Review: Inland Waterways

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INLAND WATERWAYS.*

By GEORGE G. CHISHOLM.

WITH the exception, perhaps, of the subject of national characteristics, there is probably no subject on which it is easier and more tempting to generalize rashly than that of transport. And yet the subject is extremely complex. A very great variety of conditions have to be taken into account in determining what is really the most advantageous mode of carriage for any class of goods. In the present paper it is my duty to bring into relief the considerations of a geographical character that affect the problem. But that does not imply that other than geographical considerations are to be left out of account. In no geographical investigation whatever is it possible to proceed without any regard to considerations which must be deemed non-geographical. Even in the surveying of a country for mapping some non-geographical facts are always tacitly, if not expressly, assumed as determining the selection of the superficial features that are to be laid down. Non-geographical considerations are still more obvious in determining the degree of importance belonging to certain facts of local distribution. It is solely, for example, on non-geographical grounds that a high degree of prominence must always be given in geography to the study of climate. The nature of the non-geographical considerations that have to be borne in mind in special investigations varies with the nature of the subject. The subject of the distribution of plants cannot be handled without regard to facts which belong to the sphere of the botanist, that of animal distribution without the knowledge that belongs to the zoologist.

In considering, therefore, the subject of this evening, even from a geographical point of view, it is necessary to begin by pointing out the more important facts of a non-geographical character that have to be taken into account in dealing with the geography of the subject, that is to say, in showing or endeavouring to show how far the utility of inland waterways is affected by local conditions and place relations. It is facts that cannot be called geographical that must determine what local conditions and what place relations are of most importance with reference to the question.

Now, it is fortunate that we are in a position to recognize one important circumstance that greatly simplifies the discussion. In this country, and in all advanced commercial countries, the question is always discussed, at least avowedly, as one of economy. It is not so everywhere, nor has it always been so in our own country. In the part of the Yangtse river where the rapids occur, the substitution of river-steamers or a railway for native junks is resisted by many Chinese on the ground that the numerous Chinese trackers who get a meagre

* Read at the Royal Geographical Society, February 25, 1907.

living by doing some of the hardest work in which human beings can engage would thereby be deprived of that living. I think I remember to have read that a similar objection to new means of transport caused the boatmen of Lech Lomond to break up the first steamboat that was launched on that lake. But we have now got beyond that stage. Such considerations are no longer taken into account in the discussion of rival modes of carriage. The question is one of economy and economy only.

But great difficulties remain. Economy in transport is not determined by the mere difference in the money cost of conveying goods, say, from one town to another. The economy to be considered with reference to transport is that of carrying goods from the place of origin to the place of consumption—the carriage of coal, for instance, from the mines to our hearths, or of wheat from the wheat-fields to our tables in the form of loaves, for the place where the loaf is to be eaten has an important influence in determining where the wheat is to be ground into flour.

Those who think only of carriage from one point to another are much impressed with such figures as these. On an ordinary good waggon-road a single horse-power will draw about 3000 lbs. at the rate of 2 miles an hour, on a railway about 30,000 lbs. at the same rate, on water as much as 200,000 lbs. When it is considered, moreover, that the ratio of the paying load to the dead weight is higher in ships and boats than in road and railway waggons, the advantage in favour of waterways seems overwhelming. Yet these figures are far from settling the question. First, there is the consideration of time. In most cases a speed of 2 miles an hour is not to be thought of. Quickness of transport is becoming every day more important. It is obvious that with rapid means of transport a given amount of capital is more frequently turned over in any business, and manifestly, too, this must be a more important consideration the greater the value that is locked up in the goods carried. Now, by water transport, even under the most favourable conditions, it is nowadays more costly to develop a high speed than it is by land, and there are very few inland waterways that offer those favourable conditions. Still, speed is not equally important in all cases. The greater the bulk of the goods in proportion to their value, the heavier will be as a rule the relative cost of carriage, the more important, therefore, a money saving in transport charges, and the less urgency to that extent for economizing merely in time.

But, further, even in considering different methods of transport between two points on which a waterway is available, it must be borne in mind that great economies in transport are secured by carrying goods in great quantities. It is for this reason that British shippers keep building larger and larger numbers of large ships and increasing the size of those ships, and Americans keep building more and more powerful locomotives for the hauling of long trains composed of huge steel waggons built as light as possible in proportion to the load they carry.

On this ground the utility of a waterway must depend very greatly on its capacity.

Again, only a comparatively small quantity of goods can be conveyed direct by one means of transport from the point of origin to the place of consumption or utilization. They have mostly to be transferred from one vehicle to another. This necessarily involves cost. The cost varies greatly with the nature of the commodities handled, but in all cases it makes it important to avoid this handling as much as possible. In a report advocating a great scheme, which I shall have occasion to refer to again in this paper, it is stated that "a ton of coal is carried the thousand miles from Buffalo to Duluth for about the cost of shovelling it from the side walk into the cellar;"* and though I would not be understood to hint that when coal is handled on a large scale, the cost of handling approaches the cost of finally putting it in the cellar, still this statement is a significant reminder of the importance of this element in the cost of carriage. The advantage to Germany of being able to communicate by rail without break of bulk with all surrounding countries except Russia (where there is a different railway gauge) can be abundantly illustrated from the commercial statistics of that country. It was to secure this advantage that great railways were built across and partly through the Alps, and the numerous trains to be seen even in central Italy (how far south I cannot say from my own observation) containing waggons that have come, if we may judge from the inscriptions on them, both from Austria across the Brenner and from the Rhine valley through the St. Gothard, are a speaking illustration of the same thing. The St. Gothard tunnel had a very speedy effect in developing a trade, even in heavy iron goods, between Germany and Italy, and German coal has been carried into Italy as far as Milan, though whether that trade is still carried on, I am unable to say. Through the courtesy of the Intercontinental Railway Company and of Mr. Ernest de Rodakowski, author of 'The Channel Ferry,' an extremely interesting and instructive work written to advocate carrying on trade without break of bulk between this country and the continent by a method not open to the objections urged against the proposed Channel tunnel, I am able to illustrate this important point by some lantern slides which, I think, will speak largely for themselves.

The first shows how the trade in imported meat is carried on between Southampton and London. The meat, on being taken out of the importing ship, is transferred, not to railway trucks, but to lorries or road-waggons mounted on the trucks. Each truck is capable of carrying 10 tons, but as the pair of lorries has a weight of between 3 and 4 tons, it is clear that there must thus be a considerable addition to the dead weight hauled, even though the trucks are reduced to a simple

* This is no exaggeration. The average freight for hard coal from Buffalo to Duluth in 1904 was about 1s. 6d. per long ton; in 1905, about 1s. 10d.

platform mounted on wheels, and on the return journey to Southampton the whole train is dead weight, as no suitable freight for the carts can be found. Yet the mere saving in handling has caused this mode of transport to be carried on with satisfactory results to the company for about seventeen years.

My second illustration is one of a channel ferry-boat, such as was familiar to me in my boyhood in the early sixties as plying between Granton and Burntisland under the name of "leviathans." The width of the crossing effected by those boats was only 5 miles, but since then the same method of transport has been adopted for crossings up to 96 miles (the widest being from Ludington to Milwaukee, on Lake Michigan). The present view shows the *Solano* on the passage from Oakland to San Francisco, a boat which carries on its four rail-tracks twenty-seven passenger cars or forty-two goods waggons of the ordinary large American type.

The third illustration shows the method by which the trucks are landed on the Warnemünde-Gjedser route between Germany and Denmark, opened on October 1, 1903, with reference to which I am able to give some particulars of direct significance regarding the subject now in hand. In the first place, I am informed that the waggon marked "Breslau" actually came from Breslau, a distance of some 350 miles from Warnemünde, 375 miles from Gjedser, and 480 miles from Copenhagen, for which it was not improbably destined. Now, if it was for Copenhagen, that was a journey on which an all-water route was available, first by means of a river accommodating boats of 400 tons burden to Stettin (305 miles), and then by sea-going vessels. Yet the rail route was preferred. On one occasion on which Mr. E. de Rodakowski accompanied the train, only six minutes elapsed between the arrival at Warnemünde and the departure of the steamer. The goods carried on that occasion were chiefly angle-iron, and I am informed by the London agent of the Intercontinental Railway Company that in the first nine months after the opening of this route 14,000 trucks and 60,000 passengers were conveyed by it; and since train-ferries were first opened for traffic in Denmark, many new industries have been developed to a considerable extent, and heavy machinery, glassware, etc., which in former years were imported into Norway, Sweden, and Denmark from England, are now being sent from Germany on the ferry-steamers.

It is the balance of advantage determined by the two considerations mentioned, the economy of carriage on a large scale and that arising from the conveyance of goods as directly as possible from the place of origin to their destination, that determines in many cases the mode of transport. It is the advantage of transport on a large scale that causes from 40 to 70 per cent. of the pepper, 50 to 60 per cent. of the rubber, and large proportions of a great many other articles imported into this country to be re-exported as they arrive, that causes raw cotton

(Egyptian) to be always one of the leading exports from this country to the United States, and causes Belfast to export directly to foreign countries (or rather to one foreign country) a greater value of raw cotton than all British and Irish goods (including ships) put together. On the other hand, to illustrate the advantage of carrying goods as directly as possible from the place of origin to their destination, I may mention as a typical case that of a paper-mill which I remember to have existed near an east coast fishing-station, not important enough to be entered in the tables of British ports, which got all its supplies of China clay and esparto in small schooners entering the fishing-harbour after voyages lasting for weeks from Cornwall and Algeria respectively. The goods were thus brought within carting distance of a mill which could use the entire cargo. To take a case more immediately cognate to the subject under consideration, the same reason explains why so much English coal for domestic use is carried long distances by rail in comparatively small waggons. It is in that way, and probably in that way only, that convenient lots of the different qualities of coal required can be brought direct from the mines within easy carting distance of everybody's coal-cellar.

Now let us apply these general considerations on the subject of transport to inland waterways and the geographical conditions affecting their utility.

It will now be manifest that inland waterways are likely to be most effective in securing traffic—

1. The greater their capacity.
2. The greater the distance for which they permit of that economy in transport which is due to easier haulage or propulsion.
3. The more direct they are between any two points between which there is a competing means of transport.
4. The more favourable they are to rapid haulage or propulsion, a condition which, for the sake of clearness, it is well to discriminate, even though the advantage under this head is almost inevitably associated with high capacity.
5. The freer they are from such differences in level as necessitate the use of locks or other lifting and lowering contrivances, this being important, not merely in consequence of the loss of time in locking or otherwise changing the level, but in consequence of the additional expense, which varies with circumstances, being in many cases enhanced by the necessity of supplying locking water artificially, or by the impracticability of making locks of large capacity.
6. The smaller the impediments to navigation due to rapidity of current, or the occurrence of low or excessively high water, or ice.
7. The greater the amount of commodities, at once heavy and bulky in proportion to their value, procurable at some point or points on or near the waterway and consumed at other points similarly situated.

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8. The less the expense involved in the handling of commodities, including any expenses arising from damage or the risk of damage to the commodities. All kinds of coal suffer more or less in the severe handling involved in the use of waterways, but the softer kinds of course suffer most. While there is an enormous trade in coal on the great lakes of North America, coke, it is said, will not bear this mode of transport at all on account of the damage involved. Earthenware and glass may be conveyed undamaged in spite of the rough handlings to which they are exposed in water-transport, but the extra care required in packing adds to the expense, and even then the risk adds to the insurance.

9. The smaller the opportunity there is for railway or other competition. Railway competition is particularly formidable, not only because "the hard smooth road" (to adopt the description which Prof. Jevons applied to a railway) allows of far quicker transport than can be effected by any other means, but also because railways with their numerous interramifications offer the possibility of transport without break of bulk to a much greater extent than any system of inland waterways can approach.

If time permitted, illustrations might be given of the special importance of several of these factors in promoting the use of inland waterways; but time does not permit, and I will only say that it seems to me, from the examination I have given to the subject, that if any one of the nine can be singled out as the most decisive in furthering inland water traffic, it is the seventh—the existence of great quantities of bulky produce to be taken up and delivered at individual points on the same or a connected waterway. And yet, singularly enough, by far the most important article of commerce on the most magnificent system of inland waterways in the world is one of great value and small bulk; I refer to the rubber trade of the Amazon, which, it may be remarked, is a water trade solely because there is too little opportunity in that region for trade in bulkier commodities to justify the introduction of railway competition.

In order to realize the possibilities of inland water-traffic it will be well to examine in the light of the foregoing considerations what has actually been done under some specially favourable conditions. For this purpose I am able, through the courtesy of Messrs. Longmans, Green & Co., to show a map of the German waterways,* which to a large extent speaks for itself. It may be added that the improvements sanctioned by the Act of April 1, 1905, are intended to provide waterways on all the sections indicated west of the Oder for barges of 600 tons, on those east of the Oder for barges of 400 tons.

Of all the waterways shown on this map there is probably none

* With regard to the French and Belgian waterways shown in this map, it should be stated that those drawn in thick lines are those with a minimum depth of 2 metres, and that not all of these are navigated by barges of as much as 400 tons.

more worthy of study than the Rhine. It has peculiar advantages under all the heads mentioned except the last, and there is something to be said on the last head also, that is, with regard to the nature of the competition it encounters. It is (1) capacious enough to be regularly ascended by fairly large sea-going steamers as high as Cologne, by smaller sea-going vessels as high as Remagen, about midway between Cologne and Coblenz, and occasionally as high as Oberlahnstein, on the left bank of the Lahn above Coblenz, where they go to load with mineral water. Since the improvements in the gorge at Bingen were completed in 1899, barges of more than 2000 tons have been known to reach Mannheim, and those of 800 tons can reach Strassburg. (2) The distance of Mannheim from Rotterdam by water is 351 miles. The river in a large part of this stretch is (3) remarkably free from windings. The river distance is only 41 miles, about 13 per cent., greater than that by rail. (4) Powerful steamers can be used for carriage or haulage. (5) There are no locks as high as Strassburg, the present limit of Rhine navigation. There is only one to Frankfurt-on-the-Main. (6) Below Strassburg the rapidity of the current of the Rhine offers no serious hindrance to navigation, except perhaps in the narrowest part of the channel at the gorge of Bingen, though it is everywhere sufficient to make a marked difference between the rate of up-stream and down stream navigation.* The geographical conditions also tend to reduce the interruptions to navigation, from irregularity of flow and from ice. The fact that the upper Rhine is partly glacier-fed and lake-regulated tends to limit the variations of high and low water, and the westerly situation of the river is against its freezing. According to an official publication, the navigation of this river "is, on the average, annually interrupted by high water for 8 days, by ice 17 days, by low water 17 days; in all, accordingly, 42 days."† (7) At the mouth of the Rhine is Rotterdam, a world-port, and accordingly a great collecting point for all kinds of commodities, bulky and other. On the banks of the river within Germany, up to and including Strassburg, there are ten communes with a population exceeding 50,000, five of these with

* Some details may be of interest. The average speed of a train of four barges, carrying in all about 4000 tons, is given at 3 to 3½ miles up-stream and 9 to 11 miles down. When the necessary night-rests are allowed for, the voyage from Rotterdam to Mannheim is made in summer in from 8 to 9 days, in winter in from 10 to 11 days; that from Mannheim to Rotterdam, in either case, in about 5 days. Express goods steamers, stopping at intermediate stations, ascend from Rotterdam to Cologne (190 miles) in about 36 hours = 5·6 miles an hour, descend on the return voyage in about 19 hours = 9·3 miles an hour. On the rare occasions on which a long voyage is made without stoppages, a speed of 5·3 miles an hour may be attained between Cologne and Mannheim (161 miles), one of 13·7 miles an hour between Mannheim and Cologne. Nasse, in 'Die Schifffahrt der deutschen Ströme,' herausgegeben vom Verein für Socialpolitik (Leipzig, 1903), vol. 3, pp. 142-3.

† Jasmund, 'Die Arbeiten der Rheinstrom-Bauverwaltung von 1851 bis 1900,' p. 54; quoted by Nasse in the work just cited, vol. 3, p. 138.

one above 100,000, and to these may be added Frankfurt, all great consuming centres for imported grain at least. Further, the river actually divides, below the point to which sea-going steamers regularly ascend, the most productive coalfield on the mainland of Europe, and this fact creates a demand for enormous quantities of imported ores. (8) Among the commodities grain is one that notoriously can be handled with peculiar facility, and ores, too, are comparatively inexpensive to handle. The German coal is, indeed, more liable to be damaged by handling than the harder English coal, but this is not enough to invalidate the overwhelming advantages of the Rhine for a trade in coal of local origin.

These considerations may serve to prepare one for the figures given below, stating in thousands of metric tons (each 2205 lbs.) the total traffic on the Rhine at Emmerich, close to the Dutch frontier, at the adjacent harbours which serve as the outlets of the Ruhr coalfield, and at Mannheim, the terminal point of navigation for the larger craft.

Years.			Emmerich. Passed.		Ruhrort, Duisburg, and Hochfeld. Despatched.		Mannheim. Arrived up.
			Up.	Down.	Up.	Down.	
1895	...	...	4,880	3048	3446	2005	2436
1900	...	...	9,036	4130	6225	2370	3917
1903	...	...	10,028	7211	7154	4615	4251
1905	...	...	12,533	8119	6172	4125	3942

For the sake of comparison, it may be mentioned that the total quantity carried by the Manchester Ship Canal in 1905 was 4,250,000 tons.

And now let us see how those totals were made up. In 1905 the quantity of iron and other ores that passed up-stream at Emmerich was 5,352,000 tons; that of wheat and other grains of the temperate zone, 3,250,000 tons—in all 8,602,000 tons, leaving only 3,930,000 for all other commodities. Coal made up more than half the quantity that passed down. At Ruhrort, etc., coal made up 5,940,000 tons of the 6,172,000 tons sent up, and 3,492,000 out of the 4,125,000 tons sent down-stream. At Mannheim coal and grain together constituted nearly two-thirds of the total quantity received. The quantity of goods sent down-stream was comparatively small—660,000 tons, of which salt formed the most important item.

It is instructive, also, to note some of the commodities carried by water in smaller amount, and for that purpose I have selected four of the raw materials according to the classification of the official report on the inland waterways of Germany. In this case I have taken the Rhine and the Elbe together as the water-avenues to the chief manufacturing districts of the empire.

IMPORTS IN 1905 IN THOUSANDS OF METRIC TONS AND ONE DECIMAL OF A TON,
WITH THE PERCENTAGE IMPORTED BY WATER OF THE TOTAL IMPORT.

	By Rhine and Elbe.	Total.	Percentage by water.
Raw cotton	73.9	402.9	18
„ wool	40.4	165.1	24
Flax, hemp, and tow	70.2	140.6	50
Hides, skins, peltries, and leather	27.7	170.3	16

The only one of the four of which a large proportion is carried up by water is flax and hemp, and this may be accounted for in two ways—first, by the fact that this is much the least valuable of the four in proportion to its bulk; and, second, that the Elbe, by which the bulk of the import takes place, carries this commodity such a long distance on the way to the chief seats of manufacture in the eastern part of the kingdom of Saxony, the adjoining districts of Silesia, and the Austrian province of Bohemia.

The water-traffic of Berlin is also instructive. At last census the population of Berlin was upwards of two millions. The city is connected by waterways with the ports of Hamburg and Stettin, and up-stream with the river-port of Kosel, in the vicinity of the Prussian coalfield which ranks next in importance to that of the Ruhr basin. The Hamburg route has been navigable since 1894 for vessels of 600 tons burden, and on that route there are only three locks. The waterway up to Kosel has been available since 1897, in ordinary states of the river Oder, for barges of 400 tons. Owing to the comparatively small depth of the Finow canal, at present $4\frac{1}{4}$ feet, and the number of locks upon it, 17, the Stettin route is the least commodious of the three. In 1905 the total quantity of goods, including floated timber, delivered at Berlin by water, was 7,364,000 tons; and it is noteworthy that the total quantity despatched was less than one-eleventh of that, even though the shippers must obviously have every inducement to take return freight at the lowest possible rate. Of the goods delivered, those entered under two headings: (1) bricks, tiles, pipes, and other articles of baked clay, and (2) earth, loam, sand, limestone, and chalk, made up more than 57 per cent. of the total. These commodities are almost entirely of local origin. The third commodity in respect of percentage is coal, and the addition of it brings up the total proportion belonging to the first three commodities to nearly 73 per cent. The coal is partly Silesian, partly English, but in spite of the advantages afforded by the Oder, in 1901 only about 35 per cent. of the Upper Silesian coal sold in Berlin and its suburbs arrived by water.* In recent years, the

* 'Die Störungen im deutschen Wirtschaftsleben während der Jahre, 1900 ff.,' 2 ter Band, *Montan- und Eisenindustrie* (Leipzig: Duncker & Humblot, 1903), p. 157.

quantity of English coal reaching Berlin by Stettin and the Finow canal has been greater than that arriving by water from Silesia, in spite of the inferiority, and consequently greater expense, of the Finow route; one important difference in favour of the Stettin-Finow traffic being that the English coal necessarily arrives at the waterway in bulk, and has not to be brought down to it like the Silesian coal from the several mines. The coal brought to Berlin from Upper Silesia is chiefly for use in the large works alongside the waterways. For the reason already indicated, domestic coal comes mainly by rail. The same reason that keeps down the proportion of coal using the waterway from Silesia to Berlin, causes the great bulk of the Westphalian coal that comes to Hamburg to go by rail. Even the opening of the Dortmund-Ems canal, which was constructed expressly for the purpose of providing a water outlet for the coal of the Ruhr basin, has done little to develop that trade. The total quantity of goods carried down that waterway to the port at its mouth (Emden) in 1904 was just under 190,000 tons, of which 97,000 tons was coal; in 1905, 224,000 tons carried down, of which 68,000 tons was coal. Up-stream from Emden there passed, in 1905, 475,000 tons, of which 258,000 tons consisted of iron ores.

Those who advocate the improvement of existing waterways and the construction of new ones, very often lay great stress on their value as a means of carrying local agricultural produce and manufactured goods specially for export. It will, therefore, be worth while to consider what is achieved by the German waterways under these heads. For the consideration of the efficiency of waterways as carriers of agricultural produce, Germany affords no better subject of study than the great consuming centre of Berlin. Elaborate tables* drawn up in a work already quoted, written in the interest of the German waterways, enable us to make comparisons on this head. The raw agricultural products most largely carried by water to Berlin are the chief bread-grains of Germany, rye and wheat, and, on the average of the years 1896-9, about 69 per cent. of these were received by water, about 31 per cent. accordingly by rail. But nearly all this was foreign grain collected at the seaports. A different tale is told by the figures relating to potatoes. In 1899 the proportion conveyed to Berlin by water was less than 2 per cent. In fact, an examination of the data regarding the trade in agricultural products generally bears out the truth of the general statement made in the work just cited,† that “the raising of agricultural products always presupposes a relatively extensive area of production, and is thus a decentralized industry, on which account, in the great majority of cases, it is only the railways that come into consideration with reference to their transport.”

* ‘Die Schifffahrt der deutschen Ströme,’ vol. 1, pp. 185 and 238-245.

† Vol. 1, p. 152.

Of manufactured articles carried by waterways, the only one of importance as regards quantity, except on the Elbe, on whose banks there are large centralized industries concerned in the refining of sugar and the manufacture of fertilizers, are iron and iron wares. Now, in 1905, of the raw and scrap iron conveyed to the seaports or across the German frontier, only about 25 per cent. was carried by water, 75 per cent. by rail, and all but a small fraction of the quantity carried by water went by the Rhine, that carried by the Dortmund-Ems canal being utterly insignificant. Of the iron and steel manufactures of all kinds similarly carried, the share of the waterways was about 40 per cent., that of the railways 60 per cent., and in this case again the share of the Rhine made up the great bulk (more than 95 per cent.) of the total water-borne traffic. That of the Dortmund-Ems canal was little more than 2 per cent.

So far we have considered only the really effective waterways of Germany, but some of the minor ones are also worthy of attention. For example, there is the celebrated Ludwig's canal, a waterway 5 feet deep, connecting, with the aid of other waterways, the Rhine and the Danube. What does it do? It carries on a trifling and dwindling amount of traffic, chiefly centred, as is natural, at Nuremberg, where, in 1905, the total quantity of goods received and despatched by it in both directions was much under 50,000 tons. At Kelheim this canal passed into the Danube 4637 tons of goods, chiefly timber; from the Danube towards the Main, 676 tons. Then there is the Ruhr, which flows through the great German coalfield to the Rhine, and can take barges of 165 tons—that is much larger than the great majority of English waterways. In this case it is worth while noting what it once did, as well as what it now does. In 1860 it carried in all 900,000 tons of goods, of which coal made up 868,000 tons. In 1905 it carried 1431 tons of stone down stream, and nothing up.

The result was due to railway competition, which comes under the ninth of the geographical considerations above enumerated as affecting the utility of waterways. And now it may be remembered that this is a subject on which, I have intimated, something remained to be said in connection with the traffic on the Rhine. That traffic is carried on against a good deal of railway competition. In the narrower part of the Rhine valley there is a double line of railway on either bank of the river, and there are more railways running in the same direction higher up. But the competition is not equal, I mean, not based solely on the merits of the two methods of transport. For, in the first place, the German state railways are admittedly not worked on the principle of offering the most effective opposition possible to the waterways; and, on the other hand, the states adjoining the Rhine have spent some £8,000,000 in bringing the navigation of the river to its present condition, and have handed over the river to the shippers free of toll. And

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yet even under these conditions some of the shipping companies in a recent period had very bad times. In 1902 eight out of nineteen companies paid no dividend. In 1903 four paid none. Under the recent Act for the improvement of the waters it is declared that when those improvements are carried out, or rather when the Rhine-Weser canal or a section of it has been brought into operation, all those rivers on which the state has spent money in the interest of the navigation shall be subjected to such tolls as shall serve to pay a suitable rate of interest on the outlay and something towards the amortization of that outlay. This enactment has caused many of those who insist most stoutly on the advantages of water-transport, to cry out with dismay that the rivers will not be able to stand such a burden. "For the human soul," says George Eliot, "is hospitable, and will entertain conflicting sentiments and contradictory opinions with much impartiality."

Let us now turn to America. The experience of that part of the world is not without instruction for us, even though the conditions under which most of the inland water-traffic is there carried on are even more unlike those in our country than the conditions in Germany. The bulk of that traffic is the traffic of the great lakes, and so far as that is confined to the great lakes it corresponds, not to our inland water-traffic, but to our coasting trade. By far the greater proportion of it is so restricted. But the great lakes also form part of two waterways from the interior to the seaboard, one Canadian and the other belonging to the United States. The Canadian is of course that of the St. Lawrence, leading to Montreal, and has peculiar advantages for carrying on an export trade in grain. Since the completion, in 1899, of the improvements on the St. Lawrence there has been a minimum depth of 14 feet on the entire waterway. At the head of the route are the enormous grain—above all wheat—collecting points of Fort William in Canada and Duluth and Chicago in the United States. But as against these advantages it has to be remembered that the route is closed by ice for about five months or more every year. In spite of this drawback the waterway carries on an average much more than half the grain carried eastwards to Montreal. In the thirteen years, 1893 to 1905, the water-borne proportion varied from 83 to a little more than 47 per cent., this minimum having been the limit of a regular decline in the proportion of grain so carried from 1895 to 1901. By 1905 the proportion of water-borne grain had risen again to nearly 72 per cent., but in this we may probably see the effect of the abolition, in 1903, of tolls on all grain carried through both the Welland and the St. Lawrence canals, though a toll of 10 cents (say 5*d.*) a ton is still levied on all grain that passes through the St. Lawrence canals only. The meaning of this discrimination obviously is that on the heavy long hauls the railway is able to offer very effective competition even with this advantageous waterway.

The success of this waterway has long ago inspired the Canadians

with the idea of taking advantage of the geographical conditions to create a more effective waterway, offering the recommendations both of a shorter route and greater depth. This project is what is known as the Ottawa and Georgian bay scheme. The promoters of this scheme urge that by deepening in places the river Ottawa, by utilizing Lake Nipissing and its outlet the French river leading to Lake Huron, and by constructing the necessary canal connections, a waterway running nearly due west from Montreal would be substituted for that which first ascends a long distance to the south-west and then turns northwards. In that way a saving of about 340 miles in the voyage to and from the higher lakes would be saved. Further, of the total length of 425 miles on this new route 307 miles would be made up of river and lake naviga-

NEW YORK STATE CANALS Constructing under a Law of 1903.

tion needing no improvement to admit of its being navigated by vessels of 20-feet draught. A committee of the Dominion Parliament has recommended the carrying out of the scheme and the adoption of a depth of 22 feet for the whole route. One drawback, however, is unavoidable on this proposed route. In consequence of its northerly situation, there would be only a very short season after harvest in which it would be free from ice.

The United States waterway which continues to the seaboard the navigation of the great lakes is the Erie canal with the Hudson river. This has the advantage of being connected with a much more important seaport than the St. Lawrence route, but, on the other hand, is much inferior as a waterway. It has at present a depth of only 7 feet, and the maximum size of the barges which make use of it is only about

250 tons. In this case, accordingly, we find that the railways are able to compete with the waterway much more effectively than in Canada, even though the canal is maintained by the state entirely free from tolls. On this head, however, one instructive difference may be noted between the practice in Germany and that both of Canada and the United States. In these two countries the railways that compete with the waterways are all private undertakings, and do all they can to compete with their rivals in the most effective manner. The result is that of the total amount of grain carried to New York in 1905 about 92½ per cent. was transported by rail as against some 6½ per cent. by water. In recent years, the actual quantity of goods of all kinds carried by the Erie canal has greatly diminished—from a maximum of 4·6 million tons in 1880 to less than 2 millions in 1904. And this was mainly made up of local traffic. The amount carried by the canal to tide-water in that year was considerably less than one million tons. In 1880 all the canals of the state of New York carried rather more than 25 per cent. of the total traffic of the state, in 1904 less than 5 per cent. In order to restore, if possible, the efficiency of the waterways, the state is now spending about £21,000,000 in making a canal with branches with a depth of 12 feet, and capable of accommodating barges of 1000 tons, on the routes shown on the accompanying map.

Of the natural inland waterways of the United States, in addition to the great lakes, the Mississippi offers advantages for traffic of a kind to which not merely our own country, but the whole continent of Europe, can offer no parallel. Yet it is a very striking fact that even on these the ordinary steamer traffic has shown a great decline. No general statistics have, I believe, been collected since 1889, but the tenth and eleventh censuses of the United States allow of a comparison being made between the total traffic of 1880 and that of 1889, between which years the total amount of traffic carried on steamers in the Mississippi valley generally sank from 13·6 to 10·3, that on the Ohio from 9·2 to 3·8 millions of tons. In 1901 the total quantity of goods received at New Orleans from the interior was less than 5 per cent. of that received by all routes.* Still, from the Mississippi and Ohio we can obtain illustrations of the kind of traffic in which good waterways are even now successful. St. Louis is a great collecting point for grain. In 1903 more than 80 per cent. of the wheat and about 40 per cent. of the maize despatched thence for export to New Orleans went by river, and by this route rates for wheat on through bills of lading to Liverpool are only about two-thirds of those by way of New York.† Yet the facts, even of this trade, give us a hint also of what waterways fail to

* See the data in the Foreign Office Report, Annual Series, No. 2752, pp. 4, 5.

† Foreign Office Report, Annual Series, No. 3202, pp. 48, 49.

do, for only about one-seventh of the wheat and one-thirteenth of the maize exported in that year from New Orleans came to the port by water.

But the grain-trade of the Mississippi is largely, and the still greater coal-trade of the Ohio-Mississippi almost wholly, carried on in a peculiar manner possible only in very wide, though not necessarily very deep, rivers. It is by means of what are called tow-barges—that is, a number of barges firmly lashed together and pushed onwards by means of a stern-wheel steamer. The coal is all brought from the Ohio and its feeders, the Monongahela and the Great Kanawha, the first of which is one of the two headstreams of the Ohio which meet at Pittsburg, while the other joins the main stream in West Virginia. At Pittsburg tows of barges drawing 8 feet are made up, carrying from 10,000 to 15,000 tons of coal. They may have to wait for a sufficient depth of water before proceeding on their way to Cincinnati and Louisville. At Louisville two or three Pittsburg tows may be made into one, carrying from 35,000 to 40,000 tons. Even one of 70,000 tons is on record. One carrying 40,000 tons, Prof. Johnson tells us, is about 10 acres in extent.*

At the same ratio, one of 70,000 tons would extend over $17\frac{1}{2}$ acres—say 140 by 600 yards.

It is boasted that this is the cheapest mode of inland carriage in the world, and yet even this traffic, which increased enormously between 1880 and 1889, would appear to be now declining in the aggregate, and is certainly not keeping pace with the enormous progress of the American coal trade generally. In 1889 the total amount of freight carried on the Ohio was officially returned at above 16,000,000 tons, of which tow-barge traffic made up considerably more than 12,000,000 tons. In a consular report for 1905, the total traffic of all kinds was estimated at 11,000,000 tons,† and the figures in the official returns for the coal trade

* Emory R. Johnson, 'Ocean and Inland Water Transportation' (London: Appleton, 1906), p. 364.

† For. Off. Rep., Ann. Ser., No. 3622, p. 35.

of the Great Kanawha in recent years are at least not progressive.* This, no doubt, is the cause of the demand made by those interested in the Ohio navigation for the improvement of that river by the Government of the United States, so as to afford a minimum depth of 9 feet at low water, a demand to which the Government has so far acceded as to obtain from Congress appropriations for a survey of the entire river for that purpose.

But a still greater project is now being agitated, one, namely, for the creation of an uninterrupted waterway of 14 feet in depth from Chicago to Orleans, so as to allow of loaded sea-going vessels passing from the one port to the other. An association, known as the Lakes-to-the-Gulf Deep Waterway Association, has been formed to carry out this scheme, and I am informed by its secretary that its total cost is estimated at about £14,500,000. Part of the proposed waterway would be formed by the Chicago Sanitary and Ship canal, connecting Chicago with the Des Plaines river, a canal with a minimum depth of 14 feet, begun in 1892, and now approaching completion. This canal the trustees of the Sanitary District of Chicago propose to hand over to the general government on condition that it completes the projected waterway; but when one considers that the 42 miles of this canal, when completed, will have cost about £11,500,000, the total estimate above given must surely be rather sanguine.

Such a project as this may at least serve to give an idea of the enthusiasm which inland waterways inspire in the minds of some people, but is not fitted to afford any guidance in the study of English waterways, and to these it is now time to devote attention. With reference to the special subject of this inquiry, namely, the influence of geographical conditions on rail and water transport, there are few countries, if any, in which the facts are more worthy of study than our own, seeing that in this country the two means of transport have been left to fight it out between themselves, with little interference on the part of the State. It has been the general rule in other countries, as in Germany and the United States, for the State to intervene on behalf of the waterways. In this country the only way in which the State can be said to prejudice the railways in the contest is in insisting, in the case of those canals which have become railway property, that the canals shall be maintained whether the railway can work them at a profit or not, and that the owning companies shall, at the demand of traders, quote rates subject to State regulation. I would not be understood to assert that this is undue interference on the part of the State. I merely mention it as at least a fact that should be recognized.

And here I may point out that the existence of railway-owned and

* See the Annual Report of the Chief of the Engineers of the War Department of the United States for 1905, vol. 6, part 2, pp. 1886-7.

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railway-controlled canals in this country introduces another geographical consideration, although only of a secondary order, by which I mean one not originally given or mainly determined by nature. Once established, however, the nature of the ownership may have geographical effects, and it is at least incumbent on us to inquire whether it has such or not. For that reason several canal maps have been drawn up in which the distinction of ownership or control is indicated, and one of these I am now able to show through the courtesy of Messrs. Longmans, Green, & Co. On this map, it should be noticed, the canals are distinguished, not as railway owned and independent, but as railway controlled and independent; for this makes an important difference, inasmuch as the Birmingham Canal Navigation belongs to an independent company. This, however, is a mere dividend-receiving company, the dividend being guaranteed by the London and North-Western Railway Co., which under an old agreement with the canal company controls the navigation.

This map also, following the well-known map of Mr. Lionel Wells, makes an attempt to distinguish the canals in respect of their capacity, and it will be noticed what a large proportion of them are small waterways of less than 4 feet in depth, many being not merely shallow but narrow and capable of being used only by what are known as narrow boats.*

Further, on this map an attempt has been made to indicate the effect of inequalities of level on inland navigation. In one respect the most satisfactory maps that have been published, so far as I know, giving indications under this head, are the large maps showing the waterways of England and Wales, of Ireland, and the Scottish midlands respectively, attached to the paper "On Waterways in Great Britain," read in November, 1905, by Mr. J. A. Saner, M.INST.C.E., to the Institution of Civil Engineers, of which the author was good enough to favour me with a copy. These maps show the waterways in relation to the physical features as indicated by contour-lines and intervening colouring. It is to be regretted, however, that they do not give the number of locks on the different waterways, which the scale of the maps would have made comparatively easy. Of the difficulties presented by English canals the best idea may perhaps be obtained from the sections published in Mr. E. A. Pratt's 'British Canals.' On the map now shown the number of the locks on different canals and waterways, or sometimes on sections of canals, has been given in figures, but the map is on rather a small scale for that to be done quite satisfactorily. It will, however, at least serve to keep us in mind of the

* The work affording the most complete information about English waterways under this and all other heads connected with their use, is Bradshaw's 'Canals and Navigable Rivers of England and Wales,' by H. R. de Salis (London, 1904).

fact that in this respect English waterways mostly suffer from great drawbacks.

It may be worth while to examine some of the more important canals separately with reference to this point. It will be noticed that there are three waterways connecting South Lancashire with the West Riding of Yorkshire, and, accordingly, crossing the Pennine chain; two of them independent canals, the third railway owned. The most important of these is the Leeds and Liverpool canal, the northernmost of the three, which, it will be observed, has fifty-one locks on the one side, forty-four on the other. It has, however, the easiest route of the three, going through the important feature which Mr. Mackinder has well called the Aire gap, at the height of only 477 feet above sea-level. The Rochdale canal, the next to the south, rises above 500 feet, and the Huddersfield canal reaches its summit, 656 feet, in the Stanedge tunnel 3 miles long. In the Harecastle tunnel, 4 miles north-west of Stoke, the Trent and Mersey canal attains a height of 460 feet. Birmingham is connected with the Thames by a waterway which starts at 380 feet above sea-level, sinks to 180 feet in the valley of the Avon, and rises again to 390 feet where it passes through the Chilterns; and with the Severn by one starting at 425 feet above sea-level, and making a rapid descent of about 250 feet in 3 miles after passing through the Tardebigge tunnel.

It has also to be noted that, in addition to railway competition, the inland waterways of this country have to encounter that of the coasting trade, and when all the drawbacks of English waterways are considered, it is not too much to say that in proportion to their capacity as regards volume and speed, the work done by them compares very favourably with that done by the waterways of other countries with which it is reasonable to make a comparison. In the absence of ton-mile statistics no satisfactory comparison can indeed be made under this head; still, it may be not altogether useless to mention that the tonnage carried by the waterways of England and Wales, according to the returns for 1898,* was larger than that carried by the waterways of France, Belgium, Germany, or Russia, for the nearest year for which I happen to have the data (in no case more than three years from 1898). England and Wales, moreover, have no waterway like the Ruhr, capable of carrying 165-ton boats and passing through a coalfield, yet carrying next to nothing. The 113,000 tons carried in 1898 by the Kennet and Avon canal and river Avon (railway controlled, be it observed) compares very favourably with the small traffic of the Danube-Main or Ludwig's canal.

The first question, therefore, to ask is, How is it that our poor waterways accomplish so much? and unquestionably the answer is, Because this country has such large quantities of bulky goods originating or

* 'Returns in Respect of Canals and Navigations in the United Kingdom for 1898. [Cd. 19], 1899.

collected at some point on a waterway and requiring to be transported to some other point on the same or a connected waterway.

We may next ask how this traffic is divided between the independent and railway-controlled waterways. In making this comparison, I leave out the sea-borne traffic of the Manchester Ship canal, which is obviously not on the same footing as ordinary inland water-traffic, and I omit the Manchester Ship canal proper in stating the total length of the canals. On this basis we find that the 2016 miles of independent canals carried in 1898, in round numbers, 22·5 million tons, the 1118 miles of railway-controlled canals roughly 13·5 millions. These figures would seem to tell rather in favour of railway control, but, of course, it would be absurd to draw such a conclusion. Such general comparisons throw no light whatever on the question. It will be more profitable to look at the facts relating to some of the individual navigations.

That which carried by far the greatest amount in that year was the Birmingham Canal Navigation, a miserable narrow-boat system of waterways which wind about and rise and fall in South Staffordshire and the neighbouring parts of adjoining counties. But it is their situation that explains their pre-eminence, the large towns and the mines and quarries of this district supplying and requiring large quantities of bulky produce, such as is indicated in the following table, one column of which is taken from the returns already cited, and the second kindly supplied to me by the clerk to the Navigation :—

THOUSANDS OF TONS CARRIED BY THE BIRMINGHAM CANAL NAVIGATION.

	1898.	1905.
Coal	4543	3786
General merchandise	1340	1336
Bricks	846	612
Road materials and manure	655	769
Pig iron	523	434
Ironstone and cinder	478	411
Sand	139	135
Lime and limestone	103	63
Total	8627	7546

The "general merchandise," I am informed, is broadly composed of grain, timber, and manufactured goods generally.

The waterway ranking next after the Birmingham Canal Navigation in respect of the volume of its traffic is the Aire and Calder Navigation. Here we have a much better waterway, throughout above 6 feet in depth, with much fewer locks, and, moreover, with large quantities of one bulky commodity (coal) to collect at or near its upper terminals, Leeds and Wakefield, and discharge into ships at its lower end, Goole. This trade has also been greatly promoted by the ingenious contrivances for dealing with this commodity devised by the engineer to the canal, Mr. W. H. Bartholomew, M.INST.C.E. The coal is carried in so-called

compartment boats, really segments of a boat, each carrying 35 tons of coal, and formed into a train which is preceded by an empty segment shaped like the prow of a boat, all drawn by a tug. On the arrival of the train at Goole, each compartment is hoisted up in order that its contents may be tipped into the hold of a ship, and on the return of the train the separate compartments are hauled out of the water on rails to be taken to the collieries for refilling.

Time fails us for the examination of other important English waterways, but attention may be drawn to two railway-controlled canals which carry a great deal of traffic, though not with such satisfactory results as the Birmingham Canal Navigation. One of these is the St. Helen's or Sankey Brook canal,* belonging to the London and North-western Railway Company. It is above 6 feet in depth, and runs from the great chemical and glass manufacturing town of St. Helens to the Mersey. In 1898 it carried above 380,000 tons of river sand, chemicals, limestone, sugar, and other produce, but at a loss to the company of £835. It is difficult to conceive what motive the company could have for carrying all this at a loss, if in any way it could contrive to carry it at a profit. The other is a very remarkable and instructive case in more ways than one. It is that of the Swansea canal,† which lies in the valley of the Tawe, and in $16\frac{1}{2}$ miles ascends 333 feet by means of 36 locks. In spite of these adverse circumstances, the canal carried in 1898 192,000 tons at a small profit to the railway company. The explanation is found, however, in the account of it given in the Returns for 1898, where the canal is described as "passing through or alongside the various works—copper, silver nickel, tin-plate, and other works, also collieries, quarries, etc." But the instructiveness of this example does not end here. In 1898 the goods stated to have been carried by this canal in order of importance were coal, ores, and pitwood. The manager of the Great Western Railway Company has been good enough to inform me that in 1905 the total tonnage carried by this canal was only 123,000 tons, and that the decrease in traffic was mainly due to the fact that, consequent upon the provision of rail access to a large colliery company's works, that company's output, which formerly passed by the canal, was now all carried by the Midland Railway, and that it was understood that the colliery company had disposed of its water-carrying plant. The coal at present carried by the canal amounts to less than 6000 tons per annum, and I am assured that, as might be expected, practically the whole of the canal traffic arises at, or is destined for, places in the vicinity of the canal. Now the traffic is carried on at a loss, and in this case it is still more difficult to conceive what inducement the company has to suffer that loss if it can prevent it.

* This is the canal shown on our map by five large dots to the north of the Mersey.

† This canal, inadvertently shown on the map by a continuous instead of a dotted line, is the western of the two canals converging on Swansea.

There can be no question, however, that in some cases it must be the interest of the railways to check the development of canal traffic. If the facilitating of traffic on a canal belonging to a railway would tend to divert traffic to other canals instead of the railway, it is in accordance with ordinary business human nature that the railway should be unwilling to grant such facilities, and it is largely on this account that the principal schemes for canal improvement in this country hinge upon the Birmingham Canal Navigation. That, of course, is not the sole reason. The concentration of a mining and industrial population on the area served by that canal affords one of the important conditions favouring through traffic by water to the coast. In the paper already referred to M. Saner has propounded a scheme for connecting this area with the ports of Liverpool, Hull, London, and Bristol by canals capable of being navigated by lighters of 250 tons carrying capacity. But suppose, as Mr. Vernon-Harcourt suggested in his criticism of that scheme, a beginning were made with a project of more modest dimensions, "the actual enlargement of the most promising canal, such, for instance, as the Worcester and Birmingham canal," let us consider, in the light of what has been set forth, what would be the prospects of traffic on that improved waterway to the sea. The Birmingham area, it may be admitted, is more promising for canal traffic than Berlin. It is rather to be compared with a portion of the area of the Ruhr coalfield. Still the waterway thus provided would be no Rhine. It would not even be equal to the Dortmund-Ems canal, the disappointing results of which we have already seen. When all the circumstances are considered, the probability is, it seems to me, that nearly all the commodities enumerated above as making up the water-traffic of the Black Country would still continue to form merely local traffic. Not improbably there would be some development in the carriage of iron manufactures to Bristol, a development hindered, as compared with the Dortmund-Ems route, by the inferiority of the waterway, but relatively favoured through the superiority of the seaports with which Birmingham would be connected. In return there would not improbably be a certain trade in ores, how great it would be difficult to estimate, but so far as it went it would no doubt be a gain to the district. From the experience of Berlin and Germany generally, we may take it as settled that the improved waterway would do little to promote the trade in English agricultural produce. On the other hand, it would help to increase the competition of foreign and colonial produce of that kind with that of home production. Those, therefore, who advocate the spending of public money on canals ought to consider whether this trade, among others, is one that it is desirable to promote by special bounties, such as an unremunerative state-built canal would constitute.

Before the paper, the CHAIRMAN (Colonel G. E. CHURCH, Vice-President): This evening we have a lecture on an extremely interesting subject—Inland Waterways