FUNCTION OF THE ODER RIVER
AS AN ARTERY OF TRANSPORTATION

THESIS FOR THE DEGREE OF PH. D.

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DON EDWARD BIERMAN

1970



This is to certify that the

thesis entitled

THE FUNCTION OF THE ODER RIVER
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of the requirements for

Ph.D. degree in Geography

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Date November 19, 1970

ABSTRACT

THE FUNCTION OF THE ODER RIVER AS AN ARTERY OF TRANSPORTATION

By

Don Edward Bierman

An analysis of the Oder River as an artery of transportation and its role in the economic development within the western territory of Poland indicates that the river has the potential of becoming the most important link between Silesia and the port of Szczecin. Nearly 90 percent of the river's entire basin is located in Western Poland in the area of the largest mineral concentration. More important than the actual increase in the total Polish natural resources is the unified control which has been established over the whole of Upper Silesia, permitting more effective use and economic development of the area. The Oder seems to be the natural outlet for the coal and the industrial products of both Upper and Lower Silesia. The river with the Gliwice Canal, in the segment from the Upper Silesian Industrial District to Wrocław, flows through the axis of a highly industrialized part of Poland which produces slightly more than half of the

national output. The pattern and flow intensity of commodities, unlike the Pre-World War II period, is between Upper Silesia and the port of Szczecin along the longitudinal axis of the Oder River.

At the present, the Oder is primarily an artery of transportation of internal significance, not always capable of meeting its quantitative and qualitative demands for movement. It also plays a relatively small role as a link within the European network of inland waterways. The full development of the Oder as an artery of transportation is associated with the concept of general economic development of its hinterland. With the allocation of additional capital to the improvements of the navigability of the river and the subsequent attraction of industry to its banks, the Oder and the carriers navigating on the river will tend to develop as a highly specialized mode within the Polish transportation system encouraging further economic development within the riparian regions.

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By

Don Edward Bierman

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INTRODUCTION

The unification of geographically separated points is the function of transportation. This view enables one to consider transportation as a system of linkages connecting different points in the spatially organized area. In this respect transportation acquires the role of an instrument by which spatial interaction is accomplished with different sectors of the economy and different parts of a region. However, before the distance which separates geographically detached places can be overcome, some economic resources have to be expended for the development of a circulatory system. The objective for all carriers within this circulatory system, both on the concentration and the dispersion sides, is to obtain maximum utility for minimum cost, thus to provide the cheapest possible means of transporting goods and people. In spite of this common objective, each mode of transportation, due to its inherent characteristics (in way, vehicle, and motive power), will tend to have a competitive advantage over other modes in moving certain types of commodities over a certain distance.¹

¹Way, vehicle, and motive power are considered here as the three major physical components of any

It has been found that water carriers, in spite of extensive terminal and transshipment costs, are well adapted to move bulk commodities which do not require prompt deliveries over long distances. The economy of water transport stems from volume operation and the relatively small range of commodities which is offered for shipment. This large quantitative and small qualitative demand imposed on water transport allows the mode to apply capital in the form of transport equipment to movement in order to obtain declining unit cost. Thus, in this case, water carriers even operating under the most adverse conditions have a substantial cost advantage over other carriers.

In addition, changing technology is revolutionizing the efficiency of waterborne commerce. The barge and towing vessel have introduced greater power and capacity to serve the growing number of industries that involve mass consumption of raw materials and have mass output. Therefore, industrial regions which have a significant number of steel mills, chemical, cement, papermills, petroleum refining industries, and other users of large inputs, and possessing the accessibility to a navigable body of water will find waterways an increasingly important mode of transportation.

transportation system. For the purpose of this study way is used interchangeably with routeway.

The Oder River which has its source in Czechoslovakia, in the eastern part of the Sudeten Mountains, flows northward across present-day Poland for 723 kilometers to the Baltic Sea. The navigable Oder, from the city of Kozle in Upper Silesia to the maritime port of Szczecin, a distance of 650 kilometers, flows through, in the upper reaches, and is contiguous, in the lower reaches, to the five most industrialized regions of the country.² This opportune location of the river gives Poland a direct water route between the concentration of heavy industry in Silesia and the maritime port of Szczecin.

The Oder River, at the present time, is the most important waterway in Poland and, due to its propitious location in relation to the five industrial regions, will play an increasing role in their development by providing the means by which interregional and intraregional spatial interaction can take place. The purpose of this research is to examine the function of the Oder River as an artery of transportation.

²Regions under investigation are Wojewodztwa Katowice, Opole, Wrocław, Zielona Góra, and Szczecin.

CHAPTER I

THE CONCEPT OF SPATIAL ORGANIZATION OF
TRANSPORTATION AND ITS APPLICATION
TO THE ODER RIVER

The role of transportation in the economic development of a region has been the subject of many studies by geographers and other scientists interested in spatial theory. For example, Ullman's studies on interaction have focused upon the importance of transportation in changing the spatial organization of man's economic endeavors.¹

Geography is widely recognized as having important contributions to make to the study of transportation because of its concern with environmental conditions. For example, Pegrum notes that geography plays an important role in transportation because it provides the physical and natural resource base upon which traffic flows are dependent, and because physical factors exercise a great influence over transportation and traffic routes.²

¹Edward Ullman, "The Role of Transportation and Bases of Interaction," Man's Role in Changing the Face of the Earth, ed. William L. Thomas, Jr. (Chicago: University of Chicago Press, 1956), pp. 862-880.

²D. F. Pegrum, Transportation: Economics and Public Policy (Homewood, Illinois: Richard D. Irwin, Inc., 1963), p. 75.

Vasilevskiy speaks of the universality of technological relationships between transportation and other branches of production which accounts for the highly "geographical" character of transportation.³ One of these relationships can be demonstrated by the examination of traffic flow patterns and the general location and grouping of routes. Many of the economic limits of transportation are established very clearly by physical conditions. These basic geographic conditions are fundamental to the need for transportation. The demand for transportation is rooted in stable structural forms, tied to the particular economic geography of the country. Kansky recognized the need for studying and understanding the structure of a transportation system within the regions, hoping perhaps this would shed light on the function of the transportation network within the region.⁴

The planning problem facing transportation development is the integration of the physical geography of the country with the economics of development and the economies of transportation. This need for the integration of areas of study is a phase of transportation planning

³L. I. Vasilevskiy, "Basic Research Problems in the Geography of Transportation of Capitalist and Under Developed Countries," Soviet Geography: Review and Translation, Vol. IV, 1963, pp. 36.

⁴K. J. Kansky, Structure of Transportation Networks (Chicago: Department of Geography Research Paper No. 84, University of Chicago, 1963).

which is essential if incorrect investments are to be avoided.⁵ "The attributes of alternative transport methods, then, need to be weighed in the light of the environment to be served and the transport tasks to be performed."⁶ Kaufman refers to geography as the "third pillar" upon which transport planning should rest.⁷

However, Wolfe has suggested that geography should do more than contribute to the framework within which transportation operates. Geographic techniques should be able to contribute greatly to transport planning if geography is, in fact, so important in explaining transportation requirements.⁸ For example, through changing the relative location of places, transportation affects the distribution of productive capacities and, thereby, the distribution of land or area values.

The integrative nature of geography and the concern for spatial interaction are both qualities needed in

⁵W. Owen, "Transportation and Technology," The American Economic Review, Vol. LII, No. 2 (1962), pp. 405-414.

⁶Ibid., p. 409.

⁷J. H. Kaufman, "Planning for Transport Investment in the Development of Iran," The American Economic Review, Vol. LII, No. 2 (1962), pp. 396-404.

⁸Roy I. Wolfe, "Contribution from Geography to Urban Transportation Research," Highway Research Board, Bulletin 326 (Washington, D. C.: National Research Council, 1962), pp. 46-68.

transportation planning. Traffic flow is dependent upon a wide variety of factors which play a part in theories of spatial interaction. In order to establish the connections between areas and the nature of the spatial interchange, it is necessary to find some way of measuring and mapping the flow of traffic, including its volume and speed of movement and its origin and destination.⁹ Geographic techniques and concepts put an emphasis upon environmental and spatial concepts which have been all too absent in transportation economics.

Statement of the Problem

As a result of the Potsdam Agreement and the subsequent shift of political boundaries by approximately 300 miles to the west in the Post-World War II period, Poland inherited the Oder River which, with its tributary the Nysa Łużycka, functions as a political boundary and, above all, as an important artery of transportation.

There are great benefits to the national economy which stem from the inherent advantages that grow out of the technical aspects of river movement. Consequently, attention will be given in this study to the significance of these advantages, not only for the general economy but

⁹Preston E. James and Clarence F. Jones (eds.), American Geography: Inventory & Prospect (Syracuse: Syracuse University Press, 1954), p. 316.

more specifically to the region contiguous to the Oder River. A review of the extensive literature on the subject suggests that, in recent years, barge transportation has become a very low cost movement and that the service has materially improved during the past two decades. The advantage of barge transportation stems from its inherent characteristics in its motive power, vehicle, and way. Technological improvements in these three components of a transport system brought the mode, once again, into competition with other modes. However, due to the mode's particular idiosyncrasies in motive power, vehicle, and way, the primary requisite for utilizing the efficiencies of barge shipment is the concentration of a massive volume of freight at one point. This is a shortcoming to some extent. It means that many products and movement on the distribution side, where break bulk of commodity occurs and where size of shipments are relatively small, are not best suited for barge shipments or are not likely to be shipped by inland waterways. To exemplify these two sides of each movement and the inherent advantage and disadvantage of the mode, it can be observed that in the United States barge lines have minimum tenders of 500 to 1,000 tons, where railroad carriers have carload rates for a minimum of 12 to 15 tons. As it appears, the requirement of such large minimum tenders certainly restricts inland waterways as a mode of transportation to a fairly limited range of commodities and

the type of movement.

In the past, the economic requirements of inland waterways for massive shipments has led some transport economists to the conclusion that the service is useful for only a limited portion of movement requirements. In recent years, development in the transportation sector of the economy in the United States and abroad suggests modification of this earlier reached conclusion. First, it must be pointed out that this is an era of specialized transportation. As the economic system becomes more sophisticated and as spatial interaction increases, both quantitative and qualitative demands for transportation rises. It can be said that the transportation system is highly tailored to the needs and requirements of the economy. The very fact that each mode can perform some functions very well and other functions only moderately well does not suggest that any single mode is unimportant or inferior. The trend toward specialization of carriers has continued to the present and there is every reason to expect that the trend will continue in the future. Any carrier that fails to measure up to the demands imposed on it by the economic system or attempts to be competitive in all markets may well be doomed to the point of extinction.

The second factor, which negates the common conclusion reached by some transport economists that the inland

waterways are only suitable for a few localized movements, is the make-up of the United States and Polish freight traffic. It is interesting to note that in both countries, in spite of great economic differences, products of mines, which are virtually all bulk materials, measured in terms of weight, constitute slightly more than 42 percent of all railroad tonnage moved.¹⁰ Agricultural products are also significant and probably 50 percent or more of these are grain which is moved in bulk. The same applies to forest products. The addition of truck and inland waterway tonnage to these figures would not greatly change the relative relationships of the various commodities. Motor transport would primarily increase the manufactured goods and the barge lines would increase the bulky categories. Therefore, one can conclude that well over 40 percent of the goods, measured by weight, moved in the United States and Poland are of a low value, bulk commodity of unprocessed nature. Inland waterways due to their inherent characteristics in motive power, vehicle, and way are unquestionably well suited for the inexpensive movement of bulk commodity, requiring large volumes, over long distances from the point of origin to the points of processing.

¹⁰U. S. Department of Commerce, Bureau of the Census, Statistical Abstract of United States 1969 (Washington, D. C.: U. S. Government Printing Office, 1969), Table 845, p. 562.

Główny Urząd Statystyczny, Rocznik Statystyczny 1968 (Warsaw: 1969), Table 7, p. 299.

Inland water transportation routes are restricted to the navigable rivers. The lack of a complete network of routes and the lack of connectivity between various river basins is a substantial limitation to the utility of the mode. But, above all, what is extremely important is the conformity of the routes to the desired direction of movement.

In this study, the author assumes that the transportation network, whether this is a railroad network or inland waterway, performs a specific function within the region. The structure of the transportation network, defined by Kansky as a set of geographic locations interconnected in a system by a number of routes, will largely depend on the function that the system of transportation is asked to play by the economy.¹¹ Therefore, as the requirements or the condition within the region has changed, the structure must also change in order to fulfill its newly assigned task. Even the most casual observer of the Polish economy must admit that the economy and the economic regions are undergoing drastic change in recent years, necessitating changes in the function and the structure of the transportation network. The purpose of this study is to examine such a change both in structure and the function of the Oder River waterway within five contiguous regions.

¹¹Kansky, p. 1.

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The lack of continuous statistical data for the period of several decades eliminates the possibility in using a mathematical model but, instead, the author will examine the function and the structure of the Oder waterway in the framework of an intellectual model.

A model, for the purpose of this study, may be defined as a master plan, a design, or some sort of a structure intended to serve as a pattern for a thing to be made. It may also be defined as a simplified representation of some complex real phenomenon in existence. It is interesting to note that Deutsch's philosophical ideas of a model are in agreement with chorological study so familiar to a geographer. As he negates one's ability to completely understand the total space, he sees that within a given structure any defined space can be studied and understood.¹²

The intellectual model has the value of aiding the researcher in focusing his attention on the relevant phenomena to the study in the mass totality of phenomena. It provides a functional mechanism by which data might be organized, processed, and interpreted, giving a clear picture of the nature and scope of physical and cultural phenomena.

¹²Karl Deutsch, "On Communications Models in the Social Sciences," Public Opinion Quarterly, Vol. XVI (Fall, 1952), pp. 356-357.

Organization

The organization of this study is based on the premise that there are three logical requirements for the existing traffic on the Oder River. They are:

- 1) a functioning mode of transportation
- 2) a demanding market with terminal facilities,
and
- 3) accessible supplies of economic goods.

On that premise, the character of the Oder waterway will be analyzed in this study. Multiple geographic techniques, including field and library research, interview, correspondence, and cartography were used.

The primary method for collecting data was field and library research. The data accumulated is presented by cartographic methods on numerous maps. This presentation provides an ideal means of locating phenomena of a particular type or showing relationships.

Identification of intervening variables was accomplished by interviews with the key officials of the agency Żegluga na Odrze, Polish geographers, and a search of the literature on the topic. Much of the statistical data came from the Polish Central Statistical Office, the Polish Academy of Science, periodicals, and other government agencies. A study of the literature of economics, transportation, regional planning, as well as that of geography was instrumental in the application of the techniques and

intellectual framework. Tables and maps are included wherever it was necessary in order to present the data which is essential to understand the study and reached conclusions.

The limitations of such a study should be noted. This study, like others dealing with Socialist countries, is also limited by the data which is available. An inventory of some resources and production figures cannot be provided. Detailed breakdown of commodity shipments is not available with the degree of reliability desired. Since this is the best available information, it is currently necessary for conclusions to be reached upon the basis of this limited data. However, conditions could be changed rapidly and dramatically by new information upon the role of the Oder River on its hinterland.

This characteristic of the basic data, together with the need to make several forecasts, must be taken into account when the results of the economic analysis are considered. Although the economic analysis will present the economic position of some of the studies quantitatively, the values cannot be considered as being precise.

The study of a transportation mode and its development should begin with some knowledge of the physical environment. In Chapter II, the broad features of the environment of the Oder River basin and the characteristics of its hinterland are described. Chapter III deals with

the technical aspect of the river as it may affect traffic densities. Chapter IV and V deal with the economic aspect of inland water transportation. Finally, in Chapters VI and VII, an attempt is made to analyze the role of the Oder River in the economic development within the five regions under study.

CHAPTER II

THE GEOGRAPHIC SETTING

The character of the transportation activities observable in any existing economy is a reflection of the geographic setting of that economy and a tangible legacy of the historical interaction between the natural environment and society. These are the forces one discovers when seeking to determine not merely what an economy's transportation system is like, but why it has assumed the configuration that it has. When questions are raised concerning the possible or probable role of the Oder River as an artery of transportation and its influence on the industrial development, it will inevitably be found that the analysis soon returns to consideration of the geographic setting of the river within the economy and its historical development as the fundamental elements of the situation.

Therefore, in this chapter it will be advantageous to analyze first the physical characteristics of the Oder River and its drainage system. Secondly, the hinterland of the Oder River and the general economic condition of the area, during the Pre-World War II period and the Post-World War II period, is discussed under the heading of characteristics of the Oder River.

Location of the Oder River

The Oder River has its source in Czechoslovakia in the eastern part of the Sudeten Mountains, flowing across the province of Moravia for 125 kilometers, and enters Poland through the broad tectonically produced Moravian Gate. Crossing the Polish-Czechoslovakian boundary, the Oder rapidly changes its course of flow from a north-easterly to a northwesterly direction and for approximately fifteen kilometers becomes an administrative boundary in the extreme south between the wojewodztwa of Opole and Katowice.¹

As Figure 1 shows, the general direction of flow of the river in the upper and middle reaches is northwesterly across the three western wojewodztwa, Opole, Wrocław, and part of Zielona Góra, for approximately 360 kilometers to the boundary line between Poland and East Germany, where the Oder meets its major tributary, the Nysa-Zużycka, flowing from the south. At that point, once again the Oder changes its course from northwesterly to northerly and flowing northward contiguous to the northern parts of wojewodztwa Zielona Góra and Szczecin assumes the function,

¹Wojewodztwo (singular) and wojewodztwa (plural), administrative regions of Poland, correspond to provinces of which there are seventeen in Post-World War II Poland. The name of the wojewodztwo derives from the major city in the region which is also the administrative capital of the province.

FIG. 1: GENERAL LOCATION MAP



in its upper reaches from the Nysa-Łużycka as the western boundary of Poland. Above the city of Gryfino, in the wojewodztwo of Szczecin, the international boundary does not follow the confluence of the river but instead circumvents the port of Szczecin by seven kilometers to the west. This gives Poland exclusive control of the maritime port and the mouth of the river and control over the major part of the Bay of Szczecin through which the Oder discharges its waters into the Baltic Sea.

The Oder is navigable from the city of Koźle, in wojewodztwo Opole in Upper Silesia, to the maritime port of Szczecin, a distance of nearly 650 kilometers, for the regular use of maximum size barges of 500 tons. Barges of lesser tonnage may continue across the Czechoslovakian border to Ostrava. However, very little traffic moves above the confluence of the Gliwice Canal at Koźle. Figure 1 illustrates the Oder's extremely advantageous geographic position in relation to the territory through which it flows. It can be seen that the river above the city of Koźle is linked by the Gliwice Canal with the industrial region of Upper Silesia, the heart of Poland's heavy industry. In its northwesterly flow to the East German-Polish border, the Oder in its upper and middle reaches traverses the industrial regions of Upper Silesia, Lower Silesia and numerous small industrial agglomerations which were attracted to the river location of the

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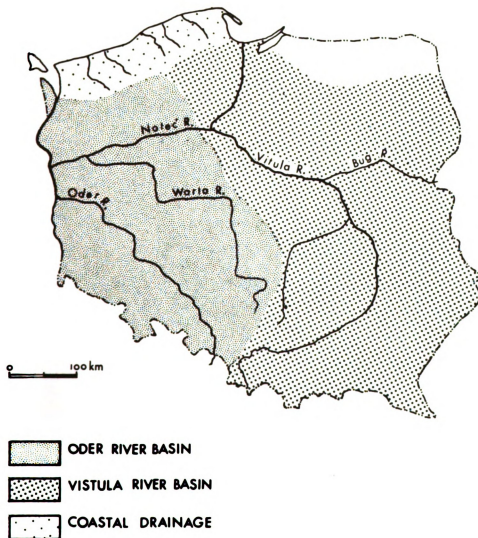
województwa of Opole, Wrocław, and Zielona Góra. On reaching the border, with the change in direction to a northerly flow, the Oder in its upper reaches is only contiguous to the western side of the województwa of the northern portion of Zielona Góra and Szczecin.

A closer look at the Oder's directional flow shows that in spite of its general northwesterly and northerly flow the river is in the habit of rapidly changing its course. A full explanation for the reason of this phenomena is beyond the scope of this study, however. A partial explanation suggests that structural control in the area of tectonic and glacial origin causes the stream to rapidly change its course. Nevertheless, the Oder laboriously progresses northward in the direction of the general slope across the landscape of Poland until it reaches its final destination, through its incipient delta, the Baltic Sea.

Both Figure 2 and Table 1 show that almost the entire country (99.7 percent) belongs to the Baltic drainage basin and less than 0.3 percent to the Black Sea and the North Sea.

The two largest river basins in Poland are the Vistula and the Oder. The western part of the country is drained toward the north by the Oder and its major tributary the Warta. The eastern regions are drained by the Vistula and its tributaries, the Pilica, Narew, Bug, and

FIG. 2: MAJOR DRAINAGE BASINS OF POLAND



Source: Panstwowy Instytut Hydrologiczny i Meteorologiczny,
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TABLE 1
POLAND'S DRAINAGE SYSTEM

	In Square Kilometers	Percent of Total Territory
Total Polish Territory	312,677	100.0
Vistula River Basin	173,900	55.6
Oder River Basin	106,177	34.0
Other Basins Draining to the Baltic Sea	30,900	9.9
Basins Draining to the Black and North Seas	800	0.3

Source: Główny Urząd Statystyczny, Rocznik Statystyczny 1968 (Warsaw: 1969), Table 7, p. 3.

Wieprz. The divides between these two major basins are distinct and there is virtually no major area in Poland of indefinite drainage.

The Physical Characteristics of
the Oder River Drainage System

The entire Oder River drainage basin covers 119,052 square kilometers of which 106,077 square kilometers or 89.1 percent are located in Poland.² The basin can be characterized as a typical one, carved by a river and its tributaries flowing on the Great European Plain, with a somewhat heterogeneous and complicated course.

²Główny Urząd Statystyczny, Rocznik Statystyczny 1968 (Warsaw: 1969), Tables 7 and 8, p. 3.

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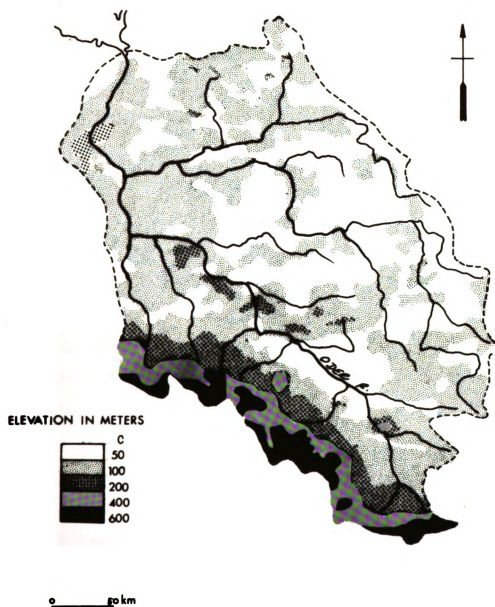
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FIG. 3: RELIEF WITHIN ODER RIVER BASIN



Source: Janiszewski, Atlas Geograficzny Polski, 1959

As Figure 3 shows, the area occupied by the Oder River Basin can be divided morphologically into two major sections, the southern section, a relatively small mountainous part, and the northern section, predominantly a plain. In the southern section the Oder rises in the Oder Mountains, which are a part of the most easterly extension of the Sudeten Range, at an elevation of 634 meters above sea level. The mountainous river valley is narrow and winding with steep slopes, particularly where the old rock is well exposed. The whole region has an appearance of being developed partially through diastrophism and partially through erosional processes. Thus in the extreme southern portion of the basin the Oder flows predominantly in a valley which is structurally controlled, whereas in the northern portion the structural control is less apparent.

As the Oder River enters the Moravian Gate it makes an almost 90 degree turn, changing direction from south-eastward toward the northeast. The valley widens from two to three kilometers in width and due to deposition, as a result of drastic reduction in velocity, it becomes swampy in some parts while alluvial terraces are clearly noticeable in other parts of the same general area. As the Oder proceeds in a general northerly direction through the Moravian Gate toward the city of Ostrava, the Oder Mountains are located on the river's left bank and the

Middle Baskity, which are a part of the Carpathian Mountains, are on the right bank. With the passage of the Oder through the Moravian Gate, the valley acquires an entirely new appearance. Here, the sizable valley was carved by the confluence of four mountain streams, the Oder, Ostrawica, Olsza, and Opawa, flowing southwest from the Sudeten Mountains of Bohemia.³ By contrast, the right bank tributaries are few and their contribution to the Oder is small in the southern portion of the drainage basin.

As the Oder River enters the broad plain it changes its direction and is prevented from pursuing its northeasterly flow by the Silesian rise which towers to the north of the valley. It appears that the Oder River valley in this region, once again, is structurally controlled. These rapid changes in the directional flow, however, are not entirely due to protrusions and the structure of the old rock formations. In many instances, particularly in the north, changes which took place in the landscape during the glacial period greatly influenced the directional flow of all European rivers draining to the Baltic Sea including the Oder. For example, the northern section of the Oder drainage basin was not developed prior to the first interglacial period. After the Baltic depression had been

³Jerzy Kondracki, Geografia Fizyczna Polski (Warsaw: Państwowe Wydawnictwo Naukowe, 1967), p. 126.

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carved out by the continental glacier in the post-glacial period, the northern section of the basin was developed.⁴ Thus, where the river has a northwestern orientation, this directional flow was imposed when the stream became temporarily blocked from its northerly flow by an ice sheet during the glacial period.

In summary, one can say that the overall northerly directional flow of the Oder River was imposed by orogenesis whereas the deflection from this flow into a westerly direction arose from the periodical halting of the receding continental glacier. The existence of former river valleys or "pradoliny" well support this view.

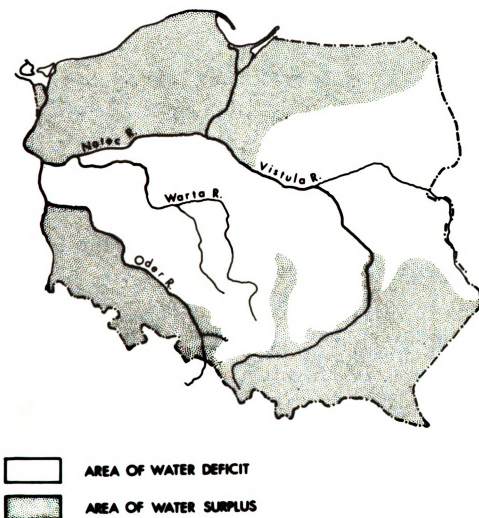
Looking at the entire Oder River basin, shown in Figure 4, one can delimit three distinctive hydrographic regions.⁵ The wide coastal belt which includes the Great Baltic End Morain extends from the Baltic Sea to the Warta-Notec Rivers. This is a region which can be characterized as having a surplus of water.

The triangular shaped area to the south of this coastal belt, extending from the Warta-Notec Valley to the eastern edge of the Oder River valley, is an area of water deficit. This deficit of surface water is caused, not only

⁴Ibid., pp. 128-129.

⁵Jadwiga Orsztynowicz, "Udział Wód Podziemnych w Bilansie Wodnym Dorzecza Odry w Latach 1951-1960," Gospodarka Wodna, No. 4 (Warsaw: 1969), pp. 157-158.

FIG. 4: SURFACE WATER BALANCE IN POLAND



Source: Based on data from Państwowy Instytut Hydrologiczny Meteorologiczny, Warszawa

by climatic conditions, but also by the constantly increasing industrial demands. The already existing water shortage is greatly aggravated by the ever-increasing consumption of large quantities of water by the industrial complexes of Upper and Lower Silesia, Łódź, and Warsaw. The third area, which is an area of water surplus, includes the valley of the Oder and extends southwestward to the Czechoslovakian border. This is an area of piedmont preceding the Sudeten Mountains. Due to the fact that the Oder from Ostrava to Głogów parallels the Sudeten Mountains for approximately 300 kilometers, the river in this area is supplied with an ample amount of water in the spring from melting snow in the mountains and orographic precipitation with a maximum in June.⁶

The middle Oder River basin, as it has been pointed out, sandwiched between two areas of water surplus, is an area of water deficit. Fortunately, the segment of the Oder River most affected by the low water level is relatively small. The apex of the triangle extends from the point where the Nysa-Lyżycka enters the Oder, to Kostrzyn', where the Warta, another tributary, empties its waters an approximate distance of 75 kilometers. The broad base of the triangle lies to the east of the river valley. Nevertheless, the extremely low water level in the late summer

⁶Biuletyn Państwowego Instytutu Hydrologicznego-Meteorologicznego Nr. 5 (126) (May, 1969).

and early fall greatly encumbers navigation in the middle segment of the Oder as it cannot permit barges of 500 or 1,000 ton displacement, which can freely navigate in the Gliwice Canal and the lower section of the river, to pass through the upper and middle Oder during the low water stage.⁷

An additional obstacle to navigation are the spring floods associated with the melting of ice and the damming-up at the mouth of the rivers. As one can see, the general direction of Polish rivers is north-south. This direction coincides with the general warming trend in the spring. Consequently, with higher temperatures in the south and lower in the north, the danger of flooding increases as the water and ice begins to flow in the upper reaches of the rivers while the mouths, on many occasions, are still frozen solid. The Vistula is particularly susceptible to spring floods while in the Oder valley major floods are very rare. This difference in the regime of these two major rivers is due to the fact that the Oder has relatively few tributaries originating in the mountains while the Vistula has quite a few. An additional factor is that the mountainous part of the Oder basin, the Sudeten Mountains, on the average receive less precipitation than the

⁷Władysław Magiera, Ekonomika Transportu Wodnego (Żegluga Śródlądowej), Wyższa Szkoła Ekonomiczna w Szczecinie Nakładem Państwowego Wydawnictwa Naukowego (Wrocław: 1951), p. 10.

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Tatra and Carpathian Mountains, which are a sizable part of the Vistula River basin.

The committee of the Polish Academy of Science investigating fluvial problems and the other water requirements of Poland declared that the need for water in the Oder Basin is most pronounced.⁸ The acute shortage of ground and surface water in the Oder River basin can be demonstrated by means of comparison with several European river flows. The annual flow of the Vistula at its mouth can rise up to 32 km³, while the Oder can attain at its maximum 18 km³. By comparing this with the Rhine's annual flow of 74 km³ and the Danube's 195 km³, the smallness of the discharge of the Oder River can be realized.⁹

What characterizes the Oder, however, from a hydrological point of view, is not the small quantity of water discharged but the rather considerable fluctuations in the levels of water. The level of water during the navigable season may range from the flood stage to catastrophically low levels. This immense variation in the water levels not only makes navigation extremely difficult and hazardous but it also threatens the already existing meager supply of water needed by the growing industry and

⁸ Aleksander Tuszko (ed.), Zarys Planu Perspektywicznego Gospodarki Wodnej w Polsce No. 8371, P.A.N. (Warsaw: 1968), p. 107.

⁹ Stanisław Skorowski, Geografia Gospodarcza Polski (Warsaw: Wydawnictwo Naukowe, 1939), p. 45.

urban places within the area. Particularly along the upper and middle river course, in the area of high industrial concentration, a shortage of water for industrial use could have serious economic consequences. In addition, extension and intensification of agriculture since 1960 within the Oder basin presents an additional demand for water, thus greatly aggravating an already existing problem.

From the point of navigability of the Oder, a very important factor is the stages of middle and low water in each month during the navigation season. During a year the stages of water are different, they range from low water to high water. The analysis of the hydraulic characteristics of the Oder River reveals that the causes for seasonal fluctuations in the water level are numerous and very complex ones. The single most important set of causes for low water level, however, is climatic. The prolonged drought in the late summer and early fall, typical for north central Europe, causes the water to fall very rapidly, where with the spring thawing of snow and ice and the June maximum precipitation, the Oder approaches the dangerous stage of flood. In the early spring the Oder floods due to ice jams accumulating in the river channel. A corollary to the climatic reason as to why the Oder's water level oscillates between these two extremes is the fact that the middle and lower portion of the river from Bedzin to Szczecin, a distance of 478 kilometers, has a small form

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ratio with an average slope of only 0.16 percent.¹⁰ The maximum discharge of water is during the spring, caused by the thawing of snow and ice, and during the early summer, which is in turn caused by the rapid downpour of rain. However, the summer peaks of flow are more rapid than the spring peak flow but of a significantly shorter duration. Periodically the water cannot be contained within the banks which causes overbank flooding and creates a flood stage. In the present century two major floods were noted, July 2, 1903, and in the middle of September, 1938.¹¹

To provide the necessary flood control and to help maintain minimum guaranteed depths of the navigable channel, a series of retention reservoirs shown in Table 2 and Figure 5 are located within the Oder River basin in the territory of Poland. In addition to the reservoirs on the territory of Poland, Czechoslovakia, and East Germany, several new projects are under consideration in connection with the proposed construction of the Oder-Danube Canal.¹²

¹⁰Form ratio can be defined as depth divided by width which can be stated in fraction, e.g., 1/100 meaning that the stream channel is 100 times as wide as it is deep.

¹¹Andrzej Grodek (ed.), Monografia Odry (Poznan: Institut Zachodni, 1948), p. 250.

¹²Kazimierz Puczynski, "Kanal Odra-Dunaj," Gospodarka Wodna, Nr. 6 (June, 1968).

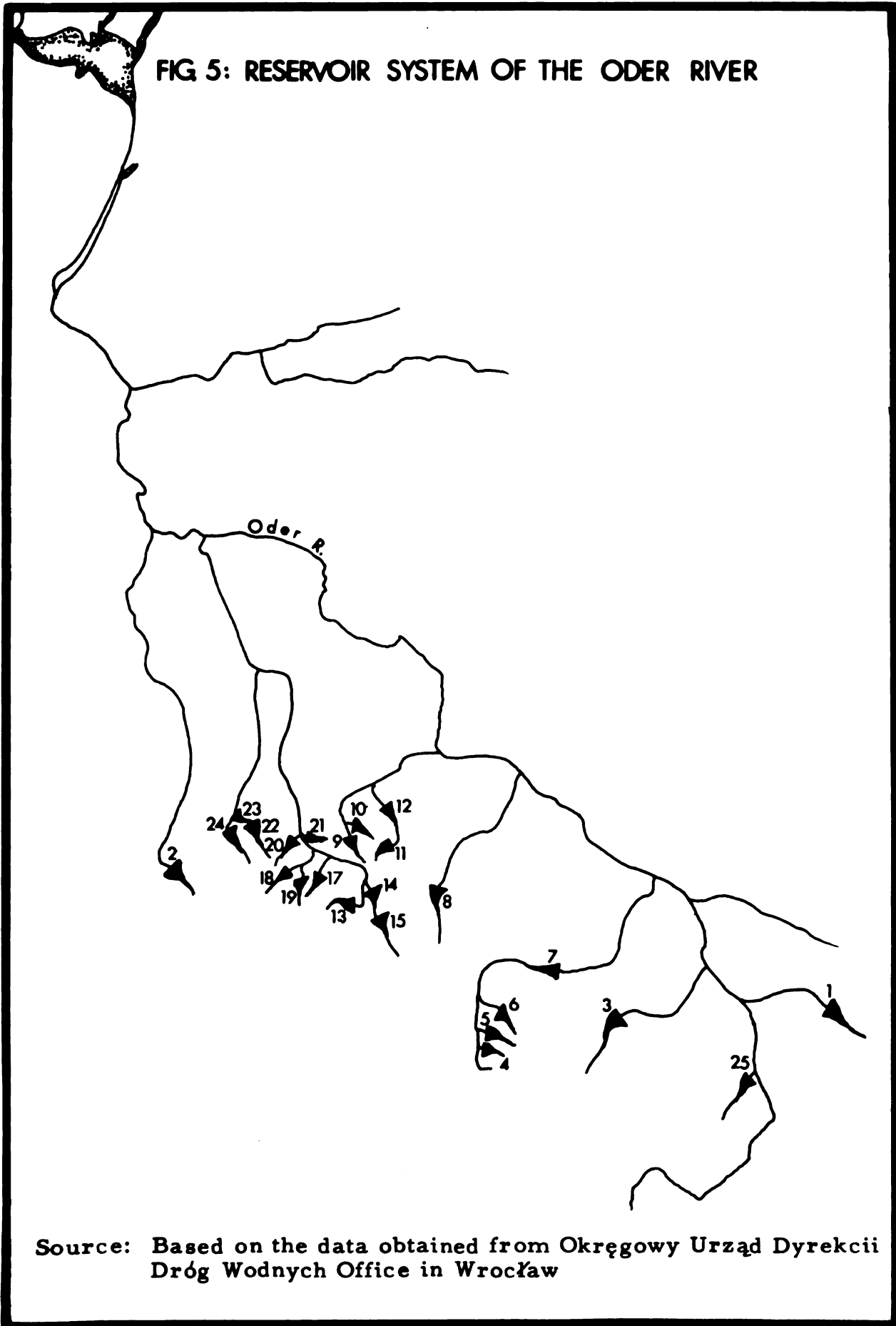
TABLE 2
RETENTION RESERVOIRS WITHIN THE ODER RIVER BASIN

Location		Stream	Total Capacity of Reservoir in Million Cubic Meter
1	Dzierzno	Kłodnica	48.4
2	Dzierzno	Kłodnica	37.1
3	Jarnoltówek	Złoty Potok, Rudawa	
		Obsobloga	2.4
4	Turawa	Mała Panew	98.5
5	Międzygorze	Wilcza	0.8
6	Stronie Śląskie	Morawa	1.3
7	Otmuchów	Nysa Kłodzka	128.0
8	Łubachów	Bystrzyca	8.0
9	Wojcieszków	Kaczawa	1.1
10	Swierzawa	Kamienny Pot.	1.7
11	Zarek	Nysa Szalona	5.0
12	Bukówka	Bóbr	2.4
13	Krzeszów I	Zadrna	. .
14	Krzeszów II	Zadrna	0.9
15	Myslakowice	Łomnica	3.3
16	Malinnik	Malinnik	4.4
17	Cieplice Sl.	Sokon W.	6.2
18	Siedlęcin	Bóbr	0.5
19	Wrzeszczyn	Bóbr	1.8
20	Pilchowice	Bóbr	50.0
21	Mirsk	Chmielenska W.	3.5
22	Złotniki Łubanskie	Kwisa	12.0
23	Leśna	Kwisa	15.0
24	Głębinow	Nysa	110.0
25	Racibórz	Oder	250.0

Note: In addition, there are five small reservoirs on the territory of Czechoslovakia.

Sources: Andrzej Grodek (ed.), Monografia Odry (Poznan: Instytut Zachodni, 1948), p. 480; Marian Milkowski, "Aktualna budowa zbiornika wodnego w raciborzu i Kanatu Zeglugowego," Gospodarka Wodna, XXVIII, Nr. 7 (July, 1968).

FIG 5: RESERVOIR SYSTEM OF THE ODER RIVER



Source: Based on the data obtained from Okręgowy Urząd Dyrekcji
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Characteristics of the Oder River Hinterland

The directional flow of the river and its relative location, in respect to the economic landscape of the country, is indicative of what role the river will play as an artery of transportation. The basic assumption here is that the demand for river transport, as of any other mode of transportation, is a derived demand which arises from economic conditions within the hinterland.¹³ Thus, by providing accessibility within the hinterland, the river, by meeting the quantitative and qualitative demand imposed by the economy, will allow one to judge the river's importance and performance in absolute or relative terms to that particular region.

The directional flow and relative location of the river in relation to the economic landscape is of paramount importance irrespective to the physical conditions of the river and its state of navigability. This point can be exemplified by pointing to the great Siberian rivers, great from the degree of volume of water and length of territory through which they flow. In spite of the hydrological and physical attributes of the mighty Siberian rivers, the directional flow of the Ob, Yenisey, and Lena is northward, emptying their waters into the frozen Arctic Ocean. An additional negative factor is that these rivers in the

¹³The term hinterland is used here to denote an undelineated area within the river's sphere of economic influence.

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middle lower reaches flow through sparsely settled wilderness and economically underdeveloped regions. Thus their status and their significance as an artery of transportation in the Soviet transportation system, in spite of the physical attributes, is relatively small. The axis of the economic landscape in Siberia has an east-west orientation and the desired direction of movement of goods and people coincides with the economic landscape. Thus these negative factors, such as directional flow and the relative location of Siberian rivers in respect to the distribution of natural resources and location of industry and markets make these rivers, as arteries of transportation, relatively insignificant. On the other hand, relatively minor rivers with less advantageous physical conditions may have great economic importance as arteries of transportation because they flow through the axis of industrial regions of great importance to the nation's economy. From the point of navigability, the Ohio and Rhine Rivers are less than can be desired, however, no one can dispute their great economic importance as arteries of transportation.

Although the Oder River watershed embraces portions of three sovereign and independent states, the German Democratic Republic, Czechoslovakia, and Poland, of these the most directly affected and presented an economic asset by the river is Poland and, to be more specific, the wojewodztwa Katowice, Opole, Wrocław, Zielona Góra, and Szczecin.

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The magnitude and the relative importance of a river to the national economy, whether this is measured by the tonnages carried, the type of commodity moved, or its share in the make up of the total transportation system, will depend on economic conditions within the hinterland through which it flows. If the regions of which the hinterland is made up are considered to be poor, underdeveloped, and relatively unimportant to a nation's economy, thus generating small shipments, then no matter what the estimated optimum capacity or physical attributes of a particular river, it has ultimately to be considered relatively unimportant to that economy. However, as the hinterland and economic conditions within the hinterland change, the importance of the river will also tend to change. Therefore, it is imperative that a brief history of the economic development of the area should be included.

In the middle nineteenth century, industrial Upper Silesia held great promise. It was described as equal to the one of England and foremost on the continent of Europe. Nevertheless, Upper Silesia, prior to World War I, did not constitute one economic unit. The Upper Silesian coal-fields and industrial area were divided between Prussia, Russia, and Austria. Both Russia and Austria held in miniature the resources and potentialities which the Prussians enjoyed in full measure in Upper Silesia.¹⁴

¹⁴Kazimierz Popiołek, "Koncentracja i Centralizacja Produkcji w Górniczo-Hutniczym Przemysle Górnego Śląska w



In looking at the Pre-World War I hinterland of the Oder River, one gains an instinctive impression that the Oder as "the river of the German East" had only secondary importance to the Reich's economy. The reason for Germany's inability to utilize the Oder to a greater advantage as an artery of transportation is not exclusively geographic in nature, but is also politico-economic. In spite of the fact that Upper Silesia, until 1853, produced over 40 percent of the total Prussian pig iron output, at the time of intense industrialization of Germany, unproportionality large amounts of capital were allocated to the western regions of Germany, more for political than economic reasons.¹⁵ The nonferrous metal industries of Upper Silesia were, except at the beginning of the century, less important than either the iron, steel, or the coal and their share in the total production of the region tended to decline during the century.¹⁶

The Ruhr area, at the end of the nineteenth century, became the most important single German industrial region. Justification for this policy was the necessity

PóXowie XIX Wieku," Kwartalnik Historyczny, P.A.N., LXIII, Nr. 4-5 (1956), pp. 265-267.

¹⁵L. Beck, Geschichte Des Eisens, IV, Hermann Fuchner, "Geschichte Des Schlesiſchen Berg-Und Huttenwesens in Der Zeit Friedrichs Des Grossen, Friedrich Wilhelms II und Friedrich Wilhelm III," Z.F.D. B.H.U.S., XLVIII (1900).

¹⁶E. A. Smith, The Zinc Industry (London: Longman's & Co., 1918), pp. 10-18.

of completing the unification of Germany politically, thus of binding the Western regions economically to the rest of Germany, as it was feared, not without justification, that the Saarlanders and Rhinelanders might find greater economic benefits with neighbors to the west than with the rest of Germany. German planners hoped that locating the major portion of heavy industry along the Rhine would assure their allegiance in two ways: one, creating incompatibility by developing competition between these regions and French heavy industry which lies immediately to the west and, secondly, by offering to the Rhineland's exclusive German markets which lie to the east protected by high tariffs.¹⁷

This process of concentration of capital in the western regions of Germany, which continued to the outbreak of World War II parallel with the migration of population, had an overall effect in increasing national revenue of the western regions and lowering it in the east.¹⁸ The fact that the eastern regions of Germany remained predominantly agricultural, generating low traffic densities, made the Oder River somewhat a less important artery of transportation, becoming subject to administrative neglect.

¹⁷Franciszek Ryszka, "Kapitał Monopolistyczny Na Górnym Śląsku i Formy Jego Polityki," Przegląd Zachodni (1952), pp. 203-265.

¹⁸Ibid.

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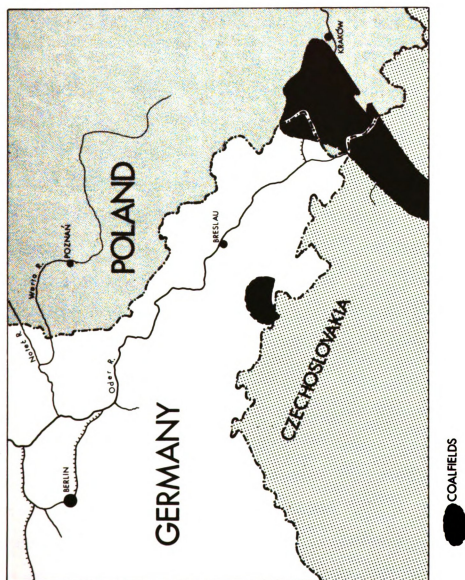
The main reason for German neglect of the Oder waterway in the interwar period was the status of Upper Silesia for which the river was a natural outlet.

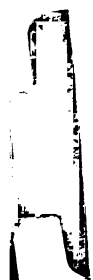
An additional reason for German economic neglect and virtual abandoning of the Oder waterway lies in the sphere of physical geography. In the interwar period, three states, Czechoslovakia, Germany, and Poland shared the basin of the Oder River. The fact is, however, as shown in Figure 6, the Oder's major tributaries, the Warta and the Noteć, linking it with the Vistula, are flowing from the east which in total represents 70 percent of its network system.

The partition of Upper Silesia after World War I, as shown in Figure 6, despite the precautions taken to preserve some functional unity, was a cruel blow to its industry and, consequently, to the transportation on the Oder. Germany retained approximately 600 square kilometers of the coalfield area of 2,800 square kilometers which she possessed before the partition and her estimated reserves of coal were reduced from about 57.8 to about 8.7 million tons.¹⁹ Her losses in coking coal were yet more severe. This dismemberment of industrial units, which had been pieced together during the previous half century and had grown slowly into a functional unit, appeared to be a

¹⁹Norman J. G. Pounds, The Upper Silesian Industrial Region (Bloomington: Indiana University Press, 1958), pp. 161-176.

FIG. 6: PRE-1939 ODER RIVER HINTERLAND





great tragedy.

The Geneva Convention had provided for the unrestricted movement of raw and part-finished materials across the boundary for a number of years. It was intended that this period should be used in each country to prepare for the full rigors of national competition and spatial realignment.

The division of Upper Silesia undoubtedly dealt more harshly with the part which remained German than with the part that passed to Poland. Firms which were left entirely on the German side of the boundary were relatively small and were dependent on coal from the other side. It had been assumed that Germany and West Upper Silesia would be obliged to import coal in considerable quantity from Polish Upper Silesia. Provision had been made in the Geneva Convention and Poland's commercial policy was based on this assumption but such expectations proved ill-founded. West Upper Silesia was in fact ill-placed to continue production of iron and steel. None of the few small iron mines of Upper Silesia were left in Germany, local supplies of coking coal were inadequate, and the rising labor cost made the area unattractive as a producer of iron and steel. West Upper Silesia was thus a high-cost producer and the prices were above that of the Ruhr. Its market was restricted to eastern Germany where it was insulated to some extent by distance from central and western Europe. Silesia was losing the battle against the

competition of the Ruhr and Rhineland.

The problem of transport cost was dominant. The German railways permitted iron ore to be carried at preferential rates, but this did not suffice to offset the immense advantage conferred on the Ruhr, Silesia's chief rival, by the facility of cheap water transport.

The Oder had, indeed, been made navigable under normal weather conditions for medium-sized barges but the Klodnit Canal, which joined the industrial area with the Oder River port of Kozle, remained as it had been left after the improvements made in the 1880's.²⁰ In the 1920's the traffic on the canal was only a minute fraction of that carried on the Oder itself. Clearly, the advantages of water transportation could be achieved only if barges could be brought to Gliwice itself. The completion of the Adolf Hitler Canal in 1940, along the route of the old Klodnit Canal, was designed to achieve this end. Indeed, the Germans envisioned a veritable network of canals linking the Oder with the Vistula, Danube, and Upper Elbe.²¹ The completion of such a project would certainly have lowered the costs and widened the market for the industries of Upper Silesia. The Second World War came before the

²⁰ In place of the old Klodnit Canal, a new canal, the Adolf Hitler Canal, was engineered and completed in 1940. It was renamed the Gliwice Canal after World War II.

²¹ Hans F. Zeck, Die Deutsche Wirtschaft und Sudosteuroopa (Leipzig: 1931), p. 81.

effects of the opening of the new canal had been fully apparent but there were indications before 1939 that industries might be relocated and revived along the banks of the new waterway.²²

In spite of this physical disadvantage to the German economy, the Oder would have been able to attain its greater economic scope if it had been given the chance to serve its neighboring territories situated on the right bank of the river where the nucleus of Polish heavy industry began to develop. Instead, however, the political boundary between Germany and Poland, reinforced by the traditional hostilities between these two nations, prevented greater use of the Oder River by Polish industry. Cheap water transportation in Poland's western provinces was greatly needed. Prior to World War II, Polish planners projected a plan linking Eastern Upper Silesia via a canal with the port of Gdynia.

Within the boundaries of 1939, the Oder was a waterway disinherited economically as it did not constitute a continuous artery of transportation throughout its entire length. Instead, the Oder was divided, from the point of traffic densities and direction, into three segments with nearly all its shipments moved in one directional flow towards the district of Greater Berlin.

²²"Oberschlesien als Standort einer Eisenschaffenden Industrie," Vierjahresplan, V (1941), pp. 472-476.

The first segment, which extended from Upper Silesia to the Oder-Spree Canal, had a canalized section extending from Koźle to Wrocław, with the remaining portion of the river running freely. Coal, the most important commodity from the point of tonnages, 95 percent in this segment, was moved from Upper Silesia through the Oder-Spree Canal to a destination in the area of Greater Berlin.²³

The middle segment of the Oder River, the sector between the Oder-Spree and the Oder-Havel Canals, was the least suitable for navigation and was a virtually unused portion. The reasons for this section not being used were not entirely due to the low water level as a result of climatic conditions and lack of navigational improvements, but rather due to the preferential direction of movement of commodity as dictated by the economy.

The third segment, the smallest of the three, extending from the point where the Havel Canal enters the Oder to Szczecin, was used as a connecting link between the industrial region of Greater Berlin and the port of Szczecin. In fact, Szczecin became the economic outlet for the Berlin area. Manufactured goods from Berlin destined to East Prussia and other Baltic ports moved via the Oder-Havel Canal and lower Oder to Szczecin. German statistics

²³Engineer Research Office, Navigable Waterways of Germany (Strategic Intelligence Branch, Military Intelligence Division, VIII, August, 1944), pp. 34-100.



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show that in 1938, out of a total of 17,658 ships navigating the Reich's inland waterways, 3,274 navigated within the Oder region.²⁴

The Oder River was never used as an artery of transportation in its full meaning of the term but rather individual segments of the Oder were used in the preferable east-west movement. Thus, if one looks at the pattern of flow of raw materials and agricultural products in the eastern regions of Germany this pattern shows convergence on Greater Berlin. The industrial might of Germany was not located along the Oder, which would in turn necessitate axial movement of freight along the entire river, but in the west. Consequently, the eastern regions were considered, in comparison to the western regions, economically less developed and primarily agricultural in nature.

The analysis of the total carrying capacity of the German inland fleet by river basin shows in Table 3 that more than 82 percent of the vessels ranged between 201 and 600 tons capacity. This can be compared with the Rhine which shows that almost 70 percent of its tonnages, in 1938, was carried in vessels ranging between 901 to 1,401 and larger ton capacity. Size of movement units, in this case size of barges, not only reflects the technical limitations of the way but also mirrors the relative

²⁴Engineer Research Office, XXXVII, pp. 11-12.

TABLE 3

TOTAL CARRYING CAPACITY OF THE GERMAN INLAND FLEET BY RIVER BASINS AND
BY TONNAGE CLASSES (JANUARY 1, 1938)

Carrying Capacity (in tons)	E. Prussia Waterways %	Oder Area %	Mark Brandenburg %	Elbe Area %	N.W. German Waterways %	Rhine Area %	Danube Area %	Saar %	German Reich %
21-50	1.3	0.4	0.7	0.5	1.3	0.2	0.2	. .	0.5
51-200	18.6	4.4	3.2	3.2	6.1	2.4	4.4	0.9	3.8
201-350	31.6	29.7	53.6	7.3	6.5	3.8	1.6	90.4	15.4
351-600	41.3	52.9	29.7	30.3	16.4	7.2	5.7	8.7	23.6
601-900	7.2	12.5	11.1	42.2	38.2	16.7	81.9	. .	24.3
901-1400	. .	0.1	1.7	16.3	31.5	40.1	6.2	. .	21.7
1401 & over	. .	. .	. .	. .	. .	29.6	. .	. .	10.7

Source: Engineer Research Office, Navigable Waterways of Germany (Strategic Intelligence Branch, Military Intelligence Division, XXXVII, August, 1944), Table 37-IV, p. 14.

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economic importance of the way to the total circulation system.

In summary, the Oder did not flow along the desired direction of movement but across it. Thus navigation on the Oder was the reflection of poor economic conditions in which the regions of the east had been left by German planners. In comparison, it can be shown that in response to economic inducements and demand, great care had been taken to provide for navigational improvement on the Rhine and the Elbe.²⁵ One can say that the German state, within its 1939 boundaries, did not allot the Oder an important economic role largely because Upper Silesia for which the Oder was a natural outlet did not represent one economic unit. The German portion of Upper Silesia, as shown in Figure 6, was small and insignificant in comparison to eastern Poland and Czechoslovakia. Poland, however, with its lion's share of Upper Silesia did not have accessibility to the Oder. The need for cheap water transportation was paramount and Polish planners, before World War II, proposed a canal which would link Upper Silesia with the maritime port of Gdynia. This proposed canal was to be located approximately 100 kilometers east of the Oder and largely parallel to it.

In the geographic and political system of central Europe in the Post-World War II period, the place the Oder

²⁵Engineer Research Office, II, p. 6A, and VI, p. 26B.

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occupies, as a link in the transportation system, is dissimilar to that of the prewar period. The river has become an important waterway in the service of Poland and, to a lesser extent, the German and Czechoslovakian economies as a result of economic changes within the regions.

The westward movement of Poland's boundary to the line of the Sudetens, the Nysa-Łużycka, and the lower Oder has not only greatly increased the country's industrial potential but also gave the Oder an extensive and rich hinterland. Poland acquired several industrial agglomerations along the foothills of the Sudetens and important industrial centers along the Oder River in Kozle, Opole, Wrocław, and Szczecin. Coal resources were increased by two-thirds with the acquisition of the Lower Silesian field at Walbrzych and the German-held sector of Upper Silesia.²⁶

The importance of the Oder to the Polish economy stems, in particular, from the river's relative location and its directional flow to the distribution of natural resources, population, and location of industry. Figure 7 shows the distribution of the major mineral resources in Poland and the relative location of the Oder to these resources. As is shown in Figure 7, nearly 90 percent of the river's entire basin is located in Western Poland in

²⁶Franciszek Barcinski, "Bogactwa naturalne ziemodzyskanych i ich znaczenie gospodarcze dla Polski," Przegląd Zachodni, III (1947), pp. 12-30.

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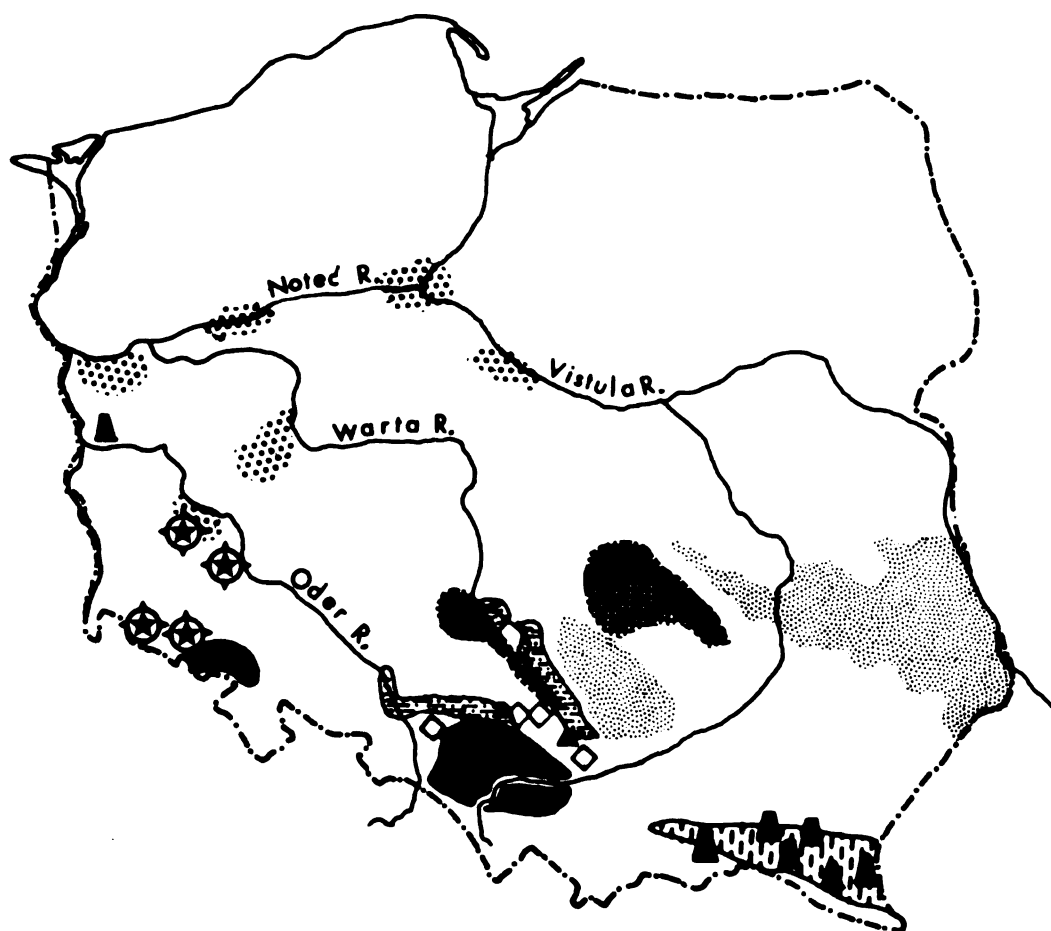
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FIG. 7: DISTRIBUTION OF NATURAL RESOURCES



Source: Stanisław Leszczyński, ed., Zarys Geografii Ekonomicznej Polski, (Warsaw: Państwowe Wydawnictwo Naukowe, 1967) p. 16

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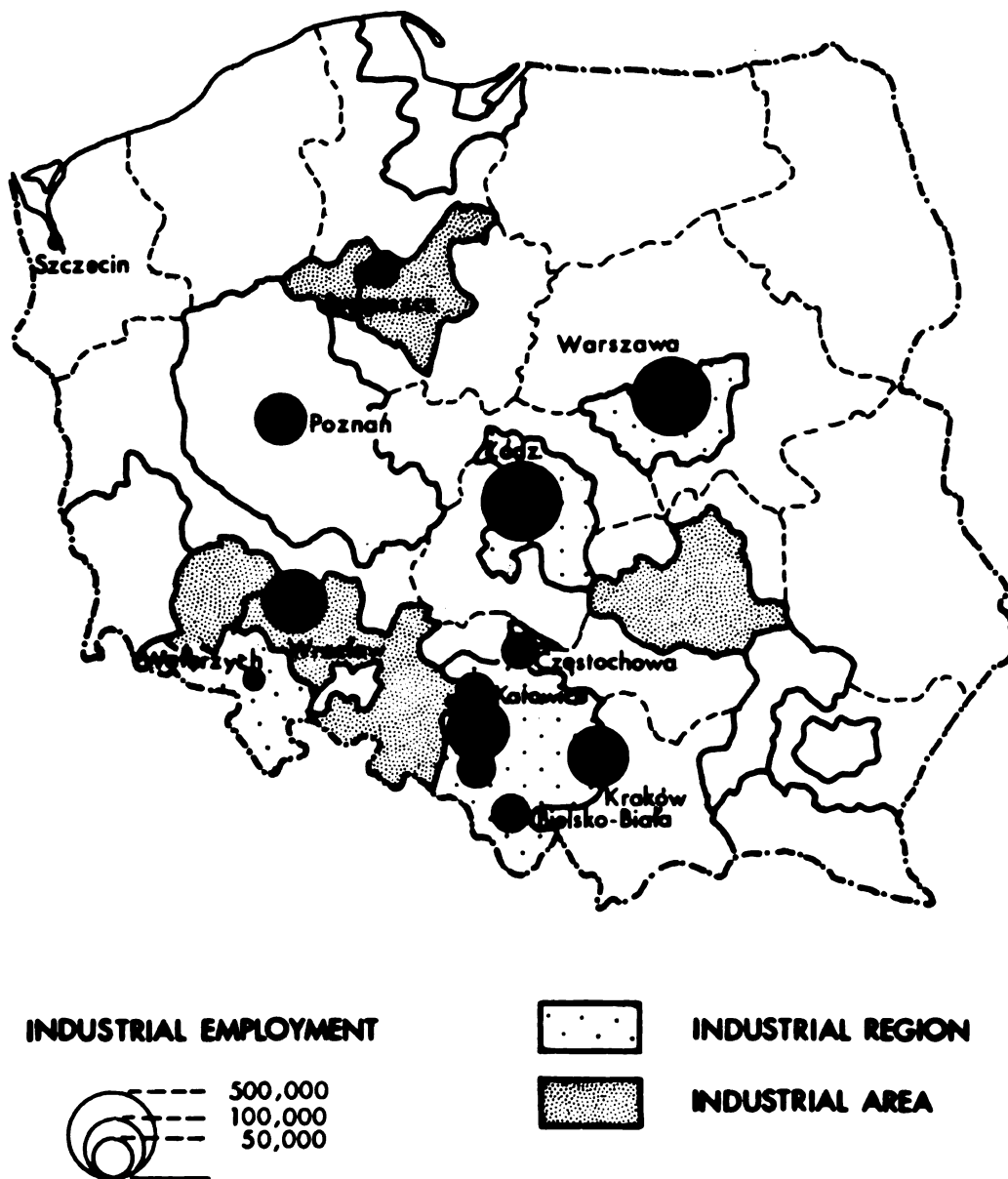
the area of the largest mineral concentration.²⁷ The Oder River, in its upper reaches, is connected by the Gliwice Canal to extensive coal, tin, and lead deposits in Upper Silesia. The coal, copper, nickel, and chromium deposits of Lower Silesia are connected to the Oder by several railroad feeder lines at Wrocław. In the middle reaches, the Oder below Wrocław flows adjacent to extensive though little-developed lignite and copper deposits in the województwa of Wrocław and Zielona Góra. Only in the lower reaches, from the point where the Warta the major tributary joins the Oder to the Bay of Szczecin, are there no significant mineral deposits in close proximity to the river.

Perhaps more important than the actual increase in the total Polish natural resources is the unified control which has been established over the whole Upper Silesia, permitting more effective use and economic development of the area. The Oder seems to be the natural outlet for the coal and industrial products of Upper and Lower Silesia.

In examining Figure 7, which shows the location of mineral resources, and Figure 8, showing the location of industry, one can see that the heaviest concentration of industry, known as Górnośląski Okręg Przemysłowy, is in województwo Katowice and in the western part of

²⁷Jan Kolipinski, "Rola Ziemi Odzyskanych w Organizmie Gospodarczym Polski," Przegląd Zachodni, II (1946), pp. 511-521.

FIG:8 DISTRIBUTION OF INDUSTRY



Source: M. Najgrakowski, "Zróżnicowanie Przestrzenne Poziomów Uprzemysłowienia i Urbanizacji na Obszarze Polski", Miasto, Nr. 7-8, 1964

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województwo Kraków. In addition, a smaller industrial agglomeration is located in the southern part of województwo Wrocław, the Wałbrzych industrial region. The areas surrounding the cities of Warsaw, Łódź, and Wrocław also show a fairly high percentage of industrial concentration. One can draw a diagonal line across Poland from Szczecin through Bydgoszcz, Warsaw, to Lublin which would separate the relatively industrialized west and southwest from an almost nonindustrialized northeast and east. The heavy predominance of Upper Silesia is apparent from Figure 8. One may delimit the industrial belt of Poland which reaches from województwo Kraków and includes województwa Katowice, Opole, and the southern portion of województwo Wrocław with its Wałbrzych district.

The Oder with its navigable tributaries is tied economically to approximately 34 percent of the Polish territory, inhabited by 40 percent of the population.²⁸ The river with the Gliwice Canal, in the segment from the Upper Silesian Industrial district to Wrocław, flows through the axis of the most industrialized part of Poland which produces slightly more than 50 percent of the total national output.²⁹

²⁸Główny Urząd Statystyczny, Rocznik Statystyczny 1968 (Warsaw: 1969), Table 7, p. 3.

²⁹Władysław Misiuna, Rolnictwo na Ziemiach Zachodnich i Północnych (Poznań: Wydawnictwo Poznańskie, 1956).

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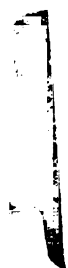
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In addition, important developments in agriculture and forestry in the area adjacent to the Oder can be noted. Particularly in wojewodztwa Opole, Wrocław, and some portions of wojewodztwo Szczecin, the best agricultural yields in the country are obtained in four types of grain. Consequently, with the help of the Oder the port of Szczecin has attained world importance as a grain shipping port. Perhaps the relative importance and the high degree of the exchange type of economic activity within the area can be better appreciated by pointing to the amount of traffic that is generated. Lijewski estimates that within the Oder River basin, which is approximately 35 percent of the territory, there is over 50 percent of the railroad lines which carry 70 percent of the nation's entire tonnage.³⁰

³⁰Teofil Lijewski, "Rozwój Sieci Kolejowej Polski," Dokum. Geogr. (1959), pp. 15-48.



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CHAPTER III

NAVIGATIONAL STATE OF THE RIVER AFFECTING TRAFFIC DENSITIES

The Oder River as an artery of transportation has evolved in a setting comprising both environmental and economic factors within the five regions through which it flows. The river's ability, however, to meet the demand for movement of goods and people generated by the economic forces within this hinterland depends to a large extent on the technological state of the waterway and its floating equipment.

Any transportation system is made up of a variety of components. A part of the system are the vehicles, containers, in which goods and people are transported. Another part of the system, as well, are routes or ways, a geometric pattern of interconnected geographic locations. Motive power moves the vehicles through the pattern of routes from one place to another. In the case of the inland waterways, the routes to a large extent are provided by nature, while their suitability for navigational purposes depends on the directional flow, width, and depth of the channel. The physical characteristics of inland waterways will certainly determine the type of floating

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Significant as components of any transportation system are the assemblages of terminals. These latter function as nodal points in the system, points of accessibility.

Therefore, the purpose of this chapter is to analyze the composite structure of the Oder River as an artery of transportation by analyzing the individual components of the inland waterway such as location and accessibility to river ports, depth of navigable channel, and type of floating equipment. The analysis of the structure will enable one to answer the question, whether the Oder constitutes a uniform and homogeneous way, capable of meeting both its quantitative and qualitative demands throughout its entire navigable length, or whether it has physical and technical limitations in way, vehicle, and accessibility which would greatly limit its usefulness as a continuous artery of transportation.

Location and Accessibility to River Ports

It is evident that early settlements along the Oder, functioning as ports, have developed precisely at the points where river traffic converged or interchanged with railroads and highway carriers. River ports, like any other terminals, an integral part of any transportation

mode, can be looked at as nodal points where various modes and systems of transportation come together.

Along the Oder, spread over a distance of 636 kilometers, are located twenty-one ports and anchorages, twelve of which are active ports as shown in Figure 9, and two, Scinawa and Głogów, which are presently nonfunctioning. A closer examination of the topographic maps reveals that with few exceptions there is a uniformity in spacing of river ports along the Oder. The distance between ports is approximately 40 kilometers. This phenomenon perhaps may be analogous to Christaller's "central place" location of towns.¹ Here the spacing factor, of the points of accessibility, appears to be the fact that a commodity from the hinterland will move only a certain distance to a river port.

The fact that the ports along the Oder are on one bank or the other cannot be considered merely a matter of topographic chance. Rather, a review of historical data suggests that economic and political forces were at play in the locational decision of the Oder's ports. The location and spacing of towns and ports along the river largely depends on the function of the river itself. The river can be thought of as either a routeway along its axis, providing unity and accessibility to the area, or it can be

¹Walter Christaller, Central Places in Southern Germany (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1966), pp. 31-60.

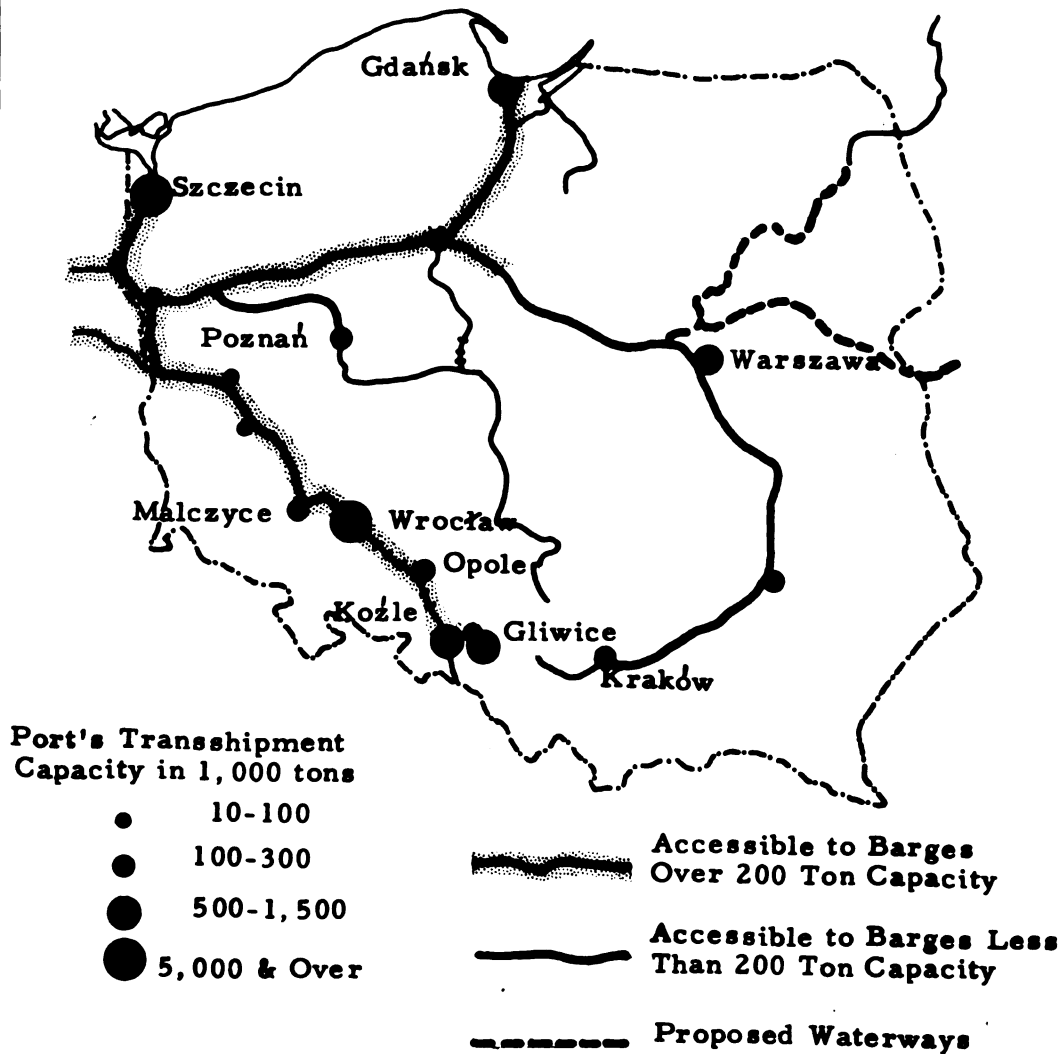
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FIG.9: INLAND WATERWAYS AND MAJOR PORTS OF POLAND



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considered as a barrier to transportation and communication by physically separating places. Rivers in their unifying function, however, are not equally accessible throughout their entire course. Rather, their accessibility is limited to several points of entry and exit along their routeway. River ports or terminals perform the function of providing accessibility to both the hinterland and the river as a routeway.

In the case of the Oder, the river was historically both a barrier and a routeway. Since the tide of German settlement, commerce, and subsequent industrialization was moving from west to east, the initial towns were usually situated on the western bank. Some of these, such as Szczecin, Frankfort on Oder, and Wrocław, due to favorable economic and physical conditions, have persisted up to the present, developing into sizable cities. The Oder in its early function as an artery of transportation attracted traffic along its course by providing a relatively inexpensive form of transportation, so towns with anchorage facilities developed somewhat equally spaced on both banks of the river. The distance between these towns constituted a day's sailing time. But those, however, on the bank toward the freight source became dominant. For example, ports such as Koźle and Opole developed on the right bank of the Oder, becoming important bulk transferring ports, particularly loading ports, for Upper Silesia, an

extensive and productive area lying east of the river. The ports of Małczyce, Wrocław, and Oława, developed on the left bank to serve Lower Silesia, an area lying to the south and southwest of the river.

Terminals are as important in the transportation picture as in line-haul. In fact, terminal problems often surpass those of line-haul in extent and complexity. The author here considers terminals as the sum total of facilities and their locale where road-haul traffic is originated, terminated, and/or interchanges before, during, or after the road-haul movement. These are the points where loads are assembled and/or broken down into smaller quantities. Such a grouping of facilities usually occurs at the end of a route but it also occurs frequently at one or more intermediate points along the route. It is only through these points, water terminals, that the river is accessible as an artery of transportation, as accessibility is not equal along the routeway's entire length.

Along the Oder from Gliwice to Szczecin twelve river ports are presently in use, including the maritime port of Szczecin. In total there are seven public terminals and twenty terminals exclusively owned and operated by industrial enterprises. The port facilities include not only those operated by water carriers serving the port such as piers, coal and ore docks, grain elevators, and other transfer facilities but also necessary local switching railroad, trucking concerns, towage, and storage warehouses. The type of

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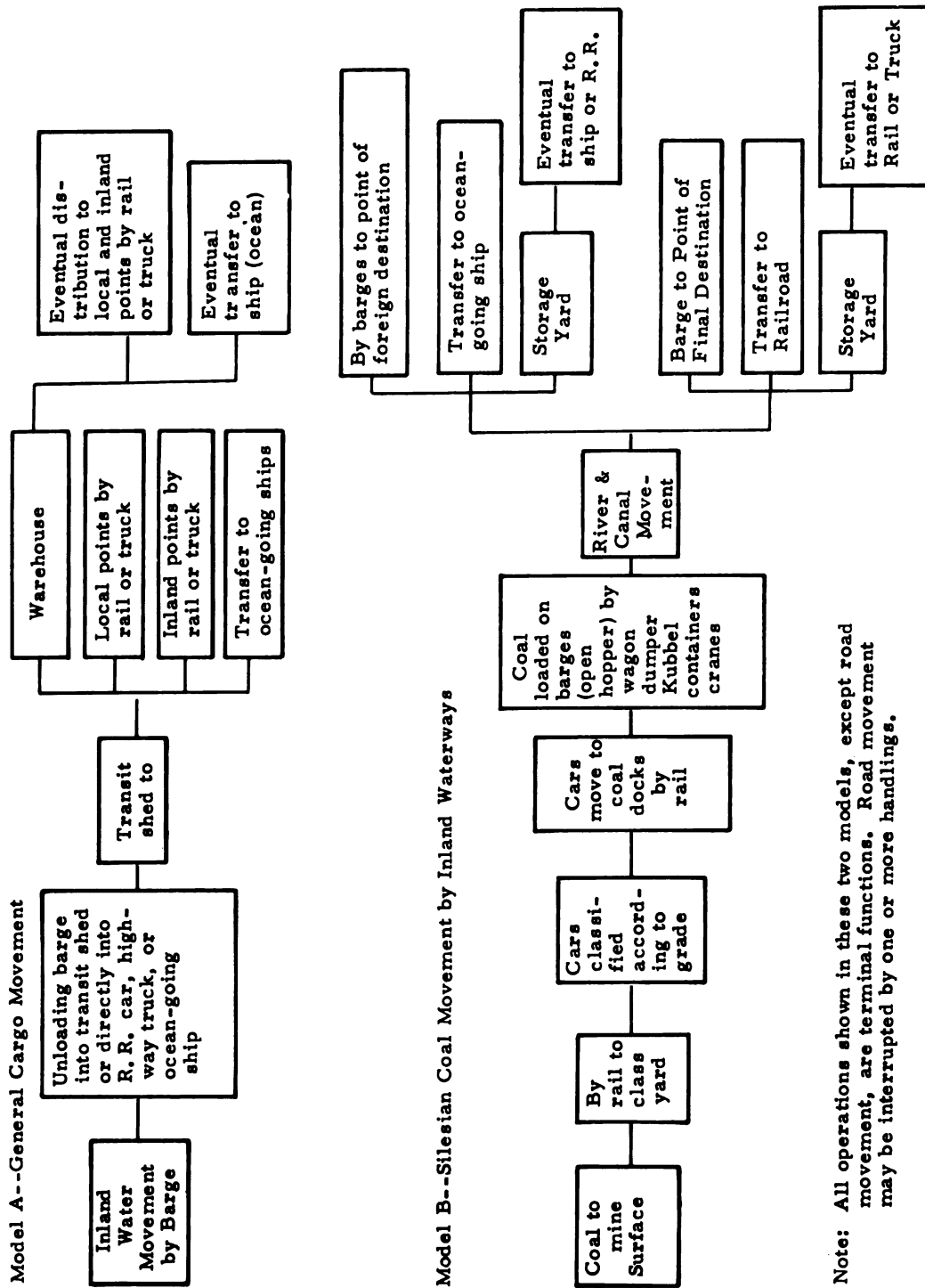
traffic passing through a terminal has important effects on the operation and the facilities required. One may distinguish between commodity and traffic types and the peculiar needs of each.

Figure 10 shows two hypothetical models of terminal operations. Model "A" shows the movement of general cargo which includes a whole array of commodities ranging from manufactured goods, semiprocessed goods, and fertilizer to agricultural products. The relatively small volumes and heterogeneous nature of the commodity requires extensive terminal operations and handling and it does not permit a high degree of mechanization in the transferring operation. One can say that this type of terminal operation is high labor intensive.

Model "B" shows the typical movement of bulk commodity. The homogeneity of the commodity and large volumes permit application of mechanization in loading and unloading operations. Here, transfer operations are a relatively small percentage of the total cost of movement while transfer cost is relatively high in the case of general cargo movement.

In the case of the Oder's ports even the most superficial investigation reveals that not all the terminals have installations capable of handling commodity, especially when large quantities are concerned. A more detailed discussion of several Oder River ports below will exemplify these differences.

FIGURE 10: Models of Terminal Operations



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The port of Gliwice, typical of Model "B," situated on the eastern extremity of the Gliwice Canal, is the most modern of all the Oder ports. It is considered by Polish authorities to be capable of handling 6 million tons annually.² Lying on the western side of the Upper Silesian industrial district, it is the most convenient point of transshipment of coal from rail into barges. The fact that large quantities are involved have made it possible as well as economical, in spite of heavy capital outlay, to introduce a great deal of mechanization in coal handling. The coal from the mines is shipped by "Kubbel" containers, which are lifted from railway wagons by four cranes of 17.5 tons, and emptied into open hopper type barges. It has been estimated by the Gliwice port authorities that by using "Kubbel" containers, the coal loading rate per crane is 330 tons per hour. Even if one takes the capacity of 250 tons per hour, as observed by the author, 2,000 tons can be handled in an eight hour working day. An additional six cranes, four of a capacity of 5 tons and two of a capacity of 7.5 tons, located in three basins make up the total mechanized transferring equipment for handling bulk commodity in the port.

The equipment and facilities, which were primarily designated to handle a large variety of small shipments,

²The estimate is based on the author's interview with the officials of the agency Zegluga na Odrze representatives in Gliwice.

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are old, inefficient, and seldom used. The third basin, designed to handle liquid fuels, is not in use for this purpose at the present time, but is used as a receiving and storage depot for the lumber used at the mines. This brief description of the port's facilities, equipment, and methods in transfer operations underscores the primary function of the port at Gliwice which is coal loading.

The port at Koźle, another example of "B" type of terminal operations like the port of Gliwice, plays an important role in the transshipment of Upper Silesian coal destined for domestic and foreign markets by inland waterways. Coal consigned for foreign export moves either by barges through a system of inland waterways to the point of destination, or it moves to Szczecin where it is loaded on an ocean going ship for further shipment. Koźle is also a major unloading terminal of imported high grade Swedish iron ore for both Polish use and for transshipment consigned to the Ostrava-Karvinski iron and steel complex in Czechoslovakia. The transshipment of coal takes place by the use of old and somewhat inefficient wagon dumpers. Czechoslovakian transit, iron ore and other raw materials, is unloaded at Koźle from barges into railroad cars for further shipment by rail to the point of destination. The annual capacity of the port of Koźle has been estimated by Polish officials to be approximately 1,100 thousand tons. With construction of the proposed canals, the Oder-Danube

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and the Oder-Vistula, the port of Koźle will assume a key national and international significance. Koźle will become a hub for two major inland water routes linking the Danube with the Baltic Sea and the Vistula, via the Oder and the Elbe, with the entire Middle and Eastern European inland waterway system.

The city of Wrocław has two ports. The port Miejski (city port) is an example of "A" type terminal operations especially equipped to handle an assortment of commodities originating or terminating locally in the surrounding areas and foreign shipments such as building materials, raw materials for light industry, as well as a multiplicity of finished goods. Lately, with increased Polish participation in foreign trade via inland waters, the port Miejski is assuming an increasingly greater function in international trade.

Wrocław's second port is Popowice, an example of "B" type. It is equipped to handle bulk commodity such as Lower Silesian coal, copper, nickel, and magnesium. The shore installations for both of Wrocław's ports are old and are long overdue for replacement. The low estimated annual capacity of 760 thousand tons for Wrocław's ports, Miejski and Popowice, reflects perhaps the inefficiency of its old shore installations and their low priorities assigned by planners in the reconstruction of port facilities.

Both ports of Opole and Malczyce, examples of "A" type terminal operations, handle general cargo. Here,

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shipments and the multiplicity of commodity handled do not lend themselves well to application of mechanization in cargo handling. By nature this type of transshipment operation is high labor intensive, thus costly. The port of Opole in recent years has begun to develop its own specialization by handling potash imported from East Germany destined for the local fertilizer plants. Both ports also service barges of the agency Żegluga Bydgoska. The total capacity of the ports of Opole and Malczyce is equal to 150 and 280 thousand tons, respectively.

An attempt was made above to exemplify briefly terminal operations of both "A" and "B" models in real content. Table 4 summarizes the major characteristics of the Oder River ports presently in use.

An analysis of Oder River ports reveals the emergence of a type of geographic division of labor between the ports. This emerging division of labor cannot be entirely attributed to conscious planning by the planning agency but, rather, it is a response to economic and locational forces. The fact is that some of the ports are in close proximity to the developing industrial complexes or sites of existing or newly discovered raw materials. Therefore, one would expect that the port would serve its most immediate area. Greater specialization of the river ports would simplify and expedite the flow of commodities on the Oder in the sense that a particular port would

SUMMARY OF THE MAJOR CHARACTERISTICS OF THE OTHER RELEVANT PROPERTIES

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TABLE 4

SUMMARY OF THE MAJOR CHARACTERISTICS OF THE ODER RIVER PORTS

Ports	Estimated Annual Capacity (1000 tons)	Location from Confluence in Km.	No. of Basins	No. of Cranes	No. of Wagon Tippers	Storage Area in 1000 Sq. M.	RR Track in Port Area (in Km.)	Primary Function
Gliwice	6,000	41.6	3	10	. .	68.3	11.5	Loading coal- 90%; unloading iron ore-5%
Koźle	1,100	96.0	3	6+	6	54.3	19.5	Loading of coal-80%; unloading iron ore (Transit Czech.)
Opole	150	155.0	1	2	2	0.8	8.6	General Cargo, Load- ing of Cement (Reserve for Gliwice & Kozle)
Oława	10	215.0	1	2	. .	10.0	*	General Cargo
Wrocław	760	256.0	2	20	1	5.8	21.8	General Cargo

Note: * Not Available

TABLE 4--Continued

Ports	Estimated Annual Capacity (1000 tons)	Location from Confluence in Km.	No. of Basins	No. of Cranes	No. of Wagon Tippers	Storage Area in 1000 Sq. M.	RR Track in Port Area (in Km.)	Primary Function
Malczyce	280	304.8	2	3	2	0.4	4.8	General Cargo
Nowa Sól	40	430.0	1	2	. .	*	*	Anchorage for tugs
Cigacice	50	471.7	1	1	. .	27.0	1.3	Transshipment of grain, Winter quar- ters (Coaling Station)
Kostrzyż	180	615.3	2	*	. .	*	*	End of line for deep draft tugs
Szczecin	7,000+	738.0	14	*	. .	*	*	Unloading coal

Note: * Not Available

Source: Data obtained from the office of the agency Żegluga na Odrze, Wrocław, June, 1968.

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transship, load, or unload only a certain type of commodity rather than all types of commodities as has been the case up to the present, which would in turn allow a greater application of mechanized equipment.

With the increased specialization of the Oder ports, the present convergence and pattern of railroad lines will also be subjected to change in order to provide greater accessibility from the hinterland to these ports. Here is an example of overlapping and complementarity between modes of transportation. At the present, there are only three main points of convergence of railroad lines along the Oder River. Several major trunk lines converge on the ports of Gliwice, Koźle, and Wrocław; consequently, these developed into the great ports of the Oder River. The major factor here that enters into consideration is the location of natural resources in close proximity to these ports. They have become outlets for the surrounding mining and manufacturing areas. For example, the coal from the Upper Silesian mines is most conveniently shipped by railroad to Gliwice or Koźle for further shipment by inland waterways. The cement from Sosnowce moves by railroad and then is loaded on barges at Gliwice. The port of Koźle lies at the intersection of the major lines connecting Upper Silesia with Lower Silesia and Czechoslovakia with Poland through the Moravian Gate.

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The pressure on Wrocław as a major point of trans-shipment from railroad to barge and vice versa and as a primary inland water outlet for Lower Silesia can be somewhat lightened. In the vicinity of Wrocław there are numerous smaller ports such as Oława, Brzeg Dolny, or Malczyce which are, at least in actual kilometer distance, closer to the sources of raw materials. Thus, in turn, they could divide some of the burden between them which is now largely borne by Wrocław's ports. Recent developments in the area point to the fact that that is exactly what is being done. For example with the recent discovery of the copper fields southwest of Głogów, this presently dead port is being revitalized.

On the basis of field examination of Oder River ports and their terminal facilities, the author has devised a simple functional classification of the ports. This classification is based on the volume of traffic and present and potential commercial significance to the movement on the Oder, rather than on the method of terminal operations. All Oder River ports can be divided into four categories:

- 1) Commercial--Class I (with annual minimum capacity of 250 thousand tons)
- 2) Commercial--Class II (with annual capacity less than 200 thousand tons)
- 3) Service Ports (no commercial value, serving exclusively the needs of the navigation agency "Zegluga na Odrze," e.g., coaling stations, shipyards, etc.)

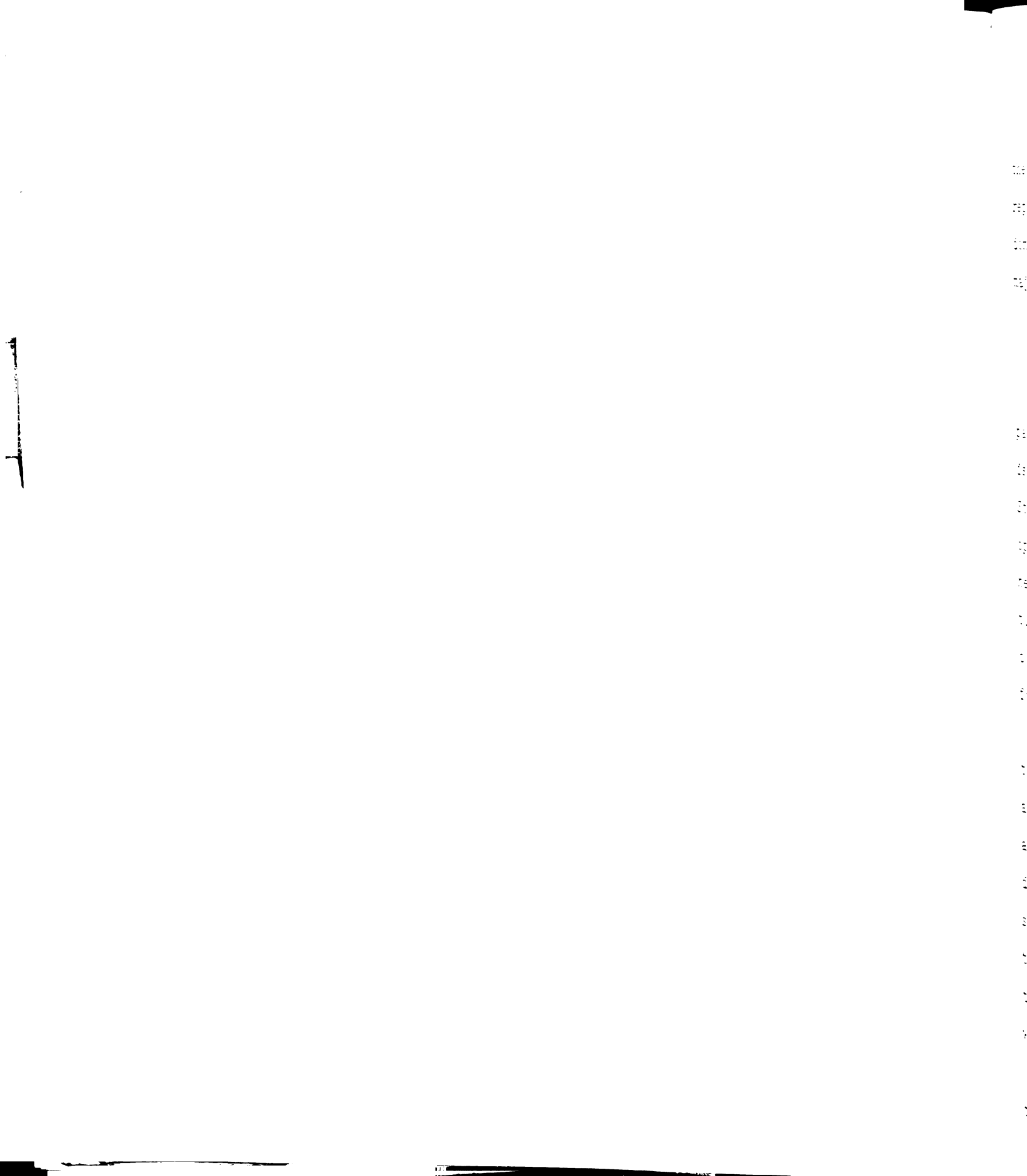
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4) Winter Quarters (for floating equipment).

As commercial ports of Class I, one can include the following Oder ports: Gliwice, Koźle, Wrocław-Popowice, Wrocław-City Port, Malczyce, and Szczecin, and the inland water port at Golęcín. The commercial Oder River ports of Class II are: Oława, Nowa Sól, Cigacice, Kostrzyn', and ports on the river Warta such as Poznań and Międzychód. The separate category is "Winter Quarters" which consist either of natural or artificially constructed basins, guarded against ice and flood. The commercial ports also perform the function of winter quarters for the fleet.

The rapid growth in inland water cargo handled by the Oder River ports in recent years has been a reflection of the expansion of physical facilities which has taken place during the period of reconstruction. Statistics show that in spite of the sharp drop during the year 1955 in the amount of cargo handled by the Oder port, inland water cargo appears to be on the threshold of continued major growth and expansion. At the end of 1968, the total cargo handled by all inland water ports in Poland was 5,314 thousand tons, 59 percent of which was handled by Oder ports.³ In spite of this rapid growth, however, if one compares it with railroad, intercity trucking, and ocean freight, it is still small business. Specialization is on

³Główny Urząd Statystyczny, Statystyka Żeglugi Śródlądowej i Dróg Wodnych Śródlądowych, 1968, Nr. 48, Table 24 (Warsaw: 1969), p. 47.



the side of inland water-bound cargo. While today it may represent only an infinitesimal portion of the total domestic freight movement, small increases will represent major growth in the actual volume of river cargo handled.

Varying Widths and Depths of the Navigable Channel

The navigation channel constitutes an important part of the waterway. The performance of vessels and tows is well demonstrated on the great waterways of the United States and Europe. The prospect for their successful operation, however, on poorly developed and neglected channels can be predicted only after consideration of the features of channel design such as depth, width, and its curvature that collectively results in a successful performance of the inland water fleet.

Channel alignment and dimensions which would permit tows or vessels to proceed with full loads and at a reasonable speed, allowing such tows or vessels to pass one another without difficulty, must be made available. The design of the navigational channel has to take into consideration total tonnages that are expected to be carried, the type of floating equipment, and the method of navigation that will be used on that particular section of the waterway.

To permit the successful passage of tows similar to those navigating on other European inland waters, the Oder

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system must have ample physical dimensions. The problem of providing a waterway of adequate dimensions on the Oder to permit barges of a minimum 500 ton displacement to navigate without difficulty along its entire length and, at the same time, be practical from an engineering standpoint, is a difficult one. The present physical characteristics of the Oder River present serious obstacles. The most crucial and seldom attainable physical characteristic of Polish inland waterways is adequate depth. The necessary depth for navigation should be sufficient that a vessel of a certain tonnage can freely navigate without danger. Ideal conditions exist when there is at least 50 centimeter clearance between the fully loaded vessel and the channel bed. A lesser clearance would cause a drastic increase in propulsive resistance. Equally important to navigation are the curvatures and the widths of the channel which in a sense determines the type of floating equipment that can be used and the method of navigation. The Oder River has numerous bends with a small arc in the navigable channel. In the channelization of the river, the minimum permissible length of the radius of the arc within the channel will largely depend on the width of the channel. The authorities in the field of channel design state that the radius should not be smaller than four times the width of the channel but, at the same time, should not exceed ten times the width.

To illustrate how the width and the curvature of the navigable channel relates to the navigation method, one

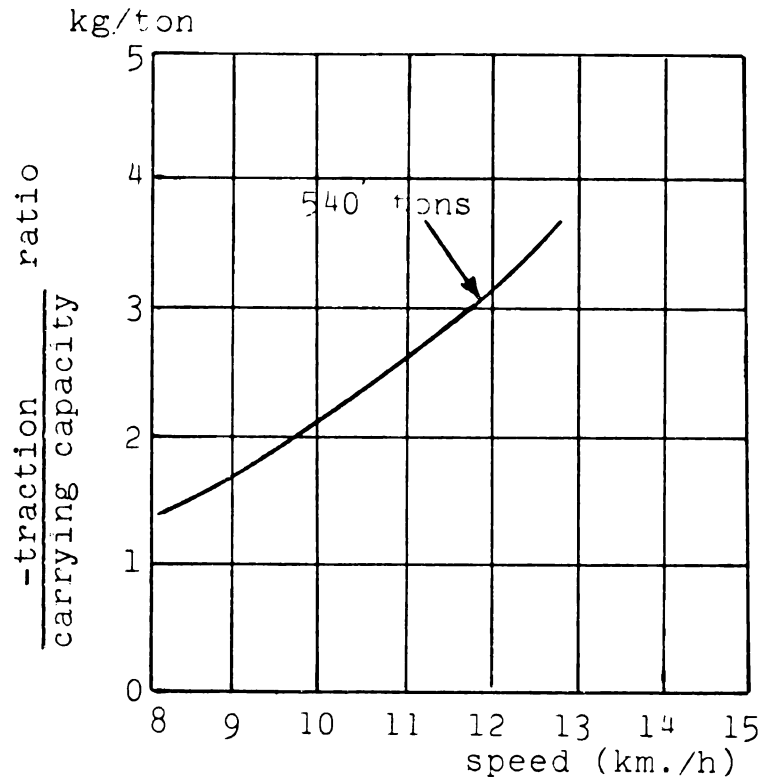


may cite an example. The physical characteristics, particularly depths, on some sections of the Oder River permit the length of a tow up to 500 meters. However, the economy and safety of movement on the channel requires that the length of the arc of the channel should at least be twice the length of the tow which would permit the easy movement and passage of two tows. Therefore, ideally the minimum length of the arc should be at least 1,000 meters. This length, however, is not always possible to obtain with the channelization of the upper Oder. In restricted channels having small radii of curvature, it may be necessary to neglect considerations of towing resistance and arrange tows in order to obtain sufficient steerability to negotiate sharp turns.

The size and shape of the navigable channel has a most pronounced influence on the performance of floating equipment and its power requirements to overcome propulsive resistance. Probably the best direct comparison of traction to speed relation was obtained in the experiments by Peters.⁴ The average values for pull needed at certain speeds were computed and are indicated in graphical form in Figure 11. The line was plotted in the graph below indicating the approximate relation between average traction and speed for barges in still water.

⁴F. Peters, Bestimmung Der Leistung von Schleppzügen; Werf Rederei und Hafen, XVI (1925), pp. 463-468.

FIGURE 11: Relation Between Traction and Speed



The channel resistance to vessels increases rapidly as the speed of the vessel increases since the resistance varies nearly as the square of the speed.⁵ The cost of additional power required for increasing the speed of the vessels above certain limits in restricted channels of given dimension may become greater than the advantage to be gained thereby. On the other hand, the provision of a larger channel would involve increasing the initial cost and annual maintenance which may not be fully justified by the benefits accruing from the possible reduced cost of

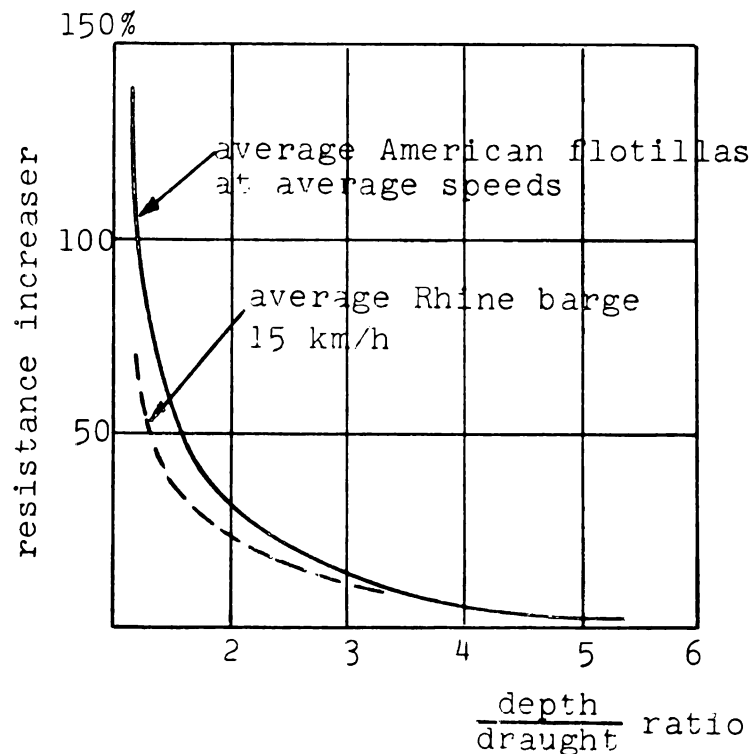
⁵Albert J. Dawson, "Design of Inland Waterway Barges," Transactions, Society of Naval Architects & Marine Engineers, LVIII (1950).

transportation.

In 1923, Kempf published the results of experiments indicating the effect of channel depth to fleet draught ratio on resistance for Rhine barges.⁶ In Figure 12 below, a curve was plotted for a constant speed of 15 kilometers per hour, indicating that speed loss or resistance increases in shallow water as compared with deep water speed and resistance, respectively.

For the purpose of comparison a line of constant speed was plotted in the figure below for barges combined

FIGURE 12: Effect of Channel Depth and Vessel Draught on Resistance



⁶G. Kempf, "Economical Speeds in Shallow Water," Shipbuilding and Shipping Record, V (June, 1924).



into flotillas on American waters. It appears that the American curve indicates a higher resistance increase than the European. This can be explained perhaps by the differences in navigation method and by the difference in the type of floating equipment. The resistance of ship-shaped barges, as used in Europe, is affected by shallow depth to a lesser degree than the resistance of scow-ended barges used on American waters.⁷

The relation of resistance to speed of vessels and tows, as demonstrated in these several experiments for subsequent use on inland waterways, indicates that high speeds for loaded tows on marginal waters, marginal from the point of width and depth of navigable channel, such as that of the Oder, are uneconomical and not warranted. Therefore, what is considered the proper dimensions of a channel involves many considerations. Conclusions reached in various investigations of restricted channels indicate that the cross-sectional area of the channel should be at least four and one-half times the submerged cross-sectional area of the loaded vessels or tows, the dimensions of which in turn are governed by the size of the locks.⁸

⁷J. F. Allen and W. P. Walker, "Resistance of Barges in Deep and Shallow Water," Transactions of the Institution of Naval Architects (1948), pp. 154-167.

⁸U. S., Congress, House Document No. 178, Lake Erie and Ohio River Canal, 76th Cong., 1st Sess., 1939.

The Oder River system can be divided from the point of navigational conditions into four large sectors: Gliwice Canal, Upper Channelized Oder, Middle shallow, freely flowing Oder, and the relatively deep, freely flowing Lower Oder. Each of these sectors has its own distinctive idiosyncrasies and suitability for navigation. Table 5 below states the major fluvial characteristics such as width, depth, and gradient of each sector.

As one can see the Oder River varies greatly in its width and depth of navigable channel from one section of the way to the other. In the lower and upper sections of the Oder, the navigable channel is approximately 60 meters in width, the middle section, however, is considerably narrower, 40 meters. The most crucial characteristic of the navigable channel is the depths; as one can see in most cases, they are not nearly adequate. This picture becomes even graver if one points to the two extremes, the average low water level with high water extends over 215 days or 80 percent of the navigation period, while the middle water level with high water extends over 135 days or 50 percent of the navigational period. Consequently, due to the extensive fluctuation of high and low water levels during the navigable season, the controlling depths cannot be maintained along the entire length of the navigable Oder. The importance of the availability of adequate depths in the channel and over the lock sills cannot be

TABLE 5
CHARACTERISTICS OF THE ODER RIVER SYSTEM

Name of the Sector	Length in Km.	Maximum Per- missible Barge Carry- ing Capacity	Depth of Navigable Channel		Average Gradient %	Width of Navigable Channel
			Min. Low Water Level	At Ave. Middle Water Level		
Gliwice Canal	40.6	1,000	300	350	. .	40
Channelized Oder						
Racibórz-Koźle	45.0	170	50	120	. .	40
Koźle-Brzeg Dolny	164.0	650	150	180	. .	60
Freely-Flowing Oder						
Brzeg Dolny-Kostrzyn	356.0	500	120	170	0.28	40
Kostrzyn-Zatoń Górna	49.0	750	200	250	0.18	60
Zatoń Górna-Szczecin	73.0	1,000	250	300	0.03	60
Oder Tributaries						
Nysa-Kuzycka (Gubin- Oder)	15.0	250	60	120	. .	. .
Warta (Konin-Prośna)	55.0	50	60	70	0.20	. .
Warta (Prośna-Poznań)	105.0	200	70	120	0.17	. .
Warta (Poznań-Notec)	173.0	550	100	180	0.19	. .
Warta (Notec-Oder)	69.0	550	140	220	0.19	. .

Source: Stanisław Andrjansk, Służba Liniowa Na Śródlądowych Drogach Wodnych (Warsaw: 1956), pp. 14-19.

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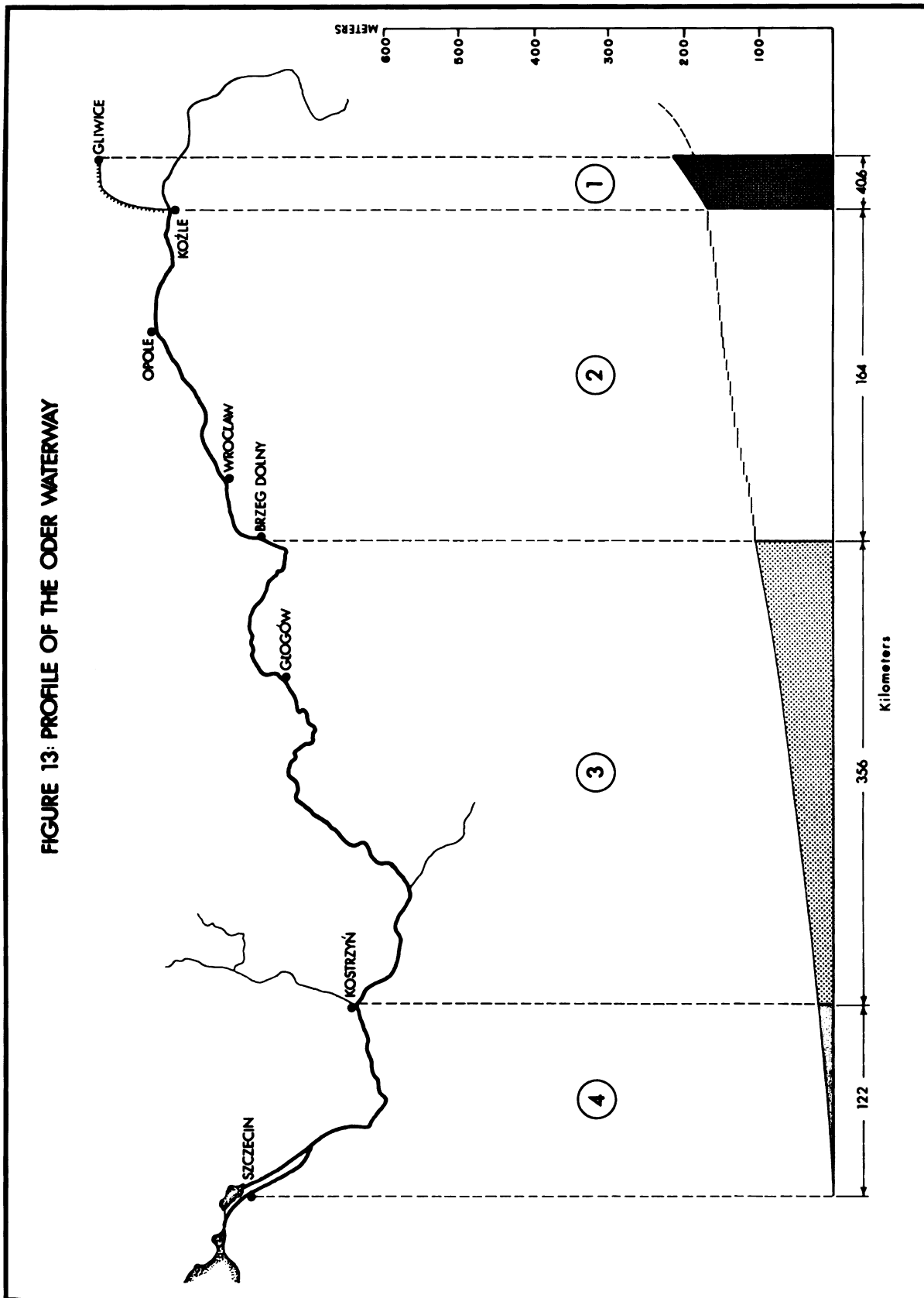
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underestimated as they determine the permissible drafts and the corresponding maximum tonnage for vessels.

The presently existing system of the Oder River is comprised of four distinctly different sectors suitable for navigation. Figure 13 shows the individual sectors and their respective make-up as a part of the inland water routeway.

The first section, Gliwice Canal, smallest of all four which is 40.6 kilometers long, 40 meters wide, and 3.5 meters deep, was designed to provide a water link between the coalfields and the center of heavy industry of Upper Silesia and the Oder. The canal is the newest and the most modern portion of the way in the entire Oder inland water system. Six twin chambers, 72 by 12 by 3.5 meters, with fully automated locks permit the passage of 750 ton barges. It has been estimated by the officials of the agency Żegluga na Odrze that in its present condition the Gliwice Canal's maximum annual capability is 5.2 million tons with 24 hours a day operation. With the modernization and enlargement of the lock chambers this portion of the waterway between Gliwice and Koźle will be capable of carrying barges of a 1,000 ton load capacity.

The second sector, 164.0 kilometers long, extending from Koźle to Brzeg Dolny, 95.6 kilometers to 259.0 kilometers on the river, is the channelized portion of the Oder. In this sector the supposedly guaranteed depth is 1.5 meters, however, during a prolonged drought it is difficult



to maintain even that minimum. Until recent years there has been no particular effort to standardize lock size on the Oder. This has resulted in a multiplicity of different types and sizes of locks. One may point out that the efficiency of operation largely depends on the standardization of transportation equipment.

Table 6 lists and summarizes the major characteristics of locks on the channelized portion of the Oder. As one can see most of the lock chambers are relatively small. Only two chambers are capable of accommodating even the smallest barges, Peniche, in a single locking operation. Some of the locks from Koźle to Nysa-Kłodzka are very old and inefficient, being long overdue for replacement as several of these have been in use since 1895.⁹ Theoretically, the maximum attainable speed on the channelized portion of the Oder waterway is listed as 12 kilometers per hour, however, this figure is very seldom achieved by even the most modern self-propelled barges. Numerous sandbars, lack of navigational aids, and obstructions make navigation on the channelized portion of the river hazardous. The objective of channelization of this portion of the Oder was to produce a minimum depth of 1.5 meters during the critical period of late summer and fall which would allow uninterrupted movement on the river. Unfortunately, this

⁹Andrzej Grodek (ed.), Monografia Odry (Poznań: Instytut Zachodni, 1948), p. 486.

TABLE 6

LOCKS ON THE CHANNELIZED SECTOR OF THE ODER

Location	Km. on Oder from Source	Elevation of Water Above Sea Level of Chambers		Height of Step (meters)	Lock Dimensions	
		Upper	Lower		Length (meters)	Width (meters)
Koźle (Januszkowice)	105.6	165.35	162.75	2.60	55.0	9.60
Stradunja	114.4	162.75	160.25	2.50	54.2	9.60
Krapkowice	122.9	160.25	157.65	2.60	55.0	9.60
Rogów Opolski	129.6	157.65	155.40	2.25	54.2	9.60
Ziemnice	137.4	155.34	153.24	2.10	55.0	9.60
Groszowice	144.6	153.30	151.20	2.10	55.0	9.60
Opole	150.4	151.20	149.10	2.10	54.2	9.60
Wróblin	157.5	149.10	146.70	2.40	55.0	9.60
Dobrzeń Wielki	164.0	146.70	144.45	2.25	55.0	9.60
Chroszce	168.3	144.45	142.70	7.75	55.0	9.60
Chroszce	168.5	142.70	140.45	2.25	187.0	9.60
Confluence of Nysa	180.4	140.45	138.10	2.35	187.2	9.60
Zwanowice	184.7	138.10	133.70	4.40	187.8	9.60
Brzeg	197.5	133.72	130.30	3.42	187.1	9.60
Lipki	208.1	130.29	128.31	1.98	187.2	9.60
Oława	213.4	127.96	124.17	3.99	55.0	9.60
Ratowice	227.2	123.70	121.14	2.56	187.8	9.60
Jeszkowice	231.7	121.10	117.70	3.40	225.1	12.00
Bartoszewice	245.0	117.70	114.60	3.10	187.7	9.60
Zacisze	250.3	114.60	112.30	2.30	186.1	9.60
Wrocław (Różanka)	254.0	112.30	110.00	2.30	196.2	9.60
Rędzin	261.6	109.80	106.06	3.58	203.1	12.00

Source: Data obtained from the office of Okręgowy Urząd Dyrekcyj Droóg Wodnych, Wrocław, June, 1968.

objective is not attainable without additional construction of retention reservoirs. In the mid-1970's it is hoped that a reservoir will be completed at Głębinów which will help to eliminate the summer interruption in navigation.

The freely flowing Oder from Brzeg Dolny to Swinoujscie, a total distance of 478 kilometers, can be divided into two sections, the 356 kilometer long middle Oder and the 122 kilometer long lower Oder.

The third sector, the middle Oder from Brzeg Dolny at 282.6 kilometers on the river to the confluence of the Warta River at 615.3 kilometers down the river, is the largest sector of the Oder waterway and the least suitable for navigation. Its shallow channel, poor quality of navigational aids, and terminal facilities greatly encumber navigation. In spite of the fact that the freely flowing Oder from Brzeg Dolny to Kostrzyn¹, at the confluence of the Warta, was regulated for low water, an attempt to maintain a minimum guaranteed depth of 125 centimeters during the late summer and early fall is not always possible. Any reduction below the minimum guaranteed depth results in a temporary halt in navigation. Temporary interruptions in navigation due to low water levels on the Oder are quite frequent and lasted on the average of forty-five days annually during the course of the last decade.¹⁰ Prior to

¹⁰From the records of Zarząd Wodny (State Water Management Office), Nowa Sól, 1968.

the construction of the retention reservoirs at Otmuchów on the Nysa-Kłodzka and in Turów on the river Panwi whose primary function, in addition to flood control, is to aid navigation during exceptionally dry years, navigation in this sector was halted for much longer periods. Interruption of navigation in a single season, due to extremely low water levels, could last as long as 110 days.¹¹ Even though the minimum depth, 125 centimeters, of the navigable channel could be maintained throughout the season, barges operating in this middle section can only maintain 65 to 70 percent of their tonnage capacity. With the average draft of a fully loaded vessel of 1.84 meters, to allow for full utilization of this section as a part of a continuous routeway from Koźle to Szczecin, a minimum depth of 2.34 meters has to be maintained throughout the season.

The fourth section of the waterway, the lower Oder from the confluence of the Warta at point 615.3 kilometers to the maritime port of Szczecin at 738 kilometers on the river, does not present major navigational problems. This is a section of relatively deep water, with a minimum depth of two meters, as a result of the Oder receiving a large supply of water from its tributary the Warta. Supplemental dredging of the channel in the lower section of the river below Zaton' Górna makes it possible for barges of 1,000 ton load capacity to navigate its waters. In the vicinity of

¹¹Ibid.

Zanton' Górna, the lower Oder is divided into an eastern branch and a western branch, both of these branches being navigable. At the present time, however, the main navigable channel used by the Polish navigational agencies is the eastern branch of the Oder. The western branch, in turn, serves as the extension of the Hohenzollen Canal, linking Berlin with Szczecin via a system of inland waterways. In the vicinity of Gryfin and Krajnik, both branches of the Oder are connected by canals equipped with locks which permit easy passage of barges from one branch of the river to the other.

The analysis above reveals that the Oder inland water system from Gliwice to Szczecin does not constitute a uniform waterway for navigation along its entire course but, rather, consists of four distinctly different segments of the way. Each segment has its own limitations, requirements and suitability for navigation.

In summary, one can say, based on the above analysis of navigational possibilities and conditions on the Oder, that on the Gliwice Canal the navigational conditions are quite good and the depth and the width of the navigable channel do not present, at least at the present time, any significant problems. On the channelized Oder, even with the minimum guaranteed depth of 150 centimeters and with the 60 meter channel, the conditions are not fully satisfactory. The major obstacles to easy movement on this

portion of the way, in addition to shallow channel, are the numerous locks with small chambers. The middle Oder is the longest sector and the least suitable for navigation because even the minimum depth of 125 centimeters in drought years cannot be maintained during the whole navigational season, thus presenting a significant problem to continuous transit. The most suitable sector for navigation, with adequate depths and widths of navigable channel, is the lower Oder. It would be highly desirable from the point of water transportation to attain a certain degree of uniformity, particularly in maintaining minimum depths and widths of navigable channels and size of locks. If the Oder is to be expected to handle present and future barge traffic, an adequate size of waterway is considered absolutely essential.

Type of Floating Equipment and Methods of Navigation

The annual carrying capacity of the Oder River has been estimated, by the Polish planners, to be as high as ten million tons. Records show, however, that both agencies which are navigating on the Oder, Żegluga na Odrze and Żegluga Szczecińska, carried only 3,495,168 tons, therefore, utilizing barely 34 percent of the waterway's estimated carrying capacity.¹² One of the possible reasons

¹²From the records of the Central Statistical Office (Główny Urząd Statystyczny), Warsaw.

for the low utilization of the Oder waterway, aside from the shipper's lack of cost consciousness and the authorities' general neglect of the waterway, is the acute shortage of floating equipment. This shortage of floating equipment is not only quantitative but also qualitative. The situation from year to year is greatly improving as can be noted by the increase in absolute tonnages carried by the waterway and also by the number of operative units in service as shown in Table 7. In comparison, however, with other European countries utilizing their inland waterways to full capacity, the Polish shallow draft fleet is very meager indeed.

As one can see from the table below, quantitatively there is a full assortment of floating equipment on the Oder, ranging from the most modern pusher type towboats

TABLE 7

TYPE OF FLOATING EQUIPMENT OPERATING ON THE ODER

Type of Equipment	1955	1959	1964	1965	1967	1968
Tugboat	21	21	65	63	57	48
Dumb Barge	278	233	210	190	135	112
Self-Propelled Barge	11	14	137	180	210	215
Towboat (Pusher)	. .	. .	24	55	79	105
Hopper (Barge)	. .	. .	85	167	200	264

Sources: Data for years 1955, 1959, 1964, and 1965 obtained from the agency Żegluga na Odrze, Wrocław; data for years 1967 and 1968 obtained from Gospodarka Wodna, Nr. 4 (1969), p. 7.

through self-propelled high speed barges to somewhat antiquated wooden dumb barges. In recent years, an attempt has been made to standardize and to systematically liquidate the old dumb barges and to replace them with self-propelled crafts and standardized hoppers which can be made up into flotillas.

The most pronounced changes in the type and utilization of floating equipment are indicated in Table 8 below. Both agencies navigating on the Oder, Żegluga na Odrze and Żegluga Szczecińska, are moving away from using

TABLE 8
MOVEMENT OF COMMODITY ON THE ODER BY TYPE
OF CRAFT USED BY ZEGLUGA NA ODRZE

Type of Equipment	1965	1966	1968
(in tons)			
TOTAL	2,052,390	2,527,617	2,795,041
Dumb Barges	1,068,941	1,057,751	710,667
Self-Propelled Barges	725,503	824,732	1,114,497
Flotillas	257,946	645,134	969,877
(in thousand ton-kilometers)			
TOTAL	1,121,187	1,367,082	1,502,225
Dumb Barges	523,423	586,302	328,973
Self-Propelled Barges	472,803	569,676	800,019
Flotillas	124,961	211,104	373,233

Source: Główny Urząd Statystyczny, Statystyka Żeglugi Śródlądowej i Dróg Wodnych Śródlądowych, 1968, Nr. 48 (Warsaw: 1969), Table 8, p. 5.

the less economical dumb type barge and replacing them with self-propelled barges and various types of hoppers. In 1955, there were only eleven self-propelled barges and no flotillas navigating on the Oder, therefore, approximately 90 percent of the total tonnage carried by both agencies was carried in the dumb type barges. Since 1959, however, fleet and shore installations operating on the Oder have gone through a process of modernization.

Barge size frequently reflects channel conditions, industry demands, and lock sizes. The type of barges operating on the Oder are listed in Table 9. For example, the three basic sizes which have become standard on the Oder River system are: first, the 55 by 8 meter two Wroclaw type which reflect the size and limitations of the locks in the upper sector of the channelized Oder and, second, the 65 by 8 meter Plauer which functions in the lower sectors.

Figure 14 graphically shows the relationship between draught and load capacity of the different types of barge operation on the Oder River system.

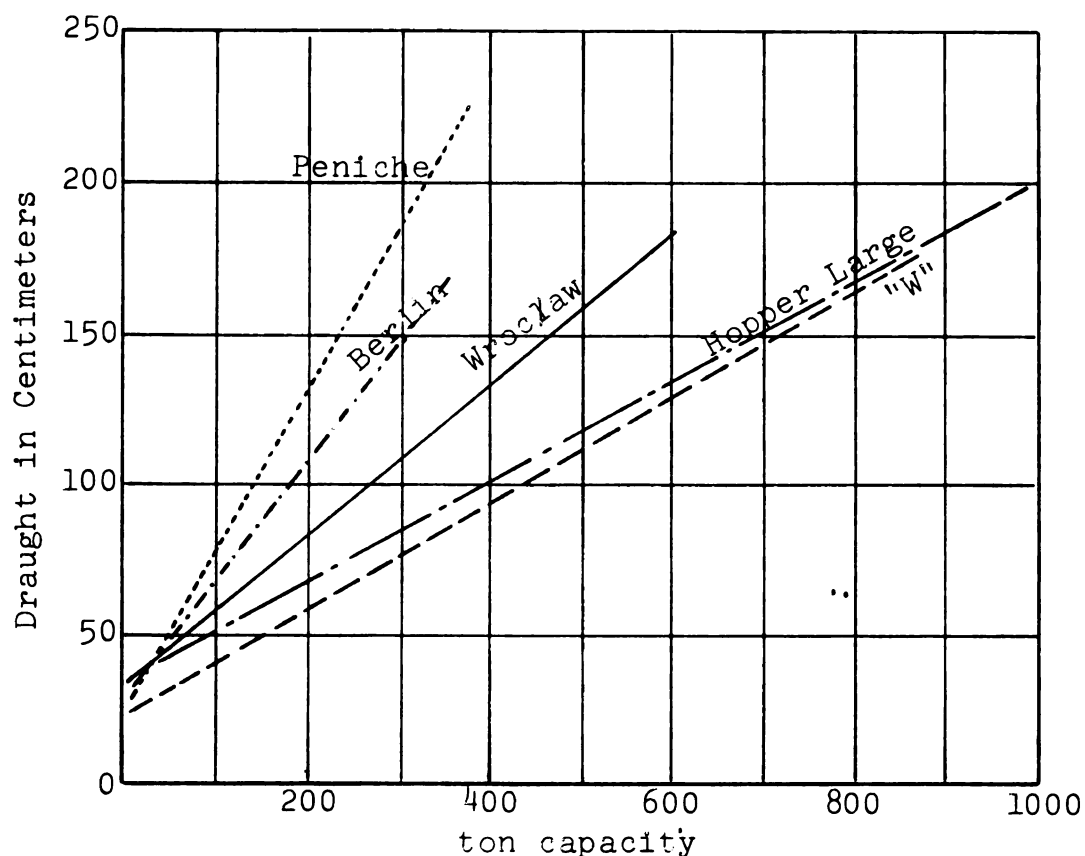
The process of modernization of the fleet, due to operative differences, did not affect both agencies at an equal rate. By converting the data in Table 8 into percentages one can exemplify this point. For example, of the total tonnage carried by Żegluga na Odrze, in 1965, 52 percent was carried in dumb type barges whereas self-propelled

TABLE 9
TYPES OF BARGES NAVIGATING ON THE ODER RIVER

Barge Type	Length (meters)	Breadth (meters)	Draught		Tonnage Capacity
			Empty (meters)	Loaded (meters)	
Peniche	38.5	5.0	0.26	2.24	374
Berlin	50.0	6.0	0.30	1.60	335
"W"	55.0	11.0	0.24	1.75	857
Wrocław	55.0	8.0	0.34	1.75	536
Wrocław (Large)	55.0	8.0	0.34	1.84	600
Plauer	65.0	8.0	0.34	1.89	692
Oder (Finow)	55.0	7.8	0.30	1.70	500
Hopper	67.0	8.0	0.35	1.75	600
Hopper (Large)	80.0	9.0	0.35	2.00	1,000

Source: Records from the office of Żegluga na Odrze, Wrocław, 1968.

FIGURE 14: Draught and Capacity of Typical Barges Operating on the Oder



barges and flotillas carried 35 and 13 percent, respectively. In the same year, Żegluga Szczecińska carried 81 percent of the total tonnage in the dumb type barges and only 8 percent in self-propelled and 10 percent in flotillas.¹³ The operative differences and, consequently, the dissimilarity in the type of craft used by both agencies to carry commodity became more apparent in 1968. Each type of craft listed above and operated by Żegluga na Odrze has

¹³Główny Urząd Statystyczny, Statystyka Żeglugi Śródlądowej i Dróg Wodnych Śródlądowych 1968, Nr. 48 (Warsaw: 1969), Table 8, p. 5.

an equal share in the movement of commodity, whereas in the Żegluga Szczecinska one detects a greater degree of specialization. Żegluga Szczecinska depends heavily on the dumb type barge, 65.1 percent of the total tonnage carried, and hopper type barge which are made up into flotillas carrying 34.8 percent of the total tonnage.¹⁴ The use of self-propelled barges by this agency is at a minimum.

This dissimilar utilization of floating equipment by the two agencies arose from economic needs and both the technical and physical differences of the waterway. The small sector of the lower Oder on which the agency Żegluga Szczecinska operates is without locks and is the deepest and widest portion of the river. In addition, the type of commodity carried, large shipments and small average distance of 68 kilometers in 1968, makes hopper barges which can be assembled into integrated tows an economical and highly desirable craft. So the tendency here is to replace the antiquated dumb barges of the Pre-World War II period with a modern hopper, deck barge, carfloat, and tank barge type of craft.

It is considered by authorities in the field of inland water transport that fully integrated tows are the most economic means of carrying large quantities of commodity. The fundamental advantage in using craft which can be assembled into tows is that a single motive power can be

¹⁴Ibid.

applied to a multi-movement unit. Particularly when the break-up of integrated tows can be held at a minimum along the way, from the port of origin to the port of destination, the economy of the cost of movement can also be held at a minimum.

In the upper portion of the Oder, where the agency Żegluga na Odrze operates, the physical and technical conditions of the routeway limit the use of integrated tows. Narrow river channels and the small radius of the channel curvature limits the size and hinders maneuverability of the large pusher flotillas. In other words, the channel dimensions have a limiting effect on the maximum number of barges that can be assembled into a tow. In addition, constant breakup of tows into smaller units which would permit passage through narrow locks make this type of operation on long distances on the waterway with a great number of locks economically prohibitive. The integrated tow is generally efficient for the carriage of a large volume of a single commodity over a long distance on a continuing basis.

Out of the seven navigation agencies operating on Polish inland waterways, the Żegluga na Odrze has the largest number of locks and the shipments on the Oder are on the average the longest. The average distance of the commodity moved on the Oder, in 1968, was 537 kilometers.¹⁵ Therefore, the physical limitations of the way, long

¹⁵Ibid., Table 3, p. 3.

distance, relatively small shipments and type of commodity carried favors the self-propelled craft in the long distance movement where speed and flexibility is at a premium while the traditional method of pulling dumb barges by tugboat are primarily used on short distances.

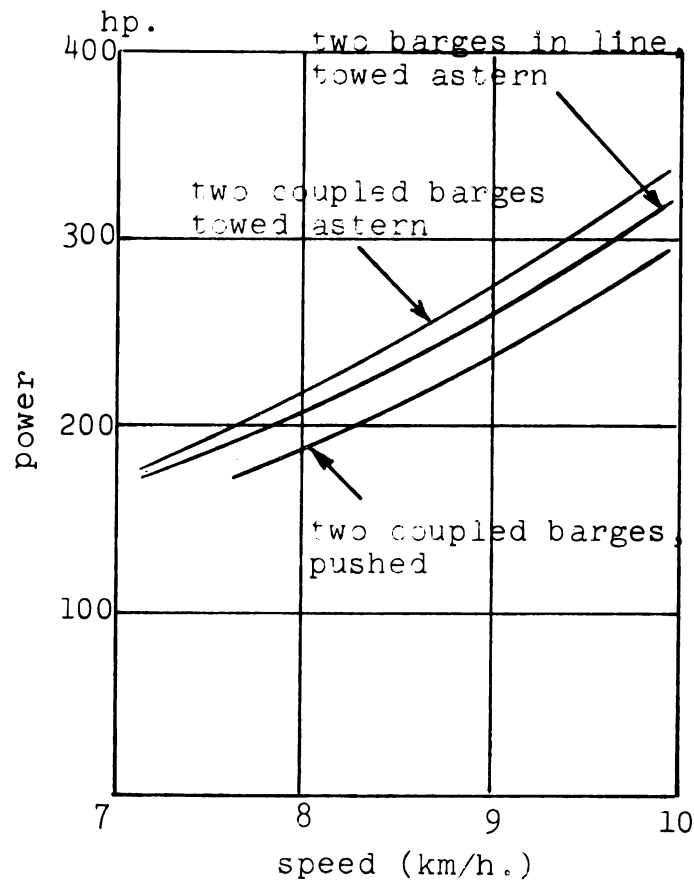
Unfortunately, few conclusive test results have been published regarding a comparison between pull and push towing. Based on various experiments by Dravo Corporation, there seems to be little doubt that pull-towing, especially when practiced with a short tow-rope, is less efficient than push towing, because in the former case the wake of the propeller increases the resistance of the first barge. When towed on a long rope of at least 50 meters in length the barge is steered clear of the propeller wash, so that its effect is almost negligible.¹⁶

Most likely the best comparison of push towing and pull towing was obtained in experiments by Beschoren.¹⁷ The results are shown below in the form of a graph. It appears from Figure 15 that at least 10 percent less horsepower is needed in pushing as compared with pulling. At higher speeds in-line towing was appreciably better than towing of coupled barges. The negative factors in using

¹⁶Albert J. Dawson, The Development of Economic Potential of Inland Waterways Transportation (Pittsburgh: Dravo Corp., 1956), p. 3.

¹⁷K. Beschoren, Schieben und Ziehen in Schleppdienst, Werft Rederei und Hafen 1931, XIII, pp. 254-259.

FIGURE 15: Comparative Power Requirements for Various Methods of Towing

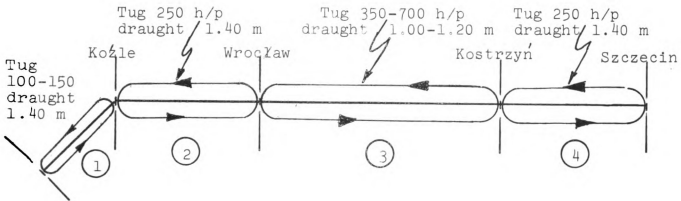


pull-tows, as they may apply to navigation on the Oder, is the low average speed of 5.1 kilometers per hour, prolonged anchorage of tugs which can only operate in their respective sectors, and the difficulty and complexity in the make-up of tows.¹⁸

Movement of tugs on their respective sector is shown in Figure 16. It is interesting to note the

¹⁸Główny Urząd Statystyczny, Rocznik Statystyczny Transportu 1945-1966 (Warsaw: 1967), Table 40, p. 581.

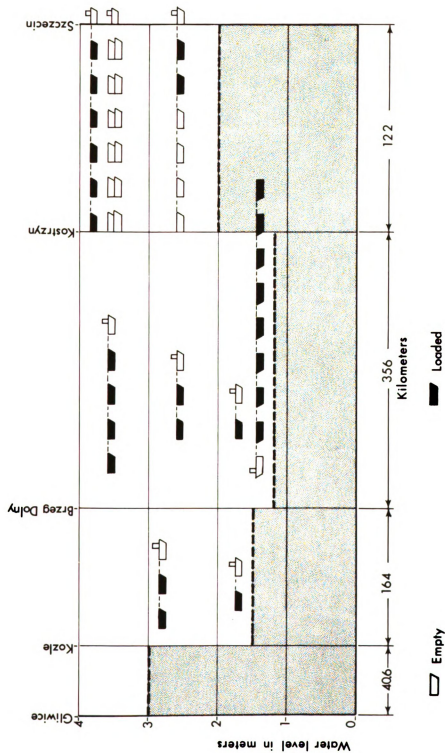
FIGURE 16: Movement of Tugs on the Oder by Sector



difference in draft and horsepower of the tugs operating on each sector. For example, on the sector from Wrocław to Kostrzyn greater horsepower is required to overcome propulsive resistance in a relatively shallow channel.

Previously the author divided the Oder system into four sectors according to physical limitations and suitability of its navigable channel. However, if one looks at the navigational practice on the Oder River system, particularly in the makeup of tows, one can detect additional variations within the above discussed sectors. The makeup of tows on the Oder are dependent on the level of water and the number and size of locks on the individual sector of the channel. Slight variations in the level of water have a grave influence on the maximum permissible number of units in the tow. In Figure 17, the vertical lines divide

FIG. 17: NAVIGATIONAL METHODS ON THE SECTORS OF THE ODER WATERWAY



the Oder system into four sectors and the horizontal lines indicate variable water levels during the navigation season. One can see as the water level falls the number of units in the tow also declines.

In the first sector, the Gliwice Canal, in order to maintain sufficient speed of movement, the tows can be comprised of as many units as can move through the four locking operations. The width of the channel is sufficient to permit the coupling of barges, but the total length of the tow should not exceed 235 meters according to regulations.¹⁹

On the Oder proper from Koźle to Szczecin, as one can see from Figure 17, there are significant differences in the composition of tows and methods of navigation between up and down river movements on the individual sectors. According to regulations, which reflect the physical characteristics of each sector of the Oder waterway, the pull-tows moving down the river may consist of the following units:

- a) On the Upper Oder from Koźle to Brzeg Dolny, the channelized portion of the river, during high water the size of a tow cannot exceed what can pass through a double locking operation of the smallest lock chamber. During low water level the pull tow is limited to two units, regardless of its size.

¹⁹Żegluga na Odrze, Przepisy dla Dróg Wodnych (Wrocław: 1969), pp. 12-29.

- b) On the Middle Oder, the freely flowing river, from Brzeg Dolny to Kostrzyn, a maximum tow can consist of five units at high water level.
- c) On the Lower Oder from Kostrzyn' to Szczecin, tows may consist of six loaded or twelve empty barges, two loaded and four empty, or one loaded and four empty, depending on the water level. The number of barges towed astern in line cannot exceed six and their total width cannot exceed 16.5 meters.

The pull tows moving up the river may consist of the following number of units:

- a) Above Brzeg Dolny, on the channelized Oder, tows may consist of as many units so that the movement to Koźle does not have to go through more than a double locking operation.
- b) Below Brzeg Dolny, on the freely flowing Oder, at high water level the tows can consist of eight barges but the total length of the tow cannot exceed 460 meters. In the movement up the river, on the deep freely flowing segment of the Oder, loaded barges cannot be coupled together while the empty barges can be coupled together if their total width does not exceed 16.5 meters.

As one can see, from the description above, there are significant differences in the movements up and down the Oder River. In both cases, as the physical limitations become less stringent in the lowest portion of the Oder River, the possibilities in size and make-up of the tows increase significantly. The upper portion of the waterway presents the greatest limitations.

By comparison to pulled tows, self-propelled barges outside of tonnage limitations do not present such a dilemma. A single unit self-propelled barge with an average speed of 6.8 kilometers on the Upper Oder and 9.8 in the Lower sector executes the entire carrying operation from the port of origin to the port of destination without any of the above-mentioned obstacles.²⁰ Therefore, where physical and technical limitations of the channel would limit the use of push flotillas where distances are great and speed is crucial, the motorized barges proved to be the most versatile and efficient type of river vessel. This is true of both domestic and international movement.

Rate of Growth of Facilities Versus Traffic

The rebirth of traffic on the Oder River since the conclusion of the hostilities in 1945 has been rather spectacular in spite of the general lack of facilities.

²⁰ Główny Urząd Statystyczny, Rocznik Statystyczny Transportu 1945-1966 (Warsaw: 1967), Table 40, p. 581.

Judging by the small investment in the inland waterways as a segment of the economy, it appears that the Polish government sought to meet its demand for water transport, in spite of an obvious need for an efficient system, through greater utilization of the existing fleet, inadequate routeway, and archaic shore installations. Irrespective of this limited investment in inland waterway transportation, the total freight traffic carried by Żegluga na Odrze has increased from 30 thousand tons in 1946 to 2,795 thousand tons in 1968. During this time, investment in inland waterways, in absolute terms, increased to 449.5 million zlotych; but, in relative terms, in comparison with other modes of transportation, actually decreased from 10 percent of the total investment in transportation in 1946 to less than 4 percent in 1968.²¹

In view of this deliberate governmental policy of putting inland waterways on short ration, it would be interesting to see how an agency navigating on the Oder with its limited fleet and inefficient shore installations coped with the ever-increasing demand for its services. This can be accomplished by examining the rate of growth of traffic on the river with the rate of growth of transport facilities. Taking the agency Żegluga na Odrze at any point in time, the distance which freight must be hauled,

²¹Ibid., Tables 24 and 25, pp. 30-32; Władysław Magiera, "Nakłady Inwestycyjne Na Drogi Wodne," Gospodarka Wodna, Nr. 1 (January, 1970).

the speed at which barges move, and the length of time it takes to unload a barge, one obtains an idea of efficiency and the ability of the mode to satisfy the quantitative and qualitative demands for its services. The shorter the haul and the quicker the terminal operations, the more tonnage the mode can load and deliver with a given amount of equipment. This generalization is not exclusive to inland waterways but can be applicable to any mode of transportation. The more efficiently the system is operated the greater the productivity that can be obtained with less line and equipment.

In trying to estimate the existing stock of the Żegluga na Odrze, in order to make an analysis of its total carrying capacity, the author was only able to obtain a few figures from scarce Polish statistics. These figures, nevertheless, indicate that with the resumption of navigation on the Oder in 1946, the Żegluga na Odrze had in stock 9 tugboats and 28 dumb barges with a total carrying capacity of 13,000 tons.²² Examination of the latter data leads the author to believe that there has been always a significantly greater utilization of floating equipment by Żegluga na Odrze than on the rest of the Polish waterways. For example, in 1968, the movement of empty barges by Żegluga na Odrze in relation to the total movement was only

²² Estimate based on personal interview with the Chief Engineer of the agency Żegluga na Odrze, Wrocław, July, 1968.

12.1 percent; however, if one compares this with the operation by Żegluga Szczecinka, its ratio of empties to the total movement is 48.4 percent.²³ In the utilization of motive power in the same year by Żegluga na Odrze, only 19 percent horsepower/kilometers was used in the movement of empty barges where in Żegluga Szczecinka as high as 56 percent was utilized in movement of empty barges.²⁴

The addition to the carrying capacity for the years from 1946 through 1968 can be examined in Table 10.

If one compares the data in Table 10 with the data in Table 11 which shows the rate of growth of traffic on the Oder, one is able to make the generalization that the expansion of capital equipment of the system has been less than proportional to the increase in volume of freight handled. Instead, it appears that the Żegluga na Odrze has been under continuous pressure until 1959 from the authorities to improve their performance in attaining optimum productivity from the old renovated facilities. In this task the agency has failed unequivocally.

To illustrate this differential rate of growth of traffic versus the transportation facilities on the Oder, the author reduced the absolute figures in Tables 10 and 11 to a common denominator, an index, where 1950 traffic,

²³Główny Urząd Statystyczny, Statystyka Żeglugi Środlądowej i Drog Wodnych Środlądowych (Warsaw: 1969), Table 31, p. 51.

²⁴Ibid., Table 30, p. 50.

TABLE 10
GROWTH OF INLAND WATERWAY FLEET

Year	Motive Power Horsepower	Index 1950=100	Barges--Total Ton Capacity	Index 1950=100
1946	1,953	6	13,000	7
1947	9,706	29	64,485	33
1948	20,045	60	139,000	71
1949	30,108	91	170,963	87
1950	33,123	100	195,876	100
1951	33,123	100	236,000	120
1952	33,123	100	253,130	129
1953	33,096	100	238,000	121
1954	32,883	99	227,485	116
1955	31,887	96	220,312	112
1956	32,588	98	214,924	110
1957	33,911	102	207,803	106
1958	33,766	102	206,649	106
1959	33,291	101	210,836	108
1960	32,826	99	221,205	113
1961	32,476	98	237,352	121
1962	33,521	101	257,190	131
1963	36,521	110	284,649	145
1964	40,273	122	323,146	165
1965	44,763	135	367,550	188
1966	48,798	147	390,631	199
1967	50,358	152	409,679	209
1968	54,120	163	458,736	234

Sources: Data obtained from the office of the agency
Żegluga na Odrze, Wrocław.

TABLE 11
GROWTH OF FREIGHT TRAFFIC ON THE ODER

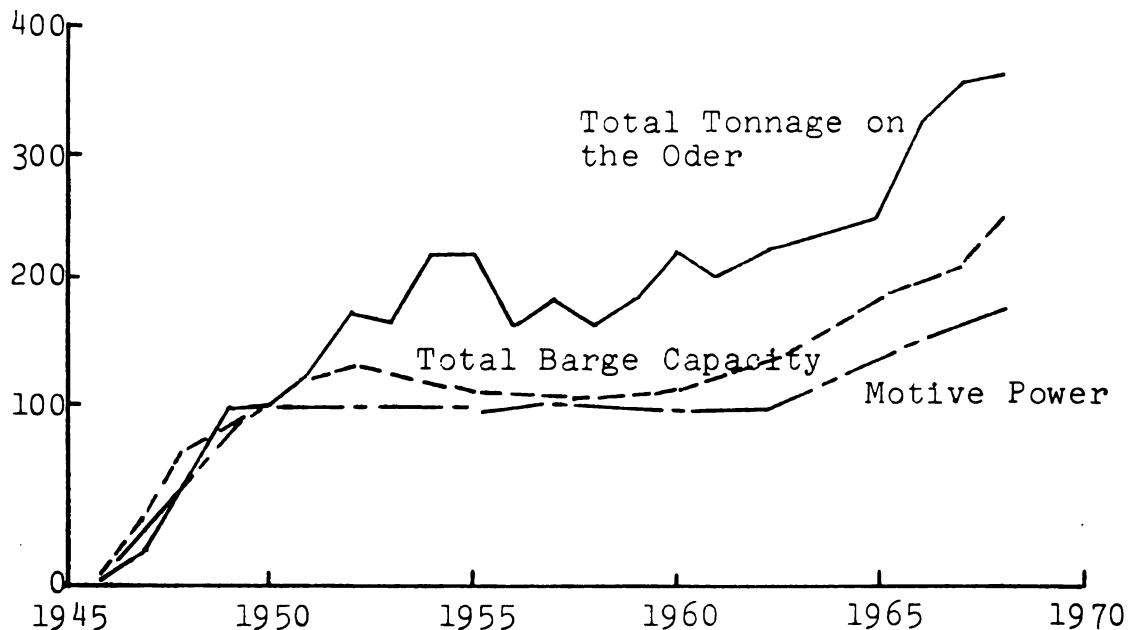
Year	In 1,000 Tons	Increase From Previous Year (%)	Index 1950=100	In Million Ton Kilometers	Average Distance in Km.
1946	30	2	4	44.4	. .
1947	125	316	16	59.2	. .
1948	440	252	58	193.1	. .
1949	745	69	98	284.2	. .
1950	758	2	100	222.2	. .
1951	946	25	125	286.1	. .
1952	1,298	37	171	464.1	. .
1953	1,223	-6	161	793.9	. .
1954	1,634	34	216	490.4	. .
1955	1,620	-1	214	643.3	. .
1956	1,216	-25	160	534.0	415
1957	1,392	14	184	601.9	432
1958	1,230	-12	162	570.5	462
1959	1,399	14	184	530.7	378
1960	1,616	16	213	759.6	467
1961	1,518	-6	200	709.9	465
1962	1,626	7	214	657.4	404
1963	1,802	11	238	841.2	463
1964	1,897	5	250	1,035.6	544
1965	2,052	8	270	1,121.1	546
1966	2,528	23	334	1,367.0	542
1967	2,751	9	362	1,432.5	521
1968	2,796	2	369	1,502.2	537

Sources: Years 1946 to 1956 from the records of Główny Urząd Statystyczny (Central Statistical Office), Warsaw; years 1957 to 1966 from Główny Urząd Statystyczny, Rocznik Statystyczny Transportu 1945-1966, Table 1 (214), p. 495; years 1967 to 1968 from the office of the agency Żegluga na Odrze, Wrocław.

barge capacity and motive power equal 100. Figure 18 shows the rise of the Oder's freight traffic and the rise of Żegluga na Odrze fixed capital, of which the motive power and barges are its two primary elements. A semi-logarithmic scale was used for the purpose of examining the rate of growth rather than absolute changes in tonnages and floating equipment from year to year. As is shown in the figure, the motive power and barge total capacity increased slightly from the base year of 1950 in relationship to a large increase in river freight traffic.

FIGURE 18: Growth of Traffic, Motive Power, and Vehicle on the Oder River 1946-1958

INDEX 1950=100



Source: Based on data in Tables 10 and 11.

The data has two very interesting aspects. First, the rate of growth, in absolute terms, particularly since 1960 has been very sharp in keeping with the vigorous national redevelopment of the floating equipment of Żegluga na Odrze. The two trend lines from the two periods, 1946 to 1952, and 1960 to 1968, computed by the least squares method, shows an estimated average annual overall traffic increase at the rate of 45 and 11 percent, respectively. In the same two periods, motive power increased 36 percent in the first period and nearly 7 percent in the second period while barge capacity increased annually 45 and 10 percent. Secondly, a notable aspect of traffic development is its surprisingly good fit to the straight-line trend for these two periods. The actual rate of growth in the post reconstruction period for all inland waterway traffic was 14 percent per year, thus closely approximating the estimated rate of growth. The findings above led the author to speculate that the actual tonnages on the Oder River were predetermined by barge total ton capacity and the motive power.

In the Post-World War II period from 1946 to the present one may distinguish in the annals of Oder River navigation three well-marked stages. Each stage is a characteristic of the agency's attempt to meet its quantitative and qualitative demand for movement. The first stage extends from the period following the conclusion of



the war through 1952, in the course of which the agency Żegluga na Odrze employed its entire energy and ingenuity in the intense reconstruction of what the military operations had destroyed. Navigation was taken up again in 1946, with the agency's entire fleet consisting of 9 tugboats and 28 barges, a total capacity of 13,000 tons.²⁵ All other units of the former German river fleet which lent themselves to being repaired, 280 barges and 60 tugboats, had been made operational in 1949 by the river shipyards.²⁶ Complete reconstruction of the other river installations devastated by the war was largely completed by 1950. By that time the tonnages carried by Żegluga na Odrze attained the 758,000 ton mark and 222 million ton-kilometers.²⁷ The inability of the agency, Żegluga na Odrze, to meet the rising demand for inland water transportation with its fleet soon became apparent. The agency's inability to cope with the rising demand stems from the fact that the greater part of the reconstructed fleet and shore installations were old and inefficient, resulting in constant breakdowns in equipment. To illustrate this point, one can cite the example that the average age of a barge in the agency's inventory was forty-one years old while the average age of

²⁵Based on the author's personal interview with the Chief Engineer of the river shipyards Panstwowe Przetrzembiorstwo Stoczni Rzecznych, Wrocław, July, 1968.

²⁶Ibid.

²⁷See Table No. 11.

a tug was fifty years. Up until 1959 the official policy of the planning authorities was to minimize the investment in Poland's inland waterways. The navigational agencies were instructed to do the best possible with the existing stock and equipment.

In spite of the fact that Żegluga na Odrze achieved maximum utilization of transportation facilities, serious operational problems did develop by 1954, which marks the second stage of the Polish experience in navigating the Oder. No immediate steps were taken by the planning authorities to remedy this situation. An increase in inland water transportation's share of the total investment in the transportation segment of the economy was not ordered until 1959. Nevertheless, before one judges the rationality of the decision of Polish planners and the seriousness of the transportation crisis in the 1954-1959 period, one should take two important points into consideration. The first is the demonstrated capacity of the agency Żegluga na Odrze to move relatively large tonnages over a long distance simply by using the existing facilities. In that case, perhaps, only a relatively small annual increment of investment in inland waterway sector of the economy would have prevented the transport crisis which did develop. Therefore, the government's policy would have to be considered, on the whole, correct. The second consideration relates to the supply of critical materials and other resources necessary

for capital formation in real terms. In this connection one must also consider the question of timing. Perhaps the volume of steel which would have been necessary for the construction of floating equipment in 1952 to forestall the crisis of 1954-1959 could not have been diverted without serious consequences to a newly industrializing economy.

By the end of 1958, with a supply of additional capital to inland waterways, the government was able to check the transportation crisis which had developed on the Oder in a relatively short time. Such prompt success in mastering the crisis gives the author reason to speculate that, aside from a shortage of economic resources, the crisis occurred due to general lack of interest and neglect of the inland waterway on the part of Polish planners.

The third period extends from 1959 to the present. The year of 1958 is a significant year for navigation on the Oder as the decision was reached by the Council of Ministers of the Polish Peoples Republic to modernize the river's fleet, shore installations, including locks, and the navigable channel. The large concentration of industry in Upper and Lower Silesia and the difficulty and rapidly rising costs in the transporting of raw materials and other bulk commodity by rail contributed to renewed interest in the Oder River as an artery of transportation. Henceforth, in response to the optimistic forecasts that the tonnages carried by Żegluga na Odrze would rise by 1972 to

11 million tons, the government embarked on an ambitious but long-range plan to expand and modernize the fleet and navigational facilities on the Oder.

This long-range plan suggests that fundamental improvements in the reservoir system of the Oder River basin would prolong the navigation season from 291 days in 1968 to a navigational season without the mid-summer interruption. In addition with the deepening of the navigable channel and maintaining a higher minimum water level, the regularity of traffic and increase in tonnage capacity of barges from the present 60-75 percent of their total capacity can also be realized. The improvement in routeway together with the modernization of ports, locks, and other shore installations will permit an increase in the Oder's total capacity. Unfortunately, up to the present time very little of this grandiose plan has been accomplished and traffic on the Oder is closely approaching the technical limitations of the routeway and the agency's fleet. Substantial bottlenecks have already developed. This probably has discouraged some traffic that would otherwise have moved on the river in recent years.

It is incredible that the Polish authorities do not take a greater interest in the nation's inland waterways. An additional connection of the Oder with the Vistula, particularly in the south, and with other navigable European rivers would make this river a channel of

communication of considerable importance. It would demonstrate in absolute terms the Oder's direct bearing on the economic development of all regions and neighboring countries contiguous to the river.

CHAPTER IV

ECONOMICS OF INLAND WATERWAYS

Modern industrial experience suggests to the student of transportation that all modes seem to evolve more or less together as each of these modes, in the past and at present, are intimately related to one another in the existing transportation system. Therefore, elimination of one mode or its total substitution by another would necessitate considerable alterations in the entire transportation system. Thus it seems reasonable to argue against dramatic and total replacement of one of the present modes of transportation by innovation. It is readily apparent that virtually all the modes of transportation that have ever existed are still "alive" somewhere on the surface of the earth. However, this does not negate the idea that, in competition between the modes, an adjustment of roles is generally made so that all continue to exist and develop, although at different rates. Very seldom the newer and better method entirely supplants the old but rather relegates it to a certain limited field.

The fact that each mode of transportation can perform some functions very well and other functions only

moderately well does not suggest that any single mode is unimportant, inferior, or obsolete. The modern transportation industry offers the shipper, depending on his needs, a vast array of services at different prices. Generally, agencies with relatively low terminal costs and high line-haul costs have an advantage for shorter hauls, whereas agencies involving high terminal pickup and delivery expenses and low line-haul costs are in a position to compete more effectively for the longer hauls.¹

When goods of high value per pound are shipped, the transfer charge constitutes a smaller relative addition to the total cost of the delivered article and such goods are said to be more "transportable," capable of bearing a higher transfer cost. The smaller the transfer cost, in relation to delivered price, the greater the disparity in elasticities in the demand for the services of transportation. In other words, the smaller the transfer cost in relation to the value of commodity, the greater is the range possibilities in transferring this commodity.

One of the major explanations of the current attraction of inland waterways as a mode of transportation is their very low cost rates compared to competitive forms of transportation. Indeed, the chief inherent advantage of barge movement is low line-haul costs for bulk commodity.

¹Frank H. Mossman and Newton Morton, Logistics of Distribution Systems (Boston: Allyn and Bacon, Inc., 1965), pp. 28-30.

One of the primary explanations of the increased productivity of the barge industry grows out of the technical improvement of the river transport equipment. The wave of technological improvements in the last decade in the barge industry and the vast physical changes in waterways have produced an inland water transportation service that has some unparalleled and unique characteristics. In this chapter, careful attention will be given to the benefits of inherent advantages that grow out of the technical aspects of inland water movement. Some attention will also be given to the significance of these advantages for the general economy.

Demand Characteristics of Inland Waterways

In the analysis of demand characteristics, economic criteria must be applied to the barge industry as a part of a circulation system as well as to the other modes of transportation. Invariably the investigation of the suitability of the barge industry turns to the analysis of comparative cost in relationship to the other modes within the transportation system. It is an undeniable fact that the low line-haul cost is the inherent advantage of water transportation. The combined factors of multiple units with single power unit and bouyancy of water makes possible the hauling of large volumes, thus operating cost per unit

of freight is relatively low.² Cost, however, is not the only factor that a shipper takes into consideration in deciding on the suitability of a particular mode of transportation in relation to this need. Beyond the cost consideration, an important question is asked: Are the existing agencies rendering a present and potential service that is safe, efficient, reliable, and continuous in spite of adverse physical and weather conditions? It is generally agreed among students of transportation that in the matter of reliability, speed, and continuity of service, and flexibility, rail and, above all, motor transportation agencies hold an advantage over water.³

It must be pointed out that barge shipments lack many of the qualities offered by other modes of transportation, nevertheless, when it comes to moving large volumes at an extremely low cost per ton-kilometer the inland waterways have no competitors.⁴ For example, in comparing line-haul rates, the American Waterways Operators, Inc., state that the cost of barge service to shippers average three mills per ton-mile, where rail and truck service costs 15 and 65 mills per ton-mile, respectively.⁵

²Ibid., p. 53.

³D. Philip Locklin, Economics of Transportation (5th ed.; Homewood, Illinois: Richard D. Irwin, Inc., 1960), pp. 634-646.

⁴Ibid., pp. 719-721.

⁵The American Waterways Operators, Inc., Big Load Afloat (Washington, D. C.: 1966), p. 2.

A question may be asked here: What is the source of these superior economies of operation for barge service? In the nature and structure of inland waterways as a mode of transportation there exist several factors which determine the relatively low line-haul cost in comparison with other modes. One of the prime explanations of barge operating efficiency, in addition to being a multi-movement unit to a single power unit, lies in the fluidity of water.⁶ The economy of inland waterways stems from relatively low propulsive resistance, consequently, it requires less energy per unit of movement to propel the total movement than is true in the case of other transportation modes.

A high ratio of horsepower to net tons as compared with the ratio of horsepower to gross tons indicates that only a small percentage of the power goes to provide transportation, while the major percentage may go to overcome the propulsive resistance. For example, river transport can combine a 2400 horsepower towboat with as many as ten or more 2000 ton barges, a total of 20,000 tons of payload.⁷ The ensuing ratio is 0.14 horsepower net ton. To compare this with railroads, to pull the average freight train of 79 cars and 1430 net tons would require a

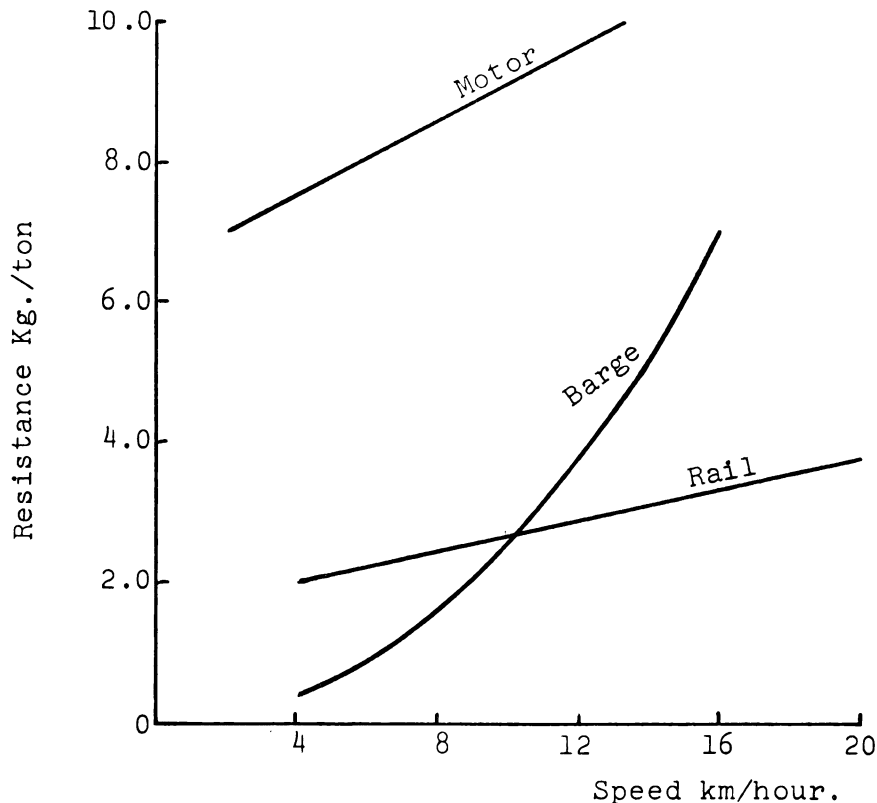
⁶Mossman and Morton, pp. 28-29.

⁷William W. Hay, An Introduction to Transportation Engineering (New York: John Wiley & Sons, Inc., 1961), p. 260.

450 horsepower locomotive.⁸ This is an average of 3.15 horsepower per net ton.

The degree of resistance as a result of movement which motive power must overcome depends wholly on the speed of movement. Figure 19 presents graphically the

FIGURE 19: Relation Between Traction and Speed for Various Modes of Transportation



Source: Millard O. Starr, A Comparative Analysis of Resistance to Motion in Commercial Transportation (unpublished Master of Science thesis, Department of Mechanical Engineering, University of Illinois, 1945).

⁸Ibid., p. 259.

relationship between the degree of resistance to the speed of movement on rail, surface road, and water for one ton of commodity.

As one can see from Figure 19, with small speeds the tractive resistance on rail and road surfaces is considerably larger than on water. With an increase in speed, however, the resistance on rails and roads rises slowly, approximately on diagonal straight lines, whereas the resistance on water is rising very rapidly. The skewed upward line indicates that with each increment in the rise in speed the propulsive resistance on water increases improporportionally by a much higher increment. Nevertheless, with the average speed of a barge between 7-8 kilometers per hour, which is the normal speed on the Oder, the propulsive resistance on water is almost half that of the rail and significantly lower than that of the highway. The barge industry's significant advantage stems from differences in horsepower requirements as the horsepower required to move one ton of pay load one kilometer is a major factor in determining capacity and cost of movement. Corollary to less propulsive resistance there is significantly less vibration on water, which is an additional factor determining the low constant and operating costs of the barge industry. Consequently, capital equipment has a greater life span and requires nominal expenditures for upkeep of floating equipment.

The weight of the container, TARE, in relationship to the load capacity of the vehicle on the inland waterways is significantly lower.⁹ For the purpose of comparison of the relative differences in the weight of containers on different modes of transportation, one can show that a railroad transport container ranges from 30-60 percent of its total shipment, whereas in the case of the barge industry, it ranges only from 12 to 20 percent of the total weight shipment.¹⁰ In comparison, the dead weight of vehicles and motive power of inland waterways is of a lesser percentage to the total weight movement than is true in the case of railroad and motor transport. As a result of these differences in physical requirements in containerization, the cost of vehicle and motive power per each ton of commodity is significantly smaller in the case of the barge industry than the other modes of transportation. For example, to move a load of 5,000 tons by inland waterway requires a barge weighing 120 tons, in this case the TARE equals to 19.4 percent of the total shipment, while to move the same load by railroad it requires 10 cars with a total weight of 250 tons.¹¹ The container in the case of

⁹TARE is the weight of a container (vehicle) and is usually deducted from the total weight to determine the weight of the load.

¹⁰The American Waterways Operators, Inc., Waterway Economics (January, 1970), pp. 77-78.

¹¹Interstate Commerce Commission, Transport Statistics in the United States, 1965, Part I "Railroads" (Washington, D. C.: 1966), pp. 16-80.

the railroad weighs twice as much as the container on inland waterways.

A major economy of inland water transportation, among other factors, results from the nature of partially completed right of way. But in many instances the length of way, as compared to straight line distance between two points, is significantly longer on inland waterways than is true in the case of other modes of transportation. Relatively, the length of way between the point of origin and the point of destination as compared to straight line distance is more favorable in railroads and motor transport. Theoretically, one can approximate the railroad's and the highway's right of ways to a straight line where it is not always physically possible in the case of the inland waterways. The right of ways of inland waterways is determined by the directional flow of the navigable river and artificial canals. Consequently, in many instances, the movement on inland waterways must travel longer actual distance in kilometers to cover the same linear distance covered by other modes of transportation. Therefore, to compare inland waterways to other modes of transportation costs, one factor for which an allowance must be made is the greater circuitry of river routes. While definite relationships between the length of rail, highways, and river haul vary according to the particular river and the particular points involved, the comparison in Table 12 below will throw some general light on the question.

TABLE 12

RELATIVE DISTANCE BY RIVER, RAIL, AND HIGHWAY (IN KILOMETERS)

Distance		Straight Line Distance	River	R.R.	Highway	Excess Distance Over Straight Line (in %)	
From	To					River	R.R. Highway
Gliwice	Koźle	28	41	38	40	46.4	35.7 42.9
Koźle	Opole	42	48	45	59	14.3	7.0 40.5
Opole	Gliwice	57	89	70	79	56.2	22.8 38.6
Opole	Wrocław	78	104	82	94	33.3	5.1 20.5
Brzeg	Wrocław	38	50	42	47	31.6	10.5 23.7
Wrocław	Głogów	89	183	100	152	105.6	12.4 70.8
Zielona Góra	Głogów	50	79	54	67	58.0	8.0 34.0
Wrocław	Szczecin	317	493	379	426	55.5	20.0 34.4
Szczecin	Kostrzyń	92	122	113	119	32.6	22.8 29.3

Sources: Wydawnictwo Komunikacji i Łączności, Rozkład Jazdy Pociągów PKP (Warsaw: 1969); Wydawnictwo Komunikacji i Łączności, Rozkład Jazdy Autobusów P.K.S. (Warsaw: 1969).

The table above shows nine points located along the river which are also connected by rail and highway. For the purpose of this experiment only, river locations were chosen in order for these to be accessible to all three modes of transportation. Each mode of transportation, converging on the same common points to all three modes of transportation, has its own characteristic pattern or system. Here the author is comparing the differences expressed in percentages between river, rail, and highway transportation systems which are converging on river points, and an imaginary transportation system which contains routes connecting all these points by the shortest possible path. The shortest imaginary line between two given locations, a straight line distance, is viewed as the most desired line of movement. The amount of variation between the "desired line" of movement and actual distance, or circuitry, by inland waterway, railroad, and highway is expressed in the percentages. The larger the percentage of excess distance over the straight line on the individual segments of the system, the greater is the degree of circuitry and vice versa. As one can see the average circuitry for the whole system varies from one system of transportation to the other. It ranges as high as 48.2 percent for inland waterway, 37.2 percent for the highway, and as low as 16 percent for railroads. One can say that the rail system comes the closest in comparison to approximating the ideal desired

line of movement.

Further, if one divides the system into smaller geographical areas, the differences on some sections between various systems are even greater. In the lower portion of the Oder River, north of Wrocław, where the river traffic is light, the excess distance in comparison to the "desired line" is 62.9 percent. On the upper portion, southeast of Wrocław, where the great bulk of the Oder River traffic moves, the excess distance is significantly lower, 36.4 percent.

The degree of circuitry must be taken into consideration in the analysis of competitive freight rates. Therefore, it seems logical to assume that to the indicated excess of water haul distance over the railroad by 30 percent in these two portions of the Oder one should add such a portion to the inland waterway transfer cost before making comparisons between these two modes of transportation. Nevertheless, the crucial issue when examining the relative benefits of river movement revolves around the relationship of river movement costs and rates compared with alternative means of transport. The low speed of inland water movement is another shortcoming. The average speed on the Oder of self-propelled barges, 6.7, and tows, 5.5 kilometers per hour, cannot equal the 22 kilometers per hour of a freight train.¹² However, the time consumed

¹²Główny Urząd Statystyczny, Statystyka Żeglugi Śródlądowej i Dróg Wodnych Śródlądowych 1968, Nr. 48

between pickup of barges and receipt at the destination is less unfavorable than the actual operating speed of movement on the water implies. Barge operation is usually relatively simple and little time is consumed in making up tows and dropping them at the point of destination.

Undeniably, the technical speed of a barge which can be defined as an average speed between two points of terminus is significantly smaller than the speed of vehicles in the case of other modes of transportation. However, to increase the technical speed of the tows on inland waterways would rapidly increase tractive resistance, which in turn would require higher horsepower to overcome this resistance.

The comparison of the profitability of movement by various modes of transportation does not entirely depend on their technical speed but, rather, on the total transfer time.¹³ The transfer time includes, in addition to technical speed of movement, terminal time and various interruptions in movement. It is the total time that is required for a commodity to move from the point of origin to the point of destination. It is a relationship between the linear distance of movement to the total time that is

(Warsaw: 1969), Table 35, pp. 57-58; Główny Urząd Statystyczny, Statystyka Transportu Kolejowego 1967, Nr. 25 (Warsaw: 1968), Table 24, p. 18.

¹³Lucjan Hofman, Ekonomika Branżowa Jako Nauka: Na Przykładzie Ekonomiki Transportu (Sopot: Wyższa Szkoła Ekonomiczna, 1962), pp. 23-40.

required for movement to overcome that distance. In each mode of transportation this relationship would differ because of its inherited characteristics and practices in terminus and its technical speed. The investigation of the inland waters led the author to speculate that perhaps the difference of average transfer speed between railroad and inland waterways is not as great as the differences in their technical speed would indicate. The final criterion in many situations is the quantity of freight that can be moved per hour or per day between two points by a given combination of plant and equipment.

The primary prerequisite for utilizing the efficiencies of barge shipment is consolidation of the massive volume of freight at one point. This is a shortcoming to some extent. It means that many types of commodity that are not subject to such massive concentration at one time are not likely to be shipped by barge. For example, the agency Żegluga na Odrze has minimum tenders ranging between 84 to 250 tons.¹⁴ The Polish railroad (PKP) has railroad rates for minimums of 5 to 10 tons.¹⁵ The requirement of such a high minimum tender certainly restricts barge service to a fairly limited range of commodities.

¹⁴Główny Urząd Statystyczny, Transport Wodny Śródlądowy, Nr. 18 (Warsaw: 1967), p. 4.

¹⁵Główny Urząd Statystyczny, Statystyka Transportu Kolejowego (Warsaw: 1967), p. 42.

In summary, inland water transport offers many technological advantages, high productivity in net ton-kilometers per tugboat hour, high cargo weight to dead weight, and low horsepower per ton ratios. Inland water transport includes three major disadvantages, lack of route flexibility, slow speed, and interruption of service due to adverse weather conditions. This has limited the barge industry to low grade freight for which speed is less important than quantity movement.

Administrative Structure of Poland's Transportation

Industrial development in modern Poland could not have been obtained without a relatively sophisticated network of transportation and communication. Physically, Poland is well adapted to the formation of such a network. The present pattern and densities of transportation network in that country, however, reflect the political and administrative past of this area. Before the end of the eighteenth century Poland as a nation state had ceased to exist. In three successive operations between 1772 and 1795 it was partitioned among its neighbors, Austria, Prussia, and Russia, and did not emerge as a sovereign and independent state until 1918.¹⁶ Consequently, the

¹⁶William Langer (ed.), Western Civilization: The Struggle for Empire to Europe in the Modern World (New York: Harper & Row, Publishers, Inc., 1968), p. 230.

densities and patterns of railways and roads and the location and spacing of settlements along the navigable rivers reflect the level of the economic development and the particular requirements of the three partitioners of Poland.

Taking into consideration the whole experience of industrialization of the area which is now Poland, one can characterize three distinct periods. In the first period, from 1850 to 1913, a span of sixty-three years when no significant territorial changes took place, each partitioner developed its portion of the area according to its economic needs. For example, Polish territory under the former Prussian administration became the most industrialized of all three, consequently, it developed the greatest railway densities. Unfortunately, however, all the important lines converged on the Prussian political capital, Berlin. In comparison, the lowest density of railroad lines of all three administrations was under Russian rule where only a few main lines converged on Warsaw, at that time an important manufacturing center of Tsarist Russia. As a result of these differences in the nature and the intensity of industrialization, Poland, with independence after 1918, did not inherit a fully integrated and unified transportation system suitable to its economic needs but, rather, inherited three parts of a transportation structure distinctly and drastically different from one another.

In the second period, the interwar period, Poland's energy, among other things, was absorbed not only in bringing about economic development in a predominantly agrarian economy but also in integrating the transportation network into a unified system. For example, the aggravated need for east-west connections, such as those between Central Poland and Silesia, and Central Poland with the coast, was partially solved by construction of several main lines in the 1920's.¹⁷

The third period began when Poland embarked on the ambitious plan of rapid super-industrialization after 1945. The same transportation problem, however, on a smaller scale, reappeared in the Post-World War II period. As the outcome of the shifting of the state's boundaries by 300 kilometers to the west, Poland acquired a portion of German territory whose transportation network was not oriented to the economic needs of Poland.

The early nineteenth century industrial experience of the area cannot be dismissed as trivial and no longer applicable and valid in the twentieth century because it created the pattern which, in many instances, acts and persists as inertia to this day. The sheer fact that there were differences in the nature, rate and intensity of

¹⁷Teofil Lijewski, "Niektóre Problemy Badawcze w Geografii Transportu Kolejowego," Zeszyty Naukowe Szkoły Głównej Planowania i Statystyki, No. 63 (1967), p. 23.

economic development between the three partitioners of Poland, the differences in the direction, pattern, and density of railroad network developed, created relic patterns which are still visible and operative in present-day Poland. For example, the average density of railroad lines is 8.6 per 100 square kilometers for the entire country.¹⁸ However, if one takes individual wojewodztwo into consideration, the density varies from 4.6 kilometers in wojewodztwo Lublin, formerly a part of the Tsarist empire to as high as 18.2 kilometers in wojewodztwo Katowice, formerly a part of Prussia.¹⁹ The density of surface roads also decreases from west to east. The highest densities, as in the case of the railroads, are in the southwestern wojewodztwa, Katowice and Wrocław.

Different demands, both quantitative and qualitative, for the services of transportation are supplied by different modes. However, the relative share that each mode occupies in the total supply of transportation varies from one economic system to the other. The share that each mode occupies will tend to reflect the demands imposed by the economic system. Therefore, it is necessary to look at the relative position of each mode and compare them in terms of a common denominator, percentages, of tons moved

¹⁸ Główny Urząd Statystyczny, Rocznik Statystyczny 1968 (Warsaw: 1969), Table 2, p. 296.

¹⁹ Ibid.

ton-kilometers by each mode of transportation.

It should be recognized that the measurement in terms of tons carried by each mode of transportation will place emphasis on heavy goods, where ton-kilometers measurement will accentuate heavy commodity moved over long distances. As one can see in Table 13 and Figure 20, which is a graphic representation of the table, it is possible to compare various measurements of the relative share of transportation with various emphasis.

TABLE 13

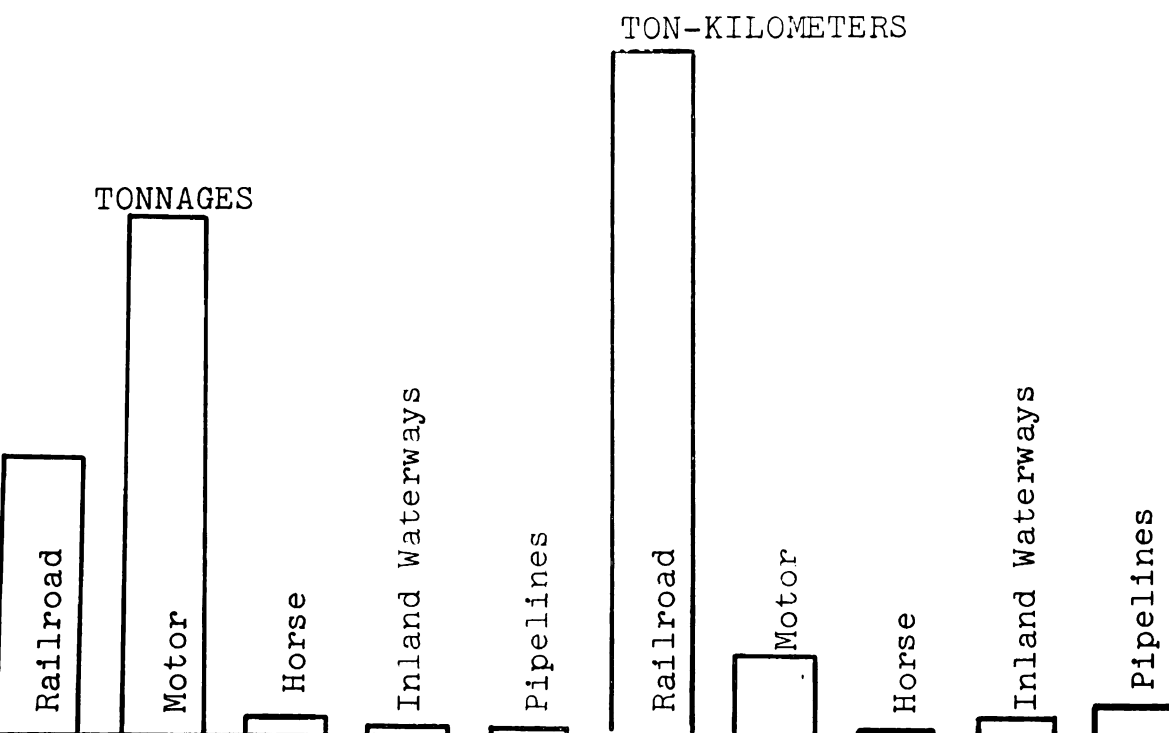
INTERCITY MOVEMENT OF GOODS AND PEOPLE BY
MODES OF TRANSPORTATION, 1968
(IN PERCENTAGES OF TOTAL)

	Freight Traffic		Passenger Traffic	
	% of Total Tonnages	% of Ton-Km.	% of Pass.	% of Pass. Per Km.
Road	34.4	82.3	49.1	60.4
air Transport	63.8	10.7	50.5	38.4
sea Transporta-				
tion*	0.4	0.01	. .	. .
and Waterways	0.6	1.8	0.4	0.2
Transport	. .	. .	0.03	0.8
lines	0.8	5.2	. .	. .

*Excluding agriculture.

Source: Based on statistics in Główny Urząd Statystyczny, Rocznik Statystyczny 1968 (Warsaw: 1969), Tables 5 and 6, pp. 298-299.

FIGURE 20: Relative Shares of the Supply of Transportation in 1968



As is shown in the table above, the dominant mode of transportation in the intercity movement of commodity traffic measured in terms of ton-kilometers is the railroad. In 1968 it carried 82.3 percent of the total interurban freight measured in ton-kilometers. The only other major suppliers of the service of transportation in Poland, however, of significantly lesser prominence when measured in terms of ton-kilometers, are the motor carriers. In 1968, motor transport carried 10.7 percent of the total freight traffic measured in terms of ton-kilometers.

Surprisingly, when one looks at the percentage of each mode of transportation in the movement of all tonnage of intercity freight traffic, the railroad is seen to be the chief supplier of transportation but, rather, motor transportation. For example, in 1968 railroads moved only 34.4 percent of the total tonnages of freight, whereas motor transport moved 63.8 percent. These differences in emphasis in measurement are clearly shown in Figure 20 above.

The noticeable differences between absolute tonnages and ton-kilometers as a measurement of a mode's relative share to the total supply of transportation, suggests to the author that in Poland there is a division of labor based on distance between railroad and motor carriers. Concentration of industry within a small geographical area, the compactness of the country, and the short distances of a large percentage of movement, favors motor carriers. As a result, motor transportation shows a greater rate of growth in tonnages and ton-kilometers of intercity freight service than any other form of transportation. For example, the motor carrier tonnages have increased from 12.5 million tons in 1950 to 721.4 million in 1968, an increase of 5,771 percent.²⁰ It should be noted that these relative shares have not been constant

²⁰ Główny Urząd Statystyczny, Rocznik Statystyczny 1968 (Warsaw: 1969), Table 5, p. 298.

a period of time. Previously, the railroad was almost exclusively the only mode of transportation in Poland. As early as 1950, railroads carried 92.2 percent of the total intercity freight traffic.²¹ While at the present time, other modes carry more tonnages than were carried in the early Post-World War II period, the relative share of each mode has significantly changed. Much of the increase in tonnage in the last eighteen years has gone to the newer modes of transportation, particularly to motor transport and pipelines.

Statistically, inland waterways in Poland have gained significance, measured in both total tonnages and ton-kilometers of commodity carried. Table 14 shows that inland and waterway carriers had 0.3 percent of the total freight market in 1946 and 1.8 percent of all intercity freight in 1968. The trend lines in Figure 21 accompanying Table 14 suggests that total ton-kilometers of motor and inland waterway freight have risen at a much greater rate than railroad movements. Waterway traffic on the inland rivers and canals has risen relatively fast since 1960.

A comparison of the percent rise in inland river freight since 1946, with rates of increase for other transportation modes shown in Table 14, reveals that freight traffic on inland waterways, in spite of the low relative position in total tonnages commodity moved, has

²¹Ibid.

INTERCITY FREIGHT MOVEMENT BY MODES (FOR SELECTED YEARS)

Mode	1946	1950	1955	1960	1964	1967	1968
	In Million Ton-kilometers						
Rail	19,473	35,139	51,969	66,547	79,060	88,543	92,656
Truck	40	210	3,965	5,692	7,772	10,384	12,001
Pipelines	.	.	.	.	1,706	4,358	5,898
Inland Water	53	265	775	904	1,248	1,881	2,020
Air	.	1	2	3	6	11	12
Total	35,566	35,615	56,834	73,187	89,810	105,189	112,565

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Percentage Distribution (of Ton-kilometers)

Rail	99.5	98.6	91.4	90.9	88.0	84.2	82.3
Truck	0.2	0.5	6.9	7.7	8.7	9.9	10.7
Pipelines	.	.	.	.	1.9	4.1	5.2
Inland Water	0.3	0.7	1.3	1.2	1.4	1.8	1.8
Air	*	*	*	*	*	*	*
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

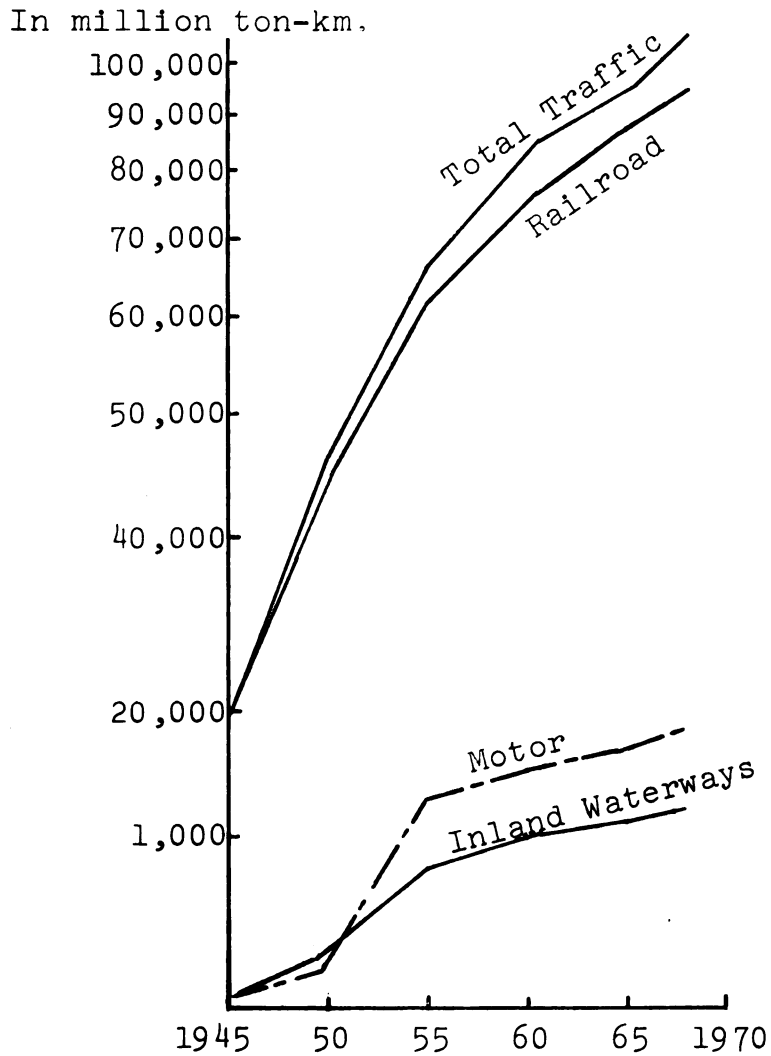
*Insignificant

Mode	1946	1950	1955	1960	1964	1967	1968
	Relative Growth						
Rail	100	180	267	342	406	456	475
Truck	100	525	9,912	14,230	19,430	25,960	30,002
Pipelines	100	•	•	•	•	•	•
Inland Water	100	500	1,462	1,705	2,354	3,549	3,811
Air	100	•	•	•	•	•	•
Total	100	182	290	347	459	538	575

*Insignificant

Sources: Główny Urząd Statystyczny, Rocznik Statystyczny Transportu 1945-1966
 (Warsaw: 1967); Główny Urząd Statystyczny, Rocznik Statystyczny 1968
 (Warsaw: 1969), p. 298.

FIGURE 21: The Trend in Intercity Freight Movement by Modes



Source: Based on data in Table 14.

risen very rapidly, second only to the trucking industry.

All inland water agencies navigating Polish rivers in 1968 carried approximately 6.6 million tons, which constitutes only 0.6 percent of the total tonnages carried by

nation's transportation system.²² The low participation in inland waterways in carrying the nation's freight traffic is largely due to insufficient technological improvements of the rivers and the lack of early cost consciousness on the part of the shippers. The most important Polish rivers from the point of navigation are the Vistula and the Oder. In spite of a great estimated potential by the proponents of inland water transportation, the present contribution of these rivers to the total movement of commodity is rather minimal. One of the problems, among a multiplicity of others, lies in the fact that most of the rivers in Poland are not channelized or regulated. However, the most important economic problem is an insufficient amount of east-west artificial connections. Construction of several east-west canals between the northerly flowing Oder and Vistula would link these rivers into a greatly needed unified network of inland waterways.

If one looks at the present pattern of inland waterways in Poland, it shows that two major streams, the Vistula and the Oder, are connected together in their lower reaches, in the northern portion of the country, via the Warta, Noteć, and the Bydgoszcz Canal. The northern portions of województwa Zielona Góra, Poznań, and Bydgoszcz, through which the Warta and the Noteć flow and by which the

²²Główny Urząd Statystyczny, Statystyka Żeglugi Śródlądowej i Dróg Wodnych Śródlądowych 1968, Nr. 48 (Warsaw: 1969), Table 1, p. 1.

is made between these two major rivers, is an area of relatively low manufacturing concentration, thus representing small economic significance. Unfortunately, no such connection exists between these two rivers in the middle of the country, connecting Wrocław and Łódź with Warsaw, an area of high manufacturing concentration. In the south, however, the Upper Silesian industrial district in Katowice, is linked with the Oder via the Gliwice Canal. Unfortunately, there is a lack of water connection between the Upper Silesian Industrial District and the Vistula, flowing only a few kilometers to the east.

In comparison with other navigable streams in Poland, the most important river for navigation, both from the physical and economical point of view, is the Oder. Its primary importance stems from its geographical location. Together with the Gliwice Canal, the Oder links the coal basin and heavy industry of Upper Silesia with the maritime port of Szczecin. The economic prominence of the Oder in comparison to the other Polish navigable streams can be shown by examining the total tonnages carried by inland waterways for 1968. For example, the total tonnages carried by inland waterways in Poland in 1968 was 6,570 thousand tons, an average distance of 308 kilometers, of which the agency Żegluga na Odrze carried approximately 43 percent at an average distance of 537 kilometers.²³

²³Ibid., Table 1, p. 1, and Table 3, p. 3.

true nature and the economic importance of the Oder
 er can be shown, in respect to other navigable streams,
 pointing out that in terms of ton-kilometers the
 Żegluga na Odrze carries approximately 74 percent of the
 tire Polish waterborne traffic.²⁴ The fact is that where
 other navigable streams in Poland and the agencies navigat-
 ing on these streams have only local significance, carrying
 primarily sand and gravel over short distances, the Oder
 River has a potential, in the true sense of the word, of
 becoming an important artery of transportation of both
 interregional and international status. For example, the
 average distance for the two agencies navigating on the
 Vistula, Żegluga Warszawska and Krakowska, in 1968 was
 70 and 41 kilometers respectively, while the average dis-
 tance of the Żegluga na Odrze in the same year was 537
 kilometers.

Administrative Structure of Poland's Transportation

Since the end of the war there have been successive
 administrative reorganizations of the transportation ser-
 vices in Poland. The reasons for these modifications have
 been the necessity to bring transportation into line with
 the Soviet directional patterns of commodity flow and,
 above all, due to growing operational difficulties arising

²⁴Ibid.

from rapid industrialization and urbanization.

In socialist Poland, all forms of transportation were in the hands of the state. State ownership cannot be attributed as a peculiar characteristic of the present form of government but, rather, is in many respects an extension of a practice which existed before World War II in so-called capitalist Poland. Prior to World War II, there were important state-owned transportation undertakings such as the Polish State Railways (PKP), Polish Airlines (LOT), three steamship companies, and the port of Gdynia. The first two came under the jurisdiction of the Ministry of Industry and Commerce. There was only one major railroad, the Katowice-Silesia, completed in 1926 which was privately owned with a large share of foreign investment, primarily French. Horse-drawn transportation, consisting largely of wagons pulled by horse, was mainly in private hands but operating licenses were issued by the less important Ministry of Transport. Under the jurisdiction of the Ministry of Transport were also included inland waterways, although the shipping companies were privately operated. Since the railroads handled by far the greatest proportion of freight and passenger traffic, it can be said that the bulk of transportation in Poland before the war was in the hands of the state.

In Post-World War II Poland, once again, the state assumed the control over the modes of transportation. The

Ministry of Transport, elevated to a new role, took over the top management of all forms of transportation with the exception of the maritime ports and the merchant marine which fell under the jurisdiction of the newly created Ministry of Shipping. In addition to the prewar state-owned transportation enterprises, several new agencies under the jurisdiction of the Ministry of Transport were created. Among these agencies were the State Highway Transportation, the State Agency for Navigation on the Vistula, and the State Agency for Navigation of the Oder.

This organizational structure of Polish transportation lasted until 1951, when the Ministry of Transport was abolished. As the problems of transportation became more complex in the early 1950's, the Polish planners attempted to solve the mounting and complex problems, arising from rapid economic changes, by administrative reorganizations. The highly centralized control over the system of transportation enjoyed by the Ministry of Transportation was divided between four ministries. Several new ministries, in addition to the already existing ones, were created, the Ministry of Railways, the Ministry of Road and Air Transport, and the Ministry of Navigation. The former functions of the Ministry of Transport pertaining to the construction, maintenance, and operations on inland waterways and river shipyards were taken over by the newly created Ministry of Navigation. The new organizational

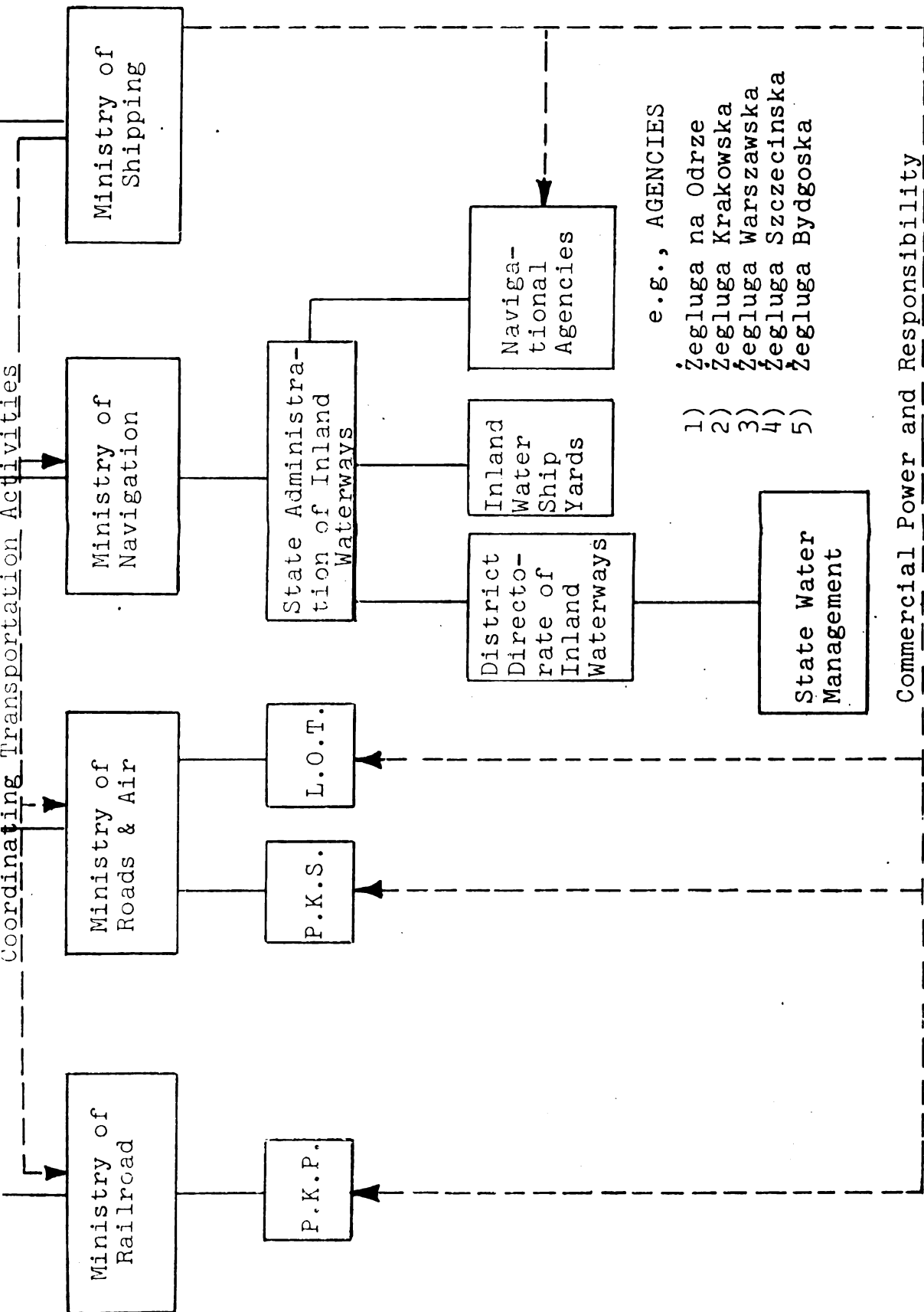
structure of Poland's transportation is shown in Figure 22.

Shipping was given the added responsibility of developing and coordinating a balanced transportation sys-

Its primary function is to move goods and people through a system of transportation. In the assignment of individual tasks to the modes and the problem pertaining to management, the Ministry of Shipping has undisputed jurisdiction and control over the transportation modes, while respective ministries have administrative responsibilities and technical power over their modes of transportation.

On the ministerial level in planning and coordinating further development of Poland's transportation system the Ministry of Shipping plays a key role. Its function is not only to keep and provide statistical data pertaining to movement on which projected plans are based but also to coordinate and develop a balanced and uniform transportation system according to the economic, political, and social needs of the country.

The main organ of the state power on inland waterways is the State Administration of Inland Waterways, with its subordinate units, District Directorate of Inland Waterways. The entire country is divided into five districts, headed by the Directorates, with seats in Wrocław, Kraków, Warsaw, Gdańsk, and Poznań. The power and



responsibilities of the District Directorate of Inland waterways fall within the following four main tasks:

- 1) Construction and development of navigable inland waterways which would include regulation, channelization, construction of retention reservoirs, dams, locks, etc.
- 2) Administration of inland waterways
- 3) Overseeing of navigational regulations
- 4) Inspection of vessels and other floating equipment.

The district directorates of inland waterways execute their function in the field, as it pertains to the development and construction of inland waterways, through a subordinate body, the State Water Management. The actual number of State Water Managements under the supervision of District Directorate depends on the size of the district and the specific characteristics of the sectors of inland waterways within the jurisdiction of a particular directorate. The amount, however, may vary between one and ten such units.²⁵

Commercial inland water ports and their facilities under the direct jurisdiction of an appropriate navigational agency, e.g., Żegluga na Odrze, which uses its facilities within the range of its operations. Other

²⁵Based on the author's personal interview with the engineer at State Water Management Office in Koźle, May, 1954.

shorages and winter quarters are under the jurisdiction
are the responsibility of the State Administration of
and Waterways.

Previous regulations governing movement of goods
people on inland waterways in the postwar planned
economic system had to be drastically modified to meet the
economic demands. Many of these laws and regulations
the interwar period were the remnants of the customary
s and regulations dating from the partition period of
and. The postwar economic and political changes gave a
endowed opportunity to break with inertia and to adopt new
form laws and regulations which would govern navigation
the Polish inland waterways for the whole country.

The first set of such laws and regulations per-
taining to movement of goods and people on Poland's
waterway was adopted on March 7, 1950.²⁶ The basis for the
economic organization of inland water transportation is
laid down in Article Eleven which states that commercial
navigation on the nation's inland waterways may be per-
formed by the government's own concerns or concessionary
enterprises.²⁷ There are nine additional articles which
cover all phases of movement and related fields pertaining

²⁶Prezjdjum Rady Narodowej, Regulamin Nawigacyjny
Wodnych Śródlądowych Rzeczypospolitej Polski
(Law: 1950).

²⁷Ibid.

to inland water navigation. These laws, which are subject to periodical scrutiny and revision, were adopted by decree of the Ministry of Navigation with the collaboration of the State Economic Planning Commission, Treasury, Public Administration, Internal Security, and the Ministry of Internal Trade.

In accordance with the regulations, enterprises navigating on Polish inland waterways must publicly announce the rates adopted by the Ministry of Navigation for shipment of goods and people. It is interesting to note that these rates are constructed on the premise that the inland water transport or combination rail-water transport should be cheaper than railroads or motor transport. In other words, the barge industry has a price advantage over other modes of transportation by administrative decree. If one assumes that the Polish shipper is cost conscious, in order to minimize his total transfer cost, then he should be using the inland waterways whenever it is accessible and profitable.

CHAPTER V

TYPE OF MOVEMENT AND TRAFFIC DENSITY

It is assumed in this study that the decision makers in the long run in a socialist economic system such as Poland, as in a free economy, strive to minimize the total cost of bringing goods and services to the consumer at the market place. Transportation cost is a part of the total cost of the goods offered at the market place. Therefore, the objective of the planners is to minimize, among other costs, the cost of procuring raw materials on the side of production and the distribution cost on the side of consumption.

Each mode of transportation, due to its inherited characteristics in motive power, vehicle, and way (which are the most important basis for cost differences), possesses an absolute or competitive advantage in moving certain types of commodity over a certain distance. These cost differences, in offering the service of transportation, determine the place a given mode of transportation occupies in the market allocation of distribution facilities.

In the preceding chapter, it was recognized that the inland water carriers, due to their inherited

characteristics, are best suited for bulk commodity movement. However, the inland waterway carriers' high terminal pick up and delivery expenses make the mode an ineffective competitor in the short-distance hauls, whereas its low line-haul costs give the mode a competitive advantage in the longer haul. In industrial society there is a whole array of demands, both quantitative and qualitative, for the service of transportation. Modes within such a transportation system tend to specialize, exploiting their peculiar competitive advantages.

In this chapter, the author will analyze the quantitative and qualitative demands for such movement on the Oder River. The question will be asked: What are the characteristics of the present movement on the Oder? The analysis will include the type of commodity moved and the mode of movement of domestic and international shipments.

Quantitative and Qualitative Demand for Movement on the Oder

When considering the relative importance of the Oder River in the inland waterways of Poland, recognition should be made of the quantitative and qualitative demands for movement on this waterway. In 1968, inland water carriers in Poland carried 6,304,892 tons of commodity which only represents 0.6 percent of the nation's intercity



traffic.¹ The state agency Żegluga na Odrze, the principal agency intrusted with the navigation on the Oder north of Szczecin, carried 43.7 percent of the total inland water traffic. None of the remaining six agencies operating on Polish inland waterways, as one can see in Table 15 approached this sizable figure. The annual absolute increase in tonnages and ton-kilometers carried by Żegluga na Odrze from 1946 through 1968 is shown in Table 11, Chapter III.

The table below shows that Żegluga na Odrze in 1968 carried 74.3 percent of the total traffic measured in ton-kilometers. The next highest carrier measured in ton-kilometers was Żegluga Bydgoska with 14.5 percent of the total traffic. If one compares the average distances of each agency, it becomes apparent that unlike the rest of the water carriers, who are primarily of local significance, the agency Żegluga na Odrze, in addition to its local importance, has national and international scope.

The analysis of qualitative demand reveals the great significance of the Oder in movement of bulk commodity. Table 16 which shows the freight traffic on Poland's inland waterways by type of commodity moved, indicates that approximately half of the inland waterway's national tonnage consists of sand and gravel. This, however, is not

¹Główny Urząd Statystyczny, Rocznik Statystyczny 1968 (Warsaw: 1969), Table 5 (450), p. 298.

TABLE 15

TRAFFIC CARRIED BY INLAND WATERWAY SHIPPERS ACCORDING TO AGENCY

Agency	In Percentages			In Percentages			Average Distance (in Km.)
	Tons			Ton-kilometers			
	1965	1966	1968	1965	1966	1968	
							(1968)
Żegluga na Odrze	43.8	42.3	42.6	79.5	77.6	74.3	537
Żegluga Szczecińska	13.0	12.6	14.7	2.4	2.6	3.7	77
Żegluga Gdańska	4.2	4.0	3.8	1.0	1.0	0.9	74
Żegluga Mazurska	2.8	2.6	2.1	0.2	0.2	0.1	17
Żegluga Bydgoska	9.5	9.4	10.0	12.8	13.7	14.5	445
Żegluga Warszawska	18.5	20.9	18.6	3.3	3.9	5.1	84
Żegluga Krakowska	8.2	8.2	8.2	0.8	1.0	1.4	52

Sources: Główny Urząd Statystyczny, Statystyka Żeglugi Śródlądowej i Dróg Wodnych Śródlądowych, Nrs. 28 and 48 (Warsaw: 1968 and 1969), Table 4, p. 3.

TABLE 16
1968 FREIGHT TRAFFIC ON INLAND WATERWAYS
BY TYPE OF COMMODITY

By Type of Commodity	Carried by All Polish Water Carriers	
	Tons	% of Total
Bituminous Coal	1,115,360	17.7
Lignite and Coke	29,786	.5
Ore	790,208	12.5
Stone	170,400	2.7
Sand and Gravel	2,962,174	47.0
Petroleum	425	*
Metals and Metal Products	44,630	.7
Brick	2,929	.04
Cement	38,182	.6
Fertilizer	389,400	.2
Misc. Chemicals	34,926	.6
Grain	160,415	.5
Sugar Beets	5,827	.1
Misc. Agricultural Products	148,159	.3
Wood and Wood Products	289,414	.6
Other Commodities	142,399	.3
Total	6,569,622	100.0

*Less than 1/100 of a percent

Source: Główny Urząd Statystyczny, Statystyka Żeglugi Śródlądowej i Dróg Wodnych Śródlądowych, 1968 (Warsaw: 1969), Table 6, p. 4, and Table 16, pp. 14-21.

TABLE 16--Continued

Carried on the Oder			
Tons	% of Total	% of Nat. Tonnages Carried by Oder	Average Distance
1,003,628	36.5	90.0	652
21,078	.8	70.8	624
484,199	17.6	61.3	602
84,684	3.1	49.7	543
714,297	26.0	24.1	49
425	0.01	100.0	428
16,929	0.6	37.9	617
624	0.02	21.3	48
22,327	0.8	58.5	911
254,321	9.2	65.3	453
10,500	0.4	30.1	414
49,479	1.8	30.8	250
13,796	0.5	9.3	341
51,314	1.9	17.7	98
23,352	0.8	16.4	364
795,041	100.0		

true in the case of the Oder River. Unlike the national make-up of cargo, the most important commodity carried by the agency Żegluga na Odrze is coal, 36.5 percent of its total tonnage, whereas sand and gravel constitutes only 26.0 percent. Probably, due to the geographic location of the Oder River in respect to the Upper and Lower Silesian coal mines and the maritime port of Szczecin, 90 percent of all coal carried on inland waterways in Poland is carried by the agency Żegluga na Odrze.

The relative importance and magnitude of movement on the Oder River can only be realized by closer examination of Table 16 which, in addition, indicates the Oder's share in inland waterway movement in relationship to the total movement. For example, of the sixteen types of commodities listed in Table 16, seven of these the agency Żegluga na Odrze carries at least 50 percent of the total tonnage moved by inland waterways in Poland. If one lowers the percentage to include commodities of 25 percent and above of the national tonnages carried, this agency on the Oder would have an impressive list of ten commodities out of the sixteen listed in the table. Even more impressive is the role of the Oder River in the inland water movement if one takes each individual commodity and its tonnages for consideration. For example, of over a million tons of coal, 90 percent of the total inland water coal tonnage is carried by Żegluga na Odrze. In addition, 61.3 percent of

the ores, 70.8 percent of lignite and coke, 65.3 percent of fertilizer, 58.5 percent of cement, and the entire tonnage of petroleum is carried on the Oder.

In comparing various inland waterway carriers, it can be seen that there is a greater concentration of large tonnage in fewer commodities on the Oder than is true in the case of any other inland water carrier. For example, four types of commodities carried by Żegluga na Odrze, bituminous coal, sand and gravel, ore, and fertilizer composed 90 percent of the agency's entire tonnage in 1968.

To compare this with Żegluga Bydgoska, the agency navigating on the rivers, Noteć, Warta, and the lower portion of the Oder, outside of sand and gravel which in 1968 constituted 48.4 percent of the agency's total tonnage, there is a complete lack of concentration.² The next highest group of commodity which was 8.7 percent is listed as miscellaneous agricultural products.³ Therefore, one can conclude that a few types of commodities and large tonnages give the agency Żegluga na Odrze an advantage in comparison with other inland water agencies in Poland, in that it can apply a greater amount of mechanization to the movement, thus decreasing the cost of transfer. Unfortunately, statistical data showing rates and comparative cost for providing

²Główny Urząd Statystyczny, Statystyka Żeglugi Śródlądowej i Dróg Wodnych Śródlądowych 1968 (Warsaw: GUS), Table 16, pp. 14-21.

³Ibid.

the service of transportation is not available to the author to substantiate this assumption. Nevertheless, the relative importance of each group of commodity in inland waterway carriers can be shown by ranking their shipments according to highest tonnages. Table 17 lists a group of fifteen commodities carried by the agency Żegluga na Odrze

TABLE 17

RELATIVE IMPORTANCE OF SHIPMENTS BY INLAND
WATERWAY ACCORDING TO AGENCIES

Commodity	Żegluga na Odrze Rank	Żegluga Bydgoska Rank	Rank on All of Poland's Inland Waterways
uminous Coal	1	.	2
nd and Gravel	2	1	1
es	3	.	3
ertilizer	4	6	4
one	5	7	6
od and Wood			
Products	6	10	5
ain	7	5	7
her Commodity	8	3	9
ment	9	8	11
ignite and Coke	10	.	13
als and Metal			
roducts	11	9	10
c. Agricultural			
roducts	12	2	8
c. Chemicals	13	4	12
ck	14	.	15
roleum	15	.	16
ar Beets	.	.	14

Source: Główny Urząd Statystyczny, Statystyka Żeglugi Śródlądowej i Dróg Wodnych Śródlądowych 1968, Nr. 48 (Warsaw: 1969), Table 16, pp. 14-21.

according to rank. The ranking of Żegluga na Odrze can be compared with other agencies such as Żegluga Bydgoska, showing no parallelism.

These obvious differences between the agencies navigating Polish inland waterways in the commodity moved, leads one to question whether there are regional variations and differences on a small scale in the tonnages and the type of commodity carried within the Oder system. Thus one should ask the question: Is the Oder River, including the Gliwice Canal, along its entire length a homogeneous way from the point of type of commodity moved and traffic density? One could only assume that the differences in the quantity and the type of commodity offered for shipment could stem from regional differences. As has been discussed before, the quantitative and qualitative demands are derived demands which are generated from the needs within the hinterland that the particular mode is serving. Therefore, if significant variations and differences exist within the hinterland that the particular mode is serving, then the quantitative and qualitative demand for movement could greatly differ from region to region.

Type of Intraregional and Interregional Movement

Within the domestic inland water freight shipments, one can distinguish two methods of moving a commodity from point of origin to the point of destination:

- (1) Exclusively by inland waterways
- (2) In combination barge-to-rail shipments
 - (a) with one transfer between modes
 - (b) with two transfers between modes.

Most of the tonnage carried by the state agency Żegluga na Odrze is of the barge-to-rail combination type. Actually, very little tonnage in Poland moves exclusively from the point of origin to the final destination by inland waterways. Surprisingly, barge-to-truck shipments virtually do not exist on the Oder. This perhaps stems from the lack of complementarity in the type of commodity moved in Poland by the barge industry and the trucking industry.

The combination barge-to-rail shipments on the Oder, measured in ton-kilometers, make up 82.0 percent of the total commodity moved.⁴ The national average measured in ton-kilometers, for combination type of movement, is 0.2 percent.⁵ Looking at the actual tonnages moved, one obtains a slightly different picture. The actual tons of commodity moved by the agency Żegluga na Odrze in combination barge-to-rail shipments, are 1,815,209 which is only 0.9 percent of the total tonnage.⁶

The differences in the measurement between ton-kilometers and tonnages suggest that relatively few types of high value commodities are shipped over long distances.

⁴Ibid., Table 8, p. 5.

⁵Ibid.

⁶Ibid.

In both cases the Oder leads the nation in combination barge-to-rail type of movement which would suggest a greater degree of integration of inland waters in this region within the total transportation system. Furthermore, the variations in the percentage of the combination type of movement from one inland water agency to another is also indicative of the type and value of the commodity that is mostly carried by that particular agency. The higher value commodity is more transferrable than low value commodity. Thus the agency whose total make-up tonnage is of relatively low value per weight will exhibit a significantly smaller percentage of combination-type movement.

To exemplify this point, one can demonstrate that the agency Żegluga Bydgoska, whose 48.4 percent share of total tonnage in 1968 was composed of sand and gravel, combination barge-to-rail type of movement was only .5 percent of the total, measured in terms of ton-kilometers.⁷ The same low percentage of combination-type movement in relation to total tonnages is also true in the case of the agency operating on the lower and middle Vistula, Żegluga Warszawska.

The combination-type shipments which are so prevalent on the Oder are primarily of that particular category representing one transfer between modes. Domestic shipments with two transfers between modes are considered most

⁷Ibid.

stly, requiring a greater output of capital and labor
 d, in recent years, statistics indicate that they are
 ing phased out from the scene of interregional movement.
 typical example of combination barge-to-rail shipment
 th two transfers is the movement of coking coal from the
 nes at Wałbrzych and coke from the processing plants to
 he steel plants in Upper Silesia. The coal from the mines
 s shipped by railroad to the port of Wrocław where it is
 loaded on barges to be moved up the river to the port of
 liwice, where once again coking coal is unloaded from the
 arges to rail hoppers for shipment to its final place of
 destination. Reduction in shipments with two transfers
 between modes in recent years is reflected in the relative
 importance of some commodities in the make up of total
 shipments. For example on the Oder in the past several
 years the share of bituminous and coking coal in relation-
 ship to the total tonnage moved decreased from 60 percent
 in 1960 to 40 percent in 1968.⁸ In spite of this decrease
 coal still occupies first place, as one can see from
 Table 16 in the previous section, indicating the relative
 importance of various commodities in interregional movement
 on the Oder.

The only available statistical data on the intra-
 regional movement of commodities via the Oder River, within

⁸Towarzystwo Rozwoju Ziemi Zachodnich, Żegluga na
Odrze (Wrocław: May, 1969).

the study area, is presented in Table 18. A close examination of the table reveals that intraregional movement by water carriers within the Oder hinterland to the total inland water movement was relatively high both in 1966 and 1967, 39.9 and 48 percent, respectively. In 1968 it had significantly increased to 75.8 percent. If one examines Table 18 in conjunction with Figures 23 and 24, it can be seen that in the case of the individual wojewodztwo Szczecin, in addition to being the major receiver of goods from the other regions, 92.9 percent of the port of Szczecin's total consignment in 1968 was destined for shipment within the wojewodztwo itself. Surprisingly, the only other wojewodztwa which show any intraregional movement are Opole and Wrocław. The share of intraregional shipment to the total consignment in 1968 was approximately 2 percent for both regions.

Looking at the interregional movement of a commodity via the Oder River, it can be seen that there is a marked increase from 1967 to 1968. The major shippers were wojewodztwa Opole and Katowice, whose entire inland shipments in 1968 were consigned for shipment outside of the boundaries of their respective regions. The next closest region with a large percentage of commodities shipped outside of the region is wojewodztwo Wrocław.

The major receivers of commodities via inland waterways from other regions in 1968 were wojewodztwa

TABLE 18
INTRAREGIONAL AND INTERREGIONAL MOVEMENT
OF COMMODITY ON THE ODER FOR
SELECTED YEARS (IN TONS)

Region	Year	Consigned		
		Total	For Shipment within Region	For Shipment Outside Region
City of Wrocław	1966	266,185	25,850	240,335
	1967	363,262	193,742	169,520
	1968	157,895	10,901	146,994
Katowice	1966	276,480	. .	276,480
	1967	297,796	32,985	264,811
	1968	551,068	. .	551,068
Opole	1966	650,127	85,314	564,813
	1967	611,174	33,512	578,242
	1968	642,523	12,510	630,013
Szczecin	1966	623,506	620,447	3,059
	1967	749,889	715,118	34,771
	1968	715,452	664,958	50,494
Wrocław	1966	14,800	. .	14,800
	1967	167,693	89,077	78,616
	1968	415,049	8,865	406,184
Zielona Góra	1966	4,421	. .	4,421
	1967	5,864	. .	5,864
	1968	28,194	. .	28,194

Source: Główny Urząd Statystyczny, Statystyka Żeglugi Śródlądowej (Warsaw: 1969), Table 15, p. 191.

TABLE 18--Continued

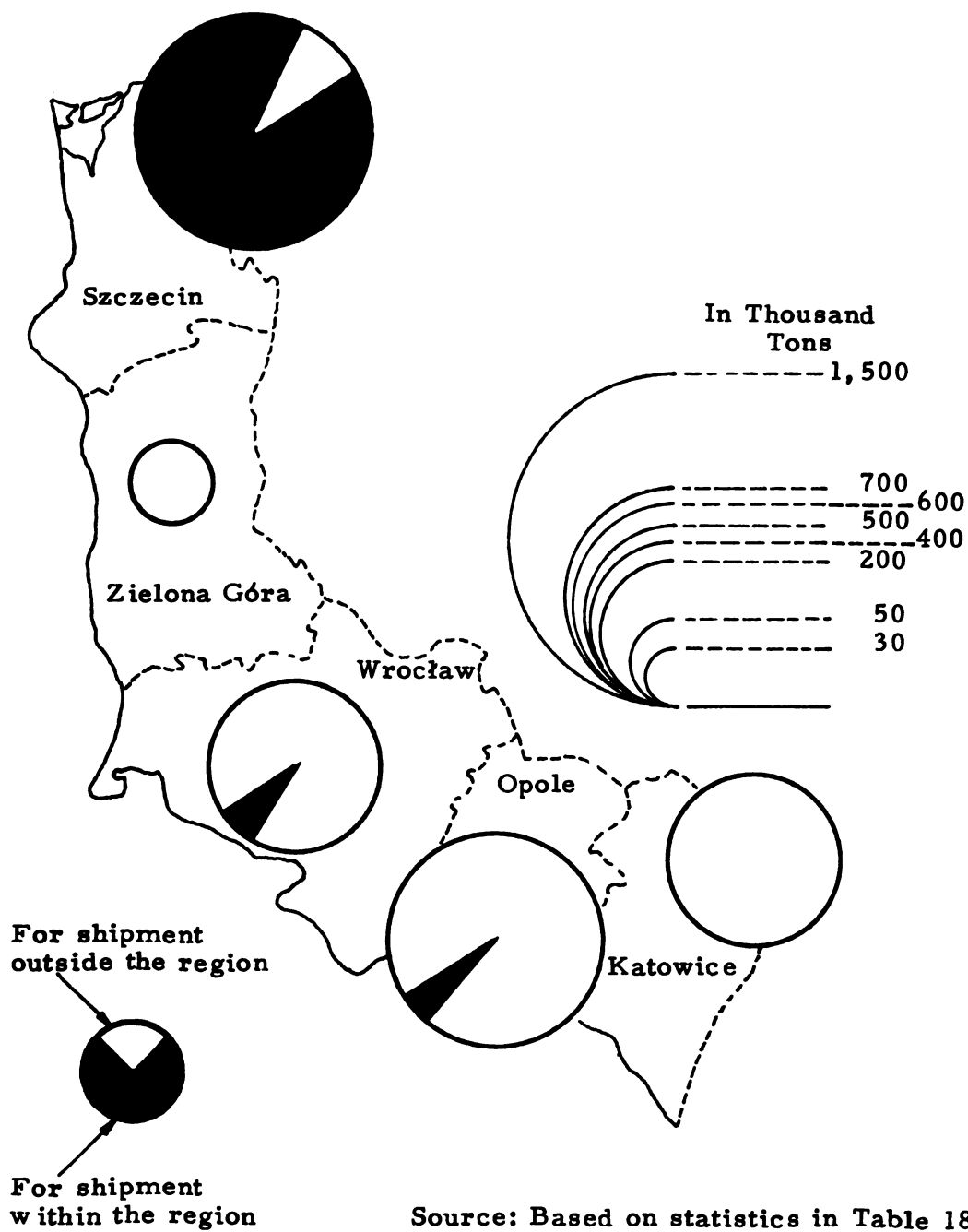
Received			
Total	Shipment From within Region	Shipment From Outside Region	Balance Export of Import
209,129	25,850	183,279	+57,056
288,315	193,742	94,573	+74,947
543,620	10,901	532,719	-385,725
380,295	. .	380,295	-103,815
437,623	32,985	404,638	-139,827
467,201	. .	467,201	+83,867
262,902	85,314	177,588	+387,225
312,587	33,512	279,075	+299,167
210,579	12,510	198,069	+431,944
1,271,096	620,447	650,649	-647,590
1,557,729	715,118	842,611	-80,840
1,526,952	664,958	861,994	-811,500
31,073	. .	31,073	-16,273
129,727	89,077	40,650	+37,966
54,849	8,865	45,984	+360,200
16,596	. .	16,569	-12,148
13,830	. .	13,830	-7,966
13,959	. .	13,959	+14,235

Szczecin and Katowice and the city of Wrocław. By comparing Figures 23 and 24 it can be seen that województwo Katowice is both the major shipper of commodity outside of its own region and the major receiver from other regions.

If one looks at the last column of Table 18, which shows the balance between export and import for individual regions, it can be seen that in 1968 the województwo of Opole showed an excess of 431,944 tons of export over import, followed by Wrocław with 366,200 tons. In the same period, on the negative side where imports exceed exports, województwo Szczecin leads with 811,500 tons, followed by the city of Wrocław, the next closest importer, with 385,725 tons of commodity. Table 19 summarizes the relative importance of the województwa in interregional trade.

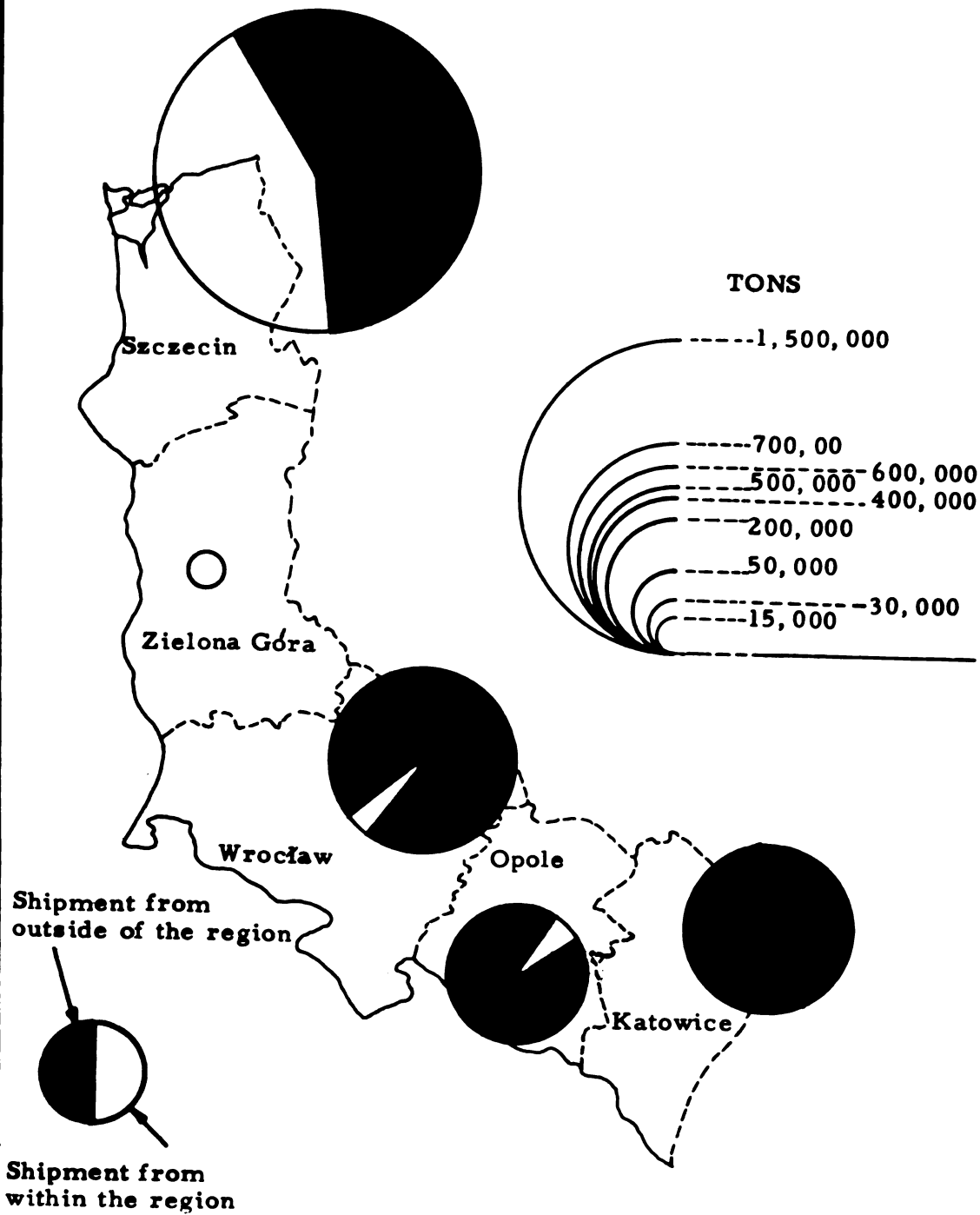
If one looks at the shipments by type of commodity by the agency Żegluga na Odrze one can see a great deal of difference between intraregional and interregional movement. In the three regions, Szczecin, Wrocław, and Opole, which are the only ones that show intraregional movement by inland waterways in Figure 25, the major commodity in 1968 was sand and gravel. This overwhelming importance of sand and gravel in intraregional movement by barges can be demonstrated by citing that in 1968, 86.3 percent of a total 880,075 tons, classified strictly as internal movement within each region, was sand and gravel.

FIG. 23: CONSIGNMENT BY REGIONS IN 1968



Source: Based on statistics in Table 18

FIG 24 SHIPMENT RECEIVED BY REGIONS IN 1968



Source: Based on statistics in Table 18

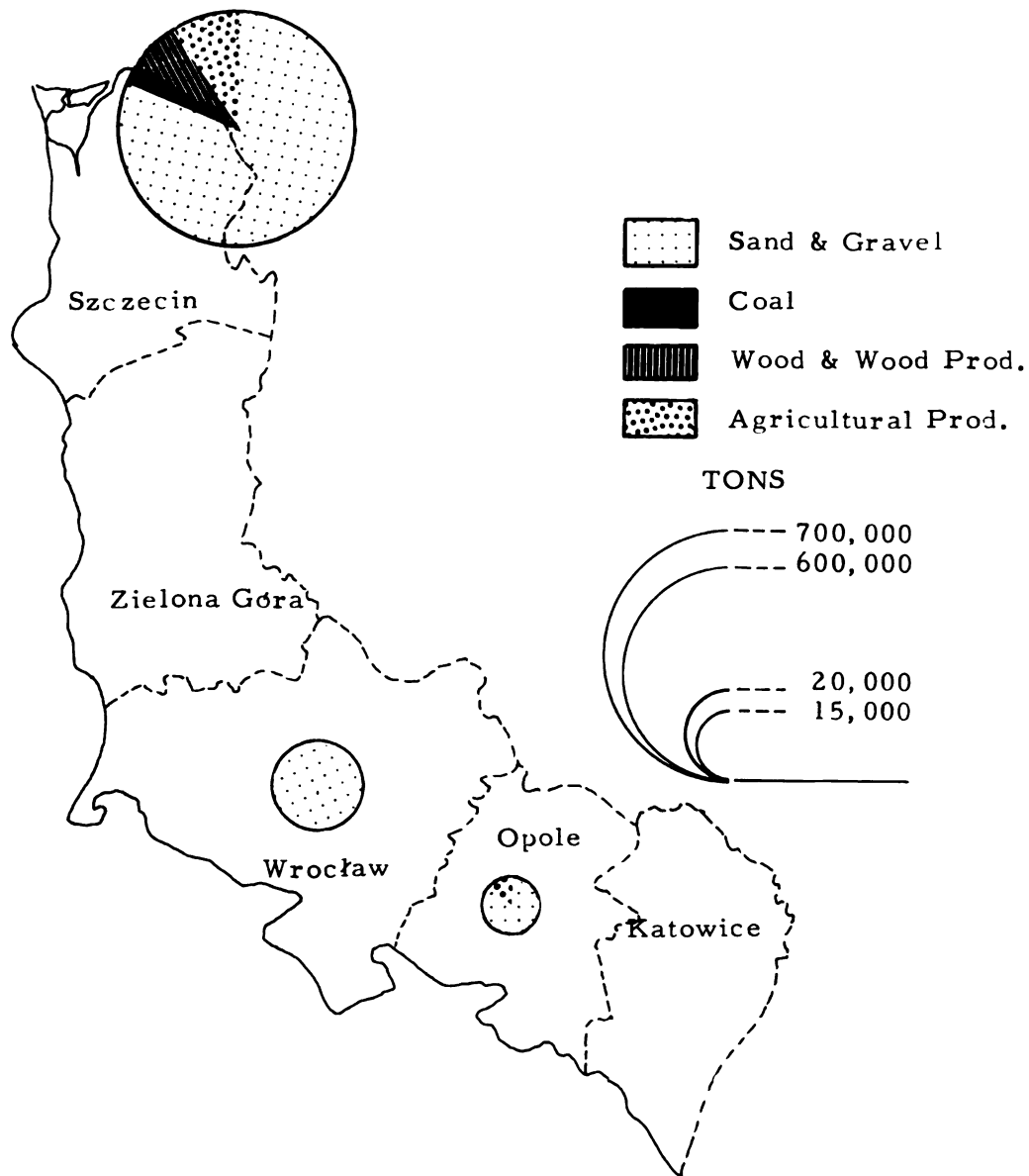
TABLE 19

RELATIVE IMPORTANCE OF REGIONS IN INTERREGIONAL TRADE FOR
1966-1967-1968 (IN PERCENT OF TOTAL)

Region	1966		1967		1968	
	Export	Import	Export	Import	Export	Import
Total for the 6 regions (in 1,000 tons)	1,104	1,439	1,132	1,675	1,785	2,120
City of Wrocław	21.8	12.7	15.0	5.6	8.2	25.1
Katowice	25.0	26.4	23.4	24.2	30.9	22.0
Opole	51.2	12.3	51.1	16.7	35.3	9.3
Szczecin	0.3	45.2	3.1	50.3	2.8	40.7
Wrocław	1.3	2.2	6.9	2.4	22.8	2.2
Zielona Góra	0.4	1.2	0.5	0.8	1.6	0.7
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Główny Urząd Statystyczny, Statystyka Żeglugi Śródlądowej i Dróg Wodnych Śródlądowych 1968, Nr. 48 (Warsaw: 1969), Table 16, pp. 12-13.

FIG. 25: INTRAREGIONAL MOVEMENT BY TYPE OF COMMODITY
IN 1968

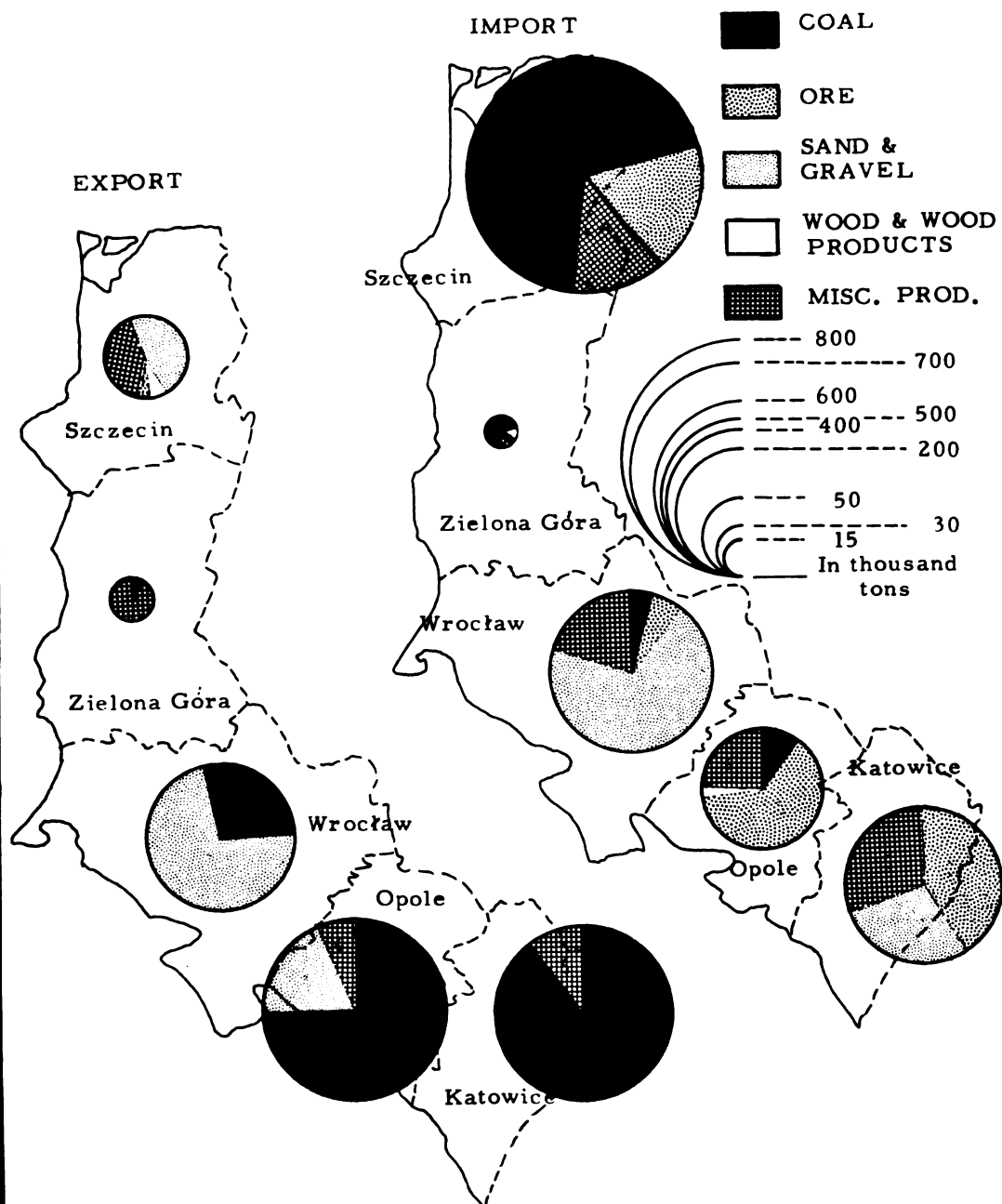


Source: Based on statistics in Tables 1, 2, 3, 4, and 5 in the Appendix

The analysis of the table, which shows both intra-regional and interregional movement by type of commodity, reveals that sand and gravel occupied a dominant but slightly different position in each region. It ranges from 100 percent of the total intraregional movement, as in the case of województwo Wrocław, to 85.3 and 82.1 percent in województwa Opole and Szczecin, respectively. The remaining barge tonnages of internal movement within the region is primarily wood and grain. The województwo of Szczecin is the only region within the study area that shows at least some degree of diversity in the type of commodity moved by barges within the region. This can be illustrated by indicating that in 1968, excluding wood and wood products and grain which were 6.6 percent and 3.5 percent, respectively, of the total intraregional barge tonnage, the remaining ten commodities within the list command less than 2.5 percent of the total.

The interregional movement of commodity by żegluga na Odrze is more diversified than that of the intra-regional. In movement between regions, in addition to having greater diversity in the greater number of commodities shipped to total movement, one also notices pronounced differences between the exports and imports of the individual regions. As one can see in Figure 26, the major share of exports of the southern województwa, Katowice, Opole, and Wrocław, consists of coal, 89.9 percent,

FIG. 26: REGIONAL EXPORT IMPORT BY TYPE OF COMMODITY
IN 1968



Based on statistics in Tables 1, 2, 3, 4, and 5 in the Appendix

75.1 percent, and 25.1 percent, respectively. The northern regions, Zielona Góra and Szczecin, are relatively small exporters of commodities via inland waterways, however, they show a greater diversity in the type of commodity.

The largest single importer among the five regions is województwo Szczecin, coal occupying 68.8 percent of its total transports. It is not surprising to find that natural resources such as various ores and sand and gravel occupy a high percentage of the imports of województwa Opole and Katowice. In the case of województwo Wrocław, there is a certain degree of similarity between its imports and exports. In both cases, sand and gravel occupy a high percentage. This may stem from the fact that the water carriers are not utilized in procurement of inputs and/or distribution of output by industry, which is predominantly light industry.

International Movement

In the geographic and political systems of Central Europe in the Post-World War II period, the Oder waterway occupies an entirely different position from that of the Pre-1939 period. This river is thought of by the enthusiasts of inland water navigation within the Polish government and the neighboring riparian states, East Germany and Czechoslovakia, as a vital link of communication between socialist states, necessary to the building of socialism

within their respective countries. Irrespective of whether one sees the river in the light of dialectic materialism, it would be interesting to analyze the function and relative importance of the Oder waterway in the international movement of commodity. The primary questions to be asked here are: What characterizes the movements of commodities to and from foreign countries? What is the quantitative and qualitative demand for this type of movement? and: How does the international type of movement differ from the domestic? It is quite possible, as in many other instances in socialist countries, that the rhetoric and optimism does not necessarily coincide with the hard economic reality.

Poland, as a country taking a part in international trade by means of inland waterways, entered the European market relatively late,⁹ in spite of the fact that the Oder River had been internationalized since World War I. The Soviet block countries prior to the death of Stalin in 1953, in conjunction with Moscow's foreign policy, practiced political and economic isolation from the rest of the world. The Oder River basin, approximately 90 percent of it being within the territory of Poland, gave the Polish authorities absolute control over navigation. This policy of selective isolationism, however, drastically changed with the new winds of the "thaw" which blew from the east.

⁹The Oder River had been internationalized by the Versailles Treaty of 1918.

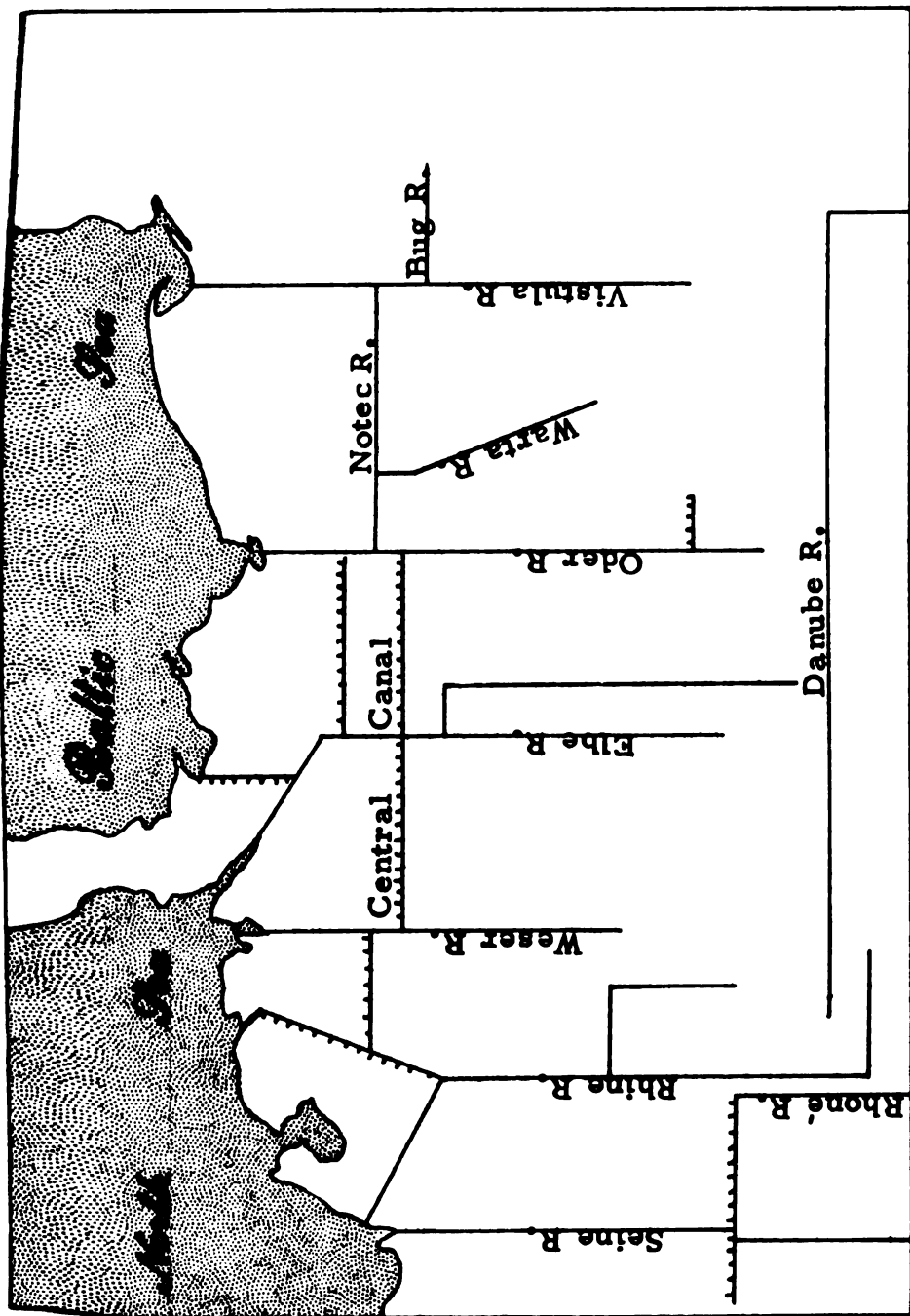
In 1954, the first shipments destined for the Western European markets via the Oder waterway were recorded. Shipments during the years 1954 and 1955 were confined exclusively to commodity exchange, excluding the Socialist block countries, between Poland and West Germany. As early as 1948, on the basis of an agreement between the Polish and Czechoslovakian governments, the Oder for a brief period of several years became a transit waterway for Czechoslovakia with its own agency, Ceskoslovenska Plavba Labsko-Oderska with its headquarters in Prague, and a river fleet navigating from Koźle to Szczecin. In 1950, the East German state agency, Deutsche Binnenschiffart Reederei, began navigation on the Oder.

Further expansion in the international movement of commodity by the Oder and Central European inland waterways was introduced in 1960. In the spirit of peaceful coexistence with the West and the realization of the profitability of trade between east and west, several commercial agreements between Poland, West Berlin and Holland were concluded. Two years later, in 1962, Belgium entered on the scene, becoming an important customer of Polish agricultural products and semi-finished manufactured goods. It is interesting to note, however, that since 1962 the number of countries taking part in the exchange of commodities with Poland via the Oder waterway and the connected systems of inland waterways has not drastically changed to the

present day.

The Oder River, as shown in Figure 27, is tied by an intricate and well-developed system of canals with the major rivers of Europe such as the Elbe, Weser, and Rhine. Due to the fact that the Oder is the eastern extremity of the great European inland waterway system, Poland is capable of exchanging commodity with most of the industrialized countries of Europe. The navigable rivers of Western Europe have been in the past and persist to be more influential as a locational factor for heavy industry than has been true in the case of Poland. Consequently, the industrial might of Western Europe is quite accessible by the European inland water system and their carriers have always played an important role in moving commodities, both on the concentration and the dispersal sides. Only recently, in the wake of renewed interest in Poland's inland waterways and the subsequent rejuvenation of the barge industry as a mode of transportation, are inland waterways beginning to play a role in locational decisions.

Unfortunately, at the present time the inland water connections between the Oder River and the rest of the European inland waterway system are unsatisfactory. The initial objective and energy should be directed to the improvement of the east-west connections between northerly flowing rivers which are the primary directional demand for movement within this region. For the Oder to play a



significant role in international movement of commodity, it must be fully integrated into the rest of the European inland water system. Prior to the intervention by the Warsaw Pact countries in Czechoslovakia, there had been expressed interest by Polish and Czechoslovakian planners in tying the Oder with the Elbe and Danube Rivers which, in turn, would link the Baltic with the Black Sea via inland waterways.¹⁰

Looking at the Oder River as an artery of transportation beyond the narrow confines of the national framework of Polish economy, it can be said that it has the potential and the possibility of becoming an international inland waterway of some consequence. The Oder River, due to its excellent geographic location, aligned along a north-south axis, constitutes the shortest and simplest water connection between the Baltic, through the Elbe and Danube Rivers, with the Black Sea. In addition, by linking the West European inland water system with that of the Soviet Union, the Oder's present peripheral position would change to that of a central one.

Thus the Oder River, in spite of its adverse physical peculiarities but with major technical improvements, could become the keystone in the whole European inland waterway system, serving in this function not only

¹⁰Kazimierz Puczynski, "Kanał Odra-Dunaj," Gospodarka Wodna, Nr. 6 (June, 1968), p. 216.

the Polish economy but other countries of COMECON and Western Europe as well. At the conference held in Koźle in July 1968 by parties interested in expanding navigation on the Oder, mainly Poland and Czechoslovakia, ambitious plans were made to modernize the river to the level of the rest of the European rivers and to begin construction of the Oder-Danube Canal. It was hoped that this river could truly become an international artery of transportation. However, the tragic events in Czechoslovakia which shortly followed after the conclusion of the conference, disrupted any further talks and cooperation regarding the Oder River.

At the present, international freight traffic on the Oder River consists of three distinctive types of movement which are: imports to Poland, exports from Poland, and transit through Polish territory to and from neighboring countries. In aggregate these three types of movements, which are distinctively classified as international traffic, are relatively small in comparison to the total barge movement on the Oder. At the beginning of Poland's participation in 1954 in international trade via inland waterways, the total international traffic on the Oder, consisting of these three components measured in actual tons carried, was less than 10 percent of the total tonnage.¹¹ After twelve years, by 1966, it rose to 18.3 percent of the total

¹¹ Główny Urząd Statystyczny, Rocznik Statystyczny Transportu 1945-1966 (Warsaw: 1967), p. 499.

tonnage, but in 1968 slightly declined to 16.0 percent.¹²

If one compares the annual rise of international inland water traffic to the rise of total Polish inland water traffic, it can be seen that there is a great deal of parallelism. The international freight traffic rose on the average approximately 8 percent from 1954 to 1968, while total barge traffic on the Oder rose 7.1 percent for the same period.

Looking at the individual components of the international traffic, it can be seen from Table 20 below that exports from Poland in the three-year period 1966, 1967, and 1968 exceeded imports by approximately 50 percent. In

TABLE 20

INTERNATIONAL FREIGHT MOVEMENT ON THE ODER
FOR SELECTED YEARS (IN TONS)

Type of Movement	1966	1967	1968
Total Freight Movement on the Oder	2,052,390	2,527,617	2,795,041
Total International Freight Movement	375,996	407,120	446,281
Imports (to Poland)	50,063	67,109	79,819
Exports (from Poland)	107,252	124,522	141,170
Transit	201,644	206,157	206,102

Source: Główny Urząd Statystyczny, Statystyka Żeglugi Śródlądowej i Dróg Wodnych Śródlądowych 1968 (Warsaw: 1969), Tables 10 and 11, pp. 7-8.

¹²Percentages calculated from the data in Table 20.

1968 exports comprised 31.6 percent of the total international freight tonnages, whereas imports commanded only 17.9 percent. The largest and most important component of international freight traffic on the Oder is the transit movement. In 1966 it consisted of 53.6 percent of the total foreign tonnage. It is interesting to note that in 1968 international traffic declined slightly from the previous year by 0.02 percent. However, in relative terms to the total foreign traffic, the reduction was much more striking. In the same year transit traffic constituted only 46.2 percent of the total international traffic. The explanation for this sizable decline of transit traffic is that Czechoslovakia in recent years has ceased navigational operations with her own river fleet on the Oder and is actively pursuing the securing of more accessible and more economical routes for her exports to foreign markets. For example, in 1968 the port of Hamburg in West Germany was receiving more Czechoslovakian transit than the port of Szczecin. Here is a prime example where economic considerations, price incentives, and self-interest of the nation state, even in this Socialist system, prevails over the ideological commitments.

The river port at Koźle still continues to be a transshipment port for the remaining Czechoslovakian transit. Freight in transit to and from Czechoslovakia is carried by the boats of the agency Żegluga na Odrze. The

Czechoslovakian transit carried by Polish barges is predominantly raw materials, such as iron ore, phosphite, and periodotite. These raw materials are loaded directly into barges from ocean bottoms in the maritime port of Szczecin and the barges then proceed up river to Koźle where trans-loading into railroad cars takes place for the remaining journey to the point of destination. This procedure is reversed for Czechoslovakian export which is predominantly manufactured and semi-finished types of commodities. In spite of the gradually declining Czechoslovakian transit carried by Żegluga na Odrze, Polish planners are quite optimistic in thinking that with the modernization of the Oder waterway and the constantly rising demands in Czechoslovakia for raw materials, especially in the Ostrava-Karvinski manufacturing district, the transit movement on the Oder will have no other choice but to increase.¹³ Thus with the modernization of the Oder River to comparable standards of other European navigable rivers and, particularly, with the extension of the navigable channel to the city of Ostrava great possibilities can be seen for Czechoslovakian transit. One would hope that not only freight traffic can be redirected to take the most direct route between this industrial complex and the maritime port but, also, differential rates between railroads

¹³Based on the author's interview with the officials of Żegluga na Odrze, Wrocław, July, 1968.

and inland water carriers for bulk commodity will be a proper cost incentive leading to the greater utilization of the latter.

In many instances the reluctance on the part of the shippers to use the services of the water carriers is directly related to the physical and technological conditions of the inland waterways. Therefore, if these structural obstacles in the routeway can be eliminated by technological improvements, then at least this mode of transportation, where ever it is accessible, can become more competitive, if not exclusively exercising an absolute advantage in the movement of bulk commodity.

In the case of Poland's imports and exports, it is interesting to note in Table 21 that imports from West Germany via inland waterways rose considerably from 21.5 percent of the total Polish imports in 1966, to 50.2 percent in 1968. At the same time, one can see that Holland and West Germany are the major receivers of Polish goods exported via inland waterways. Here one can suggest some degree of complementarity between these respective countries which always preempts the conditions for trade.

Examination of the qualitative demands show that, as in the case of domestic traffic, in international movements the Oder River is a carrier of bulk commodities and the range of the type of commodities approximates that of the domestic movement. In this respect there is a great

TABLE 21
RELATIVE IMPORTANCE OF NATIONS PARTICIPATING
IN FOREIGN TRADE WITH POLAND VIA
INLAND WATERWAYS

Country	Import to Poland					
	1966	%	1967	%	1968	%
(in tons)						
Total	50,063	100.0	67,107	100.0	79,819	100.0
Belgium	3,995	8.0	•	•	1,750	2.2
Holland	17,179	34.3	16,786	24.9	18,519	23.2
East Germany	21,107	42.2	20,992	31.3	19,515	24.4
West Germany	10,782	21.5	29,331	43.8	40,030	50.2
(in thousand ton-kilometers)						
Total	49,923	100.0	64,513	100.0	78,094	100.0
Belgium	5,559	11.1	•	•	2,182	2.8
Holland	18,472	37.0	20,797	32.2	22,816	29.2
East Germany	15,916	31.9	15,963	24.7	14,259	18.3
West Germany	9,976	20.0	27,753	43.0	38,836	49.7

Source: Główny Urząd Statystyczny, Statystyka Żeglugi Śródlądowej (Warsaw: 1969), Table 10, p. 7.

TABLE 21--Continued

Export from Poland					
1966	%	1967	%	1968	%
(in tons)					
107,252	100.0	124,522	100.0	141,170	100.0
7,751	7.2	9,565	7.7	21,531	15.3
21,410	20.0	30,061	24.1	35,138	24.9
22,030	20.5	22,041	17.7	20,760	14.7
24,325	22.7	37,759	30.3	28,896	20.5
(in thousand ton-kilometers)					
94,830	100.0	118,837	100.0	134,990	100.0
11,733	12.4	13,816	11.6	30,274	22.6
25,703	27.1	37,197	31.3	41,967	31.3
16,131	17.0	16,396	13.8	15,980	11.9
25,934	27.3	38,426	32.3	29,789	22.2

deal of parallelism between domestic and international movement. The major difference in these two movements, as one can see in Table 22, was the complete lack of a concentration of large tonnages in a few commodities in 1968. Instead, one sees a more or less even distribution of total tonnage among the twelve commodities listed. In comparing the year 1966 with that of 1968, it can be seen that in 1966 coal was the primary commodity carried by the inland waterways, 37.1 percent of the total international tonnage. In 1968, however, shipments were more diversified and the share that coal occupied in the international movement dropped significantly to 16.9 percent of the total tonnage. In domestic traffic, as has been noted, sand and gravel held second position in tonnages carried on the Oder River, however, in the international movement the table below shows that sand and gravel constituted only 3.5 percent of the total tonnage in 1968. As a result of the economic reforms in the 1960's, the greater emphasis on cost accounting and the encouraged competition between carriers in Poland makes long hauls, of a commodity whose value per weight is relatively low, economically prohibitive. Therefore, it is not surprising to find that, as in the case of domestic movement, the international movement of sand and gravel over a long distance does not take place. One other distinctive dissimilarity between the domestic and international movement via inland waterways is that the

TABLE 22
INTERNATIONAL MOVEMENT BY TYPE OF COMMODITY
FOR SELECTED YEARS (EXPORT-IMPORT)

Commodity	In Tons		
	1966	1967	1968
Total	157,315	191,631	220,989
Coal	58,450	50,188	35,330
Ores	. .	8,508	17,456
Stone	20,662	13,891	29,235
Sand and Gravel	11,563	8,425	7,754
Metals and Metal Products	7,838	37,333	23,734
Cement	1,197	16,356	27,192
Fertilizer	22,500	20,992	27,884
Misc. Chemicals	1,474	813	2,577
Grain	15,471	. .	5,163
Misc. Agricultural Products	7,947	11,530	13,065
Wood and Wood Products	5,334	14,893	18,245
Other Commodities	4,879	8,702	13,354

Source: Główny Urząd Statystyczny, Statystyka Żeglugi Śródlądowej (Warsaw: 1969), Table 11, p. 7.

TABLE 22--Continued

In Thousand Ton-Kilometers			Average Distance		
1966	1967	1968	1966	1967	1968
144,753	183,350	212,084	920	957	960
44,731	37,390	24,856	765	745	704
. .	8,665	21,423	. .	1018	1227
25,669	16,651	26,616	1242	1199	910
4,843	3,556	4,513	419	422	582
8,030	36,406	22,537	1025	975	950
1,838	21,461	30,537	1535	1312	1123
17,269	15,963	20,541	767	760	737
1,854	1,013	3,076	1258	1246	1194
21,062	. .	7,044	1361	. .	1364
7,973	14,305	14,462	1003	1241	1107
5,454	17,661	21,660	1022	1186	1187
6,030	10,279	14,819	1236	1181	1181

international movement is marked by much longer hauls for the individual type of commodity.

Functional Analysis of Movement

The analysis of intraregional and interregional freight movement on the Oder River reveals that a commodity will move through the inland water system from the point of origin to the point of destination in a somewhat specified and predictable direction and distance. This suggests, perhaps, that the Oder waterway can be divided, based on direction and distance of movement, into easily identifiable major functional sectors. However, as a result of the fundamental differences between domestic and international freight traffic, in the points of origin and destination and subsequent differences in the direction, distance, and the pattern of movement, the system through which the commodity moves must also be different.

In other words, these two systems could not possibly be identical, as each one has its distinctive focal points which are connected into a circulatory system by different sizes and types of links, thus creating its own distinctive pattern. This does not negate the fact, however, that one can find and expect to find a certain degree of similarity and overlap through common points within these two systems. Therefore, the functional sectors within the system which can be identified and delimited for

domestic traffic could have a certain degree of similarity, but will not coincide with those of the international sectors.

First, the author will examine the functional divisions of the Oder inland waterway system for domestic traffic. In such a division, one can recognize two major distinctive sectors. The first sector is Gliwice to Wrocław and the second one is Wrocław to Szczecin. In addition, the first sector can be further subdivided into functional subsectors. Consequently, one can obtain the following functional division of the Oder waterway which is illustrated in Figure 28.

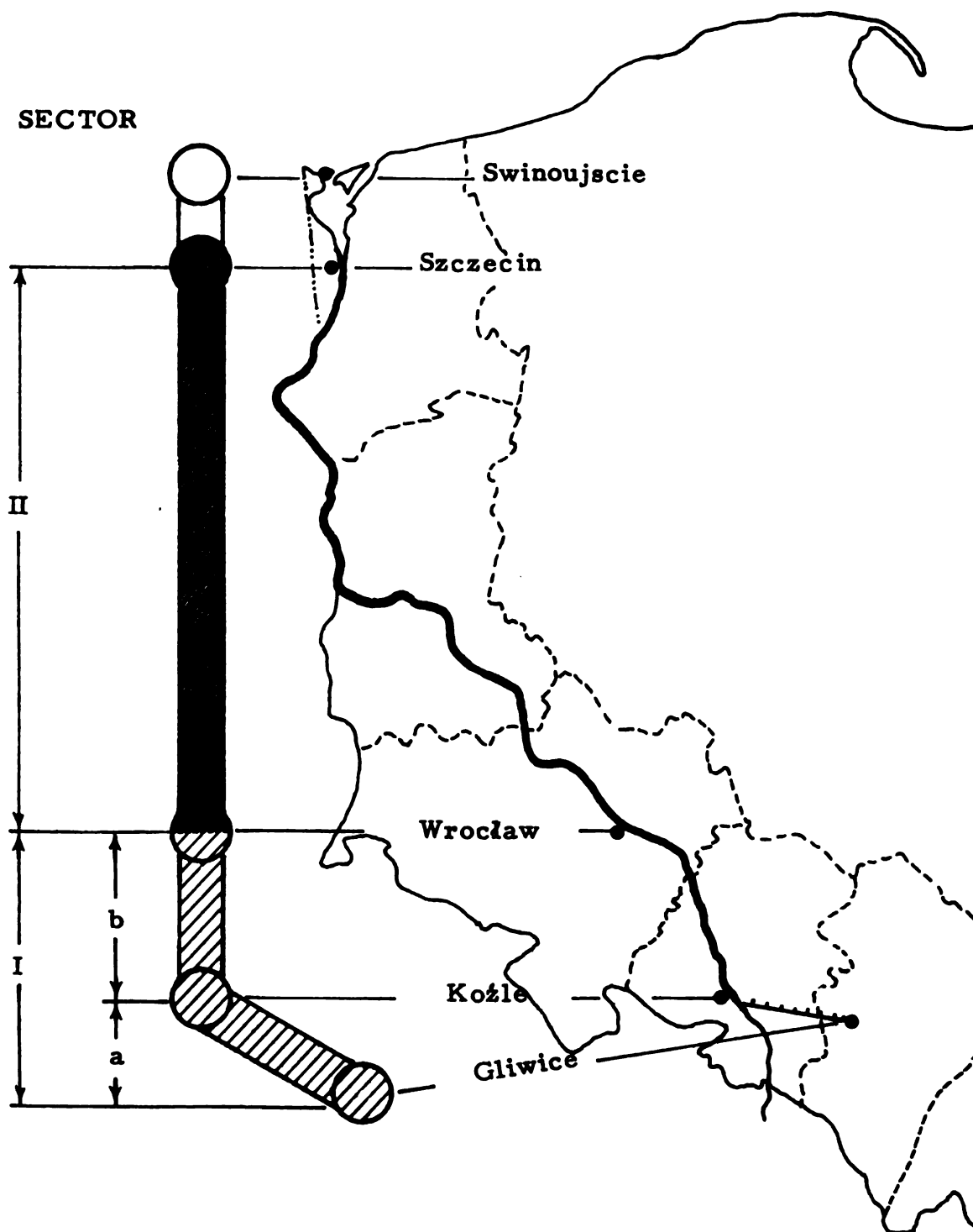
Sector I Gliwice-Wrocław
 a) Gliwice-Koźle
 b) Koźle-Wrocław

Sector II Wrocław-Szczecin

It is not surprising that these individual sectors, with their subsectors, converge on and at the same time are separated from each other by major river ports. In this case, the river ports not only serve as a nodal point where modes of transportation come together but also as separators of various movements.

The few available figures on intercity movement of commodity by the agency Żegluga na Odrze emphasize the importance of the great river ports such as Gliwice, Wrocław, and Szczecin. Each one of these major ports are the beginning and/or end of a functional link of the Oder's

FIG. 28: FUNCTIONAL DIVISION OF THE ODER WATERWAY
BASED ON DOMESTIC TRAFFIC MOVEMENT



inland water system. Each one of these sectors of the Oder's waterway system, identified above, has its own distinctive characteristics and idiosyncrasies relating to volume of traffic, diversity in commodity, and direction of movement.

The first sector, Gliwice-Wrocław, has high densities as its regions, wojewodztwa Katowice, Opole, and Wrocław, generate large volumes of traffic. Large volumes but a small number of commodities, such as raw materials and finished manufactured goods, are moved between the end terminals of this sector. This sector is further divided by the port of Koźle, whose primary function is a point of transshipment from barge to railroad and vice versa, into two subsectors each with its own distinctive characteristics. The smaller ports within the Gliwice-Wrocław sector such as Opole and Oława play only secondary roles.

The second sector, Wrocław-Szczecin, is significantly longer and more diversified. It performs an explicitly throughway function. Along the way, from Wrocław to Szczecin, there are no major ports of transshipment. From the point of strictly national traffic, this sector actually ends at the port of Szczecin. To Swinoujście, 60 kilometers north of Szczecin on the island of Uznam, the only movement consists of that portion of coal which is consigned for export to Sweden. There it is transloaded into deep draft bottoms for the further journey

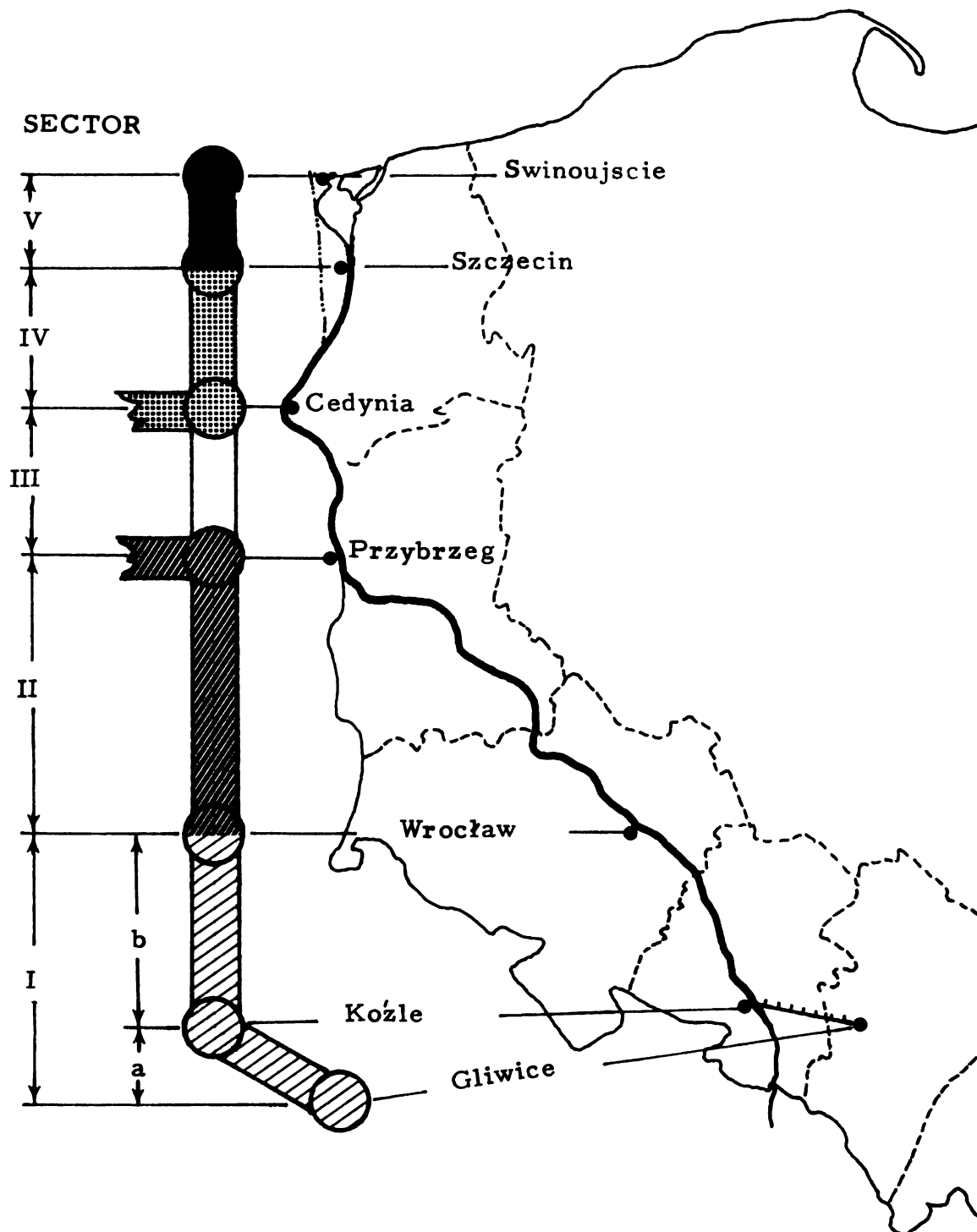
via the Baltic Sea. Therefore, the segment, Szczecin to Swinoujscie, cannot be included within the domestic transportation system. The wojewodztwo Szczecin receives large volumes of commodities from Upper and Lower Silesia, not only for eventual export to foreign markets, but also for consumption and processing of raw materials in the local iron and steel, chemical, and energy generating industries which cluster around the city of Szczecin.

In analyzing the directional movement of international shipments, the division of the Oder waterway into functional segments appears to be entirely different from that of domestic traffic. As is shown in Figure 29, one may distinguish five sectors:

- Sector I Gliwice-Wrocław
 - a) Gliwice-Koźle
 - b) Koźle-Wrocław
- Sector II Wrocław-Przybrzeg
- Sector III Przybrzeg-Cedyna
- Sector IV Cedynia-Szczecin
- Sector V Szczecin-Swinoujscie.

This diverse division of the Oder waterway is a result of differences in the characteristics of foreign movement in the flow of commodity. The important fact, in this functional division of the Oder waterway, is the directional flow of goods between the points of origin and the destination. It should be pointed out that the movement of commodity on the Oder itself, in the case of international

FIG.29: FUNCTIONAL DIVISION OF THE ODER WATERWAY
BASED ON INTERNATIONAL TRAFFIC MOVEMENT



traffic, measured in time or actual kilometers in relation to the total journey, is relatively small. For example, on the journey from Wrocław to Amsterdam by inland waterways less than 3 percent of the total travel time is spent on the Oder.¹⁴ Thus the Oder in this movement becomes a relatively small segment within the broader circulatory system.

The importance of the direction of commodity flow, as a factor in the functional division of the Oder waterway, can be exemplified by citing two typical movements. For example, barges destined for West Berlin, Magdeburg, and the southern portion of West Germany will move by the Oder to Przybrzeg where they will enter the Oder-Spree Canal and proceed to their final destination through the inland waterway system of East and West Germany. However, barges consigned for Hamburg, Holland, and Belgium will move by the Oder to Cedynia where they will enter the Oder-Howel Canal. Thus, as a result of this directional movement of the commodity in international trade, one can obtain two functional segments of the middle Oder, Wrocław to Przybrzeg and Przybrzeg to Cedynia.

Because Wrocław and Gliwice are the most important transshipment ports for both domestic and international traffic on the Oder waterway, the portion of the waterway

¹⁴Lucjan Hofman, Ekonomika Branżowa Jako Nauka (Sopot: Wyższa Szkoła Ekonomiczna 1962), p. 124.

which connects these two ports must be considered, in both cases, as a functional sector. These ports are either points of origin of goods destined for export, such as coal from Upper Silesia loaded at Gliwice, or points of destination for imports from Western Europe. The ports of Gliwice and Wrocław are the focal points for both domestic and foreign traffic. Here the two systems come together and overlap on common points. So far the three functional segments on the Oder were obtained as a result of the peculiarities of the outward movement of Poland's exports.

The fourth segment, Cedynia-Szczecin, is a result of the return flow of a single commodity. Hardwood imported from Holland moves through a system of mid-western canals and enters the Oder River at Cedynia and proceeds north to the woodworking plants at Szczecin. This segment, in comparison to the other three, has the least traffic density because, aside from hardwood, little or no other imports or exports are moved through this sector. The last segment, the smallest of all, Szczecin to Swinoujście, as has been already discussed results from the movement of Silesian coal for export to Sweden.

The analysis of domestic and international traffic and their respective functional divisions into segments suggest that both divisions should be compared. The question asked here is: What are the similarities and differences between these two divisions? In the course of the

examination of similarities and differences between national and international movement, particularly in view of the lack of statistical data which would permit a more quantitative analysis, one is forced to make only a few superficial generalizations. Whatever are the shortcomings of these generalizations, they should still shed some light on the idiosyncrasies of both types of movements.

In the sector Gliwice to Wrocław, a sector of high traffic densities, there is a great deal of similarity between domestic and international movement. As one can see, the sector Gliwice to Wrocław continues to be subdivided into two functional subsectors. Beyond this portion of the waterway, the similarities between national and international traffic cease to exist. The second major sector, Wrocław to Szczecin, which appears as a throughway segment in the interregional domestic movement of commodity, does not exist in the case of international movement. Instead, this portion of the waterway from Wrocław to Szczecin is divided into three equal sectors with their own characteristics and idiosyncrasies. The last sector of the Oder, Szczecin to Swinoujscie which continues to play only a secondary role in the international movement, does not appear at all in the domestic division.

In summary, one can say that as it appears from this functional analysis of both domestic and international movement, the Oder River is not a transportation artery of

uniform traffic densities and the intensity and direction of movement differs from the domestic to that of the international. In comparing the physical division of the Oder waterway with the functional, it can be said that there is a surprisingly degree of similarity. For example, the sector Gliwice to Kozle appears in both divisions. Moving further down the river we have the channelized sector of the Oder from Kozle to Brzeg Dolny, this sector is somewhat longer than the functional sector, extending beyond the city of Wrocław.

At the city of Wrocław, the similarities between the physical and functional divisions end. The segment of river from Brzeg-Dolny to Szczecin, the freely flowing Oder, has the least suitable navigational conditions, but nevertheless from the city of Wrocław one can distinguish three functional sectors.

It is possible from the discussion of the above similarities and differences between the physical and functional division of the Oder River to derive two conclusions. One may say, first, that the movement of commodities on the Oder waterway does not in great measure, at least at this point, depend on the navigational conditions of the routeway. Secondly, the sectors with better technical conditions in the navigable channel and port facilities are not fully utilized to their capacity, to underline relative differences in the Oder waterway stressing

physical limitations of the least developed portions of the routeway. Because total tonnages, at the present time, are relatively small on the Oder and there are not any significant differences in the intensity of traffic volume on the individual sectors, the author suspects that both generalizations are valid. However, with a rise in the volume of traffic on the Oder in the near future, one can expect that the physical differences of the waterway will be accentuated and intensity of movement will tend to reflect these physical limitations.

CHAPTER VI

THE ODER RIVER AND ECONOMIC DEVELOPMENT WITHIN THE FIVE REGIONS

The function of a transportation mode is to provide time and place utility. In technologically advanced societies, regardless of their political and economic systems, in order to utilize the economic resources to their greatest advantage in the production of goods and services, the basic question faced by transportation agencies is invariably: How much transportation service does each sector of the economy need? Thus it is not surprising to note that even in a planned socialist economy such as Poland, during a period of economic growth the question of increments in the demand for and the supply of transportation services assumed critical importance. Therefore, the logical answer to the above-stated question in the planned economy may, just as in the free economy, have to be based on past, present and anticipated relationships between, and activity within the regions in each sector of the economy on the one hand, and transportation output measures on the other. Among the problems facing transportation geographers in Poland, some have particular significance since they are

connected with the specific conditions of economic development.

In this chapter, the author will first examine whether such relationships between the industrial sectors of the Polish economy in the five wojewodztwa which are contiguous to the Oder River, and the volume of freight traffic on the river actually exists. For that reason, if one in evaluating various demands for transportation on the Oder would compare rates of growth in the value of production, within the five regions, with rates of growth in freight traffic on the river, the relationship between the two aggregates can be established.

The material to be set forth below, while it would be quite inadequate for a thorough analysis of detailed relationships, should nevertheless, reveal overall parallelism in growth trends for the two aggregates. If there are, as one would expect, stable relationships between the physical volume of freight traffic on the Oder, then it would be desirable to undertake a more detailed analysis. Secondly, the author will examine whether a transport-output correlative relationship exists for individual type commodities, such as coal, iron ore, fertilizers, and agricultural products. This analysis is undertaken because the author speculates that if one is able to establish the growth of the individual commodity and its demand for land and water transportation, then this would be a useful

instrument in the planning and future development of the navigation on the Oder.

Method of Analysis

At first glance the growth of traffic on the Oder and industrial output in Poland shows a great deal of parallelism. If one assumes that the foremost objective of any statistical investigation, in geography or any other discipline, is to forecast one variable in terms of another, then it would be highly desirable to estimate a formal relationship between waterborne traffic on the Oder and the rate of industrialization.

First, for the purpose of this study, a simple regression analysis is used to determine the "best" fit for a given functional relationship. With the help of the method of least squares, the author will strive in this chapter to explain variation in the dependent variable, which is the freight traffic on the Oder, by variations in the independent variable, industrial output. Therefore, if the two variables, y (freight traffic on the Oder) and x (industrial output) are linearly related, the equation expressing this relationship will be of the following form:

$$y = B_0 + B_1x.$$

B_1 is the parameter expressing the slope of the line and B_0 is the parameter which tells at what value the straight line cuts the axis of the y . The slope B_1 tells by how much y increases for an increase of unity of

the value of x . Before one can employ the method of least squares, however, there are two assumptions that must be made. First, one must assume that the independent variable, industrial output, is measured without an error. Second, one must assume that for a given x (industrial output) there exists a normal and independent distribution of y (freight traffic on the Oder) values with mean, $B_0 + B_1x = \mu_{y/x}$ and variance σ_E^2 . As we previously assumed that the demand for transportation is a derived demand, which stems from geographically removed places of production and consumption. An additional factor is that the variances for each distribution associated with each x value must be assumed equal. The least square estimators of B_0 and B_1 are:

$$\hat{B}_0 = \bar{Y} - \bar{X}b$$

$$\hat{B}_1 = \frac{\sum_{i=1}^n (X_i - \bar{X})(Y_i - \bar{Y})}{\sum_{i=1}^n (X_i - \bar{X})^2}$$

These estimators will give a fit leveling to a minimum unexplained variance. Success in fitting will be measured in terms of the coefficient of determination, r^2 .

$$r^2 = \frac{\text{Explained Variance}}{\text{Total Variance}} \times 100 \text{ percent, } 100 \text{ percent being a}$$

perfect fit and zero percent indicating that the fit of the regression line is so poor that the knowledge of x will in no way aid in the forecasting of y .

Secondly, the author employs a coefficient of partial correlation which can be expressed in the following formula:

$$r_{12.3} = \frac{r_{12} - r_{13}r_{23}}{\sqrt{(1 - r_{13}^2)(1 - r_{23}^2)}}$$

which measures the correlation between x_1 and y independently of x_2 .

The subscripts refer to the three variables, x_1 (output), y (traffic), and x_2 (industrial index). This means that one can keep one variable constant, for example x_2 and find the coefficient of partial correlation between x_1 and y . This was introduced for the express purpose of differentiating between correlation of two variables as separate entities and two variables with an interdependence on the third variable which one chose to hold constant.

Relation Among Aggregates

In this section an examination will be made of the relationship between aggregate freight traffic on all Polish rivers and on the Oder and the total industrial output. The degree of parallelism in the trends of growth of the total freight traffic on the Oder and the total industrial output is brought out here through the use of a linear equation. As a measure of total industrial output,

the author calculated the index of the Gross National Product which can be considered the only available indicator of the growth of Polish industrial output. The total ton-kilometers of freight traffic on all Polish rivers and freight traffic on the Oder and their total growth is shown in Table 23.

A regression analysis between these two aggregates, the index of industrial output and freight traffic on the Oder, was run on a 360 IBM computer and the results with their co-variations are very significant. As one can see in Figure 30, straight lines have been separately fitted and inserted on the chart for the two periods, 1946 to 1959 and 1960 to 1968. It can be seen that not all observations lie close to the two straight lines.

The least squares line fitted to observations for 1946 to 1959 has the equation $Y = 66.66 + .87 X$ where x is industrial output and y is freight traffic. The average absolute percentage deviation of actual from predicted values over these fourteen years is 4.2 percent. The record for the later period, after the reconstruction and the improvements in the physical facilities on the Oder is significantly better. The equation $Y = 790.81 + 1.56 X$ fits the observations from 1960 through 1968 with an average absolute percentage deviation of 2.3 percent.

The findings below indicate that the relationship between industrial production and aggregate freight traffic

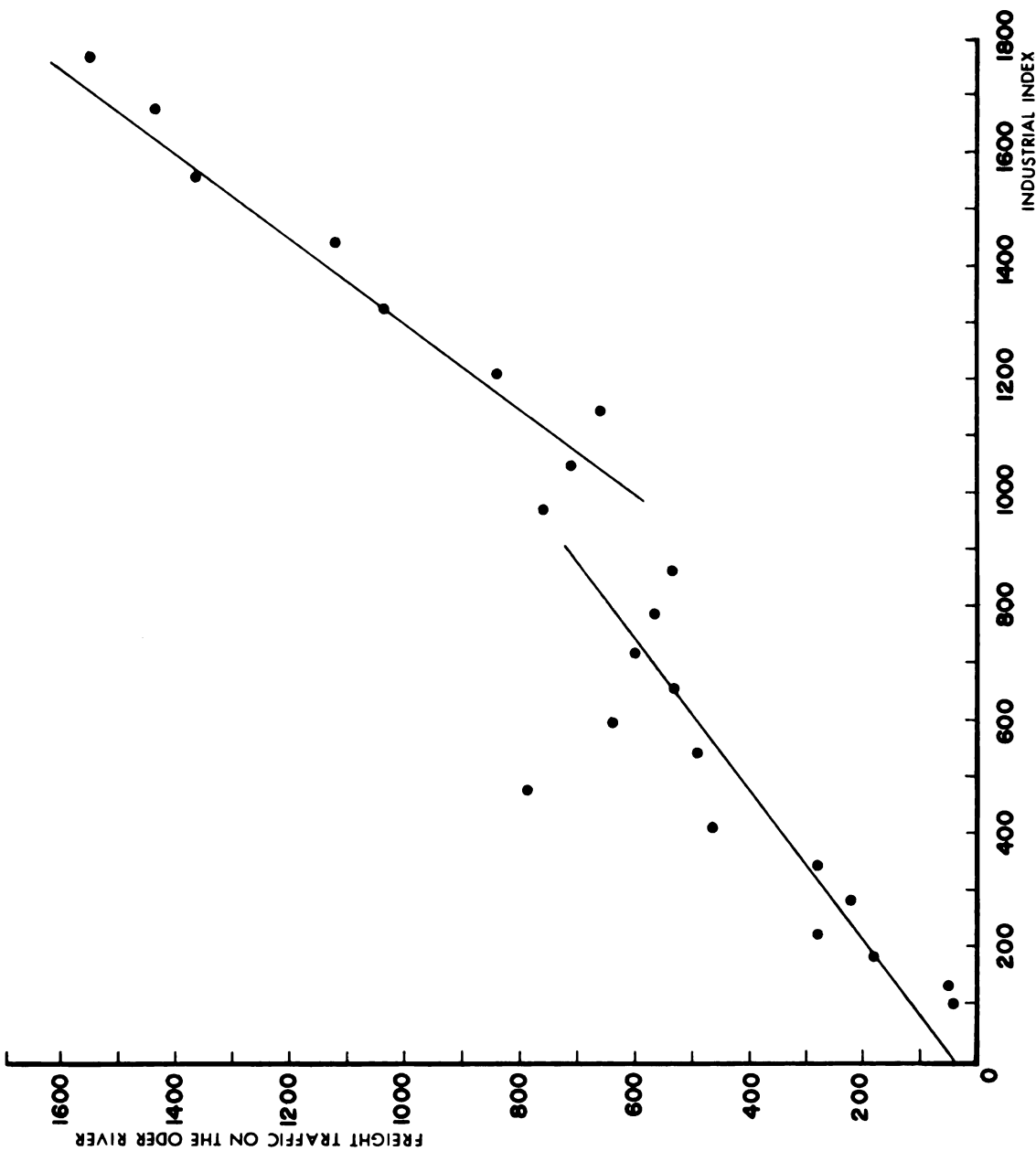
TABLE 23
INDEX OF GROSS NATIONAL PRODUCT AND GROWTH
OF INLAND WATER TRAFFIC IN POLAND
AND THE ODER RIVER

Year	Rise of Poland's Gross National Product	Growth of Inland Waterway Traffic on All Polish Rivers in Million Ton-Km.	Growth of Traffic on the Oder in Thousand Ton-Km.
1946	100.0 Index	53.5	44,405
1947	133.3	69.7	59,245
1948	182.6	227.2	193,120
1949	222.3	334.4	284,240
1950	284.0	264.5	222,180
1951	346.7	340.6	286,104
1952	412.2	559.1	464,053
1953	484.2	597.1	793,910
1954	539.3	576.9	490,365
1955	600.9	775.0	643,250
1956	655.0	628.2	533,970
1957	719.9	708.1	601,885
1958	790.8	695.7	570,474
1959	863.5	639.4	530,702
1960	959.0	904.3	759,612
1961	1047.8	855.3	709,899
1962	1147.9	821.7	657,360
1963	1210.3	1025.8	841,156
1964	1323.4	1247.7	1,035,591
1965	1442.3	1409.3	1,121,187
1966	1562.6	1761.7	1,367,082
1967	1685.4	1881.4	1,432,535
1968	1786.5	1979.7	1,549,326

GROSS NATIONAL PRODUCT calculated as a sum of the following elements:

- a) sale value of industrial goods and services
- b) value of finished product, semi-finished, and unfinished production plus the value of means of production
- c) value of consumed resources.

FIG. 30: CORRELATIVE RELATIONSHIP BETWEEN FREIGHT TRAFFIC ON THE ODER RIVER AND INDUSTRIAL OUTPUT



on the Oder River, particularly in the 1959 to 1968 period, is a close one indeed; the value of r is .7728. It is not surprising, however, that large economic aggregates are at least casually connected through time and technology because these massive composites are but two facets of a single industrial process. Even if the success would have been limited, the experiment above suggests that one has here a useful instrument for projecting into the near future, at least, observed relationships in the past.

Correlative Relationships for Individual Commodity

The preceding examination of the aggregate freight traffic and total industrial output gives ground for hope that significant transport-output relationships will be found for individual commodity groups. As raw materials for these comparisons one needs annual output figures for representative elements in as many commodity groups as possible with the freight traffic records on the Oder. Table 24 presents annual data for the years 1957 through 1968, covering the physical output of coal, iron ore, fertilizer, and agricultural products. Table 25 presents freight traffic records on the Oder for these commodities. These four commodities were chosen by the author because in total they represent 90 percent of all the traffic moved by the agency Zegluga na Odrze. Examination of the correlative relationship between physical output and the freight

Year

1957

1958

1959

1960

1961

1962

1963

1964

1965

1966

1967

1968

Sources:

TABLE 24
 OUTPUT OF COAL, IRON ORE, FERTILIZER, AND
 AGRICULTURAL PRODUCTS 1957-1968
 (IN THOUSAND TONS)

Year	Coal	Iron Ore	Fertilizer	Agricultural Products
1957	94,096	1,785	2,081	44,582
1958	94,981	1,962	2,186	49,675
1959	99,106	2,014	2,285	54,347
1960	104,438	2,182	2,604	62,926
1961	106,606	2,386	2,888	72,763
1962	109,604	2,436	3,281	61,817
1963	113,150	2,609	3,402	70,589
1964	117,354	2,680	3,933	74,423
1965	118,831	2,861	4,329	71,917
1966	122,000	3,053	4,619	75,687
1967	124,000	3,077	5,209	80,600
1968	127,720	3,139	5,834	85,436

Sources: Główny Urząd Statystyczny, Rocznik Statystyczny Przemysłu 1945-1965 (Warsaw, 1967), Table 29, pp. 188-189; Główny Urząd Statystyczny, Rocznik Statystyczny Przemysłu 1967 (Warsaw, 1968), Table 29, pp. 201-202; data for 1968 from the office of Główny Urząd Statystyczny, Warsaw.

INLAND WATER

Year

1957

1958

1959

1960

1961

1962

1963

1964

1965

1966

1967

1968

Sources:

TABLE 25

INLAND WATER FREIGHT TRAFFIC BY MAJOR COMMODITY 1957-1968
(IN THOUSAND OF METRIC TON-KILOMETERS)

Year	Coal	Iron Ore	Fertilizer	Agricultural Products
1957	351,580	146,250	76,515	59,235
1958	289,667	166,028	76,166	65,170
1959	241,212	130,734	62,176	62,450
1960	299,243	192,903	102,093	89,181
1961	256,033	189,596	76,461	92,234
1962	234,653	166,732	103,148	81,620
1963	343,932	225,737	127,208	80,227
1964	402,043	356,551	151,218	74,871
1965	454,370	376,170	176,336	129,356
1966	621,208	479,350	188,345	112,160
1967	727,272	475,528	176,318	82,872
1968	836,362	496,653	194,815	149,243

Sources: Główny Urząd Statystyczny, Rocznik Statystyczny Transportu 1945-1966 (Warsaw: 1967), Table 5, pp. 496-497; data for 1967 and 1968 received from the office of Żegluga na Odrze, Wrocław.

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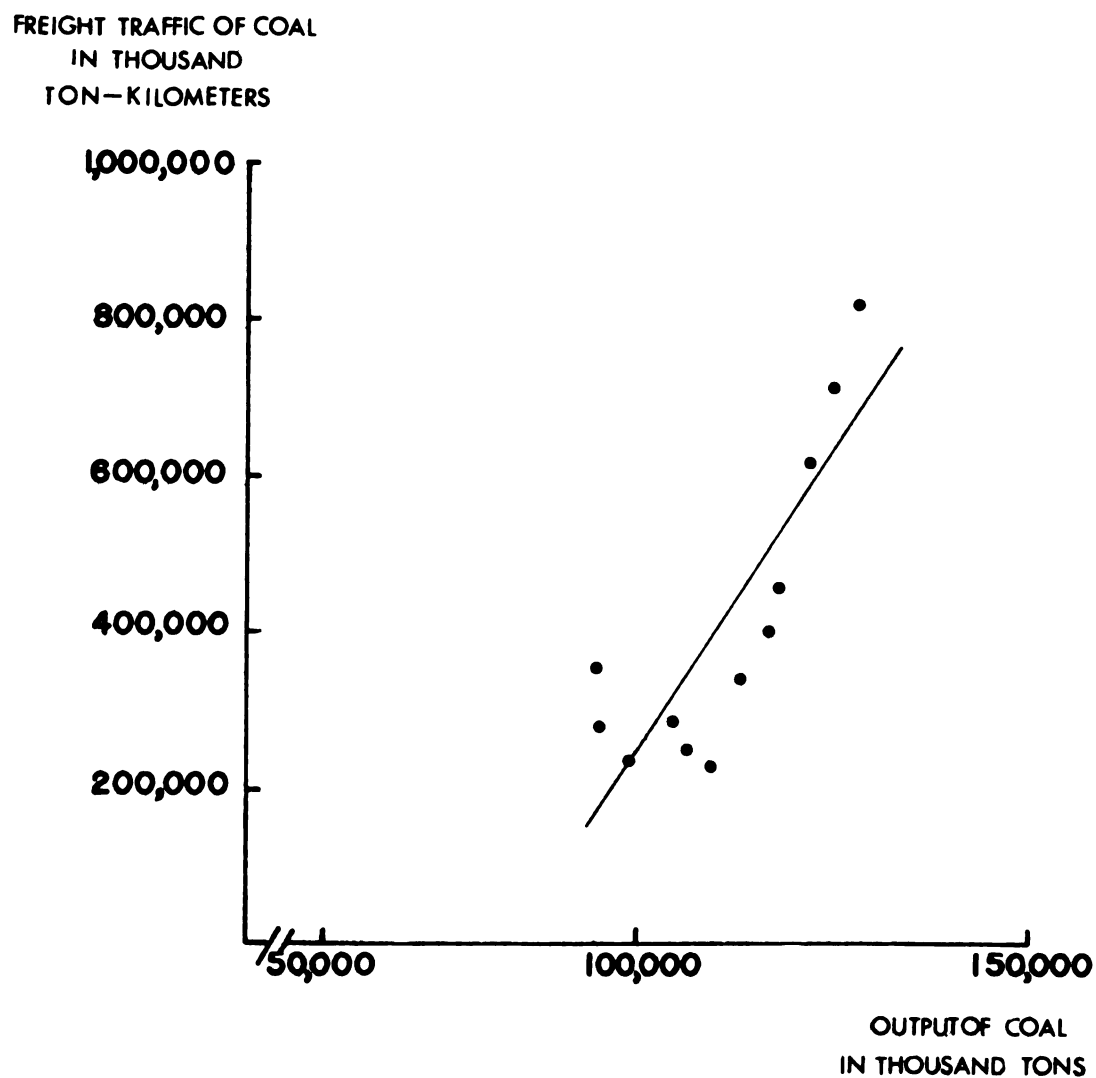
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traffic can be indicated by running a simple regression analysis between production and the volume of traffic carried by Zegluga na Odrze for each of the four chosen commodities.

The author begins by examining the relationship between coal production within the five regions under investigation and the volume of coal traffic on the Oder. In this case, the output of coal is referred to as the independent variable (x) where the ton-kilometers of coal moved is regarded as the dependent variable (y). This decision was made on the basis of preconceived reasoning that the demand for transportation is a derived demand. The production of coal being located in relatively few areas and the demand for coal being distributed throughout a wide geographic area causes this commodity to move from points of production to points of consumption. Thus the freight traffic of coal arises from the want of coal by the industry or the consumer. The method of least squares gave r^2 equal to 0.6506, meaning that 65.06 percent of the variations in the coal traffic carried by the agency on the Oder is due to the variation in the output of coal in the five regions.

Figure 31 shows that the line of least squares is equal to $Y = -1161153.66 + 14.26 X$, showing a relatively good fit, with r^2 equal to 65.06 percent. This suggests that a firm relationship has existed between the output and

FIG. 31: CORRELATIVE RELATIONSHIP BETWEEN OUTPUT OF COAL AND FREIGHT TRAFFIC OF COAL



Note: Due to technical difficulties in the construction of the graph negative values are not shown.

traffic expressed in ton-kilometers over the period from 1957 through 1968. Hence, one gains considerable respect for the stability embedded in Polish industrial geography in view of the tumultuous changes in Polish industry in the Post-World War II period.

Close inspection of the scatter diagram, however, suggests that there may have been a slight change in the coal traffic output relationship over this period. The 1957 and 1958 increments in coal output were associated with somewhat higher increments in coal ton-kilometers than was true thereafter. The point representing the year 1962 lies appreciably below the predicted level, indicating that the output of coal was associated with lower increments in coal ton-kilometers. The observations after 1965 show that a stable relationship has been established but it lies at a higher level.

The largest absolute deviation between any one year's observation from the lines occurs in 1968, when the absolute actual coal traffic of 836,362 thousand ton-kilometers was 236,351 thousand ton-kilometers above the 660,011 thousand ton-kilometers indicated by the line. This is an error of 21.1 percent.

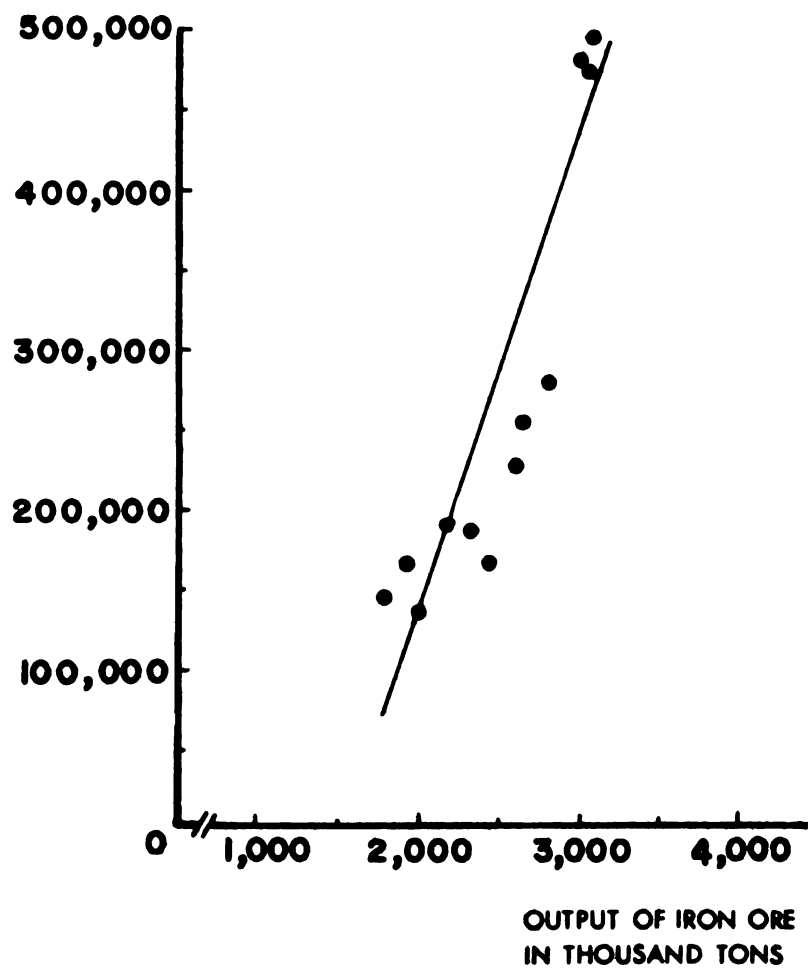
The steady increase in inland water coal movements, in recent years, is not particularly surprising. In view of the continuous economic reforms in Poland which include cost minimization and efficiency in transportation, coal

shippers apparently must think there are substantial economic benefits in transporting their products via the Oder River. But what is equally important is that the agency Zegluga na Odrze in recent years became capable of meeting its demands. This trend is reflected in Figure 31, which shows that starting with 1966 the ton-kilometers of coal moved are rising above the expected height.

The second commodity group under investigation in this study is that of iron ore. The method of least squares explained that 86 percent of the variation in iron ore freight traffic was attributed to the variation in iron ore production. The equation of the line fitted is $Y = -435056.41 + 285.68 X$. Figure 32 discloses a very interesting pattern of relationship between freight traffic and output in this category. For the early period, a curve concaved downward would seem to provide the best fit. The early parallel relationship between output and barge traffic shown in the figure reflects the gradual depletion of the domestic iron ore deposits in close proximity to the Oder River and the increasing dependency of the Polish iron and steel industry on fields not accessible by inland waterways and Soviet iron ore shipped by railroad from the Krivoy Rog and Kerch fields to Upper Silesia. A relatively small tonnage of high grade Swedish iron ore continues to move by barge up the river to the iron and steel complexes of Upper Silesia, however, its low tonnage is inadequate to

**FIG. 32: CORRELATIVE RELATIONSHIP BETWEEN OUTPUT OF
IRON ORE AND FREIGHT TRAFFIC OF IRON ORE**

**FREIGHT TRAFFIC OF IRON
ORE IN THOUSAND
TON-KILOMETERS**



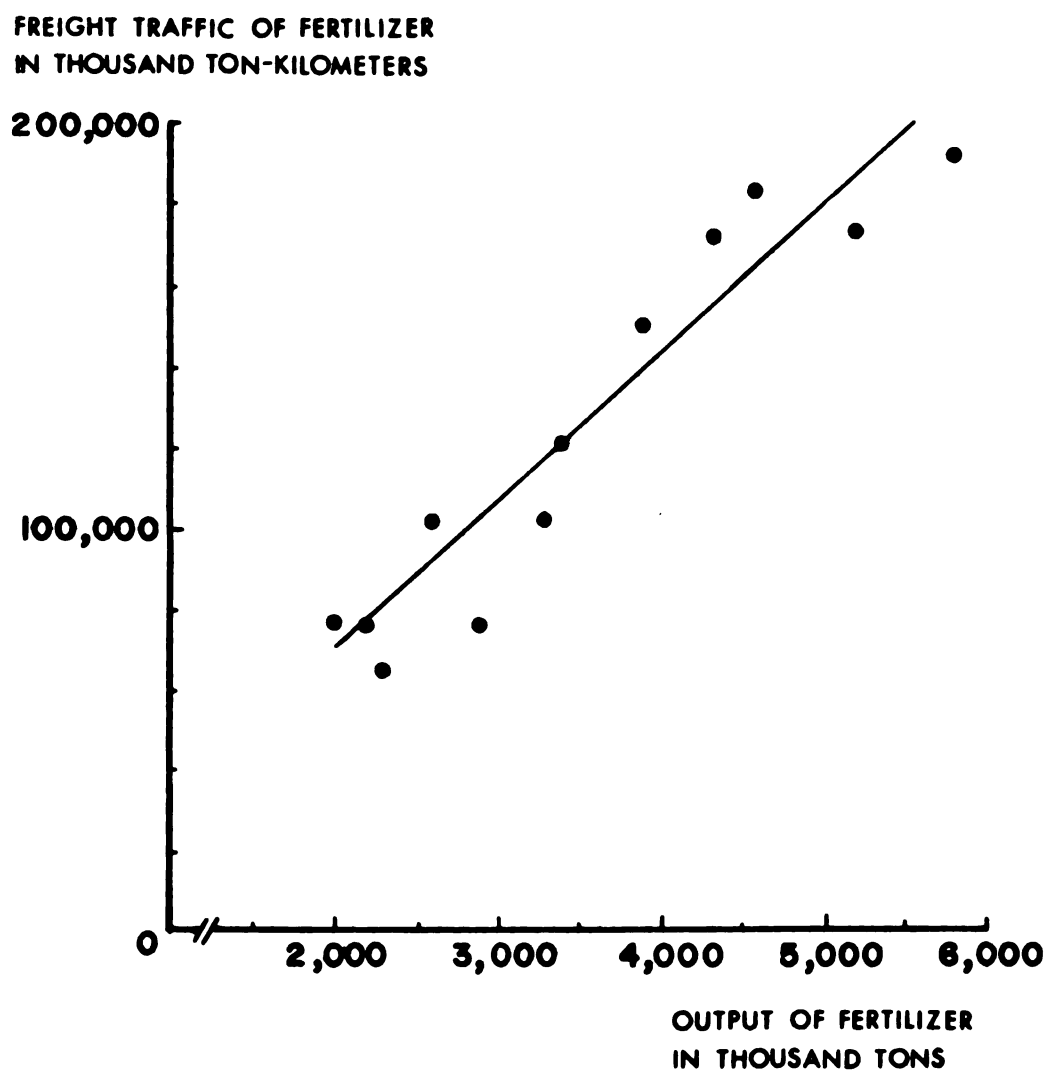
**Note: Due to technical difficulties in the construction of the graph
negative values are not shown.**

affect the output traffic relationship. The high traffic output in 1966, 1967, and 1968 is presumed to be in response to exploitation of newly discovered iron ore deposits in very close proximity to the Oder River in wojewodztwo Zielona Gora.

Turning now to the relationship between physical volume of fertilizer production within the five regions and inland water freight traffic carried by Żegluga na Odrze, Figure 33 presents a line of regression which is equal to $Y = -8390.76 + 37.78 X$. In this case the fit explained 89 percent of the variation in fertilizer traffic on the Oder by the variation in fertilizer production. The scatter diagram discloses a pattern significantly different than the one for coal and iron ore for the years 1957 through 1968.

With the location of a substantial number of chemical plants including fertilizer plants along the Oder River, the physical output and barge freight traffic subsequently underwent substantial alteration. The establishment of fertilizer plants in Kędzierzyn and Brzeg brought with it a noticeable increase in the volume of fertilizer carried by the Żegluga na Odrze. This relationship seems to have persisted until 1967 when the fertilizer output was associated with a slightly lower barge traffic than in the early 1960's. This decline in tonnage of fertilizer carried by Żegluga na Odrze can be explained perhaps in the

FIG. 33: CORRELATIVE RELATIONSHIP BETWEEN OUTPUT OF FERTILIZER AND FREIGHT TRAFFIC OF FERTILIZER

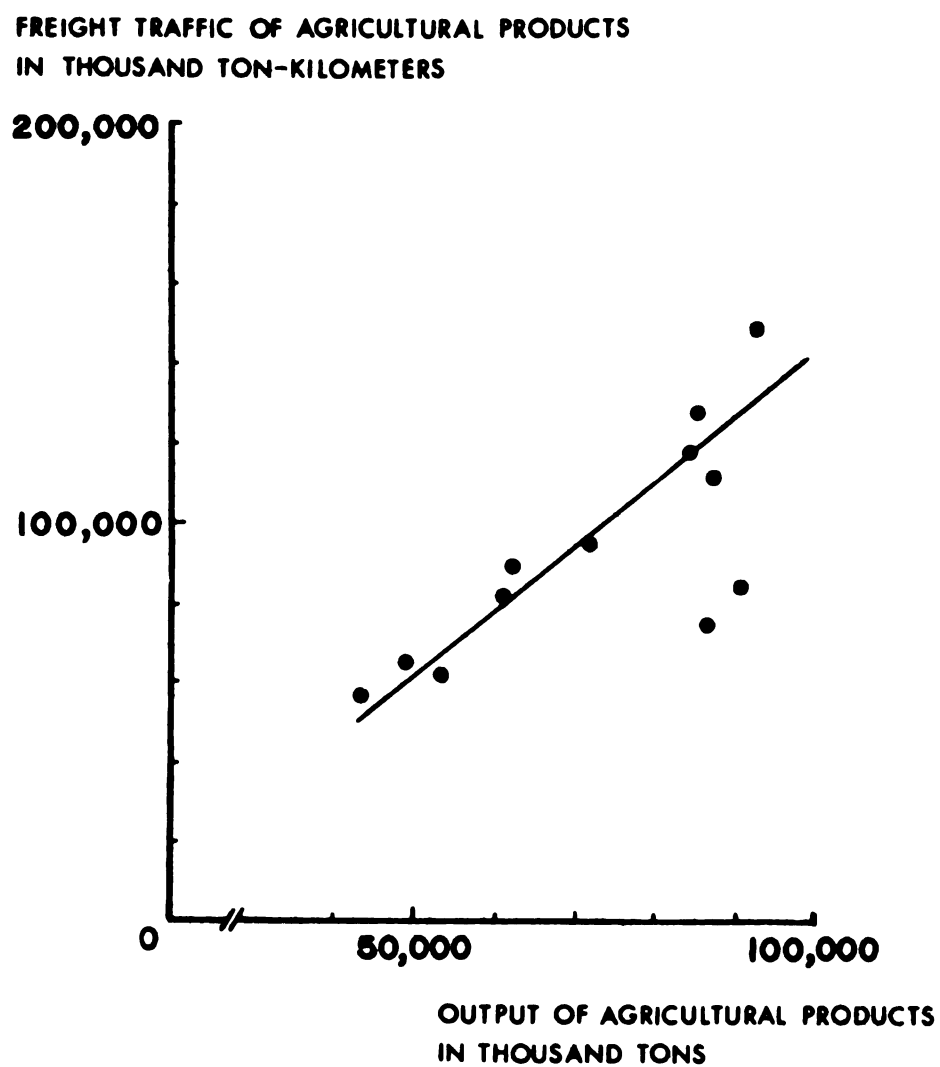


Note: Due to technical difficulties in the construction of the graph negative values are not shown.

marketing changes which necessitate different channels of distribution. The fertilizer produced along the Oder River in the late 1960's extends along a wider geographic market, not necessarily accessible by the inland waterways.

Still another pattern comes to light with an examination of the relationship between agricultural production and agricultural commodity movement on the Oder. In this case, the method of least squares shows a disappointingly poor fit of 52 percent. Figure 3⁴ shows the line of least squares to be $Y = -17069.15 + 1.59 X$. One notes here what is evidently a graphic indication of the fundamental changes in the late 1960's in the movement of agricultural products. Since the conclusion of World War II and until recently, Poland was a major exporter of grain and other agricultural products. The port of Szczecin attained a world reputation of being the grain port of Poland. Agricultural products from the fertile Oder valley and the eastern regions moved north and northwest by inland waterways to the port of Szczecin. The seasonal demand of agricultural products for transportation and the direction of movement made the inland water carriers a particularly attractive mode of transportation. In the late 1960's, however, directional changes in the movement of agricultural products occurred. Poland has ceased to be a major exporter of grain and is entering the world market with processed and manufactured goods while agricultural

FIG. 34: CORRELATIVE RELATIONSHIP BETWEEN OUTPUT OF AGRICULTURAL PRODUCTS AND FREIGHT TRAFFIC OF AGRICULTURAL PRODUCTS



Note: Due to technical difficulties in the construction of the graph negative values are not shown.

products are allocated for the domestic market to help feed the growing population. Agricultural products destined for the domestic market which necessitate constant break-in-bulk operations would obviously have entirely different channels of distribution.

The encouraging results of the above simple regression analysis urged the author into pursuing the task of establishing a further relationship between the rate of industrial growth within the five wojewodztwa, Katowice, Opole, Wrocław, Zielona Góra, and Szczecin, and the rate of growth of demand for inland water transportation on the Oder. In spite of these findings, the question can be asked: Can the two variables, for example, the production of coal and the freight traffic of coal, have a large degree of fit and actually be related through time without being linearly related? To eliminate this doubt, the author employs a multiple regression analysis in which, aside from the two previously used variables in the simple regression analysis, the physical output of the four commodities and their freight traffic records, a third variable is introduced, the industrial index of the Gross National Product. Multiple regression analysis was used in this case, both to predict output by using freight traffic records and using the output to predict ton-kilometers. Finally, the residuals from the simple regression analysis were used in the second order of partial correlation coefficient ($r_{12.3}$)



which measures the correlation between the output of each commodity and the freight traffic independently from the industrial index of the Gross National Product. The coefficient of correlation (r) for these set of values is equal to 0.99. The above significant findings are summarized in the table below.

TABLE 26
DEGREE OF FIT (r^2) IN VARIOUS METHODS
OF LINEAR REGRESSION

	Coal	Iron Ore	Fertil- izer	Agricul- tural Products	
Simple Correlation Coefficient	.94	.95	.95	.76	Using ton- km. to pre- dict output
Adjusted for Industrial Index of GNP	.99	.99	.99	.93	Using out- put to predict ton-km.
Partial Correlation Coefficient Adjusted for Eco- nomic Index	.80	.93	.95	.73	

Analysis of the Oder River and Economic
Development Through Time

Having found a formal relationship between the growth of industrial production and freight traffic, it would seem instructive to investigate through time the influence of the development of industry within the five regions and the role of the Oder River on this development. The question should be asked: How well did the Oder serve the regions in their development? This is an important question because a mode of transportation in a socialistic economy, like in a capitalistic economy, provides an essential service of accessibility by creating time and place utility. Accessibility, in turn, allows for the division of labor within the economy which is basic to a modern industrial economy. Therefore, the more sophisticated the transportation system within the economy, the greater the regional division of labor that can be achieved, allowing the regions to specialize in the production of goods and services in which they have competitive or absolute advantage.

In answering this particular question of how well did the Oder River, as an artery of transportation and its agency Żegluga na Odrze, serve the five regions, it would be useful to divide Polish experience in navigating this waterway into periods. The examination of the performance of the Oder River as an artery of transportation should be

within the political and economic setting of Post-World War II Poland.

The first period covers the years from 1946 through 1949 when the entire Polish economy underwent a drastic, fundamental structural reorganization. In the three year plan, the principle task was the reconstruction of the economy from the severe war damage, in addition to carrying out political, social, and economic revolutions. War destruction of the total assets of communication and transportation facilities within the five regions under investigation were estimated by planners to be as high as 54 percent and 93 percent, respectively.¹

The Oder waterway had been damaged during the war to the point that navigation on the river had been rendered impossible. About 1200 vessels, the remnants of the Oder fleet which had not been evacuated to the west by the retreating German Army, lay on the bottom of the river bed, in the ports, and winter harbors.² Moreover, 45 wrecked bridges, 25 lock weirs, and other shore installations laid in ruins, obstructing river traffic.³ The reservoirs at Turawa and Otmuchow needed major repairs. In addition,

¹Główny Urząd Planowania Przestrzennego, Atlas Ziem Odzyskanych (Warsaw: 1947), p. 22.

²Z. Dziwowski, "Odra w Gospodarce Ziem Odzyskanych," Życie Gospodarcze, No. 16a (1947), p. 8.

³Ibid.

there was heavy destruction in port buildings, loading facilities, and quays. For example, approximately 90 percent of the port facilities in Głogów, Malczyce, and Wrocław were devastated.

The maritime port of Szczecin, also the major terminal for the Oder waterway, suffered greater destruction than any other port in Europe due to the mass raids carried out by the Allied Air Force, retreating German Troops, and invading Soviet armies. Both Germans and Russians blew up many port facilities and also dismantled and carried away others. All factories, industrial establishments, warehouses, elevators, and railroad facilities in Szczecin were set on fire. Communications were totally paralyzed as all bridges were destroyed, the floating equipment was scuttled or taken away, port cranes were toppled into canals, and the port entrance was blocked by the ruins of docks and other equipment.

The enormity of the destruction in the transportation system of the five wojewodztwa Katowice, Opole, Wrocław, Zielona Góra, and Szczecin, was a major obstacle to the recovery of these regions. There is no need to speak here of the importance of the transportation system to the economy of the country as it is obvious. In the first period, when Poland took over this area under its administration, operation of an adequate transportation system was of the utmost importance. For example, in the

course of the campaign for populating this area by a Polish population, it became evident that the flow of settlers from the east followed the direction of the operating transportation lines. The areas with a transportation system rendered inadequate by the destruction were virtually unpopulated by Poles in the years immediately following the conclusion of the war. This same situation was applicable in the case of the Oder River. Transportation was of the utmost importance, not only to the Polish settlement of the area, but also to industry which was starting to operate in Upper and Lower Silesia. Before the war, local industry was heavily dependent on water carriers in procuring its raw materials and other resources necessary for production. In 1946 industry could not possibly utilize the Oder waterway for that purpose when the river and her fleet lay in ruins. Instead, industry had to depend on alternate routes and modes of transportation.

In order to render the Oder River as a useful routeway, it was necessary for the Polish government to allocate a considerable amount of capital in order that the newly created agencies Żegluga na Odrze and Żegluga Szczecińska, could once again resume navigation of that important waterway. However, the process of rapid industrialization on the Soviet model in the period immediately following World War II did not permit allocation of a large number of resources to the development of the Oder's

routeway and construction of the river fleet. Instead, the government rested its total hopes on the railroad's ability to meet both the qualitative and quantitative demands for movement. In this respect the Polish National Railroad (PKP) did its job well, in spite of the high cost per ton of commodity moved.

Reconstruction of the Oder waterway to the prewar level was thought by planners to be no longer sufficient to meet the anticipated demand for inland water transportation. The general view was that a waterway of prewar carrying capacity and technological status could no longer satisfy the needs of the most industrialized area incorporated into the economic system of Poland. The task of reconstructing and improving the Oder waterway was a difficult one for a country faced with the problems of adopting the transportation system of these regions to the new economic direction and forces and of merging it with the transportation system of the whole country. Due to the enormity of the problems which Poland's economy faced after the conclusion of the hostilities, the reconstruction and development of inland waterways could not be considered of primary importance. This policy pertained not only to the Oder River, but also extended to the whole nation's inland waterways. It was a simple question of priorities in allocating resources to the modes of transportation and, in this case, the railroad proved to be a more suitable and

the more flexible mode of transportation than inland waterways.

In the period between 1945 and 1952 the flow of capital and other economic resources into the development of navigation on the Oder had been held down to a fraction of the prewar period. Judging by the performance of the inland water carriers on the Oder, it appears that the flow of economic resources was not sufficient to enable this waterway and its carriers to meet the demands imposed by the heavy and related industries in the five wojewodztwa. As a result, a transportation crisis on the Oder waterway developed by 1952 which persisted through 1959. The transportation crisis on the Oder waterway extended to the point that the water carriers in Poland were considered, by the shippers, only capable of moving sand and gravel at a short distance. Thus, until full reconstruction of the Oder waterway took place and a new efficient river fleet was built, the Oder River contributed little or not at all to the economic development of the five regions.

In the period prior to 1959, slow but systematic reconstruction of the Oder waterway took place with a minimum use for the purpose of navigation. First of all, the most dangerous damage to the water reservoirs and the embankments had to be removed as the Oder and the water in the reservoirs was in danger of breaking through and inundating the land. The river was cleared of the debris

of boats and bridges so that by 1946 some inland water traffic could move without major difficulties on the Oder proper and the Gliwice Canal. It was also necessary to channelize and regulate the river, since the Germans had not completed this task, and to construct shore installations and a fleet almost from scratch, for these were almost completely destroyed. In this period, two important projects were carried out, a large water reservoir in Turow was built to help maintain the minimum depths and the locks at Brzeg Dolny were built which extended the channelized Oder by 30 kilometers.

The need to modernize the entire Oder waterway was so great in the late 1940's and early 1950's that the Polish economy could not possibly satisfy it in the period of intensive industrialization. In spite of obvious shortcomings in the waterway and physical facilities, the demand for cheap transportation services in the five wojewodztwa increased tremendously. This is the same period during which Polish transportation and locational policies were directed toward holding down the demand for transportation. For example, on the completely war-devastated Oder waterway freight traffic, as shown in Table 8, increased from 30 thousand tons in 1946 to approximately 12.9 million tons in 1952. Economic policies which attempted to curb the demand for transportation had been confronting powerful objective forces generating

additional traffic demands within these regions. Polish industry became dispersed, dispersed in the sense that the traditional centers of industry and newly acquired centers in the western and northwestern wojewodztwa were separated by economic distance. Therefore, in view of the locational pattern of resources and population distribution, this dispersion tended to raise, for most commodities, the average length of haul. This increase of the average length of haul is barely evident in the Żegluga na Odrze shipping records but, nevertheless, it shows a trend in the rise of the average distance of commodity moved. The primary reason for the lack of a drastic rise in the length of haul on the Oder, until 1959, was the fact that this water carrier was considered marginal as a mode of transportation and unsuitable to meet both quantitative and qualitative demands within the five wojewodztwa.

As Table 27 below shows, the average length of haul on the Oder for basic commodities such as coal, cement, and fertilizer declined rapidly to 1959, while rising significantly since 1960 when the waterway and the agency's river fleet became fully operational.

The cost of transporting commodity by water carrier on the Oder prior to full reconstruction, in comparison with other modes of transportation, was rather high. Consequently, in addition to the transportation cost factor, the emphasis on speed of industrial development and the

TABLE 27

AVERAGE HAUL PER TON OF FREIGHT ON THE ODER
(IN KILOMETERS)

Year	All Freight	Coal	Ores	Sand & Gravel	Metals and Metal Prod.	Cement	Fertilizers
1947	398	391	489	60	.	454	.
1950	409	396	475	62	.	401	385
1955	426	375	498	55	130	372	389
1957	432	382	529	50	134	375	379
1959	378	509	507	62	531	323	376
1960	467	529	538	66	451	452	406
1962	404	562	499	57	213	998	357
1964	544	605	602	60	469	717	428
1966	541	635	577	44	634	864	434
1968	537	662	611	53	637	917	456

Sources: Główny Urząd Statystyczny, Rocznik Statystyczny Transportu 1945-1966 (Warsaw: 1967), Table 5, pp. 496-497; and data from the office of agency "Zegluga na Odrze," Wrocław.

overall lack of locational pull of the manufacturing establishments to the river location were fundamental factors in preventing a much earlier development of the Oder waterway as an artery of transportation.

As a direct consequence of the postwar selective investment policy in transportation by the central planning agency, an essential change was effected in the character of industry's methods of procurement and distribution that existed in the five regions. It reoriented some of the basic industry, which before the war heavily depended on and was well served by the Oder waterway, into chief dependency on the railroad for the service of transportation.

Modernization of the Oder waterway and the subsequent rise in tonnages was primarily an adjunct to the investment possibilities. After 1959 when the government planners turned their interest toward inland waterways and their carriers and allocated a substantial amount of resources, one can see a gradual but persistent rise in tonnages carried by Żegluga na Odrze. The activation of the Oder became important, not only to the five wojewodztwa through which the waterway flows, but to the entire economy. As a result of the more accelerated development in the Oder waterway, its structure and function within the five wojewodztwa differs at present from that of the pre-1959 period. The most striking difference is the increasing role that the Oder waterway is beginning to play in the

basic industries, such as metallurgy, chemicals, building, electric power producing, and agriculture.

Districts in which favorable physical and economic conditions existed for the development of heavy industry, and at the same time are contiguous to the Oder River, particularly in the wojewodztwa Katowice, Opole, and Wrocław, reached a much higher level of industrialization than the outlying districts concentrating on small or light industries as in wojewodztwa Zielona Góra and Szczecin. This disparity in industrial development among the five regions cannot be attributed to the selectivity of the Oder waterway among the industries or the inherent advantage of the inland water carriers in moving bulk commodity which are the primary inputs of heavy industry, but is rather a response to a combination of forces such as conscious planning, accessibility, and a region's endowment in natural resources. Particularly, in view of the fact that by the time that the Oder waterway became capable of meeting the demand for the service of inland water transportation, heavy industry in Upper Silesia was not only rebuilt but had also expanded. By 1959, the iron and steel industry in Upper and Lower Silesia was annually producing 2.6 million tons of pig iron and 3.9 million tons of crude steel which is 70 percent and 73 percent, respectively, of the total Polish iron and steel production.⁴ In wojewodztwo Katowice

⁴Główny Urząd Statystyczny, Rocznik Statystyczny Przemysłu 1967 (Warsaw: 1968), Table 20, pp. 230-271.

alone, as early as 1957, 83,995 thousand tons of coal was extracted, which constituted 89.4 percent of the total Polish production.⁵

Therefore, it would be completely erroneous to say that the Oder River prior to 1959 played a substantial role in the industrialization of these five wojewodztwa under investigation, while it would be quite proper to say that since 1959 the Oder River has begun to perform a considerable role in the further industrialization of this area. Not only are the waterway carriers developing into highly specialized mode of transportation with increasingly larger tonnages with each year but, what is more important, the Oder River location for some industries is becoming essential. One may speculate that with further technological improvement of the routeway and the carriers' floating equipment this mode of transportation will be capable of providing adequate service, both quantitatively and qualitatively, without major interruptions. The Oder River will definitely continue to be a major asset to the five wojewodztwa contiguous to or through which it flows.

⁵Marek Grabania, Regiony Przemysłowe Województwa Katowickiego (Katowice: Śląski Instytut Naukowy, 1963), p. 50.

CHAPTER VII

REGIONAL DEVELOPMENT WITHIN THE FIVE WOJEWODZTWA AND THE DEMAND FOR SPATIAL INTERACTION

The economic development of Poland since the conclusion of World War II has led to considerable changes in the regional economic patterns and significant changes in the circulation of goods and people. If one looks at the transportation system as the means by which circulation takes place, or to be more specific as a vital link between spatially distributed points, such as location of raw materials, industry, and markets, then the volume and the pattern of transportation required by the economy would clearly depend, aside from the type of economic activity, on the location and locational relationship of raw materials, place of production, and the points of consumption. If these places of economic activity can be related from transportation's point of view as focal points, then any change in the location of one of these focal points would tend to alter the entire relationship between all of these points, necessitating changes in the links, thus change in the pattern.

The Oder River as a link within the inland water transportation system, due to physical limitation in the

directional flow of the river, does not change its direction in response to the desired direction of movement. Hence, there have been significant changes in the Oder's hinterland since being incorporated into the rest of Poland. The river as a link assumed a new function in the relationship of the distribution of raw materials, centers of production, and markets. In view of these assumed changes, an analysis of the commodity flow patterns in response to regional changes must be made.

The analysis of the average distance of freight movement alone will not be sufficient to detect changes in the function of the Oder within its hinterland because they are made up of overlapping long, medium, and short-distance hauls. They conceal the essential characteristics which typifies the circulation of goods. In analyzing the response of the modes of transportation to changes in the regional patterns, aside from the analysis of distance, one should consider the intraregional and interregional commodity flow, the location of the Oder as an artery of transportation in relation to source of raw materials, centers of production, and markets.

In this chapter, the author will make a brief study of the response of the Oder to the changing regional patterns. The analysis will also involve the examination of intraregional and interregional flow of the four commodities on the Oder which constitute approximately 90 percent

of the tonnage carried by the agency, Żegluga na Odrze.

General Economic Impact of the Oder River

The most effective way to determine the economic effects of the Oder River navigation would be to trace through on a commodity basis. One danger of such an approach is that the total impact is submerged in the analysis of specific industries. The aggregate impact can be traced by looking at the region's effects of the river as a whole. Nevertheless, commodity analysis shows that Polish industry is making a subtle but pronounced movement to the river's banks. In the Oder valley the boom is only in its infancy. Cheap electric power, an important locational magnet, has barely had time to make itself felt in the postwar period. In addition, the development of huge industrial complexes such as the aluminum industry and metal-alloy plants is a harbinger of what hydro- and thermoelectric plants located along the river will mean in the future. This coupled with the steel complexes in Szczecin and the nonferrous metals in Iwiny, Legnica, and Wilkow, and the petroleum refineries add up to an imposing array of basic industries in the Oder valley. Chemical plants such as "Odra" cement works in Opole, the nitrogen works in Kędzierzyn, Rokita Organic Chemical works in Brzeg, Wizów chemical works in Gorzów, and the staple fiber and rayon works in Jelemia Góra and Szczecin show

preference for a river location. Of course, these primary industries all attract complementary manufacturing and this secondary wave of growth has already started. For example, the electrical appliance industry in the city of Wrocław in recent years has greatly expanded. This central location allows the plant to receive its large steel volume by water carrier from upriver and simultaneously enjoy low outbound transportation costs by rail.

Clearly, in the spirit of operating the Polish economy more efficiently, the shift of industry within the Oder valley to the river location is destined to continue. All the attractions of the waterway that have developed in recent years remain and the industrial boom along the river will have a tendency of breeding a secondary boom of its own creation.

One indication of the size of the industrial boom occurring in the valley is the amount of capital invested in new plants and equipment and in the expansion of the existing plants. Unfortunately, the statistical data showing annual investment outlay in new plants and equipment which would support the author's above speculation was not available in Poland. It may be stated, however, that in the five wojewodztwa, Katowice, Opole, Wrocław, Zielona Góra, and Szczecin, the investments made in industry, per inhabitant, are higher than in the remaining twelve

województwa of the country.¹ The same result can be achieved by looking at the sheer number of manufacturing establishments and the rise in industrial employment.

Table 28 below indicates that in 1960, of the total manufacturing establishments, 42.4 percent were located in the five województwa, Katowice, Opole, Wrocław, Zielona Góra, and Szczecin, while the remaining twelve województwa in Poland shared 57.6 percent of the manufacturing establishments. The data for 1968 indicates a more favorable percentage distribution of manufacturing establishments for the województwa within the study area. The five regions under investigation in 1968 contained 47.8 percent of all manufacturing establishments. However, if one looks only at the numerical distribution of the manufacturing establishments as the sole indicator of the region's economic contribution to the nation's economic strength, one would invariably get a distorted picture. Not only do the manufacturing establishments vary in size, ranging from gigantic steel foundries employing thousands of skilled workers to small ceramic "factories" employing a few artisans, but they also differ in their importance to the economy.

Therefore, one of the major indicators of the region's level of industrial development or its contribution to the total economy would be the ratio of employment

¹Based on the author's personal field observation during travel in the area, May to July, 1968.

TABLE 28

COMPARISON OF MANUFACTURING AND INDUSTRIAL EMPLOYMENT IN THE STUDY AREA
WITH THE REST OF POLAND (FOR SELECTED YEARS)

	Within Five Wojewodztwa Under Investigations			Rest of Poland		
	1955	1960	1968	1955	1960	1968
No. of Manufacturing Establishments	. .	12,137	37,763	. .	28,631	78,927
Employment in Industry in thousands	1186.8	1200.1	1514.3	1492.2	1697.2	2274.4
Employment in Industry as % of Total Employment	50.3%	46.0%	49.3%	37.1%	36.1%	38.9%

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Sources: Główny Urząd Statystyczny, Rocznik Statystyczny Przemysłu 1945-1966 (Warsaw: 1967); Główny Urząd Statystyczny, Rocznik Statystyczny 1968 (Warsaw: 1969).

in industry to the total employment, or the region's share of industrial employment in relation to the rest of the country. For example, in 1955 the five wojewodztwa contiguous to the Oder River contained 79.5 percent of the total employed in industry. In 1960 and 1968 their relative share dropped to 70.7 percent and 66.6 percent, respectively. In the ratio of industrial employment to the total employment within the regions, one can see that in 1955 in the five wojewodztwa under study 50.3 percent of the total employment was in industry while in the rest of the country the percentage was significantly lower, only 37.1 percent. In 1968 industrial employment in the five wojewodztwa declined slightly to 49.3 percent, while rising in the remaining wojewodztwa to 38.9 percent.

Taking both the number of manufacturing establishments and employment in industry as an indication of industrialization, it can be seen that in the five regions contiguous to the Oder River, the number of manufacturing establishments rose 67.9 percent from 1960 to 1968, while the number of manufacturing establishments in the remaining regions of Poland increased 63.7 percent. The percentage change in the industrial employment for the same period shows that in the five regions employment in industry rose by 20.8 percent, while in the remaining regions of the country the increase was slightly higher, increasing by 26.4 percent. Nevertheless, major disproportions continue

to exist between the western regions of the country and the eastern regions, between the old industrial agglomerations and the slowly developing new centers.

Analysis of the data in the table above indicates two trends. First, it is quite evident by the distribution of the industrial employment that Polish industry in the past thirteen years has been gradually decentralizing in favor of the previously poorly industrialized regions. Nevertheless, the distribution of natural resources and locational inertia created by the traditional centers of industry continue to act as an important magnet in attracting new industry to the already well-established centers. The fact is that, contrary to the wishes of the central planning agency, the bulk of Polish industry is located in the southwestern regions of the country and the five wojewodztwa in the Oder River basin contain a major share.

Second, the gradual changing economic structure of the country is manifested in the percentage of employment in industry to the total employment. In spite of the fact that industrial employment declined slightly in the 1955 to 1960 period, the rise in subsequent years indicates that Poland is becoming an industrial economy. The decline in industrial employment in 1960, after a period of forceful industrialization effort, denotes a certain degree of relaxation and subsequent allocation of resources, including

labor, to other segments of the economy. A rise again in 1968 in industrial employment seems to be a response to economic forces.

What is apparent from the analysis of the table above is that the Oder River basin continues to be an area of high industrial concentration. If one compares individual wojewodztwa within the study area with the rest of the country, the findings are even more impressive.

If one takes as a base not the absolute increases in industrial employment, but the rise in industrial employment in relation to size of the region, then it can be seen that in the period of 1947 to 1959 Katowice shows the highest increase per 100 square kilometers, an increase of 3,467, followed by Wrocław with 880 and Opole with 837.² This absolute increase can be compared with wojewodztwa Warszawa and Lublin, with 641 and 202 employees per 100 square kilometers, respectively.³

As one can see, the rise in industrial employment in relationship to the size of the region was the slowest in the wojewodztwa that are considered to be poorly developed and was the highest in the traditional area of large industrial agglomeration. The primary obstacle to the more even distribution of industry throughout the

²Tadeusz Mrzygłód, Politica Rozmieszczenia Przemysłu w Polsce 1946-1980 (Warsaw: Książka i Wiedza, 1962), p. 58.

³Ibid.

country and comprehensive development of primarily agricultural wojewodztwa was the early emphasis on the speed of industrialization. Consequently, already established centers of industry received heavy outlays of capital. This only further deepened regional differences. A more even distribution of industry throughout the country was obtainable only at the price of weakening the already established and well-developed heavy industry in Upper and Lower Silesia, and with a lowering of the level of the Gross National Product. This price was too much for the young country to bear.

In the period 1959 to 1968 one can see a more selective diversification of Polish industry. An attempt was made to integrate clusters of industry on incorporated territories with the rest of the nation's economy. Corollary to the development and expansion of both the already established and the newly developed centers of industry is the unification of these into a gigantic urban-industrial agglomerations such as the Silesian-Kraków industrial region lying at the eastern extremity of the Gliwice Canal. At the end of 1968, this region contained approximately 1212.4 thousand industrial workers, constituting 32 percent of the nation's total.⁴

⁴Główny Urząd Statystyczny, Rocznik Statystyczny 1968 (Warsaw: 1968), Table 5, p. 67.

Another sizable industrial agglomeration within the Oder River basin is the Wałbrzych industrial region in województwo Wrocław, which in 1968 employed approximately 13 percent of the nation's industrial workers.⁵ In addition, there are smaller important clusters of industry along the Oder, stretching from Koźle in the województwo Opole to and including the city of Wrocław. The middle section of the Oder valley, which lies within the województwa Zielona Góra and the southern portions of Szczecin, has the least number of industrial establishments and has industrial employment slightly below the national average. Nevertheless, what little industry is located in these two regions and what is being located shows a preference for a river location. Northern Szczecin, including the maritime port by the same name, has an important cluster of heavy industry ranging from iron and steel plants to thermo-electric power plants.

In summary, the Oder River basin is characterized by relatively wide extremes in economic development. It has localities among the highest per capita share of industrial output and some areas with very low per capita industrial output. It has an extraordinarily wide diversification in its economic development, including every major type of economic activity in Poland. In this respect, it is one of the most balanced economic regions of the

⁵Ibid.

country. Population settlements, mining, manufacturing, agriculture, and forestry are all concentrated along the Oder River. The period, from 1959 to the present, is marked by rapid technological improvements in the waterway and the agency's floating equipment. The subsequent rise in the tonnages carried by the Żegluga na Odrze is indicative of the relationship between the technological status of the waterway and the role that it plays in facilitating industrial development within the five wojewodztwa.

Changing Regional Patterns and the Oder River

Prior to World War II, the directional flow of commodity in the study area did not correspond with the longitudinal axis of the Oder River but, rather, it deviated westward toward Greater Berlin from the general north-south direction. If one looks at Table 29 in conjunction with Figure 35, which shows the flow of commodity on the Oder River in 1938, one can say that the intensity and the tonnages carried on individual sectors of the river corresponded to the physical conditions on the river. The tonnages, like the depths in the navigable channel, rose with the northerly direction and both drastically declined in the middle sector of the Oder River. Both the intensity of flow of commodity and the depths in the navigable channel rose again in the lower sector from Cedynia to Szczecin. It should be pointed out, however, that the

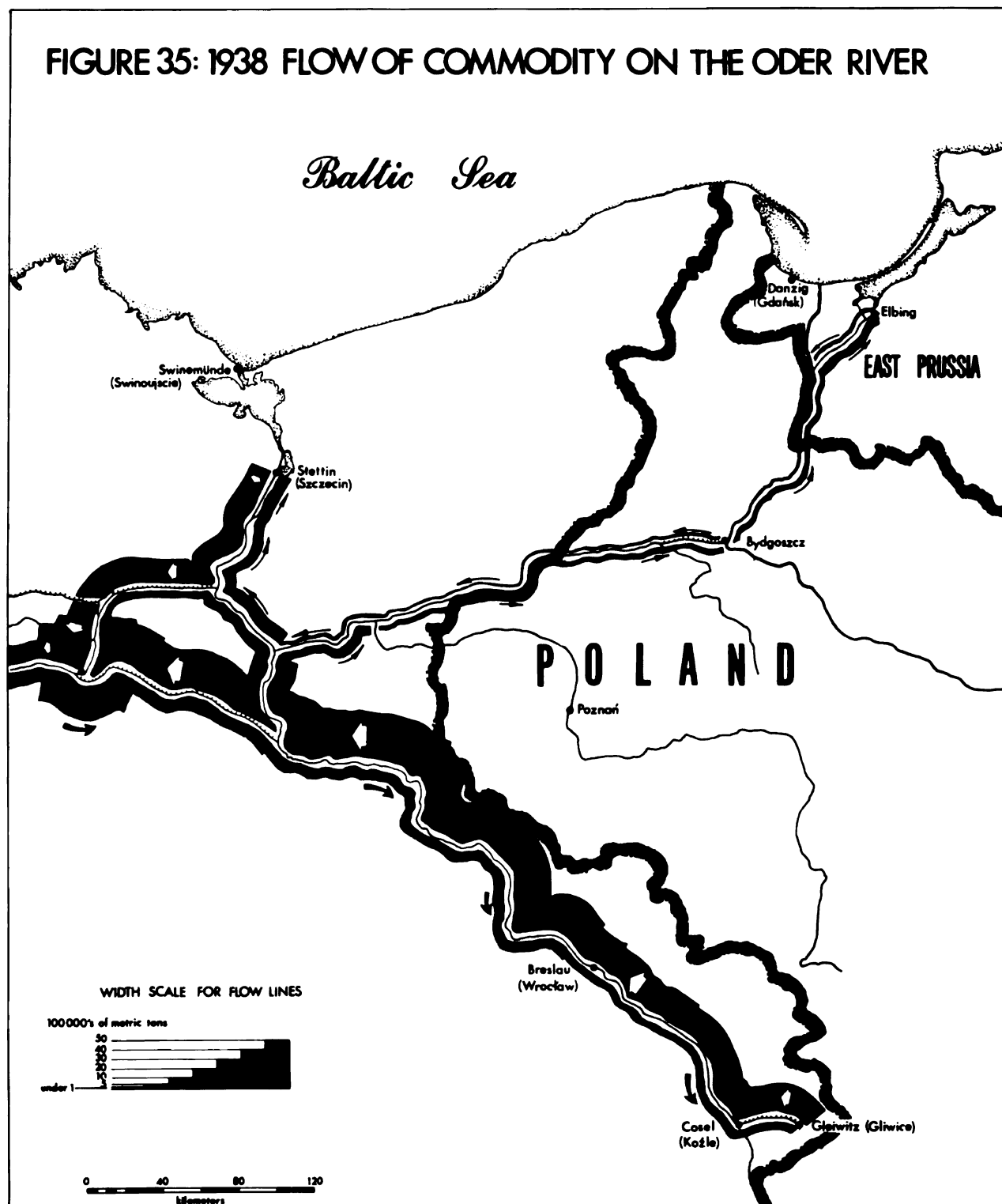
TABLE 29

TONNAGE AND THE DIRECTION OF COMMODITY MOVEMENT
(IN THOUSAND TONS)

Place	1910		1938		1947		1968	
	Up River	Down River	Up River	Down River	Up River	Down River	Up River	Down River
Gliwice	.	.	.	.	90	450	137	520
Koźle	638	2735	470	3201	320	500	640	914
Wrocław	1070	2831	787	3595	410	968	870	1351
Głogów	1144	3210	.	.	.	.	.	.
Prybrzeg	1185	3331	1055	4119	485	940	921	1459
Kostrzyn	1041	1503	991	1544	480	885	871	1438
Szczecin	2062	1323	2443	1814	450	862	1019	1415
Swinoujście	.	.	420	809	.	428	.	600

Sources: Nils Holmberg, Oderhndeln (Lund: 1941); Engineer Research Office, Navigable Waterways of Germany (Strategic Intelligence Branch, Military Intelligence Division, VIII), August, 1944; Statistics for 1947 from the records of the agency Żegluga na Odrze, Wrocław, 1968; Główny Urząd Statystyczny, Statystyka Żeglugi Śródlądowej i Dróg Wodnych Śródlądowych 1968 (Warsaw: 1969).

FIGURE 35: 1938 FLOW OF COMMODITY ON THE ODER RIVER



intensity of flow was not predetermined by the physical conditions of the individual sectors of the waterway but, rather, the lack of use of a particular sector of the Oder River contributed to its physical deficiency by administrative neglect.

In Upper Silesia, as an important producer of raw materials and industrial output, the northerly flow of commodity by the inland waterway was significant. In Kozle, for example, in 1938 the annual flow down the Oder was 3.2 million tons, at Wrocław the tonnages increased to 4.0 million.⁶ In Przybrzeg the northerly flow of commodity, approximately 3 million tons, was diverted to the west through the Oder-Spree Canal in the direction of Greater Berlin.⁷ In the middle Oder from Przybrzeg to Cedynia, the least suitable portion of the Oder for navigation, the gains of 400 thousand tons in tonnages from the local ports in this section could hardly balance the significant loss in flow which was diverted westward. From the east by her tributaries, the Warta and the Noteć, the Oder received 240 thousand tons but, at the same time, it lost to the easterly flow, 73 thousand tons.⁸ The overwhelming pull of the flow of commodity toward Berlin and the provinces lying west of the Oder was such that, in the vicinity of

⁶Gerhard Giesecke, Oderschiffahrts und Oder Wirtsdiäftsfrzgen (Emsdetten: 1940), pp. 41-46.

⁷Ibid.

⁸Ibid.

Kostrzyn, the tonnages moving down the Oder toward the maritime port of Szczecin were merely 1700 thousand tons.⁹ A portion of this tonnage at Cedynia, a point where the Oder is linked with the Hohenzollern Canal, was directed toward the west. However, at the same time, this is a point of convergence of the commodity moving east from the direction of Greater Berlin and the western regions through the Hohenzollern Canal and the commodity moving north via the Oder River. The consequence of the meeting of these two flows was that the lower Oder at Cedynia received approximately 800 thousand tons, half of which was unloaded in the small ports along the way, leaving approximately 400 thousand tons to eventually reach the port of Szczecin.

If one looks at the flow of commodity up the Oder River, one may notice certain structural similarities in both flows. As in the case of the flow of commodity down the river, in the up-river flow the primary direction of the flow was toward Berlin. These two flows of commodity from the southeast and northeast converged on the area of Greater Berlin. For example, in 1938, 2443 thousand tons of commodities moved southward from Szczecin, at Cedynia 1500 thousand tons of it was diverted in a westward direction through the Hohenzollern Canal.¹⁰ Thus the middle portion of the Oder, north of Cedynia, received less than

⁹ Ibid.

¹⁰ Engineer Research Office, VIII, pp. 429-431.

a million tons, from which 130 thousand tons moved east through the Oder tributaries, the Warta and the Notec. Consequently, south of Kostrzyn', the total southward flow was only 884 thousand tons. The small port of Przybrzeg was the point where the flow of approximately 300 thousand tons moving on the Oder-Spree Canal, from the direction of the Greater Berlin area, met the southward movement on the Oder. At that point, the commodities destined for Silesia were slightly over 1 million tons. As the flow moved up the river, tonnages gradually declined along the way and the flow, not quite one-half million tons, reached the southern terminal port of Koźle.

As one can see, the general flow of commodity on the Oder in 1938 was under the great influence of Berlin and its vicinity. The mastery of Berlin can be illustrated by pointing to the aggregate and directional movement of commodity. For example, from the extreme southeastern portion of Germany, almost 3 million tons of commodities moved toward Berlin and the western provinces. Outflow of commodities from Upper and Lower Silesia to the west via inland waterways was two and one-half times larger than the return flow down the river. From Szczecin and Western Pomerania more than 1.5 million tons was moved westward.¹¹ In the return flow eastward, from Greater Berlin and the western provinces through the inland waterway connecting

¹¹Ibid.

the Elbe with the Oder, significantly smaller tonnages were moved. In total, Greater Berlin and the western provinces of Germany received 4.5 million tons of commodities from Silesia and Szczecin, in the form of raw materials, manufactured goods, and agricultural products and, in return, the west gave slightly over 1 million tons.¹²

It is interesting to note that there was more of a balanced relationship in the movement of commodity on the Oder River itself, between the upper and the lower Oder valley. For example, the port of Szczecin received from Upper Silesia 568 thousand tons and consigned to Upper Silesia 375 thousand tons.¹³ From Lower Silesia Szczecin received 224 thousand tons and was sending up river 369 thousand tons.¹⁴ Together, Szczecin received from Upper and Lower Silesia 693 thousand tons and consigned for shipment to Silesia 643 thousand tons.¹⁵

The movement of commodity on the Oder from the end of the nineteenth century until the outbreak of World War I rose rapidly. For example, the tonnages carried on the Oder, at Wrocław, was 1.8 million tons in 1880, increasing to 2 million and 5.5 million in 1910 and 1913, respectively.¹⁶ After World War I tonnages on the Oder fell rapidly, due to the new economic conditions arising from the political partition of Silesia. A large portion of

¹²Ibid., pp. 437-442.

¹³Ibid.

¹⁴Ibid.

¹⁵Ibid.

¹⁶Ibid.

Upper Silesia was awarded to Poland, which was excluded from the use of the Oder River for the purposes of navigation. It is interesting to note that after Hitler came into power in 1933, as a result of Germany's preparation for war, shipments on the Oder rose gradually until the outbreak of World War II. Nevertheless, none of these years surpassed more than 80 percent of the 1913 tonnages.

As one can see from Table 29 and by comparing Figures 35 and 36, the freight flow intensity is not much different between the years 1910 and 1938. In both cases the flow of commodity from southeast and northeast converged on Berlin. The only significant difference is the intensity of the flow on the Oder's tributaries, the Warta and the Noteć, linking the Oder River with the lower reaches of the Vistula. In 1910, when both of these tributaries were under Prussian administration, sizable tonnages moved between East Prussia and the western part of the state. Later, however, in 1938 when political boundaries had cut across the east-west flowing streams, very little traffic, either German or Polish, moved on the Warta, Noteć, and the lower Vistula. In this respect, political boundaries between Poland and Germany were such a significant barrier to trade, that even economic incentives to trade were unable to overcome.

The fundamental changes in regional structure and the pattern of movement of commodity on the Oder was forced

FIGURE 36: 1910 FLOW OF COMMODITY ON THE ODER RIVER



on the Polish planners and, at the same time, fostered by them. The examination of Figures 37 and 38 reveal that the Pre-World War II pattern has been modified to the point of nonrecognition by the changes in the direction and intensity of flow. The total freight traffic on the Oder in 1968, in comparison, is only a fraction of the German traffic. It constitutes approximately 70 percent of the total movement on the Oder of 1938. What is more important in the analysis of the function of the waterway are not the total tonnages, but the traffic flow intensity on the individual sectors and the direction of movement. The shift in the political boundaries to the west of the Oder River in the south shattered the ascendancy of Berlin on this waterway. Unlike the Pre-World War II pattern of flow, the highest freight flow intensity is between Upper Silesia and the port of Szczecin, along the longitudinal axis of the Oder River. The Oder River became, in the true sense of the word, a major artery of transportation along its entire length which, in turn, necessitates technological improvements in the middle sector of the river neglected by the Germans.

Examination of the data in Table 29, which shows the commodity flow at various points along the waterway for different periods, indicates that in the middle part of the Oder there is a great deal of similarity in the flows in 1938 and in 1968. In the regional distribution of traffic

FIGURE 37: 1968 FLOW OF COMMODITY ON THE ODER RIVER

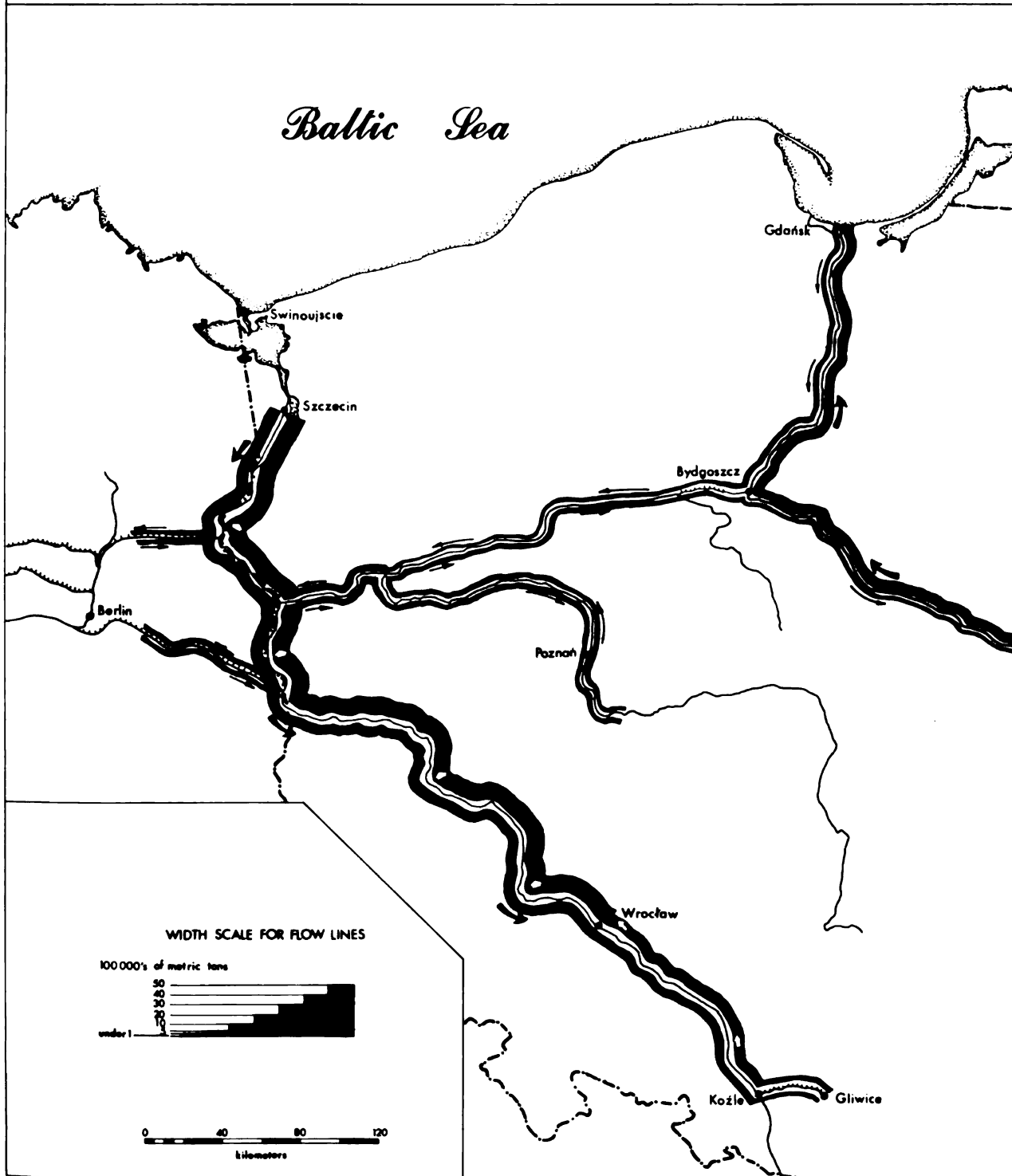
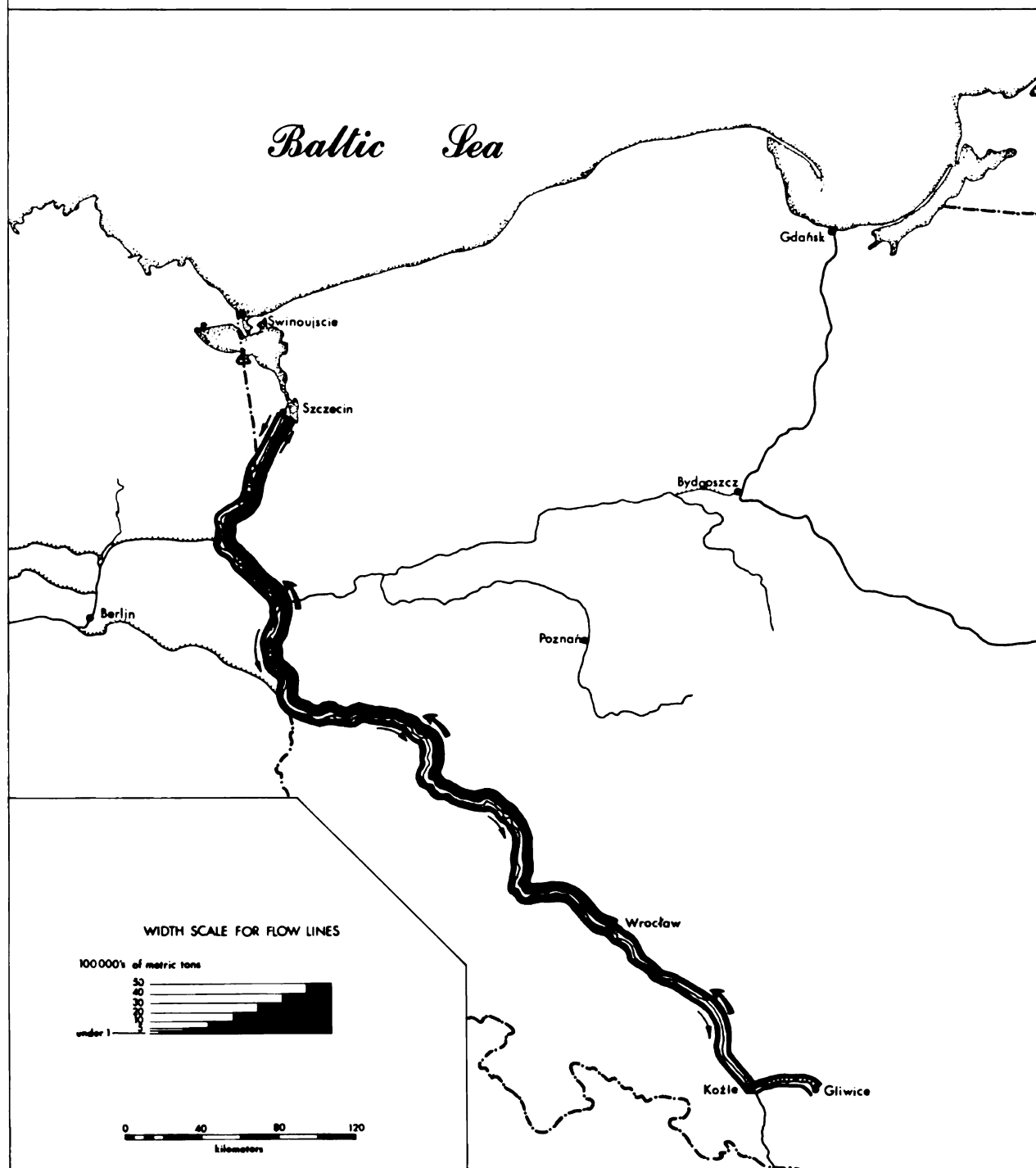


FIGURE 38: 1947 FLOW OF COMMODITY ON THE ODER RIVER



requirement and traffic flow, both in 1947 and 1968, as indicated by the statistics in Table 29, there is a greater degree of complementarity between Silesia and the maritime port of Szczecin than was true in the 1938 period. One would also expect that in the near future, with the technological improvement of the Oder tributaries, the Warta and the Noteć, it will show an increase in tonnages carried.

It would seem fair to conclude that traffic growth on the Oder has resulted in the strengthening of the hinterland's concentration. In addition, to some extent, traffic growth and commodity diversification resulted in a change in the area of the river's hinterland. Both the shape and intensity of a hinterland vary with changes in the direction and volume of cargo flows at different points of time. In the Post-World War II period, the major influence on the Oder River hinterland has been the growth in the volume of established commodity movements, parallel with the directional change of movement as have occurred in the last twenty-two years.

The expansion of the iron and steel industry in Upper Silesia has been of paramount influence on the intensification of inward cargo flows, although, at the same time, an internal diversification and dispersion has occurred in the chemical and building material industries locating along the Oder. In similar fashion, outward

moving coal, to the new centers of industry, has become more significant in the Post-World War II years.

The present traffic on the Oder is dominated by raw materials such as coal, iron ore, sand and gravel, and agricultural products, and is heavily imbalanced toward the north. Therefore, it is desirable to take a closer look at the intraregional and interregional flow of these commodities.

Geography of Commodity Transport

The analysis of major commodity group traffic on the Oder is somewhat limited by the incomplete release of data by the Polish statistical office. In spite of this difficulty, even a limited review of broad traffic trends can provide one with a skeletal insight into one aspect of the regional development and industrialization process. Therefore in this section an analysis is undertaken regarding interregional movement, by the Oder waterway, of bulk commodity such as coal, sand and gravel, iron ore, and agricultural products. The available statistical data on the shipment of raw materials in 1968 indicates that the entire supply of coal for export and industries located in the Oder River valley comes from Upper and Lower Silesia. Thus the flow of this commodity is northward to Wrocław and Szczecin and the smelting and power producing plants located along the river's course.

In spite of the persistent effort of the Polish planners to decentralize the Polish iron and steel industry, there have been no significant changes in the flow of coal. Coal still moves north and northwest from the outlying regions in the south to the manufacturing centers of Poland. The present geographic pattern of interregional and intraregional coal shipments within the study area can be examined in the table below. As is shown in Table 30, there are three major consigners of coal within the study area, who in aggregate export more than 97.6 percent of the total coal carried by the agency Żegluga na Odrze. The coal supplied to the western wojewodztwa comes entirely from Katowice, Opole and the Wałbrzych area in wojewodztwo Wrocław.

Examination of Table 30 along with Figure 39, which graphically presents the interregional distribution of coal, indicates that the largest consigner of coal shipped by inland water carriers is wojewodztwo Katowice, with 50.4 percent of the total coal tonnage shipped via the Oder. This region is followed closely by wojewodztwo Opole with 41.7 percent. In total, these two regions account for 92.1 percent of the coal tonnage consigned for shipment via this inland waterway. In turn, the largest single receiver of coal is wojewodztwo Szczecin with 94.8 percent of the total tonnage of coal carried by barge on the Oder. It is interesting to note that the entire consignment of coal

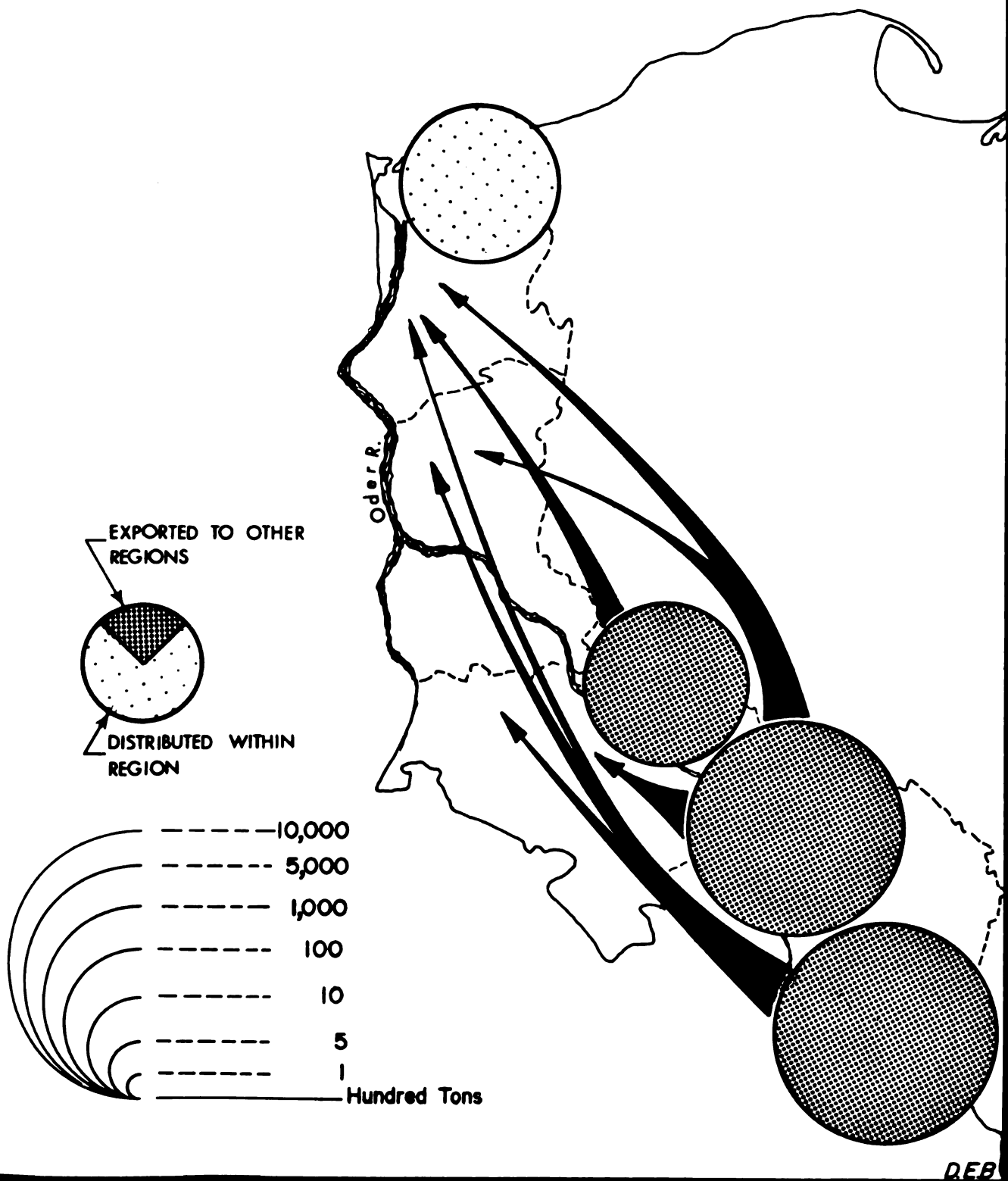
TABLE 30

INTERREGIONAL EXCHANGE OF COAL VIA THE ODER WATERWAY IN 1968 (IN TONS)

Destination Origin	Total	Katowice	Opole	Szczecin	Wrocław	Zielona Góra
Katowice	323,194	. .	. .	306,303	10,558	5,687
Opole	267,473	. .	. .	251,184	12,890	3,399
Szczecin	15,462	. .	. .	15,462	. .	. .
Wrocław	35,442	. .	. .	35,442	. .	. .
Zielona Góra	. .	. .	. .	. .	. .	. .
TOTAL	641,571					

Source: Główny Urząd Statystyczny, Statystyka Żeglugi Śródlądowej i Dróg Wodnych Śródlądowych 1968 (Warsaw: 1969).

FIG:39 INTERREGIONAL DISTRIBUTION OF COAL BY THE ODER WATERWAY



from the coal producing regions is destined for shipment outside of the region of origin. In the wojewodztwa Katowice, Opole, and Wrocław, intraregional distribution of coal does not take place by inland water carrier, whereas in wojewodztwo Szczecin, the largest receiver of coal, its entire distribution within this region takes place by inland water carriers.

The primary explanation for these differences in the interregional distribution of coal lies in the variations in the accessibility of different modes of transportation, directional movement, and the channels of distribution. For example, coal from Upper Silesia moves a relatively short distance by rail east and southeast of the Gliwice Canal to the iron and steel plants in "Główny Okręg Przemysłowy" which are accessible to the inland water carriers. Thus the intraregional distribution of coal in wojewodztwo Katowice, due to short distances, direction of movement, and accessibility, is done entirely by rail. On the other hand, the coal consigned for shipment to distant outlying regions north and northwest whenever possible is transported by inland waterway as the cheaper mode of transportation. In wojewodztwo Szczecin, due to the river location of iron and steel plants and power producing plants, the reconsignment of coal from storage yards within the region takes place by inland water carriers even when involving relatively short distances.

Unlike coal, the interregional movement of iron ore by inland waterways is less significant. This stems from the fact that the deposits of this natural resource has been exhausted in close proximity to the Oder River. Consequently, the Polish iron and steel industry largely depends on domestic and foreign iron ore shipped by rail. Table 31 below shows the interregional shipment of iron ore via the Oder River.

The table shows that three regions, Szczecin, Zielona Góra, and Wrocław are the sole consigners of iron ore for shipment by the agency Żegluga na Odrze. The major single consigner of iron ore to be shipped by the Oder is województwo Szczecin, 59.5 percent of its total consignment moves to województwo Katowice. The entire inland water consignment of the newly discovered iron ore fields in Zielona Góra moves south to Upper Silesia. Analyzing the table above with Figure 40, which presents interregional distribution of iron ore, shows that the directional movement of iron ore is opposite to that of coal.

Sand and gravel movement, the second largest tonnage on the Oder waterway, is somewhat more complicated. In order for a load of sand and gravel to be recorded as part of the Oder inland water movement it must travel a minimum distance of five kilometers. Sand and gravel obtained from dredging operations performed by "Zarząd Wodny" is counted as part of the tonnage carried by

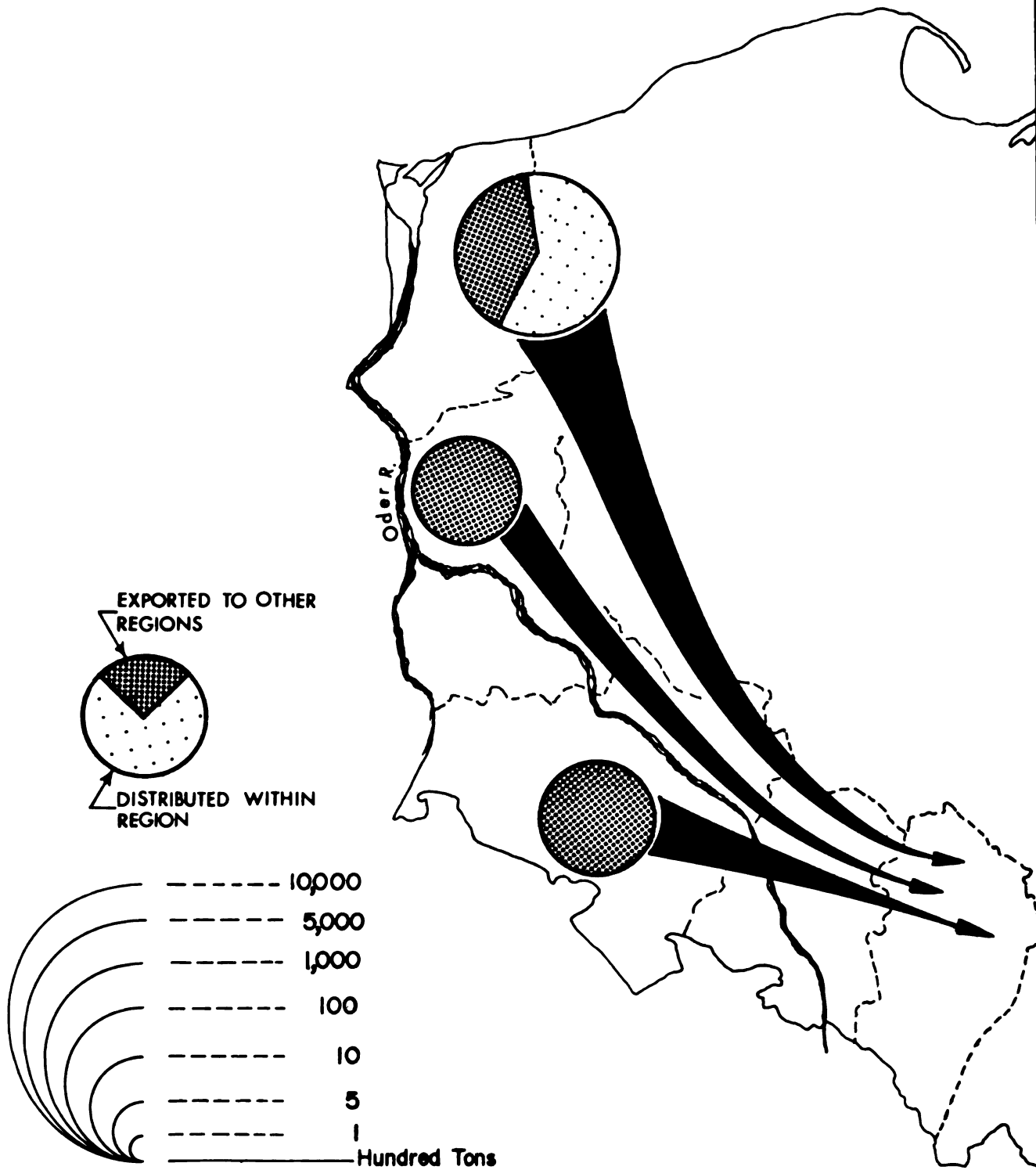
TABLE 31

INTERREGIONAL EXCHANGE OF IRON ORE VIA ODER WATERWAY IN 1968 (IN TONS)

Destination Origin	Total	Katowice	Opole	Szczecin	Wrocław	Zielona Góra
Katowice	..	..	..	..	..	..
Opole	..	..	..	..	..	..
Szczecin	25,215	15,000	..	10,215	..	..
Wrocław	1,791	1,791	..	..	..	..
Zielona Góra	12,673	12,673	..	..	..	..
TOTAL	39,679					

Source: Główny Urząd Statystyczny, Statystyka Żeglugi Śródlądowej i Droóg Wodnych Śródlądowych 1968 (Warsaw: 1969).

FIG.40: INTERREGIONAL DISTRIBUTION OF IRON ORE BY THE ODER WATERWAY



Żegluga na Odrze if the movement extends over the five kilometers limit.

The general abundance of this material in the post-glacial topography and the extremely low cost per ton affects the interregional distribution. In other words, sand and gravel is not transportable over long distances. Table 32 below shows that out of 1,147,851, tons of sand and gravel carried by the agency Żegluga na Odrze, 88.0 percent is distributed within the region of consignment.

The single largest shipper of sand and gravel by inland water carrier is wojewodztwo Szczecin with 49.6 percent of the total tonnage, followed closely by wojewodztwo Wrocław with 36.6 percent. Thus these two regions make up 86.2 percent of the total sand and gravel tonnage carried by the agency, Żegluga na Odrze.

In the interregional movement of sand and gravel, as can be seen in Table 32, the only major shipper of that commodity is wojewodztwo Opole, 91.5 percent of its 125,435 ton consignment is shipped to wojewodztwo Katowice. The only other region shipping sand and gravel outside the confines of its boundaries is wojewodztwo Szczecin.

The flow and the pattern of movement can be seen in Figure 41, which shows surprisingly that some sand and gravel from Szczecin travels the considerable distance to wojewodztwa Wrocław, Opole, and Katowice. This small tonnage, which can be considered a nontransferrable commodity

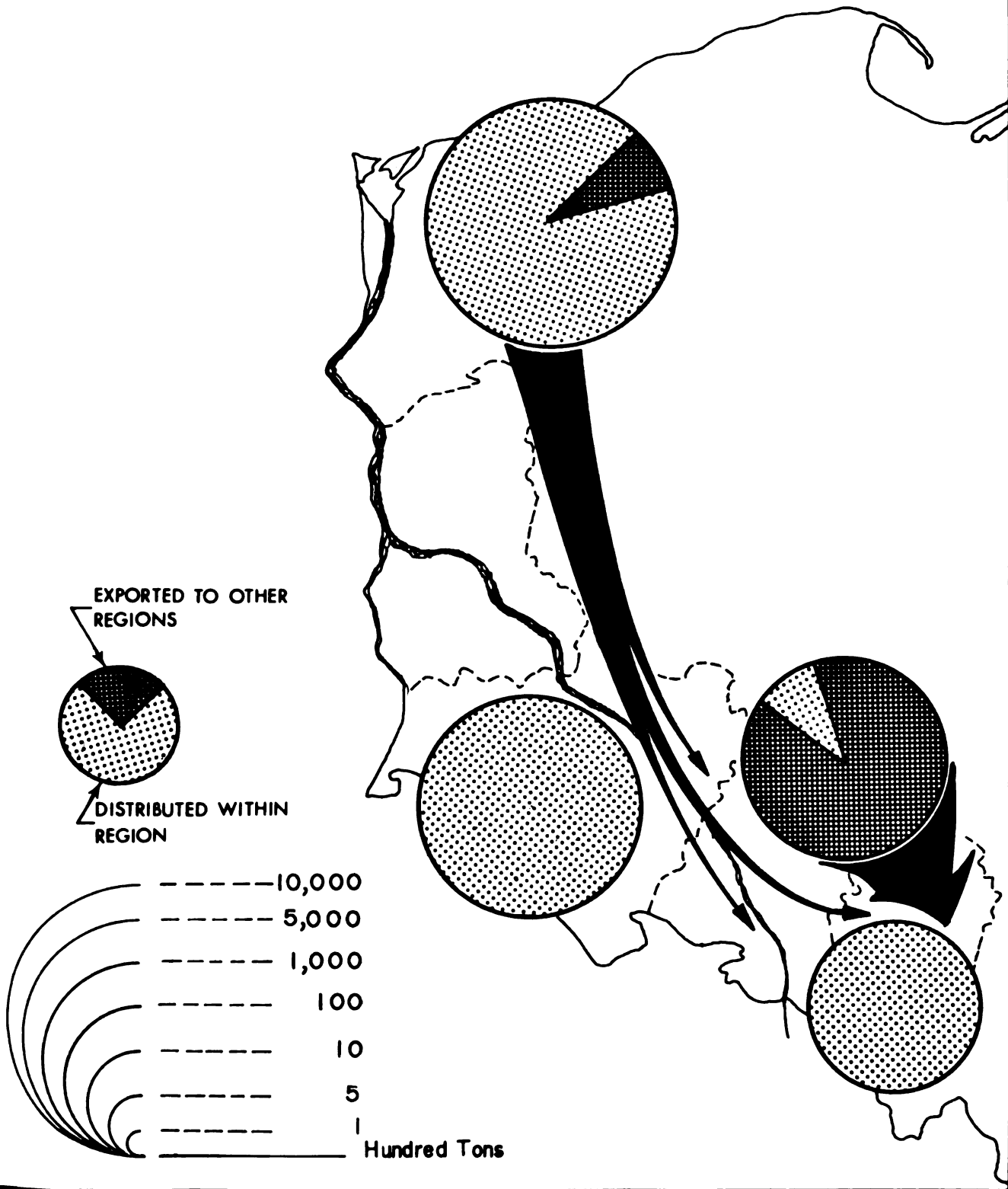
TABLE 32

INTERREGIONAL EXCHANGE OF SAND AND GRAVEL VIA ODER IN 1968 (IN TONS)

Destination Origin	Total	Katowice	Opole	Szczecin	Wrocław	Zielona Góra
Katowice	32,985	32,985	. .	. .	. .	. .
Opole	125,435	114,759	10,676	. .	. .	. .
Szczecin	569,407	18,552	242	545,859	. .	. .
Wrocław	420,924	. .	. .	. .	420,924	. .
Zielona Góra	. .	. .	. .	. .	. .	. .
TOTAL	2,147,851					

Source: Główny Urząd Statystyczny, Statystyka Żeglugi Śródlądowej i Dróg Wodnych Śródlądowych 1968 (Warsaw: 1969).

FIG. 41: INTERREGIONAL DISTRIBUTION OF SAND AND GRAVEL
BY THE ODER WATERWAY



over long distances, is part of the load on the return movement of empty coal hoppers up the river.

The interregional traffic of agricultural products in this traditionally agricultural country has always been small. It stems from the fact that most wojewodztwa, to a large extent, are still self-sufficient. The regional specialization which is developing in Poland is not exclusive to the point where a wojewodztwa with industrial agglomerations would not have, at the same time, a large segment of its population engaged in agriculture.

As one can see in Table 33 below, the interregional shipment of agricultural commodity via the Oder River is virtually nonexistent. Out of the 30,913 tons of agricultural products carried by the agency Zegluga na Odrze in 1968 only 2.8 percent was part of the interregional movement.

The largest single shipper of agricultural products via the Oder River within the five regions, as is shown in Figure 42, is wojewodztwo Szczecin, with 93.7 percent of the total movement, followed by wojewodztwo Opole with 5.9 percent. The only other region to record shipment in 1968 of agricultural products by water carrier was wojewodztwo Wrocław. This movement primarily consisted of shipment of sugar beets, as in the case of Szczecin and Opole, to the local refineries located along the banks of the Oder.

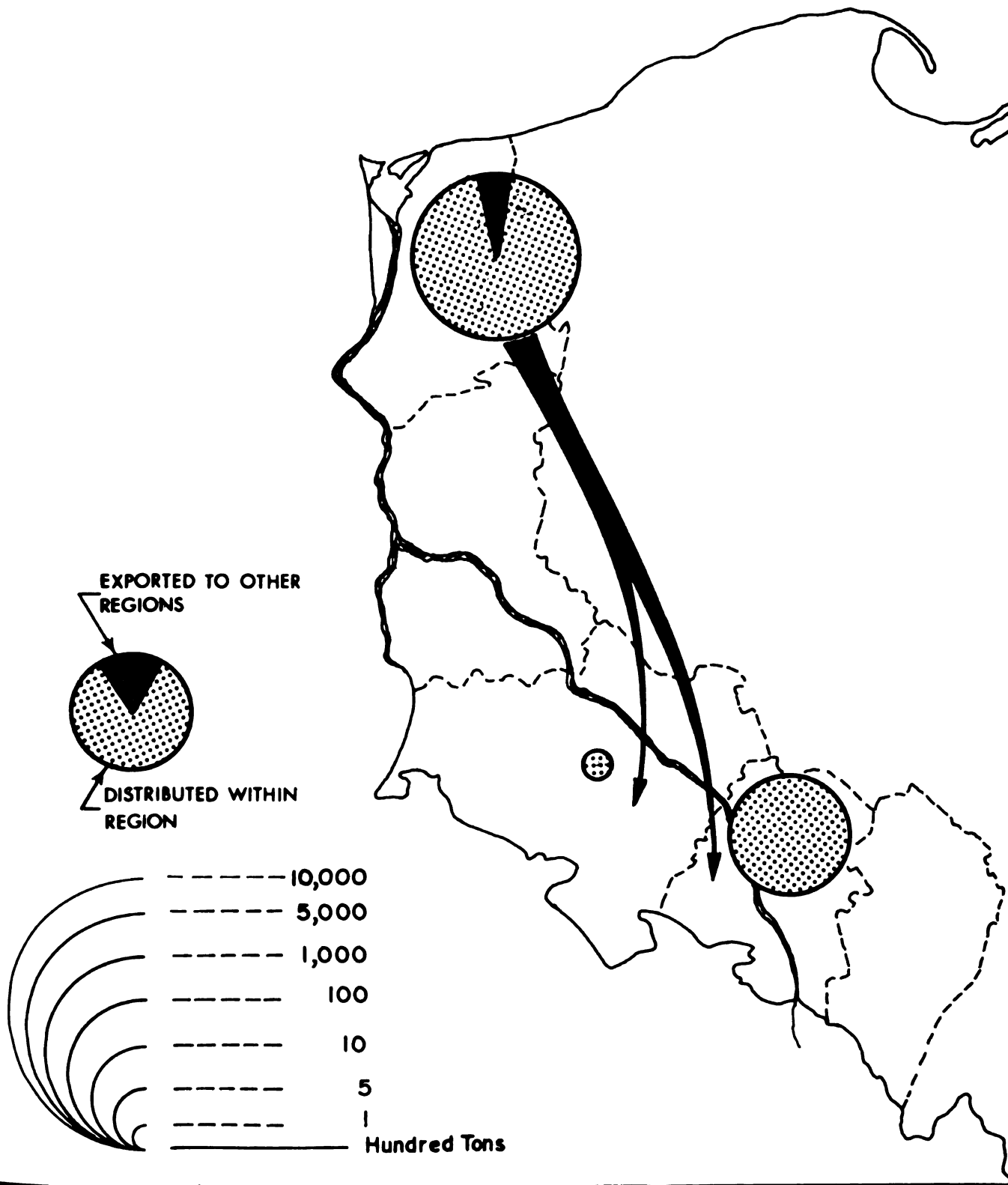
TABLE 33

INTERREGIONAL EXCHANGE OF AGRICULTURAL PRODUCTS VIA ODER IN 1968 (IN TONS)

Destination Origin		Total	Katowice	Opole	Szczecin	Wrocław	Zielona Góra
Katowice		..	..	..	..	..	..
Opole		1,834	..	1,834	..	..	..
Szczecin		28,972	..	234	23,398	860	..
Wrocław		..	..	..	..	107	..
Zielona Góra		..	..	..	..	..	..
TOTAL		30,913					

Source: Główny Urząd Statystyczny, Statystyka Żeglugi Śródlądowej i Dróg Wodnych Śródlądowych 1968 (Warsaw: 1969).

FIG. 42: INTERREGIONAL DISTRIBUTION OF AGRICULTURAL PRODUCTS
BY THE ODER WATERWAY



The examination of the intraregional and inter-regional movement of the four commodities within the five regions under investigation permits one to make the generalization that the distribution or mal-distribution of inputs of production with respect to each other, is permanently embedded in the area's environment. Consequently, a policy intended to reduce the traffic-output ratio confronts a massive barrier. Therefore, with the expected rise in quantitative demand for transportation, one would also expect a rise in qualitative demand necessitating greater specialization between carriers.

CHAPTER VIII

CONCLUSION

An analysis of the Oder River as an artery of transportation and its role in the economic development within the five wojewodztwa, indicates that the waterway in the period immediately following the conclusion of World War II has responded rather sluggishly to the demands imposed by the economy. The importance of local natural resources to the economic growth of the five regions under investigation is most pronounced. The major identifiable characteristic of the economy of these regions is that they are the centers of mining and heavy industry. The development of the natural resources within the area such as bituminous coal, lignite, copper, lead, and zinc, and large outlays of capital in the development of heavy and related industries created immense quantitative and qualitative demands for the service of transportation. Investment in the system of transportation has been essential to the development of industry within the area and to enable the exploitation of these natural resources. In view of the limited economic resources at the disposal of the planners in the Post-World War II period, the principal investment,

understandably, was not in the inland waterways, which were completely devastated by the war but, rather, in the higher cost but more flexible railroad.

At the present time, the Oder River is mainly an artery of transportation of internal significance which serves the economy as a major link between Silesia and the maritime port of Szczecin. The state agency navigating the waterway Żegluga na Odrze is the most prominent water carrier, not only on the Oder River itself, but also in the nation as a whole. The Oder River as an international waterway has very little significance. The international exchange of commodities via inland waterways with Poland amounts to only several thousand tons annually, while only 10 percent of all transit through Poland avails itself of this water carrier. It should be pointed out that before the Oder River would be able to play a more eminent role in the transportation system there is a need for additional technological improvements of the waterway and its fleet.

The full development of the Oder as an artery of transportation should be associated today with the concept of general economic benefits to its hinterland. The presence of mineral resources and centers of industry in close proximity to the waterway, in spite of its physical limitations, would allow the river to function as an important link within the transportation system, providing a cheap and efficient means of mass movement. Supplemental

technological improvements on the Oder River tributaries and the linking of the Oder with the Vistula via a canal in the south would tend to extend the hinterland, giving favorable opportunities for the development of traffic. The present east-west connection between the Oder and the Vistula in the north via the Warta-Noteć, and Bydgoszcz Canal is inadequate in respect to the distribution of mineral resources and industry.

The future volume of traffic which the Oder will be expected to haul is in part a function of the size of the hinterland and its predominant economic activity. It is expected that the dominant position of the natural resources on which the heavy industry of Poland in the wojewodztwa Katowice, Opole, and Wrocław is based will persist despite the planners attempt to decentralize it. Therefore, it is likely that the subsequent expansion of industry and the economic development of the five wojewodztwa will rely more heavily upon a fuller utilization of the Oder River as an artery of transportation capable of mass movement.

The Oder waterway needs to be looked upon as a specialized carrier, well adapted to moving large volumes at relatively low costs. However, to reap the full benefits of the advantages would require not only full integration of the Oder River as a mode of transportation within the transportation system but also would require a

greater degree of specialization among other carriers.

The Oder River as an artery of transportation for some time to come will remain a valuable waterway of internal domestic importance and in this direction the investments should be made. Since the location and directional flow of the Oder River is so important, particular attention should be given to its full utilization. The comprehensive exploitation of the river's capacity will considerably release the mounting pressure on the railroad line from Silesia to Szczecin.

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APPENDIX

TABLE A1

INTRAREGIONAL AND INTERREGIONAL MOVEMENT ON THE ODER BY TYPE OF COMMODITY

YEAR: 1968

REGION: KATOWICE

(in tons)

Type of Commodity	Consigned		Received		Balance of Shipment
	Total	Shipment Within Region	Shipment Outside Region	Total	
TOTAL	551,068	. .	551,068	467,201	+83,867
Coal	496,545	. .	. .	. .	. .
Sand and Gravel	. .	. .	. .	133,311	-133,311
Ore	. .	. .	. .	189,367	189,367
Fertilizer	. .	. .	. .	129,183	-129,183
Agricultural Products	. .	. .	. .	284	-284
Wood & Wood Products	. .	. .	. .	. .	. .
Misc. Products	54,523	. .	54,523	. .	+41,143

Source: From the records of the agency Żegluga na Odrze, Wrocław, 1969.

TABLE A2

INTRAREGIONAL AND INTERREGIONAL MOVEMENT ON THE ODER BY TYPE OF COMMODITY

YEAR: 1968

REGION: OPOLE

(in tons)

Type of Commodity	Consigned			Received			Balance of Shipment
	Total	Shipment Within Region	Shipment Outside Region	Total	Shipment Within Region	Shipment Outside Region	
TOTAL	642,523	12,510	630,013	210,579	12,510	198,069	+431,944
Coal	474,354	.	474,354	19,219	.	19,219	+455,135
Sand and Gravel	133,189	10,676	122,513	10,918	10,679	242	+122,271
Ore	.	.	.	124,189	.	124,189	124,189
Fertilizer	89	.	89	30,512	.	30,512	30,423
Agricultural Products	1,834	1,834	.	15,181	.	13,347	-13,347
Wood & Wood Products	.	.	.	3,430	.	3,430	-3,430
Misc. Products	33,057	.	33,057	2,723	.	2,723	+30,334

Source: From the records of the agency Żegluga na Odrze, Wrocław, 1969.

TABLE A3

INTRAREGIONAL AND INTERREGIONAL MOVEMENT ON THE ODER BY TYPE OF COMMODITY

YEAR: 1968 REGION: WROCLAW

(in tons)

Type of Commodity	Consigned			Received			Balance of
	Total	Shipment Within Region	Shipment Outside Region	Total	Shipment Within Region	Shipment Outside Region	
TOTAL	572,944	19,766	553,178	598,467	19,766	578,703	-25,523
Coal	131,190	.	131,190	27,484	.	27,484	+103,706
Sand and Gravel	420,924	19,766	401,158	421,468	19,766	401,702	-544
Ore	1,791	.	1,791	37,091	.	37,091	-35,300
Fertilizer	454	.	454	79,863	.	79,863	-79,409
Agricultural Products	1,764	.	1,764	22,492	.	22,492	-20,728
Wood & Wood Products	16,824	.	16,824	10,071	.	10,071	+6,753
Misc. Products							

Source: From the records of the agency Żegluga na Odrze, Wrocław, 1969.

TABLE A4

INTRAREGIONAL AND INTERREGIONAL MOVEMENT ON THE ODER BY TYPE OF COMMODITY

YEAR: 1968 REGION: ZIELONA GÓRA

(in tons)

Type of Commodity	Consigned			Received			Balance of Shipment
	Total	Shipment Within Region	Shipment Outside Region	Total	Shipment Within Region	Shipment Outside Region	
TOTAL	28,194	. .	28,194	13,959	. .	13,959	+14,235
Coal	. .	. .	. .	9,086	. .	9,086	-9,086
Sand and Gravel	. .	. .	. .	332	. .	332	-332
Ore	. .	. .	. .	779	. .	779	-779
Fertilizer	. .	. .	. .	354	. .	354	-354
Agricultural Products	3,115	. .	3,115	546	. .	546	+2,569
Wood & Wood Products	2,003	. .	2,003	720	. .	720	+1,283
Misc. Products	23,026	. .	23,026	2,142	. .	2,142	+20,884

Source: From the records of the agency Żegluga na Odrze, Wrocław, 1969.

TABLE A5

INTRAREGIONAL AND INTERREGIONAL MOVEMENT ON THE ODER BY TYPE OF COMMODITY

YEAR: 1968 REGION: SZCZECIN
(in tons)

Type of Commodity	Consigned			Received			Balance of Shipment
	Total	Shipment Within Region	Shipment Outside Region	Total	Shipment Within Region	Shipment Outside Region	
TOTAL	715,452	664,958	50,494	1,526,952	664,958	861,994	-811,500
Coal	34,248	16,726	17,522	610,966	16,726	594,240	-576,718
Sand and Gravel	569,407	545,859	23,548	545,859	545,859	.	+23,548
Ore	10,215	10,215	.	168,647	10,215	158,432	-158,432
Fertilizer	2,710	2,710	.	88,846	2,710	86,136	-86,136
Agricultural Products	29,417	26,398	3,019	32,313	26,398	5,915	-2,896
Wood & Wood Products	47,042	43,612	3,430	47,164	43,612	3,552	-122
Misc. Products	22,413	19,438	2,958	32,533	18,814	13,719	-10,120

Source: From the records of the agency Żegluga na Odrze, Wrocław, 1969.

