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Inland water transport in Poland

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Abstract

Water transport is also the most energy effective means of transportation. Diesel consumption by inland waterway for every 100 tonne-kilometres is lower than for other modes of transport – rail or road.
It can be assumed that the main driver of demand for container transport on inland waterways in Poland will be cross-docking in seaports with Polish supporting facilities (including in western European ports). Based on available forecasts it is assumed that level of cross-docking at maritime container terminals in Gdansk and Szczecin – Świnoujście port complex accessible to inland waterway transport will develop by 2027 at 2.57 million TEU per year. Inland waterways could potentially participate in handling the transport of these cargoes to business support facilities (competing with road and rail transport).

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1. Is inland waterway transport innovative?

Innovation is any change that improves something, giving it a new quality, or allowing the creation of a new product or service. Joseph A.Schumpeter in his definition of innovation focuses on new combinations of production factors. In his view, innovation is the introduction of new products and new methods of production, the opening of

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a new market, the acquisition of new sources of raw materials, and finally the implementation of a new means of organising business processes.

Inland water transport developed in ancient times, when in the 25th century BC the Nile was used to transport building materials for the construction of the pyramids at Giza. It was also used in Poland many centuries later. During the early middle-ages, the Vistula was used as a waterway to transport mainly salt, both upstream, imported from Gdańsk, and downstream, from the mines in Bochnia and Wieliczka and from Ruthenia. Later on, copper was transported down the Vistula on boats from mines located in present-day Slovakia. In turn, the end of 19th and beginning of 20th centuries saw the rapid development of the Oder Waterway. It was then that the stretch from Koźle to the mouth of the Nysa Kłodzka was canalised and 12 barrages were constructed with locks. In the years 1907–1922, as part of the second stage, a further 10 barrages were constructed. In 1973, approximately 2900 boats passed through the lock in Brzeg Dolny going upstream and the same number downstream (statistical data, Regional Water Management Authority Wrocław).

So what makes it worthwhile looking at this traditional, and seemingly not very innovative, means of transport?

2. The benefits of inland waterway transport

Before I discuss the undoubted advantages of this type of transport, I should briefly mention its main weakness, namely its slow speed.

In today's world, where the emphasis is on time, one cannot usually permit the delivery of a product after a few days or a few weeks. The Antwerp – Bonne route is covered by barges in 3 days, while the Rotterdam – Avelgem route takes 18 hours. In the case of road transport, the 230 km from Antwerp to Bonn can be overcome in less than three hours, just like the 201 km from Rotterdam to Avelgem (http://www.containerafvaarten.be). In the current world, this slow speed is undoubtedly a drawback for water transport.

Of course, the delivery of goods can be planned to take into account the longer time needed for their transportation. This is what happens with transport by sea – it does not pay to transport all goods by air. However, in most cases, goods must be delivered quickly on a specific date. In this case inland waterway transport loses out to road, rail or air transport.

In Poland, in 2014 out of a total amount of 1,840 million tonnes of cargo – 1,548 million tonnes were transported by road transport, 228 million tonnes by rail, 50 million tonnes by pipeline, 7.6 million tonnes by inland waterway transport and 6.8 million tonnes by sea transport (Transport. The results of activities in 2014, Central Statistical Office of Poland [CSO]). Inland water transport accounted for only 0.41% of total transport.

However, there are products, for which it does not pay or which are even impossible to transport by road or rail. These are bulk goods, including containers and bulky items.

2.1. Bulk goods and large sized cargoes

At present, most of the goods transported by inland waterway in Poland is made up of bulk goods. The most important products transported by inland waterways in Poland are sand, gravel and coal and other mining and quarrying products. These goods account for about 66% of the cargo carried by inland waterways in Poland (in the EU they constitute less than 30% of cargo transported).

A considerable share of inland water transport in Poland is taken up with the transport of large sized and non--standard sized cargoes. In the case of cargoes, such as ship hulls or equipment for the power sector, inland water transport has a significant advantage over road or rail transport.

2.2. Containers – the objective of inland water transport in Poland

Containers have a significant and growing share in transport by inland waterways in Europe. In 2013, ships transported 533 million tonnes in total (Transport of goods by type of transport – 1000 tonnes 2013.png, Eurostat, 04.08.2014), of which approximately 8% was transported in containers (4.5 million TEU[1]).

Unfortunately, in Poland containers are absent as a cargo on inland waterways. There are many reasons for this. The lack of specialised ships is one of them, another is the lack of loading and unloading facilities for containers in Polish river ports. In addition, seaports are also not suited to loading and unloading containers on inland waterway vessels. However, the main reasons that make it difficult and sometimes even impossible to use inland waterways are the low clearances under bridges, which limit the possibility of stacking containers on vessels and negatively affects the profitability of their transport, and the unsatisfactory parameters of inland waterways – insufficient transit depths and small radii in bends on routes.

2.3. Economic benefits

Inland water transport is one of the cheapest modes of transport. It is characterised by:

- Low energy consumption, where the ratio of energy consumption to transport work is 1/10;
- Low external costs;
- Low number of accidents.

Water transport is the most energy efficient form of transport. Diesel consumption by inland waterway transport for every 100 tonne-kilometres is lower than for other forms of transport, such as rail or car.

According to German and EU data, the external costs of inland water transport is many times less than for other forms of transport. The external cost of transport using inland waterways for 1000 tonne-km is 19 euro less compared to the same transport by road (Wojewódzka-Król K., Rolbecki R., Proposal for a strategy to develop inland waterways in Poland).

In Table 1 below, taking as the baseline the parameters for water transport, a comparison has been made of the external costs of the three branches of transport: water, road and rail.

Table 1. External costs of various forms of transport.

Form of transport	Costs of air pollution	Noise costs	Costs of accidents	External costs per 1000 tonne-km
Inland waterways	Baseline (1)	Baseline (1)	Baseline (1)	< 5 euro
Road	7 times more	70 times more	178 times more	24.12 euro
Rail	no data	87 times more	12 times more	12.35 euro

Source: Prospects and barriers to the development of inland water transport in the context of reducing CO_2 emissions and energy savings – Ministry of Infrastructure, 2009. The results of tests performed by ADEME and the German Institute for Energy and the Environment.

2.4. Impact on the environment

According to a study by ADEME – the French Agency for Energy Management and the Environment and the German Institute for Energy and the Environment (see Table 2) it can be seen that water transport is the most economical and environmentally friendly form of transport when compared to other forms of transport.

[1] TEU – twenty-foot equivalent unit.

Table 2. An economic and environmental comparison of forms of transport.

	Number of km completed with a consumption of 5 litres of fuel and a cargo of 1 tonne.	The amount of cargo transported a distance of 1 km with fuel consumption of 1 litre	Number of grams of CO_2 emitted per tonne-kilometre
Inland water transport	500 km	127 tonnes	33.4 g/tkm
Rail transport	333 km	97 tonnes	48.1 g/tkm
Road transport	100 km	50 tonnes	164 g/tkm
Air transport	6.6 km	no data	no data

Source: Prospects and barriers to the development of inland water transport in the context of reducing CO_2 emissions and energy savings – Ministry of Infrastructure, 2009. The results of tests performed by ADEME and the German Institute for Energy and the Environment.

The above table shows that water transport emits approximately 5 times less carbon dioxide per tonne-km of distance travelled than road transport.

3. Is it worth developing this form of transport, is there demand for inland waterway transport?

In the previous section it was shown how cheap water transport is, while simultaneously having only a small negative environmental impact compared to other forms of transport. Knowing that the extent of this form of transport is limited by the course of inland waters, consideration should be given to the potential possibilities of using this type of transport to create an intermodal system.

3.1. European transport waterways

In 2009, European waterways transported almost 4 million TEU (Table 3).

Table 3. The transportation of containers using water transport in Europe grouped by country (TEU).

Countries	2009	2008	2007
European Union (27 countries)*	3,961,933	4,366,782	-
Belgium	2,202,327	2,290,290	2,324,129
Bulgaria	11,455	116	-
Germany	1,845,566	2,034,269	2,129,899
France	419,141	374,768	416,829
Netherlands	2,361,771	3,105,447	3,362,270
Austria	6,086	6,922	-
Poland	-	-	40

Source: Programme for the development of inland water transport infrastructure in Poland, the Ministry of Infrastructure, Warsaw, 2011.
*transportation in the EU does not represent the sum of freight in different countries; some containers are transported over international routes and are thus counted several times.

Most containers are transported by inland waterway in the Netherlands, Belgium and Germany. In the case of Belgium and the Netherlands, they are mostly transports from seaports, mainly Antwerp and Rotterdam, to inland ports supporting both ports. In 2010, over 6.7 million containers were handled in the port of Rotterdam (TEU 11 million), of which 1.46 million containers (about 2.4 million TEU) were handled involving river barges, which represented more than 30% of transhipments to forms of transport from supporting facilities. In 2014, the port handled 7.4 million containers (12 million TEU), of which 35.7% involved river barges (Modal split maritime 2014–2011, www.portofrotterdam.nl).

The situation looks slightly different for German inland waterways. In 2008, over 2 million TEU was transported in containers on German waterways. The main direction of this container transport was the Rhine corridor, once

again primarily to the ports of Rotterdam and Antwerp. The vast majority of the remaining container traffic was carried out with the port of Hamburg. In 2008, 119,000 TEU was loaded on and off river barges at this port, representing an almost 30% increase compared to 2007 (Port of Hamburg boosts inland waterway box transport, http://www.maritimejournal.com, 19.03.2009). The relatively low share of inland waterway transport in the port of Hamburg (compared to Belgian and Dutch ports) is the result of insufficient parameters for the waterway on the upper and middle section of the Elbe.

In an era of an increase in the importance of the idea of sustainable transport, at European seaports with good connections to the inland waterway network, the importance of inland waterway transport as supporting transport is growing. As early as 1999, every fourth tonne of cargo cross-docked in Antwerp was transported to/from inland waterway facilities. Within 10 years the share of river barge transport in supporting transport increased to 34.8%. In 2013, the port handled an average of 156 barges per day (Annual Report, 2014, Port of Antwerp, www.portofantwerp.com). The port of Antwerp plans an increase in the share of inland waterway transport in 2020 to the level of 43% (The Master Plan for Barge Transport, Annual Report, 2009, the port of Antwerp, www.portofantwerp.com).

The approach to the inland waterway network is also changing. Until recently it was believed that barge transports are profitable at distances over 350–400 km. With the increase in congestion on roads in the vicinity of seaports, the average distance over which containers are transported on inland waterways is decreasing. Currently, the minimum distance for barge transport, guaranteeing a profit, is about 60 km, and some intermodal terminals are located within 15 km of seaports.

Intermodal terminals are increasingly being establish performing the function of “dry ports”. Their main task is to take over some of the logistics and distribution services from overloaded sea terminals. An example of such a terminal would be the Gosselin Container Terminal located in Deurne, about 16 km from the main container terminals in Antwerp. This terminal offers, among others, storage and stuffing of containers, cargo storage, container fumigation and customs clearance (information material for Gosselin Container Terminal http://www.gctnv.be).

3.2. The projected demand for container traffic in Polish ports

3.2.1. Seaports

In the case of the handling of intermodal transport for inland – seaports routes, this transportation is usually for containerized cargo. The handling of this cargo group in seaports usually takes place within the framework of specialized container terminals. In Poland, marine container terminals are located in the following seaports:

- Gdańsk: two terminals – the Deepwater Container Terminal Gdańsk (DCT) and the Gdańsk Container Terminal (GTK) located in the inner port
- Gdynia: three terminals – the Baltic Container Terminal (BCT) Gdynia, the Baltic General Cargo Terminal (BTDG) Gdynia and Gdynia Container Terminal (GCT)
- Szczecin: one terminal – DB Port Szczecin.

In terms of location, these terminals primarily handle feeder container ships, and in the case of the terminal at the external port in Gdańsk, they also handle ocean-going container ships. In terms of supporting facilities these terminals cooperate with road and rail transport, and in the case of the ports in Gdańsk and Szczecin, they can also potentially handle inland waterway transport. Despite the fact that the port of Gdynia has the greatest potential among Polish seaports for handling containerized cargo, it is not connected with an inland waterway.

With this in mind, the current and future container terminals in the port of Gdańsk and the major seaports in the mouth of the Oder were subjected to further analysis. Cross-docking and the utilisation of cross-docking capacity at the currently existing container terminals in Gdańsk and Szczecin-Świnoujście port complex are shown in Table 4.

Table 4. Cross-docking and utilisation of cross-docking capacity at the container terminals in Gdańsk and Szczecin in 2010 and 2013.

terminal	cross-docking in TEU – 2010	utilisation of cross-docking capacity in %	cross-docking in TEU – 2013
DCT	451,730	75.3	1,150,000
DB Port Szczecin	56,398	47	78,000
GTK	62,309	62.3	28,188
Total	570,437	69.56	1,256,188

Source: The development of inland water transport infrastructure in Poland, the Ministry of Infrastructure, Warsaw, 2011, and www.gospodarkamorska.pl, 12.03.2014, and forsl.pl Business World Economy, 01.01.2015.

The unique nature of the DCT container terminal in Gdańsk, at the scale of Poland and the Baltic, where in addition to feeder container ships it also handles ocean-going vessels means causes that in the coming years it will be this terminal that will have the greatest capacity of all Polish container terminal ports. The development of the terminal is confirmed in the investment plans of the port of Gdańsk for the period 2016–2020, which has taken into account the implementation of the project entitled "Expansion of the DCT container terminal in the External Port (the addition of a third berth)". A continuation of the expansion of the DTC container terminal has also been included in the investment plans of the port authority in Gdańsk for the period after 2020 (Pluciński M., Concept for the development of maritime transport as part of a coherent, sustainable and user-friendly transport system, taking into account the concept for the development of seaports and access to them, with reference to issues of maritime safety, a study carried out on behalf of the Ministry of Infrastructure, Szczecin, 2010).

The future handling capacity of the container terminals in Gdańsk and Szczecin-Świnoujście port complex is shown in Table 5[2].

Table 5. Forecast handling capacity of the container terminals in Gdańsk and the Szczecin-Świnoujście port complex.

terminal	handling capacity in 2027 in thousands of TEU	handling capacity in 2047 in thousands of TEU
DCT	2,000	4,000
DB Port Szczecin	360	360
GTK	100	100
container terminal in the outer port of Świnoujście	200–400	400
Total	2,660–2,860	4,860

Source: Programme for the development of inland water transport infrastructure in Poland, the Ministry of Infrastructure, Warsaw, 2011.

The cross-docking capacity of the terminals analysed over the period up to 2027 will achieve a value of 2,660–2,860 thousand TEU, and in the period 2027–2047 it will increase to 4,860 thousand TEU. Despite the fact that there are no investments among the planned investments dedicated strictly to inland waterway transport, it will be possible to handle inland water vessels at the same quays used by sea-going vessels.

3.2.2. The possibility of including the most important economic centres located in the vicinity of shipping routes in the intermodal system

Due to the fact that in Western Europe container shipping primarily takes place between inland ports and seaports, it can be assumed that the main driver of demand for container transport on inland waterways in Poland will be cross-docking in seaports with Polish supporting facilities (including in western European ports). Projected cross-docking at inland ports in the coming years was estimated based on forecasts for cross-docking in Polish seaports contained in the study for Balticon (Functioning and prospects for the development of the container

[2] Given the fact that barge transports from Gdynia are significantly hindered, the Gdynia terminals were not included in the forecasts constituting the basis for estimating cross-docking at inland ports.

transport market in Poland up to 2015, a study commissioned by Balticon S.A., Gdynia, December, 2010). According to the authors' projections, cross-docking in Polish seaports should reach a level of 1.2–2.6 million TEU in 2015, and 3.1–6.3 million TEU in 2030 (Programme for the development of inland water transport infrastructure in Poland, the Ministry of Infrastructure, Warsaw, 2011).

The rate of change in container cross-docking volumes at Polish seaports in 2009–2010 shows that actually implemented cross-docking in 2015 and 2030 should be close to the upper limits of the forecast ranges. Some of the projected handling will be so-called transshipments, carried out in deep-water terminals and intended for other Baltic states.

Furthermore, apart from container cross-docking at Polish seaports, inland waterway transport can also handle Polish foreign trade cargoes handled directly in the ports of Western Europe. Table 6 below shows container transport in international routes in the years 2007–2009 and 2013 and 2014. Assuming a conservative assumption that 50% of containers handled in international routes is being transported to/from the ports of Western Europe, based on data from the years 2007–2009 it can be assumed that about 250–350 thousand TEU per year goes to Poland by-passing Polish sea ports. This is the potential volume of cargo cross-docking, which – with the creation of the right conditions – could also be handled by inland waterways.

Table 6. The transport of containers in international routes in the years 2007–2009 and in the years 2013, 2014.

years	2007		2008		2009		2013		2014	
	millions of tonnes	TEU*	millions of tonnes	TEU*	millions of tonnes	TEU*	millions of tonnes	TEU*	millions of tonnes	TEU*
Rail transport	3,322	474,571	3,989	474,571	2,749	392,714	5,925	833,394	6,342	906,000
Road transport	1,356	193,714	1,446	193,714	1,366	195,143	2,557	365,286	2,966	423,714
Total	4,678	668,286	5,435	776,429	4,115	587,857	8,482	1,198,680	9,308	1,329,714

Source: based on Transport. The results of operations for the years: 2007, 2008, 2009, CSO, Warsaw 2008–2010 and Transport. The results of activities in 2014, CSO.
* assuming 7 tonnes/TEU.

Given the above analysis, the following assumptions have been made to determine the forecast cross-docking at seaports:

- cross-docking in Polish seaports will reach a level of 4.4 million TEU (the average level of the forecast) in 2030
- the number of containers transported directly to/from the ports of Western Europe will be similar to the transshipments carried out by Polish seaports
- after 2030, the annual increase in container handling will be relatively small, at a level of 2%.

Based on the above assumptions, the following level of cross-docking at maritime container terminals in Gdańsk and the Szczecin-Świnoujście port complex accessible to inland waterway transport was adopted:

- by 2027 – 2.57 million TEU/year
- by 2047 – 4.71 million TEU/year.

Inland waterways could potentially participate in handling the transport of these cargoes to business support facilities (competing with road and rail transport).

The share of individual inland intermodal terminals in handling container units was determined based on the GDP of a subregion (NUTS-3), which is in the impact area of a specific terminal in 2012. In the event that there is more than one inland port in a specific subregion or the subregion is too large, the share in the GDP of the port area was calculated on the basis of the number of inhabitants of districts in the immediate vicinity of the port.

Table 7 shows the share of individual regions located around waterways in the GDP of Poland and determined (based on the above analysis) demand for transport of containerized cargo in routes from seaports to/from the analysed regions in 2010. The calculations show that the GDP of areas located around waterways accounts for about 60% of Polish GDP, which means that about 600 thousand TEU was transported by road or rail transport to/from the analysed regions. Some of these cargoes could be handled by inland water transport if the conditions for container traffic existed.

Table 7. Potential demand for cross-docking of containers in inland ports.

inland ports	NUTS-3 subregions	share in Poland's GDP (2012)	cross-docking demand [TEU]
Kraków	the city of Kraków, krakowski	4.3%	42,580
Warsaw	city of Warsaw, warszawski wschodni and warszawski zachodni	17.2%	171,247
Włocławek	włocławski, excluding the nakielski district	1.3%	12,943
Bydgoszcz	bydgosko-toruński: bydgoski district and city of Toruń	1.3%	12,943
Gliwice	bielski, rybnicki, bytomski, gliwicki, katowicki, sosnowiecki, tyski	11.5%	119,873
Opole	opolski: districts excluding kędzierzyńsko-kozielski	1.3%	12,943
Wrocław	city of Wrocław, wrocławski	3.9%	37,775
Głogów	legnicko-głogowski	2.0%	17,701
Nowa Sól (KSSE/Cigacice subzone)	zielonogórski	1.4%	13,939
Szczecin	city of Szczecin, szczeciński	2.0%	21,349
Poznań	city of Poznań, poznański	4.7%	46,794
Konin	koniński	1.3%	12,943
	others 10 NUTS-3 regions	6.2%	61,928
Total			584,958

Source: own study based on the assumptions of the Programme for the development of inland water transport infrastructure in Poland, the Ministry of Infrastructure, Warsaw, 2011.

4. What is missing, what is needed to enable the transportation of containers by barge in Poland?

The analyses carried out in the previous chapter showed that in the case of the adaptation of the parameters for waterways in Poland to handle container shipping, this transportation could be carried out mainly in routes from intermodal terminals at Polish seaports and in container hub ports (Rotterdam, Antwerp and Hamburg).

According to the assumptions set out in the AGN agreement (European Agreement on Main Inland Waterways of International Importance), the minimum clearances under bridges for class IV[3] waterways and above, designated for use by container shipping and depending on the number of layers of containers transported, has been determined as follows:

- 5.25 m – for two layers of containers,
- 7.0 m – for three layers of containers,
- 9.0 m – for four layers of containers.

[3] Ordinance of the Council of Ministers dated 07/05/2002 on the classification of inland waterways (Journal of Laws 77, item 695). The width of the navigable route, the transit depth, the radius of bends in the route, the minimum clearance under bridges over the highest navigable water and the dimensions of locks determines determine the seven classes of waterway Ia, Ib, II, III, IV, Va and Vb. Classes I–III are of regional importance and classes IV and V are of international importance.

Currently no waterway in Poland meets these parameters. It is true that certain stretches are classified as shipping class IV and V but the limitation in the transport of containers is the minimum clearance under bridges.

Based on an analysis of transport conditions in Poland, the minimum parameters have been defined for waterways necessary for vessels transporting containers in Poland. The required draft and clearance under bridges was estimated based on the average total weight of containers handled in Polish seaports and capacity of the push-boat[4]: BISON III + 2 OBP500 barges. Table 8 shows the required minimum clearance under bridges for a pushed convoy loaded with two layers of containers with an average total weight of 7 tonnes/TEU and with acceptable loading of the pushed convoy.

Table 8. The required clearances under bridges and draft for Bison III pushed container convoys and OBP500 barges for two layers of containers.

average total weight of container (t/TEU)	total weight of the load for the convoy (t)	draft (m)	minimum clearance under bridges (m)*
7.0	336	~0.85	4.95
20.8	1000	1.60	4.20

Source: Programme for the development of inland water transport infrastructure in Poland, the Ministry of Infrastructure, Warsaw, 2011.
*Includes a safe distance of 30 cm between the highest point of the ship's structure or its load and the lower edge of the bridge.

According to the data presented in the table above, the draft of a pushed convoy loaded with containers with an average total weight is not large. It is sufficient that a waterway meets the parameters of third-class shipping for a pushed convoy consisting of two barges in terms of the depth of the waterway. However, the clearances under bridges are the problem. The minimum clearance under bridges on a third class waterway it is 4.0 m. This is definitely not enough to run container shipping. On the Oder Waterway alone these parameters are not meet by 16 bridges (excluding the Western Oder and Parnica).

The Vistula does not have these problems. There are no bridges from Warsaw to the river mouth nor any other obstacles with a clearance of less than 5 m. Unfortunately, the remaining parameters of the waterway, including in particular the transit depth and unstable river corridor over the course of a year, prevent the efficient operation of shipping.

5. Is inland waterway transport innovative?

Returning to the question raised at the beginning of this report of whether inland waterway transport is innovative it should be said that, like other modes of transport, in itself it is not innovative. However, the possibility of using this means of transport in conjunction with other types of transport offers new possibilities for the organization of economic processes. The use of this type of transport as one of the elements of an intermodal transport chain can reduce the transportation costs of goods.

Extremely important are also the lower external costs of inland transport – such as the costs of air pollution, noise costs, and the costs of accidents, which in the case of water transport are many times lower than in the case of road or rail transport. Also, CO_2 emissions per 1 tonne/kilometre is up to five times less in inland waterway transport than road transport.

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[4] Due to the placement of a spreader at cross-docking facilities (along the line of the waterfront) it is possible to load 12 containers in one layer on an OBP500 barge. In total a convoy can take 48 containers. The distance from the barge bottom to the highest point on the barge, on the assumption that containers will be carried with a height of 8'6" amounts to approximately 550 cm.

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