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Restoration of Inland Waterway E40 Dnieper – Vistula: from Strategy to Planning

Final Feasibility Study Report

Corrected Report

(According to the remarks and requirements introduced by Willem Zondag, Legal and Technical Consultant IWT in the: Evaluation Report on the Restoration of Inland Waterway E40 Dnieper-Vistula: from Strategy to Planning)

GDANSK, December 2015

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INTRODUCTION

The International Waterway E40 (IWW E40) is one of the main inland waterways of international importance, which development is supported by both the United Nations (UN) and the European Union. IWW E40 runs through Gdansk - Warsaw - Brest - Pinsk - Kyiv - Kherson area connecting the Baltic Sea with the Black Sea basin.

The waterway running through the territory of Poland, Belarus and Ukraine connects the seaports of Gdansk and Kherson. It is made of following rivers: Vistula, Bug, Mukhavets, Pina, Pripyat and Dnieper. However, given the current hydrotechnical conditions it is not possible to conduct inland shipping on the section of the Bug River, between Warsaw and Brest.

The matter of shipping restoration on the entire length of the route was often undertaken at the Inland Transport Committee of the United Nations Economic Commission for Europe, national transport ministries, border regions and research institutions in Poland, Belarus, Ukraine and Germany. As a result of joint discussions, a concept to work on possibilities of revitalization of IWW E40 was created.

International waterway E40 is perceived, both by experts and the authorities of the three countries, as an opportunity to relieve road congestion, reduce carbon dioxide emissions, improve transport services in the hinterland of seaports, and improve water management including water retention and development of tourism based on the use of waterways potential.

This report titles: Restoration of Inland Waterway E40 Dnieper – Vistula: from Strategy to Planning is the result of research implemented within the project: ”Restoration of E40 waterway on the stretch Dnieper – Vistula: from strategy to planning” financed by European Union Cross-border Cooperation Programme Poland - Belarus – Ukraine 2007-2013

PL-BY-UA Programme was funded by the European Commission and aims at promoting cross-border development processes on the Polish - Belarusian – Ukrainian bordering area. This goal is achieved through the co-financing of projects which results benefit the border regions.

This project is a grassroots initiative of three border regions strongly interested in the revitalization of international waterway E40: Brest Region in Belarus, Lublin Region in Poland and in Volyn Region in the Ukraine. Reintroduction of shipping on the inland waterway route from the Baltic to the Black Sea could become an impulse for socioeconomic development of less developed areas and for industrial centres located in the area it would be an efficient transport solution within the logistic supply chain.

The presented report whose primary goal was to select the optimal variant of E40 route in its existing bottleneck between the Vistula River and Mukhavets was made by an international consortium of institutions from Poland, Belarus and Ukraine under the leadership of Maritime Institute in Gdansk.

The document was elaborated accordingly with requirements of Terms of Reference and it consists of four parts:

I. Analysis of Transport and Market Economics
II. Assessment of social and environmental effects
III. Technical and navigational issues
IV. Financial, legal and institutional aspects

It should be emphasized that the realization of the idea of restoration of the waterway connecting the Baltic Sea with the Black Sea through the Vistula and the Dnieper requires a serious revitalization and modernization works, mainly on the Polish section between the Vistula and the Dnieper, but also to

building and modernizing hydrotechnical infrastructure on the Vistula River to ensure a continuous and smooth transport of freight. The Vistula River also plays a key role in other water transport connections passing through Polish territory. The report elaborates in detail issues of costs, environmental safety and the possibility of using European best practices in creating favourable conditions for navigation on the Vistula River and along the E40 route.

It should be noted that along the missing link of E40 on the Bug River, between Warsaw and Brest, there can be found valuable landscape and protected areas that belong to the European network of protected areas "Natura 2000". Therefore, planning and construction of hydrotechnical and engineering infrastructure in these areas and development of shipping will require a more thorough study. Also a prescribed by law durations of research should be considered. A detailed analysis of the environmental conditions is included in a report developed for the assessment of environmental impact.

In principle, this report should be used at national and regional level to generate strategies for revitalization of inland waterways. In addition, the report may constitute a material supporting policies and development of companies conducting their activities based on the logistics infrastructure located along the IWW E40.

I. ANALYSIS OF TRANSPORT AND MARKET ECONOMICS

1. Analysis of the transport market in the catchment area of the international waterway E40

1.1. Methodology and delimitation of the area

International Waterway E40 (IWW E40) connects the Baltic Sea with the Black Sea. It starts in Gdansk and later in the Polish part runs along the Vistula and the Bug River, to Terespol, the Polish-Belarusian border. In the Belarusian part it runs across the river Mukhavets, Dnieper-Bug channel, Pina and Pripyat rivers to the Belarusian-Ukrainian border. In the Ukrainian part waterway E40 is formed by waters of the Pripyat and the Dnieper rivers, which leads to Kherson and the Black Sea. The course of the waterway E40 is presented in Figure 1.

Fig. 1. International Waterway E40
Source: Elaboration based on: *Map of the AGN network*, White paper on Efficient and Sustainable Inland Water Transport, Inland Transport Committee, UNECE New York and Geneva 2011.

The total area of the regions through which runs E40 route is 392 949.08 km^2 and it is inhabited by 28 690 834 people.

For the purpose of the analysis there were identified areas of direct impact of IWW E40 revitalization project. On the Polish side there are Pomorskie, Mazovia, Kujawsko - Pomorskie, Podlasie and Lublin regions. In Belarus regions of Brest and Gomel were indicated, and in Ukraine: Kherson, Cherkasy, Chernihiv, Dnipropetrovsk, Kyiv, Kirovohrad, Poltava, Rivne, Volyn, Zaporizhia, Zhytomyr regions as well as Kyiv City. Regions (oblasts) in Belarus and Ukraine administratively correspond with Polish regions (voivodeships). However, when cargo catchment area and freight market are discussed, analysis surpasses the above-defined impact area.

Market analysis includes freight and inland shipping in the EU and in other countries on route IWW E40 (Belarus, Poland and Ukraine). Transport market on the route from the Baltic Sea to the Black Sea is determined by the volume of the cargo streams generated in the trade exchange between Belarus, Polish and Ukraine, and originating/destined from / to those countries in transit through Polish and Ukrainian seaports as well as transit of other countries using the territory of the three countries in the cargo transport.

From the perspective of Dnieper – Vistula restoration project for the transport purposes which is part of an international waterway E40, an analysis of the volume and structure of the existing freight market between Poland, Belarus and Ukraine was conducted. Based on the results of this analysis an attempt was made to estimate the potential for shifting cargo from land routes to the waterways and to determine the potential demand for freight from the Polish economy. The research is based on Polish foreign trade data from database of the Maritime Institute in Gdansk, and from the Analytical Centre of Customs Administration in Warsaw.

1.2. Inland shipping in EU

In the EU in 2013 the share of inland waterway transport in total surface based carriages in terms of ton-kilometres totalled 6.7% overland transport carriages expressed in volumes per tonnes (excluding deepwater shipping and air and pipeline carriages). The prevailing waterway transport was performed by the Netherlands – 38.9%, then Romania and Belgium with 20% share each. Also in Germany and Bulgaria the inland waterway plays important role in cargo transport.

In freight between some seaports and their hinterland the inland transport is of special importance, particularly for Rotterdam, Antwerp and Amsterdam (Fig. 2).

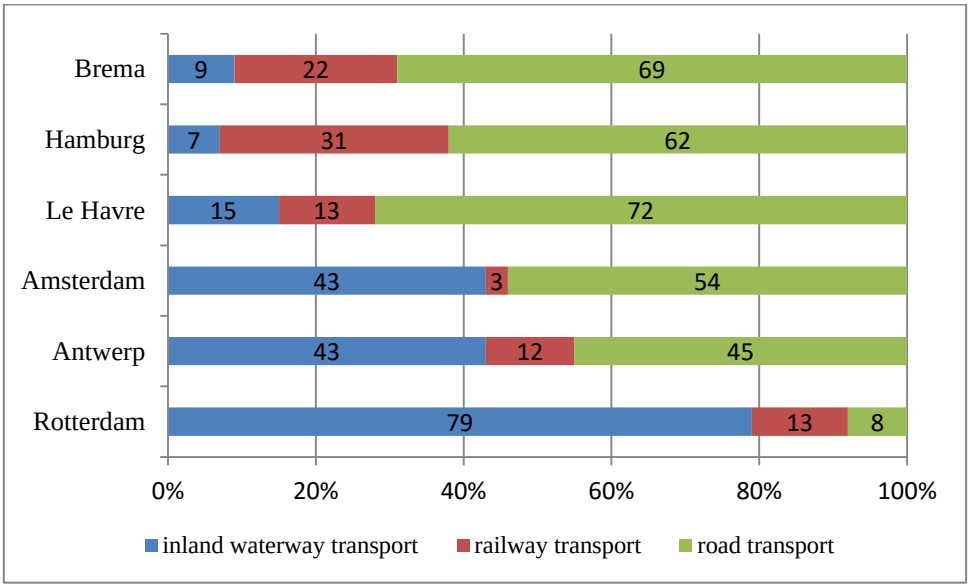


Fig. 2. Inland waterway transport share in cargo transport between European seaports and hinterland
Source: Just add water, Inland Navigation Europe, Brussels 2009.

In the structure of cargo transport by inland waterways in the European Union countries, 28% of cargo shipments consist of coal, 14% of coke and oil products. Also relatively large share of total carriages are agricultural products and chemicals as well as machineries and transport means (Fig. 3).

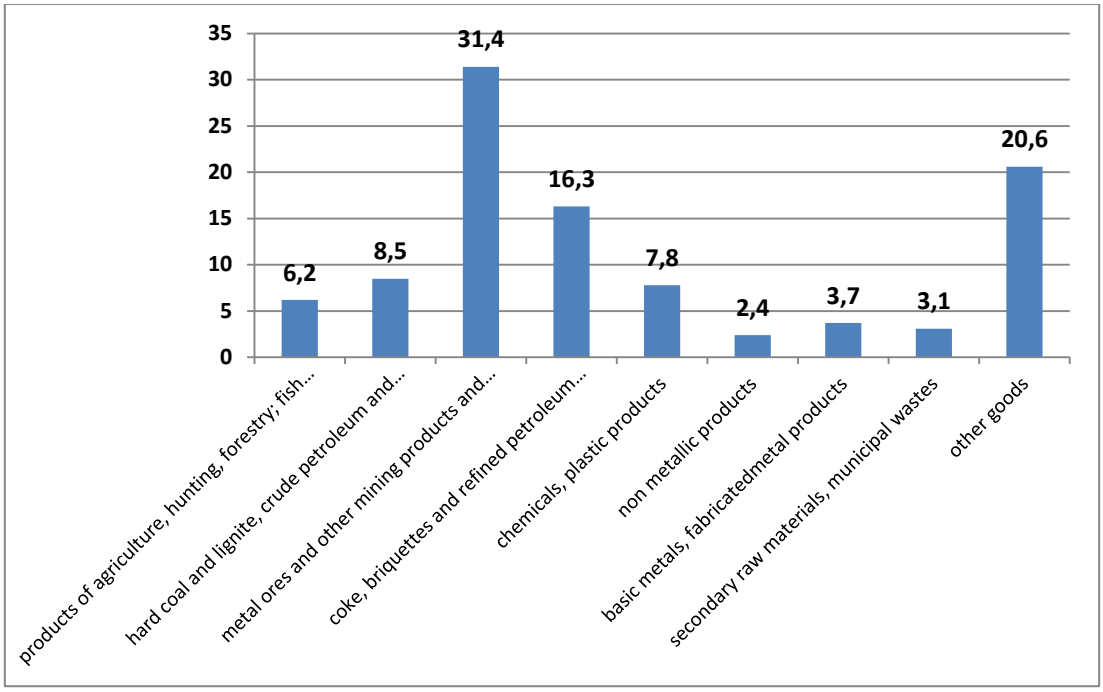


Fig. 3. Percentage structure of inland waterway freight transport in EU in 2012.
Source: Żegluga Śródlądowa w Polsce w latach 2010-2013. GUS Oddz. w Szczecinie, 2014.

The share of inland shipping in cargo carriages in Poland, Belarus and Ukraine is significantly lower than the EU average (Tab.1).

Tab. 1. Inland shipping share in freight transport in EU and countries of IWW E40

Specification	Railway transport		Road transport		Inland navigation	
	mln tons	%	mln tons	%	mln tons	%
EU (28 countries)	**1398**	**17.80**	**5924**	**75.40**	**526**	**6.70**
Poland	231	12.60	1493	84.00	4.6	0.38
Ukraine	457	24.12	1260	68.48	4	0.23
Belarus	154	29.71	189	40.85	4	0.96

Source: Elaboration based on data from: EUROSTAT and GUS

Realisation of IWW E40 investment would result in an opportunity to increase volumes of bulk and containerised cargo transported by inland shipping.

1.3. Cargo flows and transport services for trade exchange

The structure of transport in Belarus is dominated by pipeline transport. In recent years also transit carried out by trucks has been developing dynamically. In Belarus, the share of inland waterway transport of goods is minor.

In Ukraine the dominant mode of transport is road transport. From geopolitical reasons pipeline transport is declining (gas from Russia) in favour of rail and road transport. Inland waterways despite excellent natural conditions for hydro - navigation, particularly in the Dnieper, carry relatively few goods (Tab. 2).

Tab. 2. Freight transport structure in Ukraine by modes of transport (in mln tons)

	2005	2008	2010	2011	2012	2013
Transport total of which:	1805.0	1972.0	1765.0	1887.0	1853.0	1839.4
pipeline transport	213.0	187.0	153.0	155.0	128.0	128.4

	2005	2008	2010	2011	2012	2013
railway transport	450.0	499.0	433.0	469.0	457.0	443.6
road transport	1121.0	1267.0	1168.0	1253.0	1260.0	1259.7
inland navigation	10	11	7	6.7	4	4.3
% inland navigation	*0.55%*	*0.56%*	*0.40%*	*0.36%*	*0.22%*	*0.23%*

Source: Own elaboration based on data from: The National Statistical Service of Ukraine. (Transport i łączność Ukrainy 2012. Rocznik statystyczny)

Road transport in Poland has been increasing its dominant role over other transport means since the 1970s (Tab. 3).

Tab. 3. Transportation and structure of freight transport in Poland

Transport mln tons	**1970**	**1980**	**1990**	**2000**	**2010**	**2012**	**2013**	**2014**
railway	382	482	282	187	217	231	233	228
road	863	2168	1292	1007	1588	1493	1553	1548
inland navigation	9.0	22.0	10.0	10.0	5.1	4.6	7.0	6.8
Structure in %	**1970**	**1980**	**1990**	**2000**	**2010**	**2012**	**2013**	**2014**
railway	*30.0*	*17.6*	*17.1*	*14.7*	*11.3*	*12.9*	*12.6*	*12.4*
road	*67*	*78.6*	*78.5*	*79.2*	*82.9*	*83.5*	*84.0*	*84.1*
inland navigation	*0.7*	*0.8*	*0.6*	*0.8*	*0.3*	*0.25*	*0.38*	*0.37*

Source: Elaboration based on data from GUS.

Polish trade exchange with Ukraine is dominated by rail transport. while trade with Belarus – road transport (Tab. 4).

Tab. 4. Freight turnover of Polish foreign trade with Belarus and Ukraine in 2013, by modes of transport (thous. tons)

Mode of transport	**Total**	**Export**	**Import**
Total	**17088.1**	**4696.2**	**12391.9**
- railway	12583.3	1692.0	10891.3
- road	4185.4	2893.8	1291.6
- other	319.4	110.4	209.0
Belarus	4807.1	1276.5	3530.6
- railway	305.5	256.8	48.7
- road	1359.8	985.8	374.0
- other	241.8	33.9	207.9
Ukraine	12281.0	3419.7	8861.3
- railway	9377.8	1435.2	7942.6
- road	2825.6	1908.0	917.6
- other	77.6	76.5	1.1

Source: Elaboration of the Maritime Institute in Gdansk - Department of Economics and Law, based on data from Analytical Centre of Customs Administration in Warsaw.

The biggest trade partners of the Republic of Belarus in export are Russia, Netherlands, Ukraine, and then Poland, Germany, Latvia, Lithuania. In 2012 value of export from Belarus to Russia amounted to 16079.6 million USD, i.e. 35.3% of total export, while the Netherlands, which is the second partner in terms of export value, 7587.6 million USD, i.e. 16.7% (Table 5). In imports, the main partner of Belarus is also Russia, the value of turnover in 2012 amounted to 27399.6 million USD, i.e. 59.2%, followed by Germany with 2725.6 million USD (5.9%) and China 2363.9 million (5.1%).

Tab. 5. Trade partners in export and import of Poland, Belarus and Ukraine in 2012.

EXPORT	**Belarus**	**EXPORT**	**Poland**	**EXPORT**	**Ukraine**
Value ($)	36 389 378 800	Value ($)	214 476 794 173	Value ($)	53 913 302 426
Key partners	%	Key partners	%	Key partners	%
Russia	35.09	Germany	24.91	Russia	25.67
Netherlands	16.39	Great Britain	6.77	Turkey	5.36
Ukraine	12.06	Czech Republic	6.20	Egypt	4.22
Lithuania	7.10	France	5.83	Poland	3.75
Germany	3.75	Russia	5.51	Italy	3.61
Latvia	2.56	Italy	4.89	Kazakhstan	3.58
Poland	2.06	Netherlands	4.44	India	3.33
Kazakhstan	1.75	Ukraine	2.94	Belarus	3.28
Brazil	1.74	Sweden	2.63	China	2.59
Italy	1.47	Slovakia	2.52	Germany	2.39
Other countries	16.03	Other countries	33.36	Other countries	42.22
IMPORT	**Belarus**	**IMPORT**	**Poland**	**IMPORT**	**Ukraine**
Value ($)	40 451 397 500	Value ($)	216 687 292 345	Value ($)	54 381 409 088
Key partners	%	Key partners	%	Key partners	%
Russia	58.76	Germany	20.93	Russia	32.39
Germany	5.88	Russia	14.60	China	9.33
China	5.05	China	9.02	Germany	8.04
Ukraine	4.97	Italy	5.03	Belarus	5.99
Poland	2.90	France	3.92	Poland	4.21
Italy	2.05	Netherlands	3.79	USA	3.44
USA	1.14	Czech Republic	3.59	Italy	2.64
Netherlands	0.97	USA	2.61	Turkey	2.31
Czech Republic	0.94	Great Britain	2.38	France	1.97
France	0.94	Korea. South	2.32	Korea. South	1.83
Other countries	16.39	Other countries	31.82	Other countries	27.85

Source: Own elaboration of Maritime Institute in Gdansk - Department of Economics and Law, based on data from Global EDGE 2014

The largest Polish trade partner is Germany. In 2012 its share in total import amounted to 21.7% and 25.1% in exports. Russia is the second biggest trading partner in imports its share amounted to 12.1%. The second largest Polish exporting partner is United Kingdom. From Ukraine Poland imported 1.1% of goods and exported 2.8% of its total turnover of trade exchange (Tab. 5).

Ukraine is a major importer of energy resources: natural gas and crude oil. The value of imports in 2012 totalled 84.7 billion USD. In the import of goods to Ukraine, the share of the CIS countries[1] amounted to 40.7%, EU 30.9% and 20.2% Asian countries. The largest supplier of goods to Ukraine remains Russia with 32.4% share in total imports. Polish share amounted to 4.2% and Belarusian to 6%. In the commodity structure of import to Ukraine 32.5% of total imports are mineral products (including 31% share of energy resources), machinery and equipment - 15.5%, chemical products and plastics - 15.4%, transport means - 9.5%, agricultural and food products - 8.9%.

[1]CIS - Commonwealth of Independent States is a regional organisation comprising of former Soviet Republics countries.

According to the EU statistics[2], commodity trade between EU and Ukraine in 2013 amounted to 37.8 billion EUR, representing 1.1% of EU total trade value, which ranked Ukraine 23rd among the EU's trading partners. On the other hand, in 2013, 26.5% of Ukrainian exports and 35.1% imports accounted for EU member states.

1.4. Trade exchange between Belarus, Poland and Ukraine

International trade exchange illustrates the intensity of the functional relations with other countries. Foreign trade is important for economic development and cross-border cooperation, contributing to the increase in production and income, transfer of technology, growth of competitiveness and wealth of society and the development of new technologies.

Polish trade with countries of Eastern Europe amount to little over 10% of the total value of Polish exports, however, trade with these countries is very important for the eastern Polish regions. In terms of cargo turnover the dominant partner is Russia, then Belarus and Ukraine. A common feature of trade with these three countries is a strong political undertone.

In the structure of Polish exports to Belarus the most important role is played by such commodity groups as: machine products, chemical products, agricultural and food products, steel products. Import from Belarus is dominated by mineral products (including liquefied propane and diesel), chemical products (fertilizers), products made of wood and paper (primarily wood, firewood, fibre board and particle board), steel products.

In 2013 Belarus ranked 21 among most important export markets for Polish economy and 34 place among importers.

Polish trade exchange with Belarus and Ukraine, in 2013 amounted to 17,088.1 thous. tons, including export 4,696.2 thous. tons, imports 12,391.9 thous. tons.

The value of Polish exports to Ukraine in 2012 amounted to 5,279.6 million USD. Ukraine's participation in Polish exports amounted to 2.89%. Among the recipients of Polish goods Ukraine ranked 8th place. According to Ukrainian statistics, the value of imports from Poland in 2012 amounted to 3,567.1 million USD. Poland is in fifth place among the major suppliers to the Ukrainian market following Russia, China, Germany and Belarus. The share of Polish imports in Ukraine was 3.9% in 2011.

The Polish export to Ukraine is dominated by fuel and mineral oils and products of their distillation, bituminous substances, mineral waxes. In 2012, the cargo exported in this group amounted to 678.2 thous. tons, while exports of processed foods amounted only to 17.3 thous. tons. The value of imports of goods from Ukraine to Poland in 2012 amounted to 2550.9 mln USD, which represented 1.31% of the total value of Polish import. Among the goods suppliers to Poland, Ukraine ranked 19. Polish import from Ukraine is dominated by wood, wood products and charcoal.

Polish regions which recorded in 2012 the highest export to Ukraine are Mazovia and Silesia regions – both over 620 thous. tons.

[2] Ukrainian statistics present different figures. Here we follow Economic Information – Ukraine, Polish Embassy in Kyiv, February 2015.

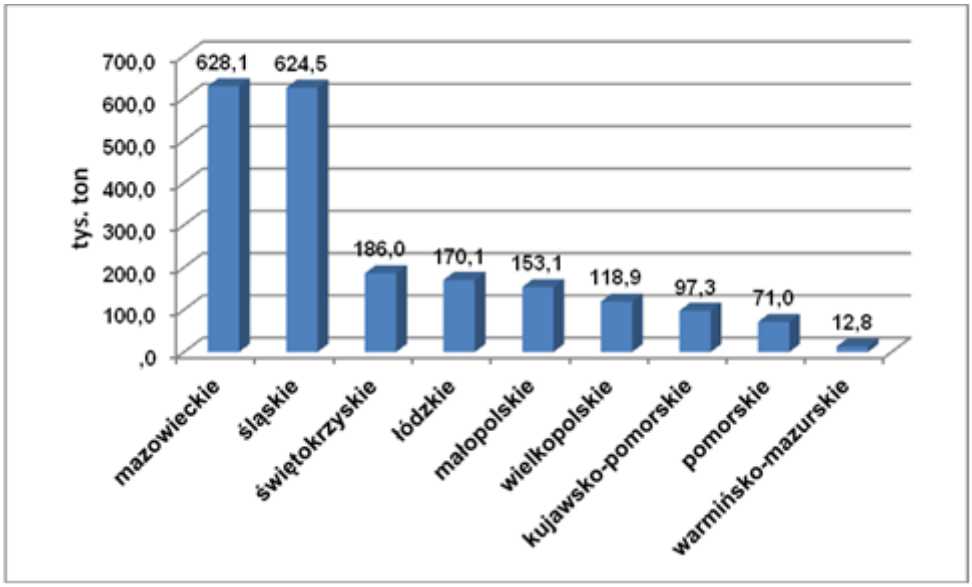


Fig. 4. Exports of goods to Ukraine from selected Polish regions
Source: Own elaboration of Maritime Institute in Gdansk - Department of Economics and Law, based on data from Analytical Centre of Customs Administration

In 2012 Polish import from Ukraine was dominated by Pomeranian region – 5,264.3 thous. tons of commodities (Fig. 5).

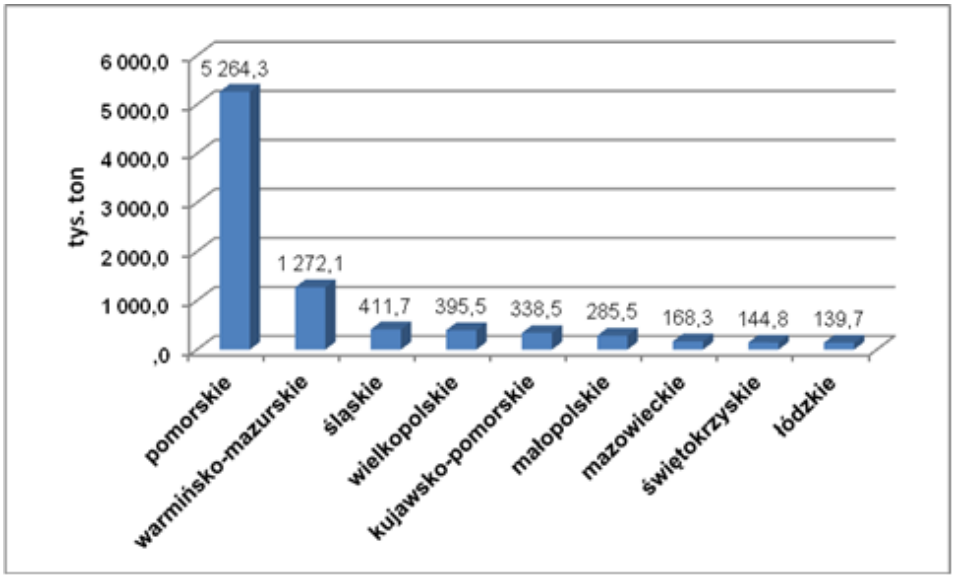


Fig. 5. Import of goods from Ukraine to the Polish regions
Source: Own elaboration of Maritime Institute in Gdansk - Department of Economics and Law, based on data from Analytical Centre of Customs Administration

The proximity of the border regions should favour intense trade change and indeed exchange of goods on the Polish-Belarusian-Ukrainian bordering regions shows a clear upward trend in recent years.

However, the participation of border regions in the regional structure of foreign trade is significantly lower in comparison to the existing demographic and economic potential measured by GDP of individual countries. In 2011 Lublin province share in total Polish export amounted to only 1.6% and 1.1% in imports. The share of Brest in Belarus exports amounted to 6.3%, while in imports to 4.6%. The share of Volyn in the Ukraine's foreign trade was 0.9% in exports and 1.3% in imports. This reflects the relatively low level of international economic relations resulting from peripheral character

of these regions and low economic competitiveness of these areas.

In the structure of foreign trade of Lublin province, which is the site of the relatively strong concentration of exports to Ukraine, the share of exports amounted to 10.3% (2008), while the entire Polish exports to 2.5%.

Belarus share in export value of Lublin region was 3%. Polish share in the import of Brest was 15.7% while the share of Polish and Belarus import from Volyn respectively 12.6% and 10.1% (2011).

Tab. 6. The value of trade between cross-border area regions.

Specification	2006	2007	2008	2009	2010	2011
Lublin region						
Export total	1406.4	1614.3	1812.5	1403.0	1726.0	2141.7
of which: Belarus		45.4	53.8			
Ukraine		147.4	186.7			
Import total	871.3	1133.2	1488.0	1011.0	1290.5	1645.6
of which: Belarus			44.3			
Ukraine			34.1			
Brest region						
Export total	905.0	960.1	1105.9	883.3	1193.8	1396.6
of which: Poland	46.6	22.5	47.0	16.9	18.6	20.0
Ukraine	56.4	58.0	77.2	55.1	80.6	82.7
Import total	841.2	856.1	1130.2	924.7	1214.8	1387.3
of which: Poland	136.5	123.1	150.2	103.4	160.6	217.9
Ukraine	56.4	58.0	77.2	55.1	80.6	82.7
Volyn region						
Export total	269.6	309.4	313.6	229.2	327.1	461.4
of which: Poland	24.5	31.3	28.1	26.3	33.3	32.5
Ukraine	12.6	10.7	15.2	9.5	12.9	15.1
Import total	523.7	773.1	881.9	307.3	429.9	756.4
of which: Poland	58.9	66.6	111.7	65.7	100.0	95.4
Ukraine	32.7	18.8	20.4	18.8	28.7	76.3

Source: Handel zagraniczny w Polsce i Małopolsce w 2011 r., Małopolskie Obserwatorium Gospodarki, Kraków 2012 and data from the Central Statistical Office of the Brest, the Central Office of Statistics Volyn Oblast.

Companies of the Brest region develop trade and economic cooperation with more than 100 countries worldwide including EU. The value of import of Volyn region in 2013 amounted to 1,131.4 million USD and exports to 686.4 million USD. In 2013 he region maintained trade relations with 76 countries in exports and 72 in imports.

Border regions are important trading partners. Major trading partners of Volyn region are: Germany, Poland, Russia, Belarus, Hungary, France and Kazakhstan. For Brest region the main trade partners include: Russia, Poland, Germany, China, Ukraine, Norway, Kazakhstan, the Netherlands, Italy and Lithuania. Companies in the Brest region account for 4.7% of foreign trade turnover with Poland. The main recipients of goods exported from Lublin region are Germany, Ukraine, France, Italy and the Netherlands. The share of exports to Belarus amounted to less than 3%[3].

[3] Gawlikowska-Hueckel K., Umiński S.: Handel zagraniczny województwa lubelskiego - Uwarunkowania krajowej i międzynarodowej konkurencyjności województwa lubelskiego. Wyd. Ernst & Young, Warszawa 2011

Export structure of individual border regions can be characterised by high export concentration. In Lublin region five major export products account for 36.1% of total export. High-tech goods are exported mainly to Italy, United States and France. The largest exporters of Lublin region include: Meat Company ŁMEAT - Lukow, Komas, Confectionery Company Solidarity, Agram, Black Red White, Bury, LST Poland, Aliplast and Rolling Bearings Factory. In the export of Volyn region prevail forest products and wood industry, including wood, chipboard, carpentry and other products made from raw wood. A growing trend shows exports of engineering products and light industry products to the EU.

1.5. Transit

The concentration of infrastructure and location on the main road and rail routes offers vast opportunities for cooperation. In recent years, there can be observed increase in cargo transit by road through Belarus regions. Transit traffic through the regions comprises almost 80% of total exports of the CIS countries to Western Europe. This in turn contributes to a high level of development of infrastructure and administration facilities associated with export services. Between Belarus and CIS countries applies free trade agreement, which allows duty-free trade of goods.

For transit of goods by road, transport corridor M-1 / E30 Berlin-Warsaw-Brest-Minsk-Moscow plays an important role. Well-developed railway and road networks enable efficient handling of large volumes of transit cargo. Through M-1 / E30 travels about 200 thous. trucks per month.

Brest railway junction is one of the largest in Central and Eastern Europe handling cargo in transit between CIS countries and the countries of Western Europe in the directions of Moscow, Bryansk and St. Petersburg. An equally important role plays a railway junction at the logistics centre in Malaszewicze in Lublin region in Terespol commune.

In transit through Ukraine pipeline transport plays a dominant role. In 2012 through Ukrainian territory nearly 5 million tons of cargo was transported by road and by train over 40 million tons (Tab. 7).

Tab. 7. Transit of goods through Ukraine by transport modes

Specification	thous. tons	%
Transport total of which:	124 893.91	*100.0*
pipeline	76 978.38	*61.64*
railway	40 940.14	*32.78*
road	4 850.03	*3.88*
inland navigation	7.78	*0.01*

Source: Informator ekonomiczny o krajach świata, Ukraina. Ministerstwo Spraw Zagranicznych, Warszawa 2014 r.

An important source of cargo volumes for freight in IWW E40 may be Ukrainian seaports. In 2012 their turnover amounted to 154 mln tons, including 7.7 million tons of container traffic. Sea-river vessels can transport goods from seaports to economic centres located of Ukraine located inland. Figure 6 illustrates structure of cargo turnover in 2012 by cargo groups.

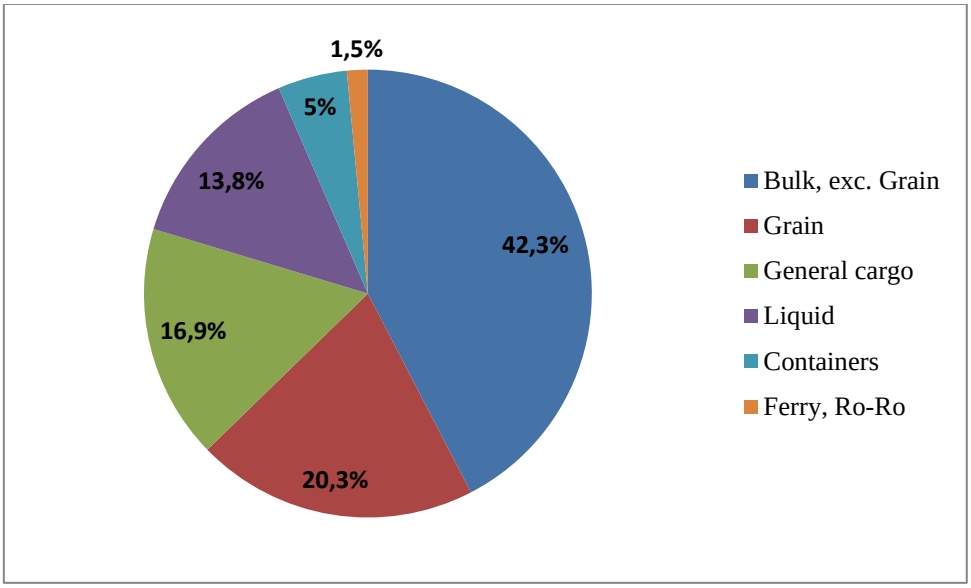


Fig. 6. Cargo turnover structure in Ukrainian seaports in 2012.
Source: Ukrainskiye Morskiye Porty, May 2013

Cargo handling capacity of Ukrainian ports was used in 28% - 83% depending on the cargo group.

Kyiv is already an important transport hub, which, due to development of inland shipping transport may become one of the key future European logistics centres. Today, Kyiv is connected with port of Odessa by a highway and two-lane expressway with Minsk and further with Lithuanian and Latvian Baltic ports. In addition, there are plans to connect Kyiv by highway directly with Cracow, Berlin, and the ports of the North Sea. At the same time, modernization of main railway lines is being conducted, which provide fast connection with Western Europe via Poland. With appropriate organizational solutions in place and necessary modernization investment of the waterway, Ukraine could become an important transit area for the EU, integrated into the development strategy of the international sea-river transport. One of the essential conditions in this regard is a consequent implementation of projects improving navigability of the route and the reduction of fees for passage through the locks and bridges.

Also in the transport directions bound from Belarus towards the Baltic Sea a part of the cargo going through the ports could be handled at the port hinterland by inland shipping. In this respect Polish seaports should be taken into account as well as German (link between IWW E40 and IWW E70), Lithuanian, Latvian and Estonian seaports. Cargo turnover volume at ports of selected countries is presented in table. 8.

Tab. 8. Turnover of selected seaports in the catchment area of IWW E40 (mln tons)

Country	2005	2010	2013		
			Import	Export	Total
Bulgaria	24.8	22.9	12.5	16.3	28.8
Denmark	99.7	87.1	49.7	38.1	87.8
Germany	284.9	276	174.7	122.6	297.3
Estonia	46.5	46	11.1	31.8	42.9
Latvia	59.7	58.7	7.7	59.5	67.1
Lithuania	26.1	37.9	16.1	23.6	39.8
Poland	54.8	59.5	35	29.3	64.3
Romania	47.7	38.1	16.8	26.8	43.6

Country	2005	2010	2013		
			Import	Export	Total
Finland	99.6	109.3	53.7	51.4	105.1
Sweden	178.1	179.6	86.7	74.9	161.6
Norway	201.7	195.1	69.3	140	209.3
Turkey	_	338.1	218.8	160.6	379.4

Source: Eurostat

This applies above all to cargo carried by intermodal transport, particularly containerized cargo and empty containers.

Launching IWW E40 will create a convenient transport connection to carry goods from Western Europe, especially in the Baltic Sea area, as well as the Netherlands and Norway to the countries in the Black Sea are through Poland, Belarus and Ukraine.

1.6. Inland shipping

Waterway with good navigation parameters stimulates economic development, attracts investors and therefore has a beneficial effect on the growth in demand.

In 2012 Ukrainian waterways transported 4,295 thous. tons of goods (12,869 thous. tons in 2005 and 6,989 thous. tons in 2010), of which 75% was carried in the catchment area of IWW E40 (Tab. 9).

Tab. 9. Territorial structure of the Ukraine inland waterway freight transport

	2005		2010		2012	
	thous. tons	%	thous. tons	%	thous. tons	%
Ukraine	12 869	*100*	6 989	*100*	4 295	*100*
oblasts, total	8196	*63.6*	4526	*64.6*	3237	*75.4*
Kherson	552	*4.3*	740	*10.6*	369	*8.6*
Cherkasy	259	*2*	90	*1.3*	45	*1.1*
Chernihiv	590	*4.6*	116	*1.7*	0	*0*
Dnepropetrovsk	1524	*11.8*	650	*9.3*	598	*13.9*
Kyiv	0	*0*	0	*0*	0	*0*
Poltava	325	*2.5*	382	*5.5*	603	*14.1*
Zaporizhia	842	*6.5*	415	*5.9*	500	*11.6*
The city of Kyiv	4104	*31.9*	2133	*30.3*	1122	*26.1*

Source: Own elaboration based on data from: The National Statistical Service of Ukraine (Transport i łączność Ukrainy 2012. Rocznik statystyczny)

In 2012 over 26% of inland waterway carriages in Ukraine was made within the city region of Kyiv, about 14% in Poltava and Dnepropetrovsk regions. The Dnieper River ranks third among European rivers in terms of length and catchment basin area. The potential of freight on the Dnieper River is not used accordingly to the existing needs national needs.

Freight on inland waterways in Ukraine, like in other countries and in the EU includes, to great extent mostly: construction materials (nearly 63% of transported cargo in 2012), iron ore (12%), grain (nearly 10%) and other commodities: coal, coke, fertilizers, metal products, machinery, paper, wood, sugar, etc. Steel products account for 40% of total Ukrainian exports.

The largest operator on the Ukrainian inland shipping market is a joint stock company "Ukrrichflot" that controls a fleet of nearly 200 vessels operating on routes between sea and river ports of Mediterranean region, but also the Baltic region (Sweden) and the United Kingdom. The share of

"Ukrrichflot" in the Ukrainian market for maritime and river shipping is about 45%. Annual freight volume amounts to about 6 mln tons and 2 mln passengers (mainly on internal tourist routes Kyiv-Odessa-Kyiv, Kyiv - Odessa -Sevastopol - Yalta - Kyiv). "Ukrrichflot" is also an owner of a number of river ports on the Dnieper (Mykolaiv, Kharkiv, Zaporizhia, Dnipropetrovsk).

On the Dnieper River in Kyiv region there are favourable conditions for tourism development and passenger shipping not only on a local scale. However, inland shipping does not play a significant economic role in passenger transport. In 2013 share of inland water transport in passenger transport in Ukraine was barely 0.01% and the number of passengers amounted to 267.9 thous.

Kyiv river port has a potential to occupy an important place in the development of transport and logistics network. What is more, big natural depths of the Dnieper (3-5 meters) allow for handling container vessels. However, in the upper Dnieper there are numerous navigation obstacles, such as low bridges and six locks with high fees for passage. Therefore, in the present circumstances it is cheaper to transport goods from Kyiv to Odessa by train. In recent years, the industry, especially heavy industry, is systematically shifted to other regions of the country. This opens an opportunity for locating industrial zones in close proximity to Kyiv river ports, for example, to Chernihiv located on the Desna River, or Belarusian Gomel.

In order to change the character of Ukrainian river ports from bulk ports to universal, major investments in handling terminals are required and a wider introduction of information technologies and multimodal solutions is a must.

In the transport systems of Belarus and Poland inland waterways plays a marginal role. Basic transport work is done by road or railways, despite the fact that these countries are located along North - South and East - West transport corridors which benefits inland shipping development.

The main cargo transported by ships on rivers in Belarus are sand, gravel, building stone, wood, potash, granulated slag, and heavy and oversized cargo. Transport is performed between such ports as Brest, Pinsk, Mikashevichi, Mozyr, Rechitsa, Gomel, Mogilev, Bobruisk, Vitebsk and Grodno. The role of water transport in the carriage of passengers is still less significant than in case of freight. In Poland the share of inland waterway transport in carriage of goods was much lower than the average for the whole European Union - in 2013 6.7% share in the transport of goods in ton-kilometres - without deep sea shipping, air transport and pipelines).

Also in the Polish foreign trade inland waterways does not play a significant role. Waterway freight in the import of goods to Poland and Polish exports are irregular and reach only hundreds of thousands of tons per year mainly to and from Germany. Yet in the 1980s inland waterway freight reached 20 mln tons. Currently, the share of this transport branch in overall freight does not exceed 1%. Even more marginal is the role of waterway to serve Polish seaports hinterland. If navigability of IWW E40 is resumed, seaports lying in the catchment area of the route (in Poland, Gdansk, Gdynia, Elblag) will have the ability to transport goods between the port and the hinterland by an additional mode of transport.

In 2012 in Poland nearly 45% of goods transported by inland waterways were metal ores and other mining and quarrying products, and 17.2% coal (along with crude oil and natural gas). Transport of oil products, chemicals, food products was of little importance.

For the analysis of E40 development, data on existing freight on Vistula Waterway (VWW) are significant. Transport of goods on VWW route represents 10% of transport waterways in Poland. Freight on VWW is performed by a small number of ship owners, offering very small and already outdated vessels. If all necessary investments opening discussed water routes are implemented, IWW

E40 and VWW, it is necessary to build capacity of entrepreneurs and vessels capable of meeting transport demand.

In the long-term perspective, inland shipping will shift into servicing significantly more containerised cargo as well as general cargo and ro-ro. Establishment of an integrated European network of inland waterways Ukrainian rivers may become important arteries linking Europe with the Baltic areas located further to the east and south. The expected dynamic growth of sea-river freight in Ukraine justifies making plans for new water connections between the basins of the Black Sea and the Baltic catchment area rivers, including the possibility to transport goods from Gdansk to Odessa through the Vistula and Pripyat rivers and revitalised Dnieper-Bug channel.

1.7. Transport corridors and logistics infrastructure

During the second Pan European Conference on Crete in 1994, 9 corridors were designated in Central and Eastern Europe. A 10th transport corridor was introduced during the next conference in Helsinki in 1997 and others were modified which illustrated by figure 7 below.

The European Union adopting the TEN-T[4] program aimed at stimulating investment in infrastructure in order to create an integrated transport network covering all member states, all modes of transport and to take into account the location of trans-European transport corridors. Starting from these assumptions, a core network was developed connecting the strategically important multimodal nodes and links creating "transport corridors". There were proposed 9 corridors of European transport network having strategic importance for the European wide transport system and a comprehensive network[5].

Through the territory of Belarus and Ukraine run two Pan European transport corridors of major importance to revitalisation of IWW E40:

- Corridor no. 2 - Berlin – Poznan – Warsaw – Brest – Minsk – Smolensk – Moscow – Nizhniy Novgorod. Corridor no. 2 covers Warsaw – Brest section of the E40 inland waterway;
- Corridor no. 9 - Helsinki – Vyborg – Sankt Petersburg – Pskov – Gomel – Kyiv – Lyubashivka – Chisinau – Bucharest – Dimitrovgrad – Alexandroupolis, including Minsk and Gomel variants. In the Ukraine and Belarus the corridor covers section of the E40 inland waterway.

Additionally through Ukraine run two other European transport corridors:

- Corridor no. 3 - Brussels – Aachen – Cologne – Dresden – Wroclaw – Katowice – Cracow – Lviv –Kyiv;
- Corridor no. 5 - Venice – Trieste/Koper – Ljubljana – Maribor – Budapest – Uzhhorod – Lviv – Kyiv.

[4] Trans-European Transport Networks

[5] Regulation (EU) No 1315/2013 of the European Parliament and of the Council of 11 December 2013 on Union guidelines for the development of the trans-European transport network and repealing Decision No 661/2010/EU.

Fig. 7. Map of Pan European transport corridors
Source: Transport Infrastructure Needs Assessment (TINA)

On the territory of Ukraine international transport corridor TRACECA was also designated which links Europe through the Caucasus and the Black Sea with Asian countries like Turkmenistan, Uzbekistan etc. Currently development of the corridor includes 13 countries, including Ukraine. However, Belarus may also benefit if the corridor is fully established.

Through Polish territory run two European transport corridors included in the TEN-T network:

1. Baltic - Adriatic runs from Swinoujscie – Gdynia – Katowice - Ostrava / Zilina - Bratislava / Vienna / Klagenfurt-Udine-Venice / Trieste / Bologna / Ravenna.

2. North Sea - Baltic Sea - will bring together Wilhelmshaven / Bremerhaven / Hamburg / Amsterdam / Rotterdam / Antwerp-Aachen / Berlin-Warsaw-Terespol (Polish-Belarusian border) / Kaunas-Riga-Tallinn.

Through the transborder areas of Lublin, Brest and Volyn regions runs transport corridor II:

- European road **E30 -** Berlin– Poznan– Warsaw– Siedlce- Biala Podlaska– Brest- Minsk- Smolensk- Moscow. On Polish side within the corridor there is National Road no.2 and on Belarusian side M1 highway,
- European railway line **E20** - Kunowice– Poznan– Warsaw - Biala Podlaska– Terespol- Brest. On Polish side within the corridor there is Railway Line no.2 and 3.

Trans-European transport network TEN-T supplements the above routes and includes:

- international road **E372** Warsaw–Lublin–Zamosc–Lviv. This line runs only in Polish

territory – National Road no. 17,

- international road **E373 -** Radom–Lublin–Chelm–Dorohusk-Kyiv. On Polish side network is made of National Road no. 12 and Expressway S12, on Ukrainian side: International Road M09. This is the shortest road link between Kyiv and Western Europe,
- international railway **E30 -** Warsaw-Lublin-Dorohusk-Kyiv. On Polish side network is made of Railway line no. 7, and on Ukrainian side main railway line Kovel-Kyiv,
- Broad Gauge Metallurgy Line, railway line 65 (**LHS)** Upper Silesia -Ukrainian border in Hrubieszow, main railway line from Brest to Minsk.

Figure 8 presents location of border regions of Lublin, Brest and Volyn along East- West - East transport integrated into the TEN-T network.

Despite the favourable location in the vicinity of important international transport corridors, determining external accessibility, the border area is characterized by low density of road and railway infrastructure. Density of public roads with hard surface per 100 km^2 in Lublin region amounts to 84.9 km, in Brest region - 31.9 km and in Volyn region 28.5 km. Density of the railway network is 3 km per 100 km² in the Volyn region, 3.2 km in Brest region and 4.1 km in Lublin region. These indicators are below the national average.

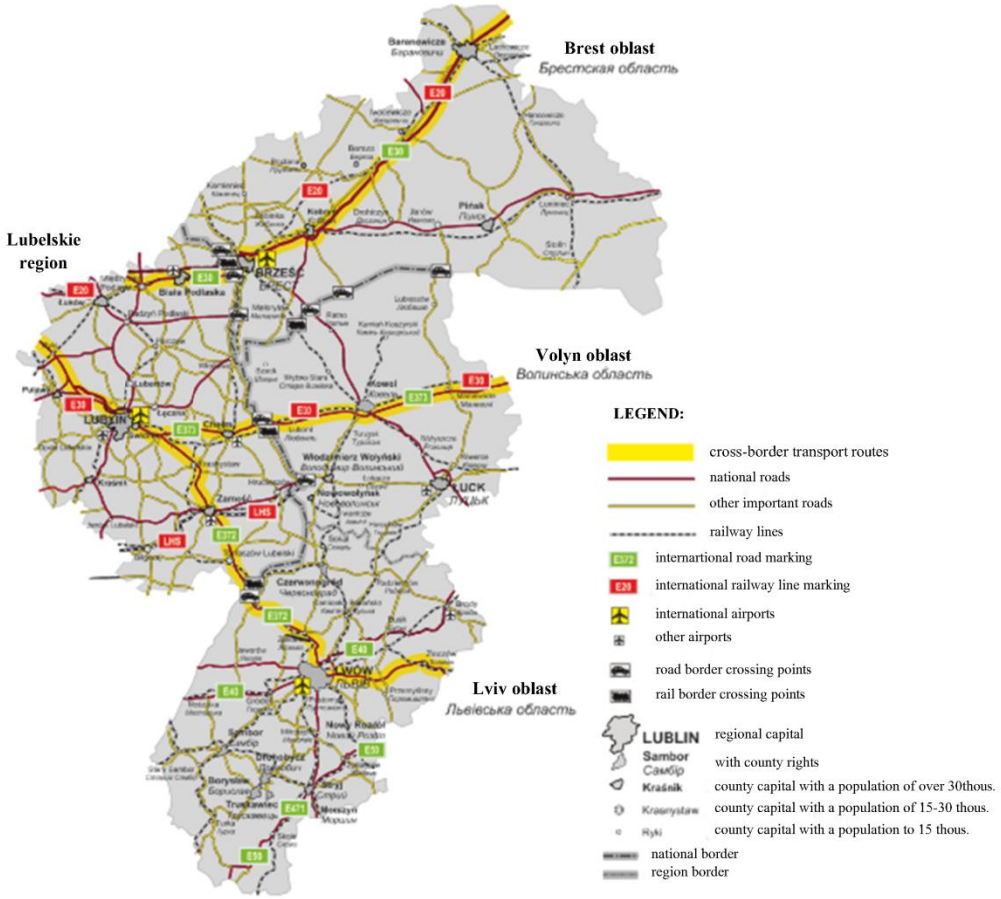


Fig. 8. International transport infrastructure TEN-T border regions: Lublin, Brest and Volyn.
Source: Strategia współpracy transgranicznej województwa lubelskiego, obwodu lwowskiego, obwodu wołyńskiego i obwodu brzeskiego na lata 2014-2020. Lublin 2013.

Location of railway and road network is closely linked with the location of the strategic logistics

infrastructure vital for the entire area. In terms of improving the logistics infrastructure there are many projects to be realised in cross-border area, including:

- modernization of handling equipment and extension of stacking yards,
- construction of terminal for combined transport on railway line no.7 in relation Lublin-Swidnik with access to national roads no. 12, 17 and 19,
- construction of logistics centres in Dorohusk, Hrebenne and Pulawy in connection with the infrastructure of border crossing in Dorohusk,
- construction of interregional logistics centre in Lukow in connection with the infrastructure of railway juncture no. 2/E20 Warsaw–Terespol, no. 12/C-E20,
- modernisation of logistics centres in Brest (area of 3 ha, located 600 m from M1 highway) and Baranovichi (area of 0.5 ha, located 2 km from M1 highway),
- construction of Kozlovichi-2 centre, with area of 13.2 ha, located in the vicinity of M1 highway, extension of existing transport infrastructure,
- construction of logistics centres in Pinsk with area of 1.6 ha, located in the vicinity of Brest-Gomel,
- development of investment area near customs point in Kozlovichi by the railway station Brest North.

Eurocentrum Logistics in Malaszewicze, commune of Terespol, is a key handling terminal for combined transport on the eastern borders of the EU. The facility consists of 7 different handling terminals, i.e. container terminal; bulk terminal for ores, fertilizers; dry bulk materials mainly cereals, unitised cargo (according to the international agreement AGTC[6]), combined transport terminal (handling and transport of trucks on railway platforms). This point is an important hub for intermodal trains, including:

- Ost Wind - Berlin/Grossbeeren–Frankfurt–Rzepin–Malaszewicze–Brest–Osinovka–Krasnoye–Moskva/Bekasovo,
- Rotterdam-Malaszewicze train,
- „Mongolian Vector" container train.

The main point of transshipment of Brest region is Brest-Beltamozhservis. The facility complements the infrastructure of the international road border crossing Domachevo. Export services constitute 80% of all transport services of the complex. Favourable geographical location is crucial in the success of the facility.

Similar beneficial location can boast Lublin region. The longest broad gauge railway line in Poland - LHS, combines Polish - Ukrainian railway border crossing Hrubieszow / Izow with Silesia through Slavkov in Zaglebie Dabrowskie area (25 km from Katowice). Length of the LHS line is 400 km and runs through five Polish regions: Lublin, Podkarpackie, Swietokrzyskie, Malopolskie and Silesia. LHS railway line is essential for the interregional development. In the future, the potential of the line may be used to generate development potential of Volyn region.

Along the borders of Lublin, Brest and Volyn regions there are located 15 border crossing points, including 10 road, 4 rail and 3 passages border crossings handling freight and passenger traffic.

However, insufficient density of roads and their low quality greatly reduce the internal cohesion of cross-border area. It is therefore necessary to gradually expand and modernize transport infrastructure and to develop alternative modes of transport, which would also include inland waterway shipping.

[6]European Agreement on Important International Combined Transport Lines

2. Assessment of the potential for capturing the market and cargo supply flows for inland shipping

2.1. Inland waterway shipping as a part of transport system

Inland shipping is part of the economic system of the country and transport subsystem. Shipping, like other modes of transport, meets the transportation needs of other sectors of national economy but also in wider scale, needs of European economic system.

Forecasts studies[7] conducted by Maritime Institute in Gdansk indicate that the cargo type having the greatest growth potential for shifting to inland waterways is mainly bulk cargo, namely coal, sand and gravel, but also building materials, energy resources, municipal waste and heavy and oversized cargo.

In comparison to other transport modes (truck, wagon), inland waterway transport uses vessels with relatively large capacity and presents possibility to form a whole set of barges. A large cubic capacity means that they are well adapted to carry large cargo loads or single pieces of unusual, oversized cargo. Characteristics of inland waterway transport make it suitable for carriage of bulk cargo between the points of origin and destination, situated in close proximity to the waterway, including seaports and major industrial plants. It also allows for carriage of cargo in relations where other transport modes cannot be used which is true for heavy and oversized cargo or cargo vulnerable to shocks, as well as liquid cargo and highly processed products.

MIGs forecasts indicate a significant increase in carriages of containerized cargo. Standardization and mass scale of container use means that their transport can be done by all means of transport within the modern logistics and multimodal transport solutions.

Inland shipping plays an important role in the containers transport in Western European countries bordering the North Sea. However container transport in Poland differs significantly from transport patterns in the old EU countries, an inland waterway transport is negligible in transport of containers.

Development forecasts for inland shipping the Europe and Poland presented in various reports show that the inland waterway transport will grow. Mostly it is due to the existing EU transport policy and various supporting instruments used. Any development forecast for transport in Poland should take into account the revitalization of waterways and inland shipping, as congestion of other transport modes and the costs associated with it might lead to change of corridors and cargo flows.

In light of the anticipated increase in freight transport and the development of multimodal logistics chains, rivers included in the area of international waterway E40 can become major arteries linking Western Europe, particularly the countries around the Baltic Sea to the countries of South-Eastern Europe and the Southern Caucasus and Central Asia. This connection has great development potential and can significantly improve the transport of goods from north to south to Belarus, Ukraine, Russian seaports on the Black Sea, Georgia and Turkey, and from east to west.

Suitable transport policy supporting development of sea-land transport chains, short-sea shipping and multimodal transport including inland shipping will give opportunity for efficient development of container services at IWW E40.

[7] prowadzone m.in.w ramach realizacji projektu INWAPO - Modernizacja Wodnych Dróg Śródlądowych i Portów Morskich w ramach Priorytetu 2 Central Europe oraz projektu INCOWATRANS w ramach programu EUREKA LOGCHAIN

2.2. Cargo supply

2.2.1. Factors generating demand for cargo transport

Freight and passenger carriage are embedded in the transport system, and this in turn is part of a specific system of economic and social infrastructure[8]. Thus, demand for transport services depends on many factors, including:

- current state and prospects of the economy - national income per capita and consumption level,
- technological progress,
- development and state of infrastructure of individual transport modes,
- number and structure of inhabitants
- structure of the economy and the location of industry,
- direction, structure and volume of foreign trade,
- technical conditions,
- natural conditions,
- organizational and administrative conditions
- legal, economic and financial conditions.

Many factors also influence development of demand for inland shipping transport which depend on[9]:

- trends in demand for cargo and passengers transport,
- changes in transport modal split and in particular the role of inland waterway transport in meeting the transport needs,
- navigation conditions that may be achieved at the analysed waterway

Growing demand for cargo and passenger freight poses new challenges for transport system and the economy, which require existing transport system to meet new needs, and ensure compliance of development directions with modern socio-economic trends.

Many of the factors affecting the freight by inland shipping are due to the characteristics of infrastructure of waterways. State of inland waterways primarily influences demand (which depends largely on the geographical pattern of waterways and its conformity with cargo flows bound for inland shipping), rolling stock, (which size, speed, design etc. depend on the quality of water routes) and the possibility of 24-hour shipping. These elements, in turn, shape the capacity of the waterways and transport technologies used, influence the volume and structure of freight and thus the cost per unit in inland shipping. An important factor influencing costs is the range and structure of infrastructure investments into the waterway. In turn, the unit cost plays an important role in shaping the volume and structure of demand for transport by inland waterways[10].

2.2.2. Basic macroeconomic indicators for Poland, Belarus and Ukraine

It was impossible to avoid the negative impact of unfavourable external conditions (recession in the euro zone since 2012) that weaken economic situation in most European countries including Belarus, Poland and Ukraine.

Republic of Belarus is situated in the area of 207.6 thous. km² with about 9.5 million inhabitants. Since June 2010, the country is a member of Customs Union of Belarus-Russia-Kazakhstan and

[8] Por. S. Dorosiewicz; Czy istnieją granice wzrostu popytu na przewozy? Logistyka i transport.
[9] Wojewódzka-Król K., Rolbiecki R., Gus-Puszczewicz A.: Analiza popytu na przewozy ładunków i pasażerów drogą wodną E70. Pomorski Urząd Marszałkowski, Sopot 2011
[10] Wojewódzka-Król K., Rolbiecki R., Gus-Puszczewicz A.: Analiza popytu na przewozy ładunków i pasażerów drogą wodną E70. Pomorski Urząd Marszałkowski, Sopot 2011

included in the Common Economic Area, created by these countries. In 2008, a record year, GDP growth amounted to 10%. In 2009, as a result of economic crisis, a slowdown is observed and a decline in industrial production by 2.8%.

Poland occupies an area of 311.9 thous. km^2 and has a population of nearly 38 million people. From May 2004 Poland is a member of the European Union. Country's economy, after a period of reform in the early 1990s is experiencing a period of economic growth, although the growth rate. In 2010 GDP increased by 3.9% in 2011 by 4.5%, in 2012 by 1.9%.

Ukraine is the second largest European country in terms of occupied territory with an area of 603.5 thous. km². At the end of 2013 Ukraine had a population of 45.4 million inhabitants, of which almost 69% was urban population.

Socio-economic indicators of Belarus, Ukraine and Poland are presented in table 10 below.

Tab. 10. Selected socioeconomic indicators of Belarus, Poland and Ukraine.

Specification	Unit of measure	Belarus	Poland	Ukraine
Total area	km²	207.600	312.685	603.550
Land use: agricultural land arable land permanent crops grassland forests other	% in 2011	 43..7 27.2 0.6 15.9 42.7 13.6	 48.2 36..2 1.3 10.7 30.6 21.2	 71.2 56..1 1.5 13.6 16.8 12
Irrigated lands	km²	1.150 (2003)	11.157 (2007)	21.750 (2010)
Renewable water resources	km³	58	61.6	139.6 (2011)
Number of inhabitants	thous. (2015)	9.589.7	38.562.2	44.429.5
Demographic burden indicators:	% (2015)	43	43.8	43.3
Rate of population growth	% (2015)	-0.2	-0.09	-0.6
Balance of migration	migr./thous. inhab.	0.7	-0.46	-2.25 (2015)
Urbanization: Percentage of urban population	%	76.7	60.5	69.7
Average life expectancy:	years	72.48	77.4	71.57
PKB per capita	USD	17700	23900	8700
GDP revenue structure by sector: Agriculture Industry Services	%	 7.3 37 55.7	 3.7 32 64.3	 12.1 29 58.8
Workforce	mln	4.546	18.26	22.11
Railway lines	km	5.528	19.837	21.733
Roads	km	86.392	412.035	169.694
Waterways	km	2.500	3.997	1.672 (mainly Dnieper)

Source: World FactBook 2015

2.2.3. Cargo supply forecast for inland shipping

Cargo flow model

Forecasts based on relevant methodological basis are a prerequisite for effective business and investment decisions. Research of the demand for transport services in general and regional dimension are most often used while forecasting the development of the transport system and projection of future

investment activities.

Making a development forecasts for transport route, which virtually does not exist and carriages which are not yet offered, is possible using transport forecast models. Forecast and analyses of development as well as cargo and passenger transport scenarios included in many studies and projects implemented for EU DG TREN. Forecast made using TRANS-TOOL, VISUM model and others for European Commission are basis for future transport development actions and EU transport policy. Forecast included many development factors such as increase in population, macroeconomic data, oil prices and technical development etc. Similar forecast will be elaborated for IWW E40. For this reason, we will present the already existing forecasts done in recent years for Vistula waterway and other selected inland waterway as they have similar character to IWW E 40 waterway.

Great demand for transport forecasts is primarily the result of the specificity of infrastructure, especially its longevity, time of realisation and cost. Forecasts for freight transport and modal split are elaborated by professional entities and constantly updated along with the changing social and economic conditions.

Effectiveness of the forecast is largely determined by the relevant data, experienced prognostic team and selection of appropriate methodology. The studies that elaborate quantitative research of the demand use, among others, extrapolation of the trend, comparative methods and econometric modelling.

Waterways are the weakest link in the transport infrastructure. This is particularly true in Central Europe, and especially Poland. Waterways presented in the report are analysed in the model from optimistic viewpoint because they may seem to be the main ways geographically, while in practice shipping may be difficult of simply impossible (as in the case of E40). However, after serious recent investments in road, rail and air infrastructure, it is time to draw attention to the waterways.

Model of transport network along the corridor of international waterway E40 for the Polish territory was built on the basis of the National Traffic Model 2008 (a similar method is also used in forecasting traffic on the waterways in the Netherlands), while for the area of Ukraine and Belarus the network was simplified to the schematic connections by rail, road and waterways. Distances between cities are given in real figures, despite the simplifications for routes of cargo carriage in the transport network. Model of transport network has been divided into appropriate categories (using the attribute "link types") allowing to differentiate types of cross-sections due to travel time and capacity. In case of road network, sections differentiated due to the cross-section (number of lanes), the capacity and speed of free traffic. Parameterization of the network sections was done in order to assign them to the appropriate values for the traffic conditions (travel) in the modelled period, i.e. one day.

Model of cargo flows has been developed using the tool to simulate the flow of goods based on the PTV Visum environment. The tool often used in the research allowed creating an interactive model, which takes into account the structure of modal split flows.

In order to determine cargo flows bound to the area, firstly model identifies other transport modes.

For the part of the model concerning Polish territory, the model was built in a classical way, with sections and nodal points which are assigned traffic parameters and coordinates locating these elements in the field. As a starting point basic system of national and regional roads was adopted. Basically, as nodal points in the road network model the following sites were included:

- existing and planned intersections of national and regional roads,
- locations of changes in road cross-section,

- places where a change in the road surrounding takes place (f.ex. outer city road changes into urban built-up area, etc.).

In order to provide a faithful representation of the national and regional road network a total of 48 basic types of sections was defined in the model. In addition, an average speed of traffic for specific transport modes (Tab. 11).

Tab. 11. Adopted communication speed for the modelled modes of transport

Transport sector	Speed [km/h]
Road	45
River (downstream)	12
River (upstream)	9
Rail	28

Source: Maritime Institute in Gdansk - Department of Economics and Law

Demand model was developed on the assumption that the area is mapped in the corridor of inland waterway E40. Transport areas correspond with division into communes and cities through which runs E40 waterway. All external areas and other areas outside the corridor of E40 waterway were aggregated into four regions corresponding to a given part of Poland. It should be emphasized that division and its resolution results from direct adaptation of the national model to the needs of the Dnieper connection with the Vistula. This methodology does not affect the model - thus leaving them in the model.

The demand model takes into account 74 counties, 29 cities and 7 border crossings. Range of the model is shown on attached map (Fig. 9).

Initial data to build the model of demand were prepared by Maritime Institute and concerned the volume of cargo transported between Belarus and Ukraine, and Polish regions, volume and direction of foreign trade of all three countries and the volume of transit through these countries. Also macroeconomic aspects of socio-economic development of the study area were taken into account. Based on these data city located along IWW E40 were chosen. According to these data, it was founded traffic movement of goods model between the towns located along the waterway E40 and Belarus and Ukraine was constructed.

For the area of Belarus data on volume of transported goods between Poland and Ukraine was used, and value of cargo flows in Ukraine among its regions. For the purposes of the model, these data were aggregated to the cities located along the waterway corridor E40.

To be able to fully reproduce the cargo traffic between countries, it was necessary to create a matrix of movement between cities in different countries. The volume of the goods was distributed proportionally to the total amount of goods from the country concerned (Tab. 12).

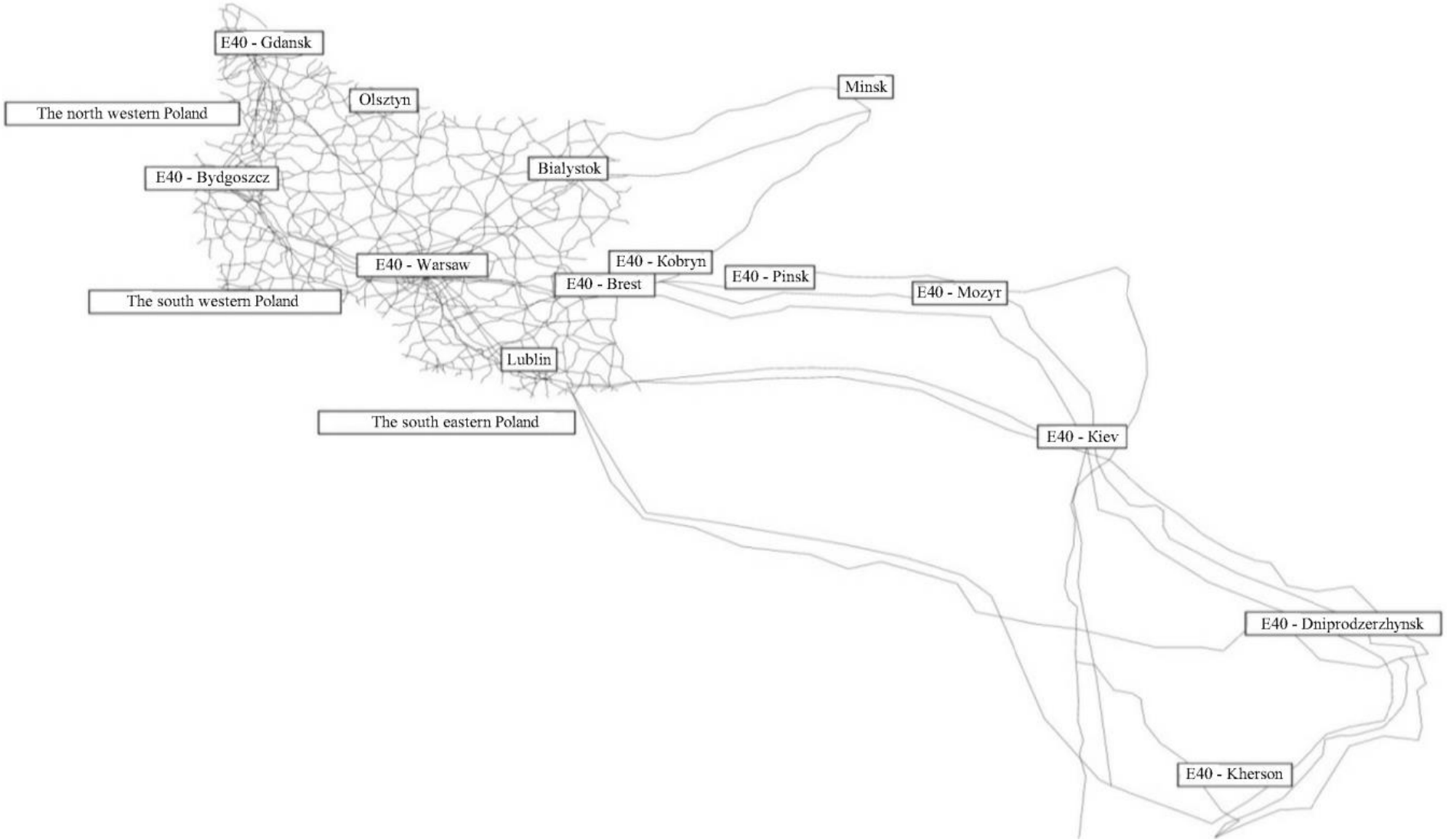


Fig. 9. Transport model area
Source: Szarata A.: Opracowanie prognoz ruchu dla potrzeb Projektu z wykorzystaniem programu PTV VISUM.

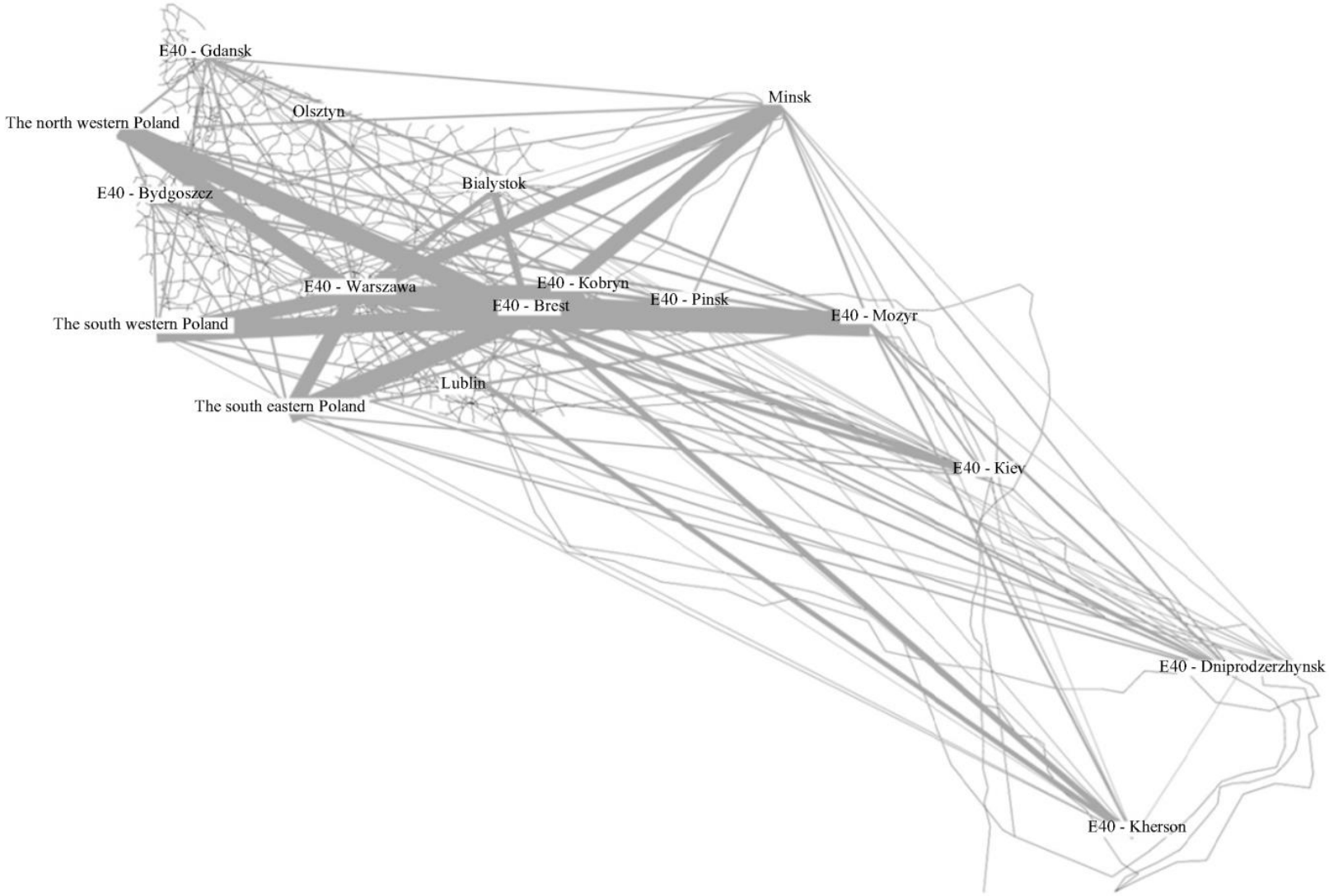


Fig. 10. The intensity of cargo flows in the catchment area of E40 waterway [tons/year].
Source: Szarata A.: Opracowanie prognoz ruchu dla potrzeb Projektu z wykorzystaniem programu PTV VISUM.

Tab. 12. Summary of cargo volumes between Poland and Ukraine (tons per year)

Name	E40-Gdansk	E40-Bydgoszcz	E40-Warsaw	E40-Brest	E40-Pinsk	E40-Mozyr	E40-Kyiv	E40-Dniprodzerzhinsk	E40-Dnipropietrowsk	E40-Kherson	Minsk	Bialystok	Lublin	Olsztyn	E40-Kobrin	The south eastern Poland	The south western Poland	The north western Poland
E40-Gdansk	0	3878	23820	32129	3878	4432	2216	3324	1108	2216	67429	55571	12667	21238	77048	121333	117476	127238
E40-Bydgoszcz	5540	0	34029	45899	5540	6331	3165	4748	1583	3165	53943	44457	10133	16990	61638	97067	93981	101790
E40-Warsaw	66398	66398	0	550155	66398	75883	37942	56913	18971	37942	431543	355657	81067	135924	493105	776533	751848	814324
E40-Brest	26091	26091	160273	0	26091	29818	14909	22364	7455	14909	539429	444571	101333	169905	616381	970667	939810	1017905
E40-Pinsk	29863	29863	183446	247439	0	34129	17065	25597	8532	17065	67429	55571	12667	21238	77048	121333	117476	127238
E40-Mozyr	193667	193667	1189667	1604667	193667	0	110667	166000	55333	110667	80914	66686	15200	25486	92457	145600	140971	152686
E40-Kyiv	47028	47028	288887	389662	47028	53746	0	40310	13437	26873	53943	44457	10133	16990	61638	97067	93981	101790
E40-Dniprodzerzhinsk	17850	17850	109650	147900	17850	20400	10200	0	5100	10200	53943	44457	10133	16990	61638	97067	93981	101790
E40-Dnipropietrowsk	5785	5785	35535	47931	5785	6611	3306	4958	0	3306	40457	33343	7600	12743	46229	72800	70486	76343
E40-Kherson	47028	47028	288887	389662	47028	53746	26873	40310	13437	0	26971	22229	5067	8495	30819	48533	46990	50895
Minsk	64342	64342	395247	533123	64342	73534	36767	55151	18384	36767	0	49000	1000	8000	0	24000	21000	25000
Bialystok	2973	2973	18260	24630	2973	3397	1699	2548	849	1699	0	0	0	0	0	0	0	0
Lublin	5705	5705	35048	47274	5705	6521	3260	4890	1630	3260	0	0	0	0	0	0	0	0
Olsztyn	575	575	3534	4767	575	658	329	493	164	329	0	0	0	0	0	0	0	0
E40-Kobrin	77336	77336	475062	640781	77336	88384	44192	66288	22096	44192	0	11000	0	2000	0	5000	5000	5000
The south eastern Poland	37925	37925	232966	314233	37925	43342	21671	32507	10836	21671	120000	0	0	0	6000	0	0	0
The south western Poland	33753	33753	207342	279671	33753	38575	19288	28932	9644	19288	87000	0	0	0	4000	0	0	0
The north eastern Poland	40658	40658	249753	336877	40658	46466	23233	34849	11616	23233	120000	0	0	0	6000	0	0	0

Source: Inputs to the model prepared by the Maritime Institute in Gdansk - Department of Economics and Law; calculation: Szarata A.: Opracowanie prognoz ruchu dla potrzeb Projektu z wykorzystaniem programu PTV VISUM.

2.3. Modal split

The waterway connection running along the planned waterway E40 was presented in accordance with the submitted schemes prepared by Maritime Institute. Road links run along national roads, where long-distance cargo traffic takes place and the rail links runs under the Trans-European Transport Network -TEN-T. Modal split using a distribution of cargo in the transport network is determined by the travel time of individual sections. This time was defined based on the adopted speeds and distance between cities along E40 waterway.

- travel time after including costs–T_k,
- route distance [km] –l,
- cost of a given transport mode [EURO/km] –k,
- cost of 1 hour - x

$$T_k = \left((l * k) * \frac{3600}{x} \right)$$

In order to be able to compare travel times of individual means of transport it was necessary to use function based on the generalized travel cost. It was also necessary to recalculate costs when taking into account the appropriate rate for 1 hour travel.

The model shows a structure for cargo transported along IWW E40:

- coal 20%,
- ores 17%
- building materials 35%
- chemicals and fertilizers 13%
- agricultural and forestry products 7%
- machinery and equipment 5%
- others 3%.

Tab. 13. Initially adopted costs in the model of transport modal split

Specification	Cost [EURO]
Road	0.046
River	0.004
Railway	0.044
1 hour	7.17

Source: Calculations of the Maritime Institute in Gdansk - Department of Economics and Law.

2.4. Results of the forecast

Forecasts for transported cargo volume of transported were calculated for the following variants:

1. W0 – missing link of IWW E40
2. W1 – link between Gdansk and Kherson, route no. 1
3. W2 – link between Gdansk and Kherson, route no. 2
4. W3 – link between Gdansk and Kherson, route no. 3

The following time spans were assumed:

- W0 – 2012, 2015, 2017,
- W1, W2, W3 – 2022, 2032, 2042.

Tab. 14. Forecast results – detail data (ton per year)

	Base scenario	+3 years	+5 years	+10 years	+20 years	+30 years
Gdansk	677 001	775 100	847 950	1 045 979	1 489 421	1 807 472
Bydgoszcz	589 999	675 494	738 984	911 570	1 289 030	1 575 211
Warsaw	4 817 001	5 515 025	6 033 386	7 442 450	10 597 669	12 860 695
Brest	5 128 002	5 871 041	6 422 831	7 922 786	11 281 634	13 690 714
Pinsk	1 192 999	1 365 899	1 494 294	1 843 295	2 624 744	3 185 233
Mozyr	4 538 002	5 195 783	5 684 226	7 011 831	9 984 344	12 116 409
Kyiv	1 433 998	1 641 840	1 796 180	2 215 693	3 155 002	3 828 723
Dniprodzerzhinsk	836 999	958 301	1 048 379	1 293 233	1 841 491	2 234 723
Dnipropetrovsk	479 003	548 416	599 964	740 084	1 053 841	1 278 878
Kherson	1 193 998	1 367 064	1 495 577	1 844 883	2 626 983	3 187 951
Minsk	1 469 999	1 542 096	1 593 102	1 732 655	2 071 588	2 525 930
Bialystok	62 001	65 042	67 194	73 080	87 375	106 538
Lublin	118 998	124 835	128 964	140 261	167 698	204 477
Olsztyn	11 999	12 588	13 004	14 143	16 910	20 618
Kobrin	1 641 003	1 721 493	1 778 434	1 934 221	2 312 579	2 819 776
SE Poland	917 001	961 975	993 792	1 080 846	1 292 276	1 575 699
SW Poland	794 999	833 990	861 574	937 046	1 120 347	1 366 062
NW Poland	974 001	1 021 770	1 055 566	1 148 031	1 372 603	1 673 643

Source: Szarata A.: Opracowanie prognoz ruchu dla potrzeb Projektu z wykorzystaniem programu PTV VISUM.

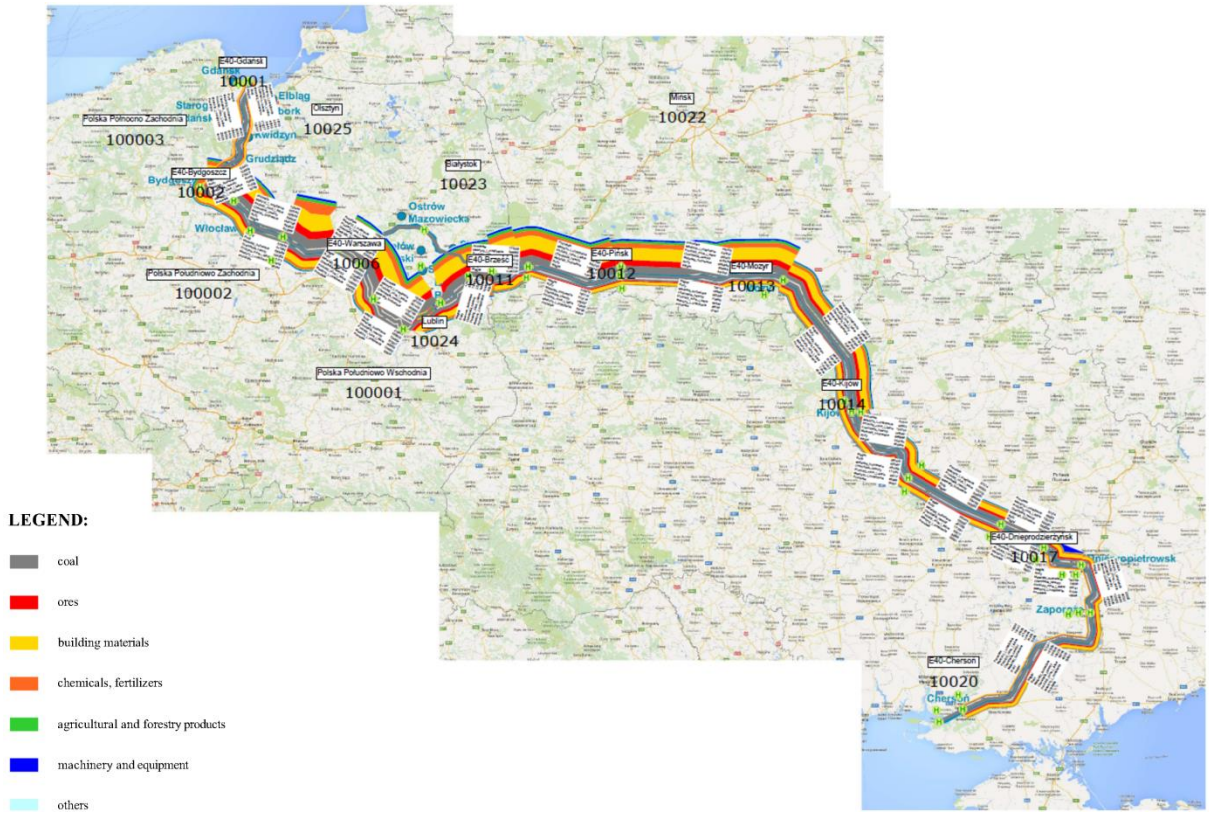


Fig. 11. Graphical presentation of the forecast model results in modal split.
Source: Szarata A.: Opracowanie prognoz ruchu dla potrzeb Projektu z wykorzystaniem programu PTV VISUM.

Reading the results of the forecasts one should be aware that the current uncertain political situation, especially in the eastern part of the road E40, as well as the unstable global economic situation is not

favourable to long-term forecasts.

Relevance of presented forecasts depends on adoption of the following determinants.

1. Eastern section of E40 road, i.e. Polish, Belarusian and Ukrainian parts will meet the required parameters along the entire section,
2. economic and political situation in Eastern Europe will gradually stabilise,
3. Ukrainian and Belarusian economies will be reformed and after a period of decline or recession they will grow at a pace similar to Polish economy, i.e. 3 - 3.5% GDP growth per year,
4. Volume of trade of Belarus and Ukraine with Poland and Western Europe will continue to grow.

2.5. Passenger traffic and water tourism

The EU passenger transport by inland waterways does not play a significant role in the transport of people, but in the economic utilisation of rivers great importance is stressed on tourism. The strategy "Europe 2020" postulates the need to develop water tourism, including the inland waterways. It indicates that land watersides, rivers, lakes are among the most attractive tourist areas.

The waterway used for transportation purposes possesses certain parameters of depth, height of bridge spans which require constant maintenance. Such waterway route can be used for water tourism, provided that it also has a well-developed network of tourist wharves and marinas. Water tourism should use inland transport routes.

Official statistics do not include data on the scale of individual water tourism practiced on the waterways in Poland, Belarus or Ukraine. In Poland, as in other EU countries, passenger traffic on waterways is an important part of the tourist offer of some cities and regions, but they have little relevance to the total volume of passenger traffic. Public transport by inland shipping in Poland is practically restricted to ferries. Therefore, passenger waterways in Poland should in principle be identified with water tourism. The same situation is in Belarus and Ukraine.

3. Optimisation

3.1. Shipping route

The fees for the carriage of waterways should be competitive with rail and road tariffs. The analysis firstly looks onto the distance that road railway and inland carrier must cover in order to deliver cargo to the selected points along the IWW E40 route.

For the purposes of the project a model of transport by waterway, railway and road was made. Also a simulation was made of cargo carriage from Gdansk to Kherson of 40 pieces of 40-foot containers (2 TEU each) loaded on average with 25 tons of cargo. The variables include:

- cargo volume,
- number of lockage,
- lockage fees and fees for waterway use.

Barge	tons	1000
Number of lockages	No./h	1
The output amount of cargo transported through the canal	thous. tons	5720

Road distances were determined using the computer programme, and the fees are given by the shipping company that transports cargo in containers from Poland to Eastern Europe. These fees correspond to the minimum prices at which the carrier would accept a cargo on the above route starting from Gdansk. Transporting 40 containers by road requires the involvement of 40 specialist truck sets.

The distances between the selected cities for railway transport are based on the list of tariff distances of PKP Cargo Logistics SA. Tariff fees are based on information from Commercial Office - Foreign Markets Intermodal and PKP CARGO SA. On this basis the average value of the rate per kilometre of railway transport of 1 standard 40 feet container was set at 3.52 EUR / km, while carriage of a set of containers (forty 40-foot containers weighing an average of 25 t) - 1.2 EUR / km. The set can be transported to its destination with one set of train made up of wagons designed to carry containers.

Distances by waterway were determined using a GPS system, and the cost of transportation was calculated with calculation model for motor barges transporting 40 containers, especially developed for the analysis. Travel time was calculated on the basis of described above assumptions about the rate and time of the vessel. A typical set of 40 containers can be transported using one motor barge with described above parameters.

Determined distances for road and rail transport are similar. Distances by waterway are about 500 km greater than by rail and road and does not differ from specific route variants (Tab. 15). Travelling by water vessels (no stops other than 8 hours rest each day) would take about 14 days regardless of the selected variant of the waterway.

Tab. 15. The distance and time of transported cargo from Gdansk to Kherson

Transport option	Distance Gdansk – Kherson (km)	Travel time (hours)	Travel time – inland navigation without stops (hours)
Road	1700	31	-
Rail	1709	66	-
Inland navigation:			
W – 1 (Variant I)	2260	226	290
W – 2 (Variant II)	2315	231	294
W – 3 (Variant III)	2309	230	293

Source: Maritime Institute in Gdansk - Department of Economics and Law - own calculations.

In the event of stops, which is scheduled for inland shipping for 16 hours while working in the following ports: Warsaw, Brest, Kyiv and Dnipropetrovsk, the time of travel would be longer and would take about 18 days.

3.2. Shipping rates

Considering the data on travel time by inland waterways as well as the fees and expenses incurred during the trip, carrier costs were calculated for each selected variant of the route. These costs, taking into account the high and low season of navigation and the profit margin are the minimum rate of carriage that could be offered to cargo owners on this route.

The costs of operating a vessel during the one hour trip include:

Operating costs – 1 hour cruise	EURO
Cost of fuel and lubricants	34
Gross salary	60

Renovation and repair	31
Other costs	17
Total	**142**

- base crew of the vessel consists of three people working for 16 hours. per day. The remaining 8 hours is a mandatory rest. This is consistent with the current legislation on working time of seafarers in inland navigation that was introduced in Poland based on EU directives,
- costs of rest during the stop during cruise - 8 hours per day equal to 60% of cost for 1 hour of operation during the trip - shown above,
- costs of fees for the use of the waterway and locks according to the rates applied in Poland in 2012,
- depreciation costs of the vessel were calculated at the rate of 5% (depreciation period units - 20 years). Annual depreciation cost would amount to 8,333 EUR,
- costs standstill during the low navigation season, the amount of 20% of the cost for 1 hour. operation during the trip.

Shipping rate for basic operating parameters of the selected vessel is shown in the following table.

Tab. 16. Economic parameters of selected vessel

Specification	EURO
Cost of 16 hours of navigation during the cruise	2 263
Cost of eight hours standstill during the cruise	679
Cost of one day during the cruise	2 942
Operating cost during the navigation season	765 003
Standstill cost during the off-season	2 971
Total annual costs	**867 973**
Gross profit	**102 421**
Net profit	**86 797**
Indispensable annual revenue EURO	**970 394**
Average daily revenue during season EURO	**3 732**

Source: Maritime Institute in Gdansk - Department of Economics and Law - own calculations.

Annual operating costs during the trips in navigation season of the selected vessel amounts to 765 thous. EUR and the total annual costs (including depreciation) amount to about 868 thous. EUR. Given that the average daily revenue necessary to cover the cost of the vessel and to achieve an appropriate level of profit should in operating season amount to at least 3700 EUR.

The rate of carriage, which could offer inland shipping operator en route Gdansk - Kherson for the carriage of cargo unit, would cover the total annual costs of 2,000 t barge with and profit margin.

Comparison of the rates offered by rail, road and inland waterways for the same unit of goods for individual variants route reveals the following figure.

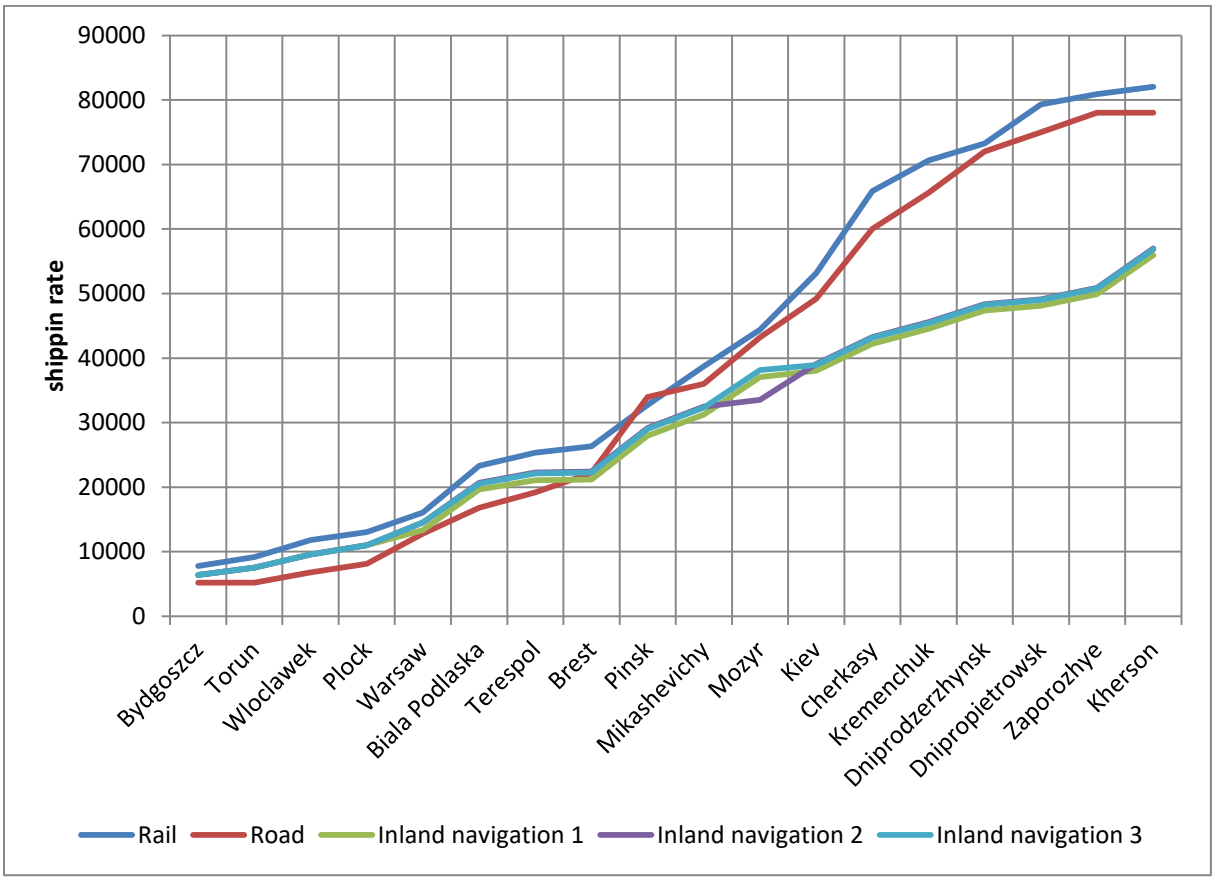


Fig. 12. Prices for the particular modes of transport for the carriage of 40 TEU on IWW E40 route.
Source: Maritime Institute in Gdansk – Economics and Law Department – own elaboration.

Calculations confirm that inland shipping can offer freight rates more competitive with other transport modes, the advantage is particularly visible on transport distances over 500 km.

3.3. Operation cost of the inland waterway channel

The report assumes that the cost of building the infrastructure of the waterway in the area of Poland connecting the Vistula with Brest (investment cost) will be covered by public funds from the state budget and the EU. Based on this, the proposed fees for the use of the waterway and its facilities will not match the cost of capital or remuneration of capital (Tab. 17). Benefits (discussed in costs and benefits chapter), that can be obtained as a result of the project by beneficiaries include power engineering, agriculture, protection against drought and flood – resulting from sustainable water management. Also project may stimulate the economic development of regions, etc. which should pay the public expenditures incurred.

Tab. 17. Capital expenditures for the construction of the Vistula - Mukhavets connection

	Length of the channel, km	Number of locks	Cost of construction of the channel thous. EUR	Cost of construction of the locks thous. EUR	Total construction cost thous. EUR
Variant I	207.8	11	2721854.2	183990.4	2905844.7
Variant II	195.9	9	2415069.3	150537.6	2565606.9
Variant III	159.6	7	1825920	117084.8	1943004.8

Source: Maritime Institute in Gdansk – Economics and Law Department - own calculations

However, fees for the use of waterways should cover the costs of their operation. Such a method of financing the costs of operation corresponds with the rule postulated by the EU in the EU White Paper

of 2011 that: "user pays". The most commonly used (and recommended) method is to determine the cost source. This method does not take into account the cost of "capital" spent on creating the infrastructure, which should be "returned" or otherwise guaranteed (this situation is similar to toll roads in Poland, where the government granted a guarantee of return on capital in the form of ensuring adequate traffic or fees in case of lower traffic intensity). This results from the assumption that the construction of transport infrastructure, including a waterway, is the responsibility of public authorities and is carried out with public funds or with their principal (public intervention).

In order to make calculations of marginal costs of waterway use and suggest appropriate fee for the use of it, cost sources were determined. The following cost sources (and revenues) were identified:

- locks.
- channels – 3 variants.

The annual operating costs of one lock consist of:

- Operating Costs - 4 full-time employees with a gross salary (total cost of the employer) of 5,000 PLN per month (1,195 EUR).
- annual cost locks maintenance and repairs in the amount of 0.01% of the investment expenditure required to build the lock. The level of costs is sufficient in the first period of the facility operation.
- energy costs - 8 PLN (2 EUR) for each lockage. These costs in 100% dependent on the intensity of use of the facility.
- General and administrative costs incurred during the year on the operation and maintenance of the lock (insurance, communication, clothing, etc.) 10% of salary costs (similar to other such facilities in Poland).
- It was assumed that during the navigation season working time of the lock will amount to 22 hours per day and at that time 22 lockages will take place with a load of 1,000 t (load unit). During the year this gives 5720 lockages per one lock.

Exploitation costs calculated for one lock, and based on that, operating costs of locks in different variants of the waterway is presented in table 18.

Tab. 18. Annual operating costs for 1 lock and all newly constructed locks on the connection Vistula – Mukhavets in particular variants of the waterway

Annual operating costs 1 lock in EUR	
Salaries	57 350
Maintenance and repairs	16 726
Energy	10 934
General costs	5 735
Total cost 1 lock	**90 743**
The cost of maintenance and operation of the locks in different variants in EUR	
Variant I	**998 174**
Variant II	**816 688**
Variant III	**635 202**

Source: Maritime Institute in Gdansk – Economics and Law Department - own calculations

Revenue from fees for use of locks by vessels were calculated in accordance with the Announcement of the Minister of the Environment of 18 October 2011 on the rates of charges for the use of inland waterways and locks and slipways for 2012 and given above calculated number of lockages in during a year (Tab. 19).

Tab. 19. Expected annual income of lockage in different variants route and financing gap

Alternative route	Lockage income in EUR	Financing gap in EUR
Variant I	**221 761**	**-776 413**
Variant II	**181 441**	**-635 247**
Variant III	**141 121**	**-494 081**

Source: Maritime Institute in Gdansk – Economics and Law Department - own calculations

Under the adopted assumptions concerning: the amount of fees for lockage, the intensity of operation of equipment, traffic of vessels and the volume of cargo, revenues from the fees are not enough to cover the operating costs of the locks.

Quantitative and pricing breakeven point - BEP for the lock shows that if other assumptions remain unchanged, the revenues from lockage to be able to cover the cost of operating the lock need more than 26 thous. lockages per year. Otherwise a fee of one lockage would have to be set at 15.9 EUR. The first solution is not technically possible, and the second would increase the transport cost by water. The results of sensitivity of revenues calculations depending on the number of lockages are presented in table 20. Even very intensive exploitation of these buildings, with the current fees for lockage, will not make that revenues cover the operating costs of the facility.

Tab. 20. Sensitivity analysis of lockage income for change the number of lockages

Alternative route	1.5 lockages/h		2 lockages/h	
	Lockage income	Financing gap	Lockage income	Financing gap
	in euro			
Variant I	332642	-725671	443522	-674930
Variant II	272161	-593731	362882	-552215
Variant III	211681	-461791	282241	-429501

1.5 lockages/h	**BEP fee (charge) w EUR**	**11.2**
2 lockages/h	**BEP fee (charge) w EUR**	**8.9**

Source: Maritime Institute in Gdansk – Economics and Law Department - own calculations

In case more intense vessel traffic is takes place and thus more lockages occur per hour, the rate of fees for lockage will allow for the operating costs of these facilities to be reduced down to 8.9 EUR per lockage. This rate will be much higher than the current level of fees, although it will still be lower than those used in Western Europe.

The calculation of the revenue sensitivity for inland waterway transport fees for lockage and thus influence of charges on the competitiveness of shipping is presented in conjunction with the projected charges for carriage through the channel as a whole waterway.

For individual variants of the connection there was calculated the quantitative and pricing breakeven point that would cover the operating costs of the channel. Under the adopted assumptions potentially feasible vessel traffic is not sufficient to ensure that the costs channel maintenance are covered. Similarly, under the same assumptions, fee for carriage of 1 ton-km of cargo does not allow to cover the costs of operating the facility. Therefore, financial feasibility of the channel means either increase of vessel traffic on the channel or raising fees for the use of the channel, or use both approaches simultaneously. As a result of this situation, a financing gap occurs since the revenue is less than the total operating costs.

Table 21 indicates that if the vessel traffic is higher (measured by number of lockage and/or volume of

transported cargo units) revenues from charges set by current regulations may cover the channel operating costs in each variant of the planned channel. In Variant III we will pass the breakeven point the earliest.

Tab. 21. Sensitivity analysis of the use of the waterway income fee for the volume of cargo and movement of vessels in the different variants of the waterway (in EUR)

Variants	1.5 LOCKAGES – 750 T		2 LOCKAGES - 750 T	
	Income	**Financial gap**	**Income**	**Financial gap**
Variant I	2 140 787	**- 718 702**	2 854 383	**- 5 106**
Variant II	2 018 191	**- 534 512**	2 690 922	138 218
Variant III	1 644 223	**- 319 331**	2 192 298	228 743
	1 LOCKAGE – 1500 T		**1 LOCKAGE - 2000 T**	
	Income	**Financial gap**	**Income**	**Financial gap**
Variant I	2 854 383	**- 5 106**	3 805 843	**946 355**
Variant II	2 690 922	138 218	3 587 896	1 035 192
Variant III	2 192 298	228 743	2 923 064	959 509
	1.5 LOCKAGES – 1000 T		**1.5 LOCKAGES – 1500 T**	
	Income	**Financial gap**	**Income**	**Financial gap**
Variant I	2 854 383	**- 5 106**	4 281 574	**1 422 085**
Variant II	2 690 922	138 218	4 036 383	1 483 679
Variant III	2 192 298	228 743	3 288 446	1 324 892
	1.5 LOCKAGES - 2000 T		**2 LOCKAGES – 1000 T**	
	Income	**Financial gap**	**Income**	**Financial gap**
Variant I	5 708 765	2 849 276	3 805 843	946 355
Variant II	5 381 843	2 829 140	3 587 896	1 035 192
Variant III	4 384 595	2 421 041	2 923 064	959 509
	2 LOCKAGES - 1500 T		**2 LOCKAGES - 2000 T**	
	Income	**Financial gap**	**Income**	**Financial gap**
Variant I	5708765	2849276	7611687	4752198
Variant II	5381843	2829140	7175791	4623088
Variant III	4384595	2421041	5846127	3882573

Source: Maritime Institute in Gdansk – Economics and Law Department - own calculations

If fees for the use of the channel are increased (or the whole tariff system is changed) it is possible to be obtaining revenue level that allows to cover the operating costs of the facility.

To calculate the level of fees that meets the principle of "user pays" a simulation was made by changing the level of fees for the use of the channel. A fee of 0.0024 EUR per lockage a 1 hour and carriage of 1,000 tonnes of cargo by a vessel on average would enable to cover the operating cost the channel for the second and third options a fee of 0.0026 EUR would be enough also to cover operating costs in the first route variant.

For the whole waterway to calculate the level of revenue to ensure the costs coverage, level of fees for the use of the entire waterway (also the Vistula river and locks) at breakeven point is: 15.9 EUR per one lockage and 0.0026 EUR per ton of cargo (one lockage means one vessel with 1000 ton of cargo).

Calculations show that at a given level of traffic you can realize the principle of "user pays" and apply rates that allows covering the operating costs of the channel and locks in each of the proposed variants for the connection Vistula- Mukhavets.

When using lockage fees and the use of the entire waterway from Gdansk to Kherson (including the Vistula) at the breakeven point, shipping will still have an advantage in transport costs over the rail and road transport. This is illustrated in the figure above.

3.4. Comparison of inland shipping tariffs

The EU countries different systems of charging are in place for the use of roads and water facilities. Some countries abandoned such payments appreciating the environmental impact of shipping and seeking to improve its competitiveness, for instance in the Netherlands[11] vessels pay only for the use of port infrastructure. In France, the carriers pay for the transport within the national system of waterways. Fees vary depending on the type of vessel, the nature of the cargo or shipping destination. The fee often consists of the charge for the right to access the network of waterways and charges for the transport of tonne-kilometres.

In Germany there are different tariffs depending on the area of navigation. There are also different ways to build tariff charges:

- tariff for the area of the Moselle River[12] charges a fee of 0.05 EUR per kilometre of carried container over 20 feet and fees for lockage that depend on the surface of deck (water footprint) in the amount of 3 EUR per vessels up to 400 m^2 and 6 EUR for vessels having over 600 m^2,
- for the waterways of southern Germany[13] tariff charges 0.05 EUR for every kilometre of carried container and for lockage 20 EUR for every cargo vessels,
- in northern Germany apply the same charges as in the south Germany[14].

In Poland, the issues of water use are regulated the Water Act[15]. However, it does not cover the "user pays" principle recommended by the EU and does not introduce charges for the use of water by all users of water resources.

System of fees for lockage used in Poland does not take into account the size of the vessel or the size or cargo type. The fees for using the waterway depend only on the number of ton-kilometre. The existing system does not allow for a proper assessment of the costs and benefits of the use of water resources, in particular in inland shipping.

Charges for the use of waterways and facilities in 2012 (a base year) and in 2015 were introduced by the aforementioned Decree of the Minister of the Environment.

The Water Act also introduces other charges for the use of waterways which belong to the Polish Treasury. Shipowners are required to pay:

- annual fees for the use of land under the flowing waters (art. 20 the Water Act and the Act on Real Estate). These fees can be burdensome, especially for entrepreneurs, whose vessels are forced into a long halts due to the low water level or ice.

[11]Program rozwoju infrastruktury transportu wodnego śródlądowego w Polsce wodnego śródlądowego oraz turystyki wodnej w Polsce (Programme of inland waterway and water tourism develpment in Poland), Ecorys, 2011.
[12]Tarif für die Schifffahrtsabgaben auf der Mosel zwischen Thionville (Diedenhofen) und Koblenz (Coblence).https://www.wsv.de/Schifffahrt/abgaben/pdf-Container/Moseltarif-VI-01012009.pdf
[13]Tarif für die Schifffahrtsabgaben auf den süddeutschen Bundeswasserstraßen, https://www.wsv.de/Schifffahrt/abgaben/pdf-Container/Sueddeutscher_Tarif_XXVI_Nachtrag.pdf.
[14]Tarif für die Schifffahrtsabgaben auf den norddeutschen Bundeswasserstraßen im Binnenbereich https://www.wsv.de/Schifffahrt/abgaben/pdf-Container/XXXI-NorddeutscherTarif.PDF
[15]Ustawa z dnia 18 lipca 2001 r. Prawo wodne; Dz. U. 2001 Nr 115 poz. 1229 z późn. zm.

- contributions to the Inland Shipping Fund on the basis of the Act on Inland Shipping Fund and Reserve Fund.

In some Polish ports demurrage and tonnage charges are taken from the berthed vessels including inland waterways vessels, also in ports located along IWW E40 in Gdansk and Elblag.

3.5. Summary

When creating a model for economic and financial calculations for IWW E40, operating inland vessel, as well as variants of waterway infrastructure between the Vistula and Mukhavets rivers, a number of guidelines was adopted on how to calculate and present independent and dependent variables. Freight by inland shipping will take longer than carriage by rail or by road, 14 days on average. However, on a planned route a barge can replace up to 40 trucks adapted for the carriage of containers. A proposed rate for the carriage of forty 40-foot containers by water from Gdansk to Kherson would amount to 56-57 thous. EUR, while transport by rail on the same distance would cost more than 82 thous. EUR, and 78 thous. EUR by road.

Rates for the use of waterway and locks currently applied in Poland (rates of 2012) are not able to cover operating costs of the proposed hydrotechnical infrastructure and create a financial gap.

Revenues from the operation of the locks are correlated with the vessels traffic on the route, but at the currently used rates even greater number of lockages cannot provide proper revenues to cover the costs of operating these facilities. In case the channel construction it will be necessary to significantly increase rates per lockage. A proposed calculated rate to maintain the facilities will still be lower than the charges applied on German waterways.

Income from fees for the use of the channel are strongly correlated with the volume of the cargo stream, number of vessels in operation and the use of cargo capacity. When making the calculation of charges for the cargo transport and the locks use in three variants of Vistula- Mukhavets (Brest) connection, a breakeven point was calculated; this provides coverage of waterway operating costs.

1. In case of locks on the Vistula- Mukhavets (Brest) connection, a rate of 15.9 EUR per lockage is proposed. This fee may be reduced if a subscription system for repeated use by vessels during the navigation season.
2. In case of fees for the use of the channel it is proposed to charge for 1 km of 40 – feet container between 0.024-0.026 EUR.

The introduction of fees of this amount will not cause loss of competitiveness of freight transport by inland waterways on the analysed route. The most important condition for economic and financial success of the project for both shipping companies as well as investment and managing entities of the waterway, is to generate an adequate cargo streams capable of providing traffic and waterway usage.

4. Economic analysis – cost – benefit analysis (quantitative assessment)

4.1. Identification of variants

Reference variant (non-investment) assumes lack of investments in IWW E40 restoration on Polish section. This applies both to specific the objective no. 2, i.e. reconstruction of Vistula waterway, as well as basic objective no. 1, i.e. construction of the Vistula - Mukhavets waterway connection. The route will not meet international standards, nor will the technical possibility of its functioning, and all cargo, as it is currently the case, will be transported by road or rail.

Investment variants (detailed variants of 3 routes are elaborated in Technical and Navigation Reports

presented in the Second Interim Report) implementing objective no. 1.

Basic variant assumes implementation of investment linking by waterway Vistula River with Brest (Mukhavets River) according to Variant III, specified by the International Commission for the revitalisation of IWW E40 during a meeting in Brest on 17 November 2015; variant recommended for implementation. **Alternative variant no. 1**, realization of the investment according to Variant I of the route that begins in the Zegrzynski Lagoon and runs further through channel to Brest. **Alternative variant no. 2** is based on the investment of the Vistula connection with Brest according to Variant II.

4.2. Investment costs

Implementation of Variant I of the proposed water link would require, apart from construction of the channel and hydrotechnical infrastructure, 9 dams forming a cascade of lower Vistula. Implementation of Variant II would require 2 additional dams, similarly Variant III. The analysis does not include issues of revitalisation of other sections of IWW E40. Assuming the previously mentioned capital expenditures in hydrotechnical facilities on the Vistula, the estimated investment cost of objective 1 and objective 2 realisation in different variants would amount to those shown in table 22.

Tab. 22. Capital expenditures for the water management of the Vistula with its streamlining and connecting the Vistula with Mukhavets.

Specification	Total expenditure (Objective 1 and 2)	Streamlining the Vistula (Objective 2)	Connection the Vistula with Mukhavets (Objective 1)
	mln euro	mln euro	mln euro
Variant I	**9 553.97**	**6 648.12**	**2 905.84**
Variant II	**10 875.76**	**8 310.16**	**2 565.61**
Variant III	**11 915.19**	**9 972.19**	**1 943.00**

Source: Maritime Institute in Gdansk – Economics and Law Department - own calculations

The primary benefits of this solution are the savings in capital expenditures and their allocation to other goals (beyond the objective of this study). The volume of investment cost for specific variants was calculated with the involvement of professionals in the construction and design bureau that has previous experience in the design and implementation of hydro investments in Poland[16].

Benefits of implementation of non-investment variant are included in the volume of capital expenditures on the cost side of objective 1 realisation (in accordance with the methodology, analysis for objective no. 2 was not considered). Since determining the probable timetable for the investment is not possible, values of corrected investment expenditures for the purpose of the calculation were placed in "zero" year, during which the investment completion and commissioning of the entire waterway for operation will take place. Capital expenditures for the construction of different variant links were corrected by the amount of transfer resulting from:

- salaries,
- income tax from legal entities.

Gross salaries of employees is in Polish conditions constitutes approximately 25% of total investment costs. Tax on personal income PIT is 18% and all surcharges on salaries on employee and the employer side amount to about 56% of gross salary.

It was assumed that 10% of the investment value is the net profit entities involved in its implementation. Transfer, which reduces the volume of the investment, is the value of income tax from legal entities CIT; 18% rate of investment gross profit.

[16] Hydroprojekt and „EKOSOFT"

Tab. 23. The adjustment to the investment (in thous. EUR)

Alternative route	Capital expenditures for the connection	Transfers together	Capital expenditures minus transfers
Variant I	2 905 844.7	470 746.8	2 435 097.8
Variant II	2 565 606.9	415 628.3	2 149 978.6
Variant III	1 943 004.8	314 766.8	1 628 238.0

Source: Maritime Institute in Gdansk – Economics and Law Department - own calculations

The calculations were carried out in net prices, so there was no need for correction of investment expenditures with transfers resulting for value-added tax VAT.

Replacement investments were not included since they increase net value of the facilities in the 30 years of exploitation. However, operating costs of the channel and the locks were increased in each year with the cost of repairs and maintenance in the amount of 0.1% of the investment expenditures excluding transfers. Replacement investments can be realized within the existing costs. The costs of repairs and maintenance are to be covered from fees for the use of the waterway and facilities. The residual value[17] of individual channel variants were adopted in the amount of 25% of the investment expenditures including transfers. This volume is justified by the rate of depreciation applied in Poland for water facilities of 2.5% (40- year depreciation period, while the period for which the results were calculated includes 30-year period).

4.3. Investment variants

Implementation of the Dnieper - Vistula channel project will bring a number of quantifiable benefits in the form of cost savings in cargo freight, savings in transport external costs as well as other positive effects that are not always possible to quantify or estimate in hard figures.

It is understood that variants of the investment will be implemented as a public purpose investment with public funds from the state budget and European Union funds. For this reason, economic calculation, i.e. cost-benefit analysis (CBA) was not taken into account in as well as the cost of the return of capital or its cost of raising, operating and compensation (interests, dividends, etc.).

It was assumed that the investment Vistula - Mukhavets connection will be carried out according to the basic variant and that navigability of the Vistula waterway will be improved, so international waterway standards for waterways will be met.

Implementation of the non-investment variant means not only benefits from the savings in investment expenditures, but will also include certain costs. If the investment were not to be implemented, the primary and most important cost would be the lack of carriage of goods by inland waterways. Instead, the goods will be transported by rail and trucks. Assuming the previously mentioned conditions, transport costs were calculated for a road transport on the Warsaw - Brest connection of 220 km and in case of railway transport across a distance of 211 km. The difference in transport costs between the transport sectors were calculated taking the average cost of transporting one ton of cargo load of 40 40-foot containers on the route Warsaw - Brest and converting them to the mass of the resulting load from the forecast. On the basis of these data, the average cost of transporting 1 t load on this route was generated. For waterway transport distances were calculated depending on different variants of the planned connection. For cost calculations it was also assumed that 20% of cargo indicated in the transport forecast for the waterway will be acquired from rail and 80% from the road transport.

[17] the value of net assets acquired at the stage of implementation of the project or during its operation, resulting from the investment in the project and replacement investments, set at the end of the last year of the reference period adopted for analysis

As a starting point for the calculation of the transport forecast on the specified route the first year of its operation after completion was treated as "zero" year[18]. Then a gradual increase of cargo volumes on the waterway over the next 30 years of service was assumed. For the basic variant, it is assumed that in the first year of operation, 6,435 thous. tons of cargo will be transported and the volume will increasing each year by 5% over the next eight years, 4% for the next 8 years, 3% over 8 years, and 1.5% over the next six years.

According to the developed model the volume of cargo per year would amount to 1,125 tons (consisting of 45 40-foot containers loaded with an average of 25 tons of goods and demanding 5720 lockages per year). The transport cost depends on the adopted unit per load, as shown in the following table.

Tab. 24. Average transport costs of cargo on the route Warsaw - Brest (in EUR per ton)

Specification	1000 t	1125 t	1250 t	1500 t
Car transport	11.20	11.20	11.20	11.20
Railway transport	10.13	10.13	10.13	10.13
Variant I	7.83	7.00	6.34	5.34
Variant II	7.87	7.05	6.39	5.40
Variant III	7.83	6.92	6.27	5.30

Source: Maritime Institute in Gdansk – Economics and Law Department - own calculations

It should be emphasized that the differences in favour of inland waterway transport costs would be even greater, if larger unit of the load is assumed for the calculation, f.ex. 2,000 t. This is possible with the adopted vessel as basic on the planned waterway.

According to the presented methodology, there were calculated transport costs of cargo for the non-investment variant by land in adopted proportions of share between railways and trucks. Also transport cost for inland waterways were calculated in each of the discussed variants of the connection. Base on that difference between the transport costs in non – investment variant and investment variant of the connection was calculated. It includes the following external costs: accidents, noise, pollution, climate change, infrastructure, congestion.

Applying to calculations proposed in EU documents the volume of social rates of external costs; the external costs of transport for the non-investment variant were calculated, assuming that projected cargo volume on route Warsaw - Brest (and Brest - Warsaw) is transported in 20% by rail and in 80% by road. The following external transport cost of inland waterway was calculated for each investment variant as well as differences between the variants.

4.4. Revenues, operating and maintenance costs

Revenues consist of user charges for the use of the waterway and facilities. Since the proposed investment options are considered only as a dedicated waterway, it is assumed that the revenue will come only from businesses shipping. The amount of these fees and revenues as well as operating costs of the waterway in its individual variants are presented in the previous chapters. Calculated revenues from fees cover the cost of operating the waterway.

[18] It does not apply to calendar dates, due to the inability to determine the real schedule of the investment. Year Zero is the year of completion of the investment and putting it to use, to which is assigned the entire investment, and the first year is the first year of operation of the building.
Adopted growth rate corresponds to the discount rate, but does not reflect the real possibilities for transport by water. The experience from the implementation of this type of investment in Europe indicate the possibility of faster growth in weight load, even above 10% per year.

According to the assumptions, using the social discount rate index Economic Net Present Value (ENPV) was calculated for individual investment variant of the project. Using the discount rate the indicator moves to the first year of waterway operation benefits that are the difference between transport costs and external transport costs of non-investment variant and investment variants, as well as capital expenditures incurred in the "zero" year. The project, to be worthy of implementation must generate value exceeding its implementation costs.

For investment projects there was also calculated the Economic Internal Rate of Return (ERR) showing the amount of the discount rate at which ENPV rate will be equal to 0, so the project will not generate a positive balance in value increase over the investment expenditures.

Tab. 25. Economic net present value (ENPV) for project investment variants (in EUR)

Variant I	1 715 591 294	-719 506 550		2.003
Variant II	1 653 582 314	-496 396 293	IRR %	2.468
Variant III	**1 636 560 093**	**8 322 088**		**4.032**

Source: Maritime Institute in Gdansk – Economics and Law Department - own calculations

Under the adopted assumptions only basic variant connection shows positive indicators of economic efficiency and justifies its implementation due to the important public interest. What is more, the implementation of the basic variant can generate an additional cargo volume, among others, from / to areas of Pulawy, Radom, Kozienice, which are not included in the transport forecast.

Indicators greatly improve when in the first year of operation freight will amount in total to 7.15 mln tons (on average 50 containers) and will grow at a described rate. These results indicate a high dependency of benefits of the project on the cargo volume that will be transported by the waterway. This is shown in table 26.

Tab. 26. Economic net present value (ENPV) at a higher level of traffic in the first year of operation (in EUR)

Variant I	2 022 773 650	-412 324 195		2.895%
Variant II	1 955 950 569	-194 028 038	**IRR**	3.423%
Variant III	**1 939 654 117**	**311 416 112**		**5.149%**

Source: Maritime Institute in Gdansk – Economics and Law Department - own calculations

4.5. Other expected unquantifiable costs and externalities from IWW E40 revitalisation

Revitalization of IWW E40, apart from the indicated above quantifiable benefits and socioeconomic costs will result in positive and negative effects (benefits and costs), understood as externalities of investment, usually difficult or impossible to measure and express in numerical values. Therefore, also in the account economic efficiency of investment they are not determined numerically. Such effects arise in various areas of socioeconomic development of regions along the waterway. Nature and versatility of these benefits should undoubtedly be taken into account when deciding on the feasibility of the investment. They can support the desirability of this investment and give impetus to its support of many non-governmental organizations, business and local governments.

The group of most significant costs and benefits includes:

- **Costs:**
  - temporary degradation of land during the implementation of the investment and burden for local residents coming from the construction site (noise, dust, vibration),
  - temporary suspension or restriction of traffic on the river and in the area of access roads to the site works (impediments to the free movement to places of residence restrictions in other local investments),

- degradation of the infrastructure used by the vehicles during the implementation of the investment and associated restoration costs,
- degradation of land and the cost of their rehabilitation.

- **Benefits:**
  - ability to use facilities of seaports, along the route by inland waterway shipping,
  - improving transport accessibility and attractiveness (competitiveness) of seaport and regions adjacent to the waterway,
  - development of industries related to construction, renovation and operation of shipping stock, as an innovative and environmentally friendly sector,
  - improving flood protection and reduction in costs and losses incurred by the budgets of state and local governments and population),
  - improvement in the water supply of the population, industrial enterprises and services,
  - improvement in the living conditions of the population, and in particular the improvement of health,
  - creating conditions for the development of renewable energy,
  - ability to retain water, thus preventing the possibility of drought,
  - stimulating development of regions, in particular due to new investments related to the revitalization and construction of Bug Vistula link and with river ports,
  - increase in the investment attractiveness of the regions,
  - creation of new jobs directly in the implementation of the investment, as well as in the sphere of the accompanying infrastructure (roads, harbours, marinas, shops, factories, services and shopping and leisure, hotels, motels, tourist offices, etc.)
  - activation of water tourism by improving access to the shoreline and adjacent buildings,
  - improvement of cohesion of the area impacted by the investment,
  - strengthening the ties of international cooperation,
  - extension of the services offered by economic centres, etc.

4.6. Summary

The analysis indicates the investment of Vistula – Mukhavets connection has sound economic justification in socioeconomic interests; Implementation of the project can bring tangible economic benefits, as well as other economic and social benefits. The project should be treated as an investment in the infrastructure of the country (Poland) and financed from public funds, including the European Union funds.

As part of the restoration of the Belarusian part of the waterway at least 20 different types of objects are planned to be built. Their construction will employ residents from areas in the vicinity of the route (including the city of Pinsk, etc.). Implementation of the project of revitalization of the waterway E40, even at the stage of construction, will be an important factor in the prevention of decline in employment and increase household incomes in the region. This will similarly influence Polish areas along the route.

The development of shipping provides an opportunity for employment of the population in rural areas. In addition to employment in the construction of infrastructure, residents could find employment in handling cruises and water tourism. Currently, this type of activity in the region is underdeveloped and the tourist facilities are located mainly in the administrative centres, far from waterways.

The main problem of Ukraine, beyond the scope of this analysis, is the political situation of the country. The strength of the economy of the country is steel industry and mining, which by nature

depend on transport and therefore could potentially be a source of cargo for inland navigation.

Revitalization of the waterway will allow the E40 to achieve direct benefits not only from the development of water transport between the Baltic and the Black Sea, but will also foster the emergence of a number of positive (but also negative) external effects which cannot be put into numbers. There are multilateral benefits, generating positive social effects especially in the sphere of the conditions and standard of living and increased income for local budgets for many years to come.

II. ASSESSMENT OF SOCIAL AND ENVIRONMENTAL EFFECTS

1. Assessment of socioeconomic effects

1.1. Scope of the analysis of the area bound for IWW E40

Analysis and assessment of the socioeconomic area bound to the development area of international waterway E40 was developed based on previous analytical materials of the whole country, as well as some administrative areas on Polish and Belarusian and Ukrainian side. There was also used available data of the national public statistics from different countries and information from many dispersed sources, data and cartographic materials, publications and programming documents. Available information from the statistical systems of the three countries has been enriched with materials derived from Eurostat statistics and other studies on the analysed issues. Existing differences in the data provided by the statistical offices of those countries did not hamper drawing conclusions on the social aspects of the project.

The study also included influences and spatial ranges between Lublin, Brest and Volyn regions, which indicate the relationship of cause and effect showing the problems and development opportunities in these areas. This allows indicating the directions of development of cross-border cooperation that favours revitalisation of shipping on IWW E40. Socioeconomic background of these areas based on development indicators of the country were analysed, including environment, society, infrastructure, the economy, with extra focus on selected elements having major impact on cross-border cooperation and economic development of the potential of IWW E40. It also included economic and demographic situation of other regions in the area of development along the E40 waterway.

In assessing the socioeconomic effects of E40 waterway revitalization and operation it has been taken into account the impact on such areas of social life as demographics, income levels and quality of life, economic activity and unemployment, social activities, etc. This shown in following figure 13.

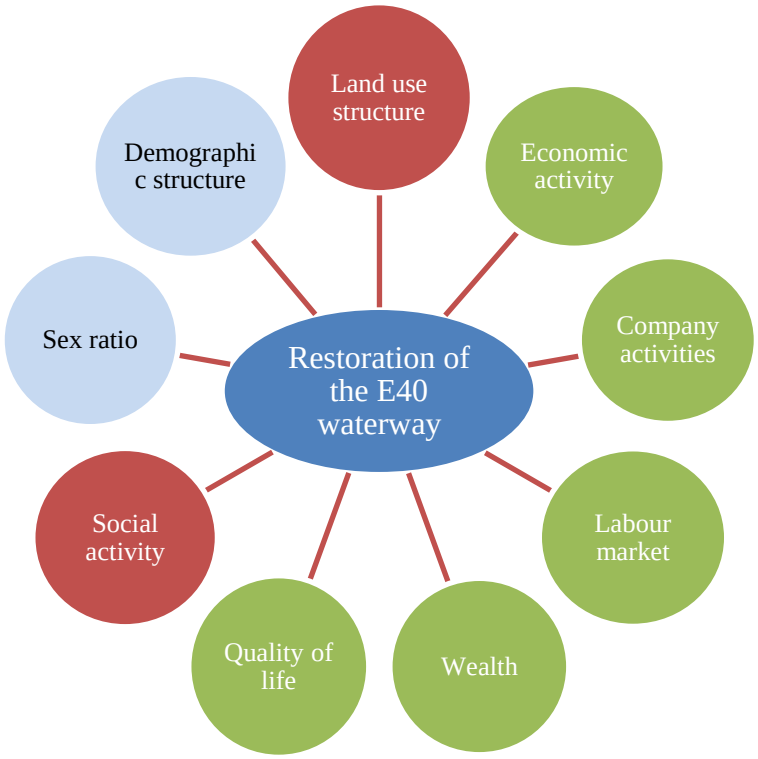


Fig. 13. Area and directions of the social impact of IWW E40 revitalization
Source: Materials of the National Academy of Sciences of Belarus

The impact of the work on the revitalization of the waterway and its subsequent operation on the social aspects of development zones of IWW E40 will be visible both in the short and also in the long term. Effects of a given factor in one area may be indirectly felt also in the entire country (countries covered by the project).

The scope of waterway revitalisation will affect differently in different areas, depending on the strength of the factor such as the structure of land use, economic activity, business activity, labour market, wealth, quality of life, social activities, standard of living, gender and demographic structure.

Construction of Vistula - Mukhavets connection including revitalisation of Vistula waterway will make navigable for shipping the entire E40 waterway which will have an impact on the social situation of all areas located along the route.

Belarusian part of E40 waterway passes through the territory of two administrative regions: Brest and Gomel. The territory of Brest region consists of seven administrative regions: Brest, Zhabinets, Kobrin, Drogichin, Pinsk, Luninets and Stolin and two cities: Brest and Pinsk. Gomel region consists of 21 regions, and the waterway runs through areas of Zhitkovitsy, Petrikovichi, Lelchitsi, Mozyr, Khoyniki and the city of Mozyr. The area including Belarusian section of IWW E40 is inhabited by 851,577 people (2014), which accounted for almost 10% of the total population of the Republic of Belarus. On the territory of Brest region is located the most significant part of the waterway - Dnieper - Bug channel. In Ukraine the following regions as most important were indicated: Dnipropetrovsk, Zaporizhia, Cherkasy, Kirovohradsk, Poltava, Kherson, Chernihiv, Volyn, Zhytomyr, Rivne, Kyiv and Kyiv City. This area is approximately 48.5% of the country and is inhabited by about 41.8% of the population of Ukraine.

As an area of potential impact of IWW E40 on the social situation in Poland, the following regions were chosen: Mazovia, Pomorskie, Kujawsko-Pomorskie, Lublin and Podlasie. It should be noted that the reconstruction of Vistula - Bug link will (depending on the chosen variant) in particular Mazovia and Lublin regions. In Poland, the area of influence covers 37.5% of the country territory, populated by 33.9% of total population.

The entire area of project influence was inhabited by over 11 mln economically active people (2013). The total area of the border area covering the Lublin, Brest and Volyn regions is 85,725 km^2, including:

- Brest region 32,791 km² (15.7% of Belarusian territory),
- Lublin region 25,122.46 km² (8% of Poland territory),
- Volyn region 20,143 km² (3.3% of Ukraine territory).

The length of the borders of neighbouring regions is 637 km, including the Polish-Belarusian border 171 km, Polish-Ukrainian border 296 km and the Belarusian-Ukrainian 206 km. 399 km of border runs along the Bug river, while the remaining 274 km of borders between countries and regions run the mainland.

The administrative structure of regions is three- level (see figure below). Lublin region, with its capital in Lublin, one of 16 regions in Poland. The administrative structure of Lublin region (NUTS 2[19]) includes:

- 4 subregions (NUTS 3),
- 24 counties (NUTS 4), 213 communes (NUTS 5).

[19] NUTS - Nomenclature des unités territoriales statistiques – classification of territorial units for statistics

Brest region with its capital in Brest city is one of 6 regions in Belarus. The administrative structure of Brest includes:

- 16 subregions and 3 regional cities (Brest, Baranovichi and Pinsk),
- 18 cities and 8 city-type villages,
- 216 village councils and 2161 village settlements.

Volyn region with its capital in Lutsk is one of the 24 regions in Ukraine. The Volyn region includes:

- 16 subregions, 1087 settlement units (33 cities, 11 regional and subregional cites),
- 22 city communes, 1054 village communes.

In 2012, the population of analysed area amounted to 4,586.51 thous. people, including: Lublin region 47%, Brest region 30.4%, 22.6% Volyn region.

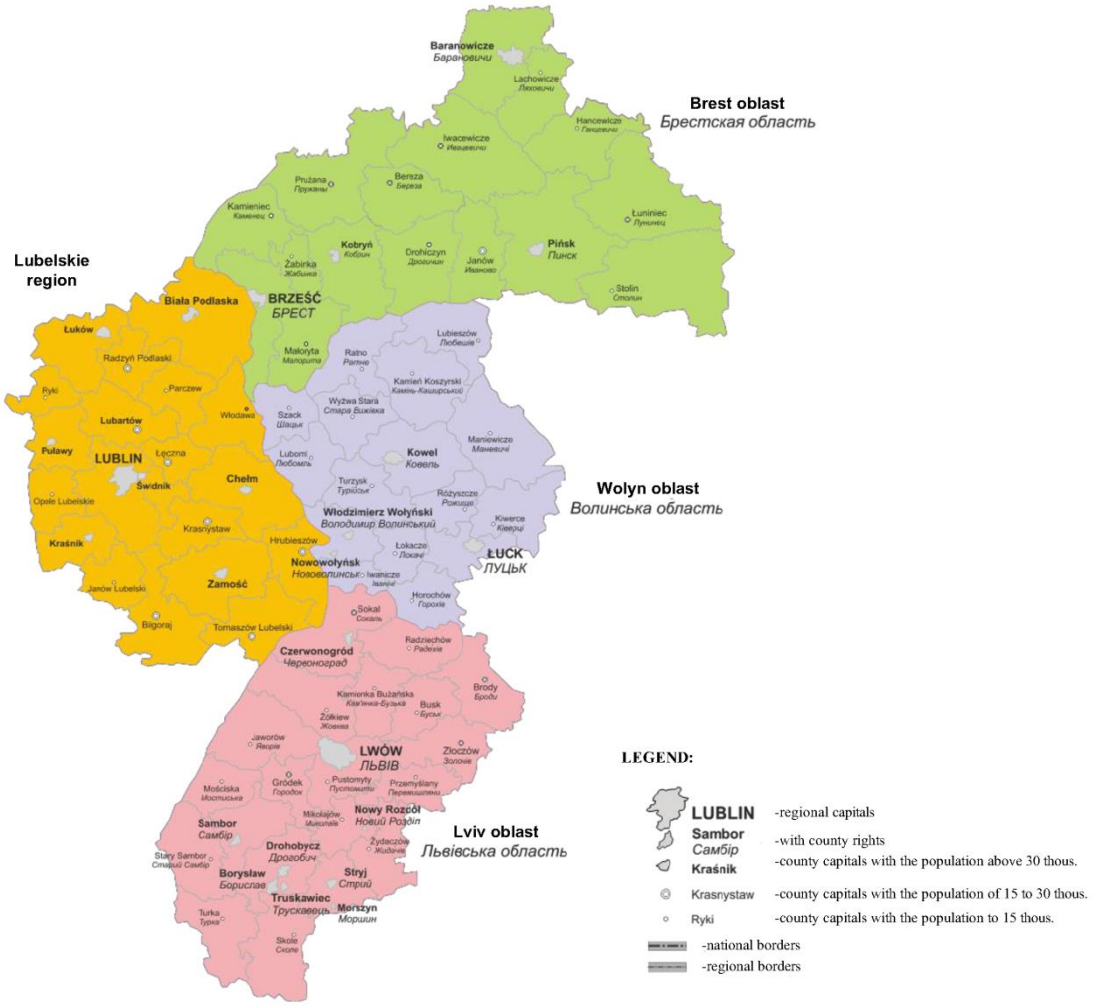


Fig. 14. Administrative divisions of the border regions: Lublin, Brest and Volyn.
Source: Strategia współpracy transgranicznej województwa lubelskiego, obwodu lwowskiego, obwodu wołyńskiego i obwodu brzeskiego na lata 2014-2020. Lublin 2013.

1.2. Demography of development area of IWW E40 route and bordering regions

1.2.1. Development trends in demographic structure

General trend in the study area is decreasing dynamics of population growth. One of the causes of the demographic situation is declining the fertility rate across the area of E40 and in selected regions. The

Population situation is also affected by migration: between regions and international migration. Changes in the demographic situation lead to changes in the proportions of the non-working population in relation to working people. This shows the demographic burden rate. The situation of the population is characterized also by the number of persons living in the same household.

Poland in recent years also observes declining rate of population growth. Negative birth-rate is particularly noticeable in the Lublin and Podlaskie regions. Mazovia and Pomerania still records positive growth, although clearly declining trend can be seen (Tab.27).

Tab. 27. Population and area of the regions in impact area to the IWW E40 in Poland

Territorial unit	Area	Population 31.12.2013			Density of population a
	in km²	total	men	women	population per 1 km²
POLAND	**312679**	**38495659**	**18629535**	**19866124**	**123**
Total impact area	**117149**	**13056330**	**6305373**	**6750957**	**111**
Mazovia	35558	5316840	2543762	2773078	150
Lublin	25122	2156150	1045350	1110800	86
Podlaskie	20187	1194965	582646	612319	59
Kujawsko-Pomorskie	17972	2092564	1014225	1078339	116
Pomorskie	18310	2295811	1119390	1176421	125

Source: GUS Local Data Bank.

On Polish territory, in addition to differences in density, the area of influence is characterized by a significant difference in the level of economic development expressed in the GDP per capita. In 2011 Polish GDP per capita achieved 88% of the EU average. Only Mazovia region showed GDP level at 107% of the EU average, while the Pomeranian region reached 62% of the EU average and 47% Podlasie and Lublin region 44%[20]. In 2013 the number of people in the area of IWW E40 influence decreased on the Polish side. Negative birth-rate is particularly noticeable in the region of Lublin and Podlasie.

Population forecast for Poland shows that until 2045 the number of people in the country may decrease down to 34.8 mln. Similar changes will include population in Podlaskie, Lublin and Kujawsko – Pomorskie regions. Population growth in the year 2045 compared to 2015 (and 2013) is projected only in the Mazovia region. A slight decrease in the number of population will record Pomeranian region - despite high fertility rate.

Kujawsko - Pomorskie, Lublin and Podlaskie regions have a negative net internal migration, while the Pomeranian and in particular Mazovia regions accept migrants from other regions. All of these regions, like the rest of Poland, have a negative net international migration.

In the analysed regions in Poland, the lowest proportions of demographic dependency ratio in 2013 showed Pomorskie region and the highest Podlaskie and Lublin regions, which indicates the specific demographic problems in these two regions.

In terms of the number of households members, the largest households are in Lublin region, that consist an average of nearly 3 persons; the smallest households are in Mazovia region- an average of 2.68 people.

In Belarus, in 2013 the catchment area along IWW E40 was populated by 614 thous. of urban population and the rural - 239 thous. people. Much of the urban population lives in the two main cities

[20] Based on Eurostat data.

of the Brest region (330 934 people) and in Pinsk (136 096). The demographic situation in the region is generally favourable (Fig. 15). Over the last decade there has been a rising trend toward higher birth rates and declining mortality rates in almost all areas of the Belarusian part of IWW E40.

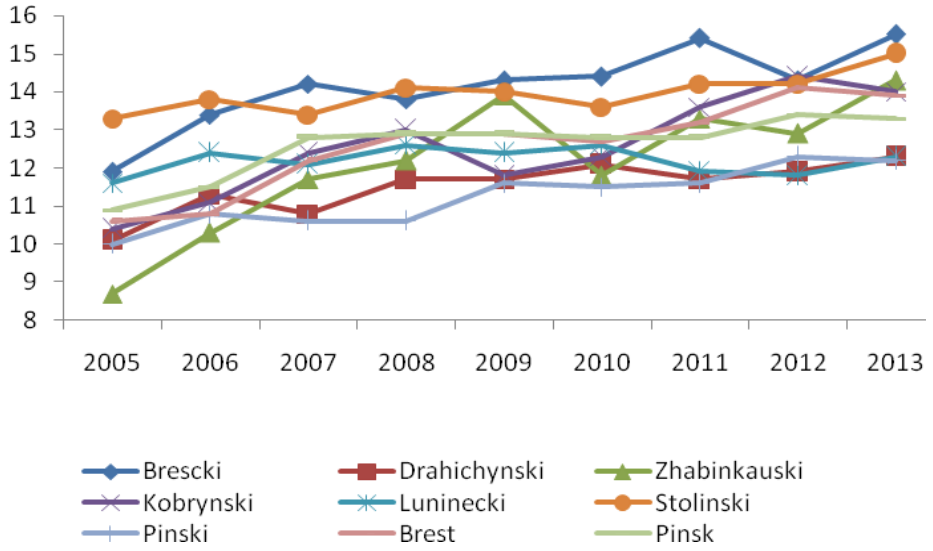


Fig. 15. The birth-rate per 10 000 inhabitants in the catchment area in Belarus
Source: Materials of the National Academy of Sciences of Belarus

Average life expectancy in the selected area is higher than in the country and it amounts to 73 years (national average 72.6 years). The age structure of the population of the study area is characterized by a high percentage of people of working age. In large cities such as Brest and Pinsk, the proportion of people of working age in 2014 was 62-63%, and in the regions on average 50-55%.percentage of population in pre-working age is on average in the region of 18% and is the highest in the country. Such age structure of the region's population signifies large development potential of the area, if the jobs in the labour market are provided.

Lower level of salaries and income affects the intensity of migration processes in the study area. Migration to the capital for work purposes in the Brest region is higher than in other areas of the country. Labour migration has an impact on all areas included in the catchment area.

The population of Ukraine at the end of 2013 comprised of 45 426,2 thous. people (Tab. 28). In recent years, the population of the country has been steadily decreasing. This is especially noticeable in the regions of Dnepropetrovsk, Kirovograd and Cherkasy. However, there are regions in the specified area of influence of E40 waterway showing a positive growth, such as Volyn and Rivne regions and the city of Kyiv.

Tab. 28. Areas and population in selected regions in Ukraine (as at 01.01.2014)

Name of the regions	Area, thous. km^2	Population	% Woman	Density of population, people per 1 km^2	% Townspeople
Ukraine	**603.5**	**45426249**	**53.6%**	**75.3**	**68.98**
Selected regions:	292.7	18970230	53.7%	64.8	-
Kherson	28.5	1072567	53.6%	37.7	61.18
Cherkasy	20.9	1259957	54.1%	60.2	56.55
Chernihiv	31.9	1066826	54.2%	33.4	63.93
Dnipropetrovsk	31.9	3292431	54.2%	103.1	83.58
Kyiv	28.1	1725478	53.6%	61.4	62.02

Kirovohrad	24.6	987565	53.8%	40.2	62.56
Poltava	28.8	1458205	53.8%	50.7	61.66
Rivne	20.1	1158851	52.5%	57.8	47.77
Volyn	20.1	1041303	52.7%	51.7	52.21
Zaporizhia	27.2	1775833	54.3%	65.3	77.09
Zhytomyr	29.8	1262512	53.6%	42.3	58.59
Town Kyiv	0.8	2868702	53.0%	3433.2	100

Source: http://www.ukrstat.gov.ua/

For several years, Ukraine has shown positive net migration. In in the years 2002-2013 came to Ukraine 125 people more than it came out. Trend is to return to the territory of Ukraine from the countries of the former Soviet Union, in particular from Russia, Moldova, Belarus and Kazakhstan. Selected regions in 2014 together had positive net migration. The capital Kyiv and Kyiv region had a dominant role in this trend. Negative balance was shown in Kherson, Chernihiv, Poltava, Zaporizhia and Zhytomyr regions.

Demographic forecasts[21] predict further decline in the population of Ukraine. In 2045 the country may be inhabited by about 33.6 mln residents.

Demographic trends for the whole catchment area of E40 waterway confirm the demographic situation in the border areas, where the population is also steadily decreasing (Fig. 16). Compared to 2010, population in 2012 was lower by 27 thous. residents, including in Lublin region lower by 9 thous. people, in Brest by 1 thous. people, however, in Volyn region population increased by 1.4 thous. people.

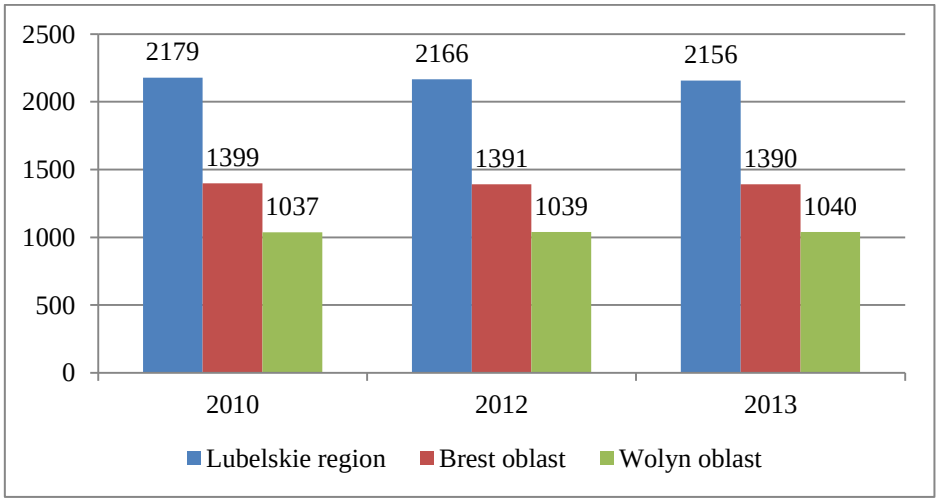


Fig. 16. The number of inhabitants of border regions: Lublin, Brest and Volyn.
Source: Strategia współpracy transgranicznej województwa lubelskiego, obwodu lwowskiego, obwodu wołyńskiego i obwodu brzeskiego na lata 2014-2020. Lublin 2013.

The highest percentage of people of retirement age can be observed in Lublin region, the lowest in Volyn region. Most people in the working age population is in the area of Brest region where at the same time there is the lowest percentage of people in pre-working age.

The urbanization rate is the highest in the Brest region - 67.2%, followed by Volyn region - 51.9% and in the Lublin region only 46.5%.

[21] UN Population Division, World Population Prospects, 2012 revision. http://esa.un.org/wpp/Excel-Data/population.htm

Dependency ratio, i.e. number of people in the productive age per 100 persons of working age, was: 59.4 people in the Lublin region, 44.7 people in Brest region and 46.9 people in Volyn region.

The analysed border area is characterized by unfavourable demographic changes. Their direct effect is a decrease in population due to the negative natural increase and a negative migration balance. This concerns Brest region the most. Population growth occurs only in the counties and areas located near large urban centres, which is primarily the result of on-going urbanization.

1.2.2. Employment and affluence level

Stimulator of countries' growth is primarily an increase in production and services, namely domestic product and the important growth factors of production include, among others, employment growth. In 2012 in Lublin region, employment amounted to 793.2 thousand. people, i.e. 58% of the region's population of working age. This number also includes working in private farms in agriculture. Among the employed 51.3% were male. According to Central Statistical Office of Poland data, at the end of 2012 Lublin region recorded more than 131 thous. unemployed, including rural areas with 55% unemployed. Women accounted for over 48% of the total number of unemployed. The level of economic activity and employment depends on where you live.

In Brest region in 2012 there were 628.1 thous. people employed i.e. 2.2% more compared to the previous year. According to official statistics of Brest region, a number of unemployed accounted for 0.9% of the total economically active population and at the end of 2012 it amounted to 5,385 people. In Volyn region working population numbered 483.6 thous. and the employment rate was 59.7%. The unemployment rate in the Volyn region in 2012 was 7.8%. The number of unemployed at the end of 2012 amounted to 37.9 thous. people.

The employment rate in the Brest region is lower than the rate for the whole country. The ratio of employed to the total population of the working age population is in the range of 0.7-0.8. In large cities and in regional centres inhabitants work mainly in state-owned factories and private, small and medium-sized enterprises (SMEs). Despite the increasing importance of small and medium-sized enterprises, most jobs can be found in the public sector - sectors include food processing, production of textiles and building materials. Most workers employed in small and medium-sized enterprises work in trade and services.

The Polish economy has undergone a period of transformation changes in the structure of employment. Employment in the industry decreased significantly and it has increased in service sector. Employment declined also in agriculture, although in terms of the number of agricultural population Poland ranks first in the European Union, as well as second place in terms of number of farms.

In 2013 more than 57% of those working in Poland were employed in service sector, including Mazovia up to 66.8%, and in Pomerania region - almost 62%. In Lublin and Podlaskie regions in agriculture work - respectively over 29% and over 27%, while in Pomorskie and Kujawy – Pomeranian regions agriculture employs respectively only 7.7% and 17.6% of the economically active population. Industry employs a large proportion of workers in the Pomorskie and Kujawsko – Pomorskie regions, less in Mazovia region, where the service sector offers most jobs.

In 2013 in the analysed Polish regions the registered unemployment rate was 13.4% in 2012 and 2013. The unemployment rate well below the national average was reported in the Mazovia region, particularly in the metropolitan area of Warsaw. Nevertheless, in Mazovia there are also areas of structural unemployment of up to 40% of the economically active population (subregion of Radom

and north-east part of the region).

One of the factors demonstrating the standard of living is the size of the average monthly salary and income per capita. Those working in Mazovia region have an average salary higher by 23.1% than the national average and 37.4% higher than in the Kujawsko – Pomorskie region, where the average salary is the lowest of the concerned regions. Lublin region has a relatively low level of quality of life compared to other regions in Poland. The average monthly gross salary in 2012 amounted to 3,382.66 PLN, which accounted for 90.3% of the national average. In 2011 gross salary in Lublin region amounted to 748 EUR, i.e. 90.1% of the national average.

The average monthly gross salary of resident of Brest region in 2011 amounted to 3185.3 thous. BYR, i.e. 246 EUR. Monthly revenue per 1 inhabitant, including salary and social benefits, such as pensions, benefits, grants, etc. in 2012 amounted to 2363.1 thous. BYR and increased nearly three times compared to 2010.

In Volyn region gross salary was 180EUR[22], i.e. only 75.7% of the national average. The average income per capita 1 inhabitant of Volyn region amounted to 19,768 UAH in 2012.

Analysis of the structure of employment by economic sectors indicates a relatively high proportion of employment in industry and construction in Brest region and those employed in agriculture, hunting, forestry and fisheries in the case of Lublin and Volyn regions. The share of employment in services was the highest in Volyn region and the lowest in Lublin region.

In Belarus, in addition to regional and county centres, in the impact area of E40 waterway is a significant number of rural settlements where the majority of the working population are employed in state-owned farms. Agricultural production plays an important role in the economic development of the area. The average monthly salary is lower than the national average in all analysed regions, except for the area of Mozyr. There is a large refinery complex and a number of industrial enterprises. The number of individual farms is small in comparison to the number of state farms but the activities of private farms are usually much more effective.

The employment rate in rural areas is lower than in urban areas, due to the fact that the people working in the countryside full-time shift into self-employment. Only in Kobrin area there was recorded a higher level of employment in the manufacturing industry. A large part of the population is employed in the public sector (education, health). The average monthly salary in the region is below the national average, especially in rural areas.

The southern part of the Gomel are, through which E40 waterway runs is the area affected the accident at the Chernobyl nuclear power plant. In areas adjacent to the waterway there are zones from which inhabitants were displaced (the zone of compulsory eviction) as well as residential area of periodic radiation control and the possibility of displacement. In the structure of household income in the region there is a high share of social transfers, since large number of people living on pensions due to disability in particular the consequences of the Chernobyl accident. The employment rate is below the national average due to the structure of the economy and the status of the areas affected by the Chernobyl accident.

In Belarusian part of the waterway within the framework of waterway restoration programme it is planned to build at least 20 constructions for various purposes. This will create jobs for workers living

[22]Strategia współpracy transgranicznej województwa lubelskiego, obwodu lwowskiego, obwodu wołyńskiego i obwodu brzeskiego na lata 2014-2020

in the area (the city of Pinsk, etc.)[23]. Implementation of the project even at the construction stage will be an important factor in the prevention of decline in employment and increase of household incomes in the region. New jobs will also be created on the water border crossings in administration and customs. As a result of the revitalization of the waterway will improve the quality of life in cities and rural areas along the channel by improving transport accessibility, creation of conditions for recreation and opportunities for a better territorial integration of the region, as well as new possibilities of professional activity for the female population of the region.

Ukrainian society is characterized by a high rate of activity. Over 65% of the population aged 17 to 70 years are economically active. The level of activity increases with the level of education. Among those with primary education or no education activity rate is only 12%[24]. This indicator and the employment rate vary in each region. The highest rate of activity and employment is observed in Kyiv and the lowest in Poltava area.

The level of unemployment in Ukraine in 2013 in comparison to EU countries can be regarded as a moderate. The lowest unemployment rate occurred in Kyiv and Kyiv region; the highest in the regions of Rivne, Chernihiv and Zhytomyr (Tab. 29).

Tab. 29. Economic activity of the population in Ukraine at the age of 15-70 in impact area in 2013

Name of the regions	Index of activity (%)	Employment index (%)	Unemployment rate (%)*
Ukraine	**65.0**	**60.3**	**7.2**
Kherson	65.2	59.6	8.5
Cherkasy	65.8	59.9	8.9
Chernihiv	66.8	60.6	9.3
Dnipropetrovsk	66.5	62.1	6.5
Kyiv	63.4	59.5	6.1
Kirovohrad	64.5	59.5	7.9
Poltava	64.7	59.4	8.2
Rivne	65.7	59.6	9.4
Volyn	64.8	59.7	7.8
Zaporizhia	65.6	61.3	6.6
Zhytomyr	66.0	59.9	9.3
City of Kyiv	68.4	64.9	5.2

Source: Ukraine in figures 2013, Statistical publication, Kyiv, 2014. * referring to ILO standards.

1.2.3. Entrepreneurship and social activity

A common indicator of the level of entrepreneurship in the area is the number of registered companies per number of inhabitants, usually per 1000 or 10000. This indicator is often specific to each country, because there are different laws governing economic activity and the resulting need for the establishment of companies, their liquidation or bankruptcy. In Poland, this indicator does not include individual farms, i.e. 2.2 mln. They are especially numerous in Lublin region - almost 260 thous. and Podlaskie region - over 160 thous.

The population of Mazovia region in particular, but also Pomerania region showed in 2008 and 2013 a significantly higher than average level of entrepreneurship for the country. The lowest rates were

[23] Średnie miesięczne zarobki przy budowach i konstrukcjach wynoszą BYR 6 812 tys. dla inżynierów i BYR 7 023 tys. dla robotników.
[24] Ukraine in Figures 2013, Statistical publication, Kyiv, 2014

recorded in Lublin and Podlaskie regions. Kujawsko-Pomorskie region also ranks below the national average.

Indicator of social activity is the number of non-governmental organizations: foundations and associations registered per inhabitant (1000 or 10000). Mazovia region shows social activity higher than average for the Poland. Activity indicator for other regions is similar to the rate for the whole country in 2013.

The analysed regions registered 35.7% of the total companies of the country. Regions house over 45% of registered companies in the country in the field of energy supply and gas, and in the information and communication as well as more than 40% in the area of research and training. Relatively less entities operates in construction sector - 33.4%, while agriculture sector remains an important part of the economy. In the regions operates 34.6% of individual farms operating in Poland. Small farms (up to 1 ha) account for almost 23% of the number of small farms in the country, a farm with an area of 10 to 15 hectares represent more than half the number of such farms in the country.

The level of household wealth in the region is determined largely by salaries. In Belarus, salaries in the cities and regions where there is manufacturing and mining industry, and where large constructions are build, there are usually higher salaries than in other areas. In 2014, income per capita in the area of interest amounted to about 3.8 mln BYR, compared to the national average - 4.6 mln BYR. In the structure of expenditures of households, spending on food and non-food products are close to the national level, at about 40% of income.

In terms of population income, Brest region is one of the poorest in Belarus. This is largely due to the very effective use of labour force. The share of unprofitable enterprises in the past five years in the region was about 20%. In terms of gross regional product per capita (3,741 EUR) and industrial production the region is the last in the country. In the field of trade, Brest region is slightly below the average. In 2013 level of direct investment in the real sector in Brest region was the lowest in the country (111.18 mln EUR).

In Ukraine the level of entrepreneurship indicates an average of 30 companies registered per 1,000 inhabitants. Compared to other regions in terms of entrepreneurship in particular stands out Kyiv, where per 1000 people there are registered 99 business entities. Higher than the national average entrepreneurship is recognized even in Kyiv and Dnipropetrovsk regions. In Rivne area per 1,000 inhabitants there were registered only 18 companies. Also, a small number of companies in relation to the population work in Chernihiv and Volyn regions.

1.2.4. Education

One of the key stimulators of economic growth is the level of education influencing the qualifications of the labour force.

In Poland in 2011 about 17% of population had higher education. The highestpercentage of people with higher education lives in Mazovia region, and the lowest in Kujawsko-Pomorskie region. What is more, the highest proportion of people with primary education was recorded in Podlaskie and Lublin regions, where there also lives the highest percentage of people with no education and those who have not completed primary school. Mazovia region shows the highest number of students - more than 5.5% of the population; the least people per 10,000 studies in Kujawsko-Pomorskie region (3.3%) and Podlaskie region (3.5%).

In Belarus, the standard of living of inhabitants of Brest region in terms of education, health, housing and social services for the population do not differ from the level of the country. Preschool education

covers about 70% of children under the age of 5. The number of students in secondary schools is generally higher than in other areas (except Minsk). Higher education facilities are located in Brest and Pinsk cities. The level of education of labour in Brest region is among the highest in the country. The percentage of employees with higher education is 26% and is higher than in other regions of the country (with the exception of Minsk).

Revitalization of E40 waterway due to the nature of adjacent areas to the waterway in the southern part of the Gomel area, and also located in the region of the refinery, will have a significant impact on the social aspects throughout the area.

In the regions of the border area level of education is relatively high. In the province of Lublin higher education has 17.5% of people, while in Brest 15%.

In Lublin region in 2012 there was over a thousand primary schools and 478 secondary schools. Higher secondary schools consists of vocational schools - 27 institutions, profiled secondary schools - 15 technical colleges - 144, art schools - 28 secondary schools - 157.

Brest region is characterised by a relatively high level of educational infrastructure with 50 specialized institutions for professional and technical education which provide qualified personnel for the economy. Secondary education in Brest region is based on three levels: general and professional and technical and specialized. In 2012, in the region there operated 610 comprehensive schools, 33 design and technical schools and 31 secondary specialist schools. The scientific potential of Brest region focuses on applied research aimed at preparing highly qualified personnel for the economy.

Volyn region system of secondary education is a three-stage. In 2012, there functioned 778 secondary schools and 20 vocational schools. Higher education is well developed in all three analysed regions. A total of 39 institutions operate there.

The number of university graduates is steadily increasing throughout the analysed border area.

1.3. Economic potential

1.3.1. Economic development of border regions and other areas along E40 waterway route

The main indicator of the economic level is gross domestic product (GDP) that shows the final result of activities of all entities of the national economy in a given year. The share of individual regions in GDP of the country is as follows:

- Lublin region in Polish GDP - 3.8% (9 place among 16 regions)
- Brest region in Belarus' GDP - 10.5% (5 place among 6 regions)
- Volyn region in Ukrainian GDP - 1.3% (23rd position among 24 regions).

Gross domestic product in purchasing power parity, shows the real figures that enable comparison of the level of wealth of the society. In 2012, Polish GDP measured by purchasing power parity (PPP) was 67%, i.e. 800,934 mln USD, for Ukraine – 335,172 mln USD and for Belarus – 146,742 mln USD.

Tab. 30. General data of countries covered by the project for 2012 (GDP gross at current prices)

Year 2012	Poland	Belarus	Ukraine
GDP (in mln USD)	489 852	63 259	176 309
GDP (in mln EUR)	352 881.0	41 613.5	102 616.3
GDP Lublin region, Brest region, Volyn region (in mln EUR)	13 462.2	4 346.3	3 949.1

Year 2012	Poland	Belarus	Ukraine
GDP per capita (in USD)	12 820	6 726	3 872
GDP per capita (in EUR)	9 240.9	4 384.6	2 237.1
GDP per capita Lublin region, Brest region, Volyn region (w EUR)	6 247.4	3 111.4	1 550.4
Population (in thous.)	38 211	9 405	45 530
Area (in km^2)	311 888	207 600	603 500
Unemployment (%)	10.1	0.6	7.2
Employment: industry (%)	30.4	-	20.7
Employment: agriculture (%)	12.6	-	17.2
Export (in mln USD)	179 603.6	46 059.9	68 694.5
Import (in mln USD)	191 430.1	46 404.4	84 656.7

Source: Elaborated based on the data of Eurostat, Statistical Office in Lublin, Central Statistical Office of Brest region, Central Statistical Office of Volyn region.

As can be seen from the above data, analysed regions are characterised by low levels of economic development. In real terms the average annual GDP growth of Lublin province in 2004-2010 period was 3.5% compared to 4.6% in Poland. The average annual growth rate in 2009-2011 in Brest region was 4.4% against 4.5% in Belarus. GDP per capita in Lublin region amounted to 25.5% of the EU average, in Brest region 12.7% and in Volyn region to 6.3%.

The economic potential of Ukraine is focused mainly in the regions of Kyiv, Dnipropetrovsk, Kharkiv, Zaporizhia and Donetsk and Luhansk. The main sectors of the economy that generate the country's GDP remain metallurgical sector (19.2% share in the structure of industrial production), fuel and energy (27.8%), engineering (6.6% of GDP in 2014.) and agricultural-food sector (9.5% of GDP in 2014.). The regions indicated as an area of potential impact of IWW E40 produce more than 50% of Ukraine's GDP (34% disregarding the city of Kyiv). Dnipropetrovsk region is the only one to generate income above the national average.

1.3.2. Main economic sectors of the regions

The economic potential of the regions along E40 waterway will be of crucial importance for the creation of transport demand. In the Lublin region in 2011 gross value added (GVA) was 51,428 mln PLN which accounted for 3.83% of Polish GVA. Structure of the economy, measured by gross value, is similar to the national structure, i.e. the most value is generated by service sector, while the industrial sector, including construction, accounts for about one-third of GVA. The sectoral breakdown of GVA produced in Lublin region is characteristic for less industrialized and economically developed regions. In comparison to the whole Polish area, the region is distinguished with high share of agriculture, which in 2011 amounted to 8.7%. This demonstrates the great potential of agriculture of Lublin region.

Lublin region is one of the least industrialized in the group of provinces in the eastern part of the country. In Pulawy there is located chemical industry. Group Azoty Pulawy is the second largest European producer of nitrogen fertilizers in terms of production capacity (7.8% of the production potential of the EU in this sector). Apart from that, a significant role in the economy of Lublin region is played by the food processing industry, machinery and furniture.

In terms of industrial capacity Brest region is represented by more than 300 companies whose annual production value amounts to 3 billion USD. Region provides about 9% of national industrial production and 19% of consumer goods. In the total volume of industrial production food industry has the largest share (about 37%), then engineering and metalworking (over 20%), wood industry (about

12% - a group of companies including furniture industry forming the eastern branch of BRW company, the largest furniture manufacturer in Poland), electricity (over 9%).

A significant role in the production structure plays light industry and construction materials industry with over 6% share each. The main industrial centres are located in Brest, Baranovichi, Pinsk, Kobrin and Bereza.

In the sectoral structure of production in Volyn region dominates agriculture, industry, trade and services. Industrial production in the region compared to 2012 increased by 3%, while for the whole of Ukraine decreased by 4.7%. Also there was recorded growth in all sectors of manufacturing industry, especially in the production of wood products, paper and printing, engineering, manufacture of food products and beverages.

Among the important sectors of the economy of border regions (including Lublin, Brest and Volyn regions) is agriculture. This area has large resources of agricultural land, high national agricultural production and a high share of agricultural employment, f.ex. Lublin region - 36.2% of the total working population (national average is 14.7% and 5.8% of the EU average)[25].

An important role in the development of the business performs institutions creating favourable business environment. The promotion of entrepreneurship and business in the border area includes entities at national, regional and local level. At the local level there are a number of non-governmental organizations, foundations, business centres, innovation centres and financial institutions. In Lublin region there are 64 advisory institutions, 49 entrepreneurship centres, 6 centres for technology transfer, 5 loan funds and 5 technology parks. Volyn region has 10 business centres, 4 business incubators, 1 industrial park, 6 centres of lease, 64 non-bank financial institutions, 11 centres for business support, 16 investment and innovation funds and 62 consulting institutions.

The impact of fully operational E40 waterway on regional economic activity will manifest through participation in various projects related to the revitalization and channel use as well as new forms of economic activity also in the service sector. Extension of business opportunities will stimulate the activation and entrepreneurship of inhabitants, in turn affecting the labour market. Increased demand for labour in the region will become an important factor in obtaining and increasing salaries and as a result for the increase in income of population[26].

1.3.3. Land use

Land in the analysed countries is divided into different types. The most classic classification, also used by national research and statistical centres, distinguishes land types by taking as a starting point a form of their use. On this basis we identify arable land, orchards, meadows and pastures.

The land classification in Poland is defined in the Regulation of the Minister for Regional Development and Construction of 29 March 2001 on land and buildings registration[27] issued under the Geodetics Act[28]. Regulation in §17 introduces 15 groups of registered owners and wielding real estate - for simplicity, we can list four major groups:

- The State Treasury - land owned by the treasury, regardless of their usage;

[25]Strategia Rozwoju Województwa Lubelskiego na lata 2014 – 2020 (z perspektywą do 2030 r.)
[26] Aktualnie w białoruskiej części drogi wodnej eksploatowanych jest 11 urządzeń hydrotechnicznych, przy których zatrudnionych jest łącznie 15 inżynierów i 76 robotników. Średnia płaca personelu zatrudnionego przy urządzeniach na początku 2015 r. wynosiła BYR 4 990 tys. dla inżyniera i BYR 4 162 tys. dla robotnika, co odpowiada średniemu poziomowi płac pracowników tej kategorii na Białorusi.
[27] Tekst jednolity, Dziennik Ustaw z 17 kwietnia 2015, Poz. 542.
[28] Prawo geodezyjne i kartograficzne; Dz. U. z 2000 r. Nr 100, poz. 1086 i Nr 120, poz. 1268.

- Communes - and the municipal associations' land are owned by the municipality, regardless of their usage;
- Individuals;
- Other entities (co-operatives, churches and religious associations, land Communities, counties - regardless of their usage, region - regardless of their usage, company's commercial law, etc.).

The Council of Ministers Regulation of 10 December 2010 on the Classification of Fixed Assets, Group O is divided into the following subgroups of land:

- Subgroup 01 - agricultural land,
- Subgroup 02 - forest land,
- Subgroup 03 - built and urbanized areas,
- Subgroup 04 - ecological areas,
- Subgroup 05 - miscellaneous areas,
- Subgroup 06 - wasteland,
- Subgroup 07 - land under water.

Land registration accepted in Polish law distinguishes the following division of agricultural land: arable land, orchards, permanent meadows, permanent pastures, built agricultural land, land under ponds, ditches.

Construction of successive roads and motorways in Poland means that part of the agricultural land is redeemed for the construction of roads. The development of residential areas, especially around large urban areas is also most often done at the expense of agricultural land. In recent years the total area of communication areas has significantly increased.

In analysed region adopted as a potential area of influence of E40 waterway there are differences in the structure of land ownership and land use. For the area of the planned restoration of IWW E40 Mazovia and Lublin regions are the most important since in their territory may be implemented Bug - Dnieper channel investment.

Land owned by the State Treasury account for 38.7% of the total land area in Poland, while communes and inter-commune associations possess 54.5% of land. In Mazovia region land owned by the Treasury represents 18.9% of the land. Land that belongs to individuals in the region consists in 86.2% of agricultural land and in 12% of forest; a small percentage of private land is the built-up areas and others. Land of the Treasury in the Mazovia region consist in 68.5% of the forests and in 13.6% of agricultural land, 9% of lands are built and urbanized areas and others.

Landlord of land owned by the state are the state authorities acting on the basis of regulations on the management of the use and protection of land. The construction of the waterway section Vistula-Mukhavets (Brest) according to the selected three variants will require to carry out procedures for expropriation of private and municipal land as well as payment of adequate compensation.

In Belarus the land use is defined in article 1 of the Land Code of Republic of Belarus of 23 July 2008 (Hereinafter referred to as the Land Code). Land classification is not fundamentally different from the one used in Poland.

To determine the patterns of land use and ownership for the project of revitalization of E40 waterway the existing legislation of the Republic of Belarus in the field of protection and use of land was analysed. Based on these studies we identified the key elements of the legal system. One of the basic rules governing land usage in the Republic of Belarus is the principle defining the relationship of land

and objects placed on it (buildings, structures). Article 5 of Land Code shows that the owner and user of the ground and owner of located objects should be the same entity, and transfer of ownership of one element should be accompanied by the transfer of ownership to the other.

A land user may be a self-employed private citizen, non-state legal entity, other states or international organizations, having it as inheritance or using it permanently or temporarily on a rental basis or sublease (art. 1 of Land Code). In accordance with Article 4 of Land Code entities in the field of land management are: the President of the Republic of Belarus, the Council of Ministers, public authorities responsible for the regulation and management of land use and protection, the citizens of the Republic of Belarus, foreigners and stateless persons, individual entrepreneurs and legal entities of the Republic of Belarus, foreign legal entities and their agencies, foreign countries, diplomatic missions and consular offices of foreign states, international organizations and their representations. In accordance with Article 3 of Land Code objects of land relations are: land, the plot, the right to land, restriction of rights (encumbrances) to the land, including land easements.

According to article 36 of Land Code, the size of the land designated for any work related to the project to improve shipping in E40 on the Republic of Belarus territory is not limited. These are set out in the decision on the occupation and division of land.

According to the Land Code, land use can be executed on the basis of the following rights:

- public property and private property, and also the property rights of foreign states and international organizations,
- perpetual use,
- permanent use (use without a specified period of time),
- temporary use,
- the lease (sublease).

In accordance with article 13 of Land Code the following land categories cannot be transferred to private entities, foreign states and international organizations, agricultural land, land in nature protected areas, land in health protected areas, land for recreational purposes, the protection of historical and cultural values, woodland and waters covered land, land for roads and transport facilities, land occupied for public purposes.

Impact of E40 waterway on the structure of land use in the Belarusian part will not be large. New buildings are not being planned and there are no plans to evict land from use. Restoration of the waterway will not affect the structure of agricultural land use, because it does not foresee major changes in the course of the river or water channel or it is not planned to construct any alternative waterway. It can be stated also that the current level of water supply for agriculture is sufficient.

The situation in the land market in Ukraine is still disordered, and transformation of the collective economic system is still in progress. Land acquisition in Ukraine is regulated by the Act No. 2768-III of 25 October 2001 "Land Code of Ukraine" and implementing acts. Land Code regulates the status of the land – state land, municipal and private land, without clarifying the rules selling it. Until 2016 there is a moratorium in force on the sale of agricultural land on the free market. In Ukraine, according to information provided by the Polish Embassy in Kyiv, there are no restrictions on trading or lease of land other than agricultural. However, this situation may change due deep economic reforms taking currently place.

Revitalization of E40 waterway will not require carrying out any hydrotechnical investments in Ukraine, which would require purchase, lease or expropriation of land, so changes in the legal

procedures should not have any significance for the project.

The project implementation will affect, among others: the structure of land use, economic activities, business enterprises, labour market, prosperity and quality of life of the population, social activities, standard of living, etc. Project influence in one area can be felt also in the entire country (countries covered by the project).

1.3.4. Foreign investments

Inflow of foreign investments is directly influenced by the investment attractiveness of the region. The main factors of investment attractiveness include: the transport accessibility, labour force, market capacity, economic infrastructure, social infrastructure, the level of economic development, state of the environment, the level of public safety and regions activity towards investors. In order to attract foreign capital to the Polish border regions several Special Economic Zones (SEZ) were created. Their primary goal is to attract investments and accelerate economic development.

Lublin region is among Polish regions with low investment attractiveness (rank 15 in 2013 in terms of the inflow of foreign direct investment - FDI[29]). The cumulative value of FDI in 2006-2009 in Lublin region amounted to approx. 90 mln USD and the value was only lower in Podlaskie region[30]. The main advantages of Lublin region include the relatively low labour costs and high level of education of the population. The largest investors in the region are:

- Augusta Westland – aviation sector (PZL Swidnik),
- Aliplast – metal sector (Lublin),
- Caterpillar – mechanical engineering sector (Janow Lubelski),
- D&D Resory Polska – metal sector – springs (Lublin),
- Tsubaki-Hoover Polska – bearing elements (Krasnik),
- Jeronimo Martins – logistics centre (Lubartow),
- Same Deutz – Fahr – mechanical engineering sector (Melgiew, Swidnicki county),
- Materne – food processing (Lopatki, Wawolnica commune, Pulawski county),
- Baxter – medical sector (Lublin),
- Huttenes – Albertus Polska – chemical products (Lublin),
- Packaging Europe, B. Braun, Prestige Poland, Ramatti, Roto Frank, Stock Poland, Genpact and others.

The total area of land of Lublin region designated to special economic zones is 408.8718 ha. The region has created several subzones SEZ - Special Economic Zone Euro Park Mielec, SEZ Starachowice S.A, Tarnobrzeg Special Economic Zone, Euro-Park WISŁOSAN.

In 2012 foreign direct net investments in Brest region amounted to 64.9 mln USD, which accounted for 4.7% of total investments in the country (1,376.5 mln USD). The priority investment projects include: projects of high technology and innovation, export and import oriented projects, production and processing of agricultural products, development of road infrastructure, tourism services (along the main transport corridors and in urban areas with high potential for cultural-historical and the Bialowieza Forest National Park).

The largest investors in the Brest region are:

[29]European Investment Monitor. Ernst & Young 2010.
[30] Badania i analizy zapotrzebowania na miejsca pracy w kontekście wspierania potencjału eksportowego województwa lubelskiego. Raport końcowy. Konsorcjum firm Ernst & Young Business Advisory oraz PBS DGA, Warszawa 2012.

- JV Santa-Bremor (fish products),
- PUE Gefest-Technika (production of gas appliances and electrical kitchen appliances),
- FE Inco-Food (meat products),
- UE STiM (production of enamel and plastics, machines for road marking),
- JSC Involux (office furniture),
- LLC Vegas (mattress manufacturing),

In Brest region there are over 500 companies with foreign capital. In 1996 Brest Free Economic Zone (FEZ Brest) was founded. The zone borders Poland along 10 km of the Bug river. Through the FEZ Brest passes the road of international importance for Kozlovichi border crossing. Benefits of the location also include Brest at the crossroads of east-west-east and north-south, which is a key transit corridor E30 Berlin-Warsaw-Brest-Minsk-Moscow.

Priority investments should be focused on the production of export and import. In 2012, foreign investment inflow to the FEZ Brest amounted to 52.200 thous. USD mainly for the production of rubber and plastics, metallurgy and manufacture of fabricated metal products and chemicals. In Brest Region there were established were 250 companies with Polish capital, including 9 in the free zone of Brest, for example: Inco-Food, Profile Voks, BRW-Brest, the first chocolate company.

In Volyn region cumulative value of foreign direct investments (2001-2013) amounted to 339.3 mln USD. Investments in the region come from 36 countries, including (in mln USD) Cyprus - 124.2, Virgin Islands - 39.1, Poland - 38.9, Slovakia - 22.6, United Kingdom - 14.4, Germany - 12.3. The value of investments of these countries accounted for 74.1% of total FDI. Capital was invested in 266 companies, of which majority is located in Lutsk and Kovel. The majority of foreign investments (62.5%) is addressed to the industry, helping to improve the competitiveness of local businesses. Trade, services and banking attracted 30.2% of the investments, agriculture 4.8%, construction industry 0.03%. Volyn region ranks 7 among 24 regions of Ukraine in terms of investment attractiveness.

One of the main barriers of economic development in the whole border area is the lack of capital, and therefore the inflow of foreign investments is essential for improving competitiveness and efficient use of resources in the area along the influence of E40 route.

1.4.SWOT analysis of socioeconomic profile of area along E40 waterway

SWOT analysis of socioeconomic profile of E40 area.

S – Strengths	W – Weaknesses
• Relatively good transport network density and transport infrastructure accessibility • Favourable location for transit • Parts of the regions located in the vicinity to the border • Increasing share of industry production and transport services in national economy • Increase in foreign trade with neighbouring countries and others • Development and modernisation of logistics terminals and multimodal transport	• Low level of socioeconomic development • Low income per capita • High registered and hidden unemployment • Unfavourable employment structure • Low quality of transport infrastructure • Congestion at border crossings, low transport capacity, low quality of railway infrastructure at border crossings • Lack of motorways and city ring-road • Lack of navigability on E40 route

S – Strengths	W – Weaknesses
• Development of special economic zones and duty-free areas • High potential of agriculture and food processing, wood and forestry industry • Low cost of labour force • High share of economically active population • Tourism potential • Relatively high level of education and training, good educational base (schools, universities)	• Outdated economic structure, decapitalisation of assets • Lack of modern technologies and innovation • High share of traditional, less efficient agriculture, particularly in employment structure • Outdated and insufficient tourism infrastructure • Ineffective institutional coordination of activities supporting business development • Unfavourable demographic indicators • Dominance of agriculture, low share of industry in national economy • Slow restructuring processes and effective job creation
O – Opportunities	**T – Threats**
• High demand of internal markets • Foreign investments • Increase of labour force mobility and quality • Transborder flow of knowledge and experiences • Increase in life quality, accessibility of social infrastructure • High volume of transit between Western and Easter Europe through the area of transborder regions of E40 • Intersection of international transport routes in E40 area, transport corridor M-1/E30 • Navigability and inland waterway infrastructure in Belarus and Ukraine • Development of small cities and towns along the Dnieper – Bug channel • Development of small – and medium – size companies	• Unfavourable demographic tendencies, aging and migrations • Discrepancies between labour skills and job market needs • Migration of economically active population to other regions and countries • Increase in harmful effects of over-developed transport infrastructure – especially road transport • Lack of joint, coordinated spatial planning in transborder region and along the E40 waterway • Neglected river infrastructure, especially at Polish section of E40, shipping impossible or barely possible • Customs and fiscal barriers, • Diverse regulations, ambiguous administrative procedures, excessive and unintelligible regulations • High level of bureaucracy of most economic and administrative sectors, over interpretation of legislation • Competency chaos and inflexibility of decision-making process • Consequences of political conflicts • Political instability

SWOT analysis of socioeconomic profile of Lublin region

S – Strengths	W – Weaknesses
• Reformed and increasing economy • EU membership and on-going integration • Increasing foreign trade; • Human capital;	• Disproportions in regional economic development; • Low investment attractiveness of the region; • Peripheral location in Poland and EU, lack of modern transport links with major economic centres, • Weak development impulses resulting from neighbouring Belarus and Ukraine; • Migration of qualified labour forced; • Unfavourable demographic tendencies; • Depopulation; • High unemployment; • Small agriculture farms and fragmented land ownership

O – Opportunities	T – Threats
• EU structural funds; • High level of economic and social activity; • SME activities; • Development of seaports in Gdansk and Gdynia; • Development of river ports; • Development of regions along E40 waterway.	• Objections of environmental organisations; • Decreasing share of industry in national income; • Insufficient capital; • Under appreciation of economic significance of inland waterway shipping

The strengths of the Polish region are a reformed and growing economy and a country's membership in the European Union. The possibility of the use EU structural funds is the greatest chance for implementation of the entire project. The construction of a channel; linking Dnieper to Vistula river is also a chance for the development of Polish seaports. The waterway can play a special role in the development of cities along E40 route, their transport functions of and port facilities, as well as the entire eastern area of the country including Lublin region and the eastern part of Mazovia region.

One of the weaknesses of the Polish area is demographic situation, which leads to the depopulation of the eastern regions lying along the planned route. The weakness of the area is also significant disparities in economic development especially between metropolitan area of Warsaw and eastern part of Mazovia region and Lublin region. A serious threat can be a decline in the share of industry in the structure of production of national income, which leads to a reduction in available volume of goods for transport.

SWOT analysis of socioeconomic profile of Brest region:

S – Strength	O – Opportunities
- Increased birth rate; - Natural increase in a number of areas; - An increase in expected life span; - A high proportion of the working age population; - Low rate of diseases; - Good living conditions in the area; - The position of the border position of regions.	- Development of small cities and towns along the canal Bug - Dnieper; - Development of small and medium-sized enterprises; - Economic development and economic area; - Investments in the area.
W - Weakness	**T – Threats**
- Low level of income; - Low employment rate; - An increase in unemployment; - Slow process of restructuring and creation of effective jobs places	- Lowering the standard of living of the population of the area; - Migration of the working age population out of the region and country.

SWOT analysis for selected areas of Gomel area shows differences between these areas due to the consequences of the disaster at Chernobyl nuclear power plant. The social situation in these areas in comparison to Brest region is much more difficult, and possibilities to improve it are limited SWOT analysis of socioeconomic profile of selected areas of Gomel region:

S – Strengths	W – Weaknesses
• Transborder location of the region; • location of oil refinery in Mozyr.	• Unfavourable demographic tendencies, negative birth rate; • High occurrence of social illnesses; • High share of social transfers in regional budget; • Contaminated are as a result of Chernobyl incident, excluded form economic operations; • Low incomes; • Low employment level; • Dominance of agriculture and low share of industry; • Slow restructuring processes, low job effectiveness

O – Opportunities	T – Threats
• Development of small cities and towns along the Dnieper – Bug channel; • Development of small – and medium – size companies; • Economic development of the region; • investments in the region.	• Decrease in quality of life in the region; • Migration of population to other countries

The strength of the Belarusian part lying in the range of influence of the waterway is a natural growth and population potential as well as the education level of residents. This area, however, is varied due to the contamination of part of the circuit Gomel as a result of the Chernobyl accident. A weakness is the relatively low income level of the residents as well as low level of social activity and entrepreneurship.

Countries along E40 route are characterised by different levels of economic development (calculated in GDP per capita), varying progress of economic reforms and integration with a variety of economic and political blocs. Regions influenced by E40 waterway in eastern Poland as well as Belarus and Ukraine, for the most part are underdeveloped in terms of socioeconomic potential and a relatively less attractive to investors with the exception of Mazovia, Kyiv and Dnepropetrovsk and Brest regions).

1.5. Summary

In the economic analysis of the project we adopted the methodology in which from the difference between the benefits and costs of the project if successfully realised we deduct cost which occur if the project is not implemented. Considering the social analysis, numerous social benefits of project realisation should be emphasised. Social costs and benefits of the waterway project are not conclusive and opinions on this subject are highly diverse. Thus, it is difficult to clearly identify the number of the lost social benefits if the project is abandoned.

The most important socioeconomic benefits of the project include:

- creation of new attractive jobs,
- improvement in the financial situation and standard of living of the population,
- sustainable economic development of cities and regions,
- cheap transport,
- environmentally friendly transport of goods, decarbonisation of transport,
- improvement in energy efficiency,
- improvement in territorial cohesion,
- new cooperation opportunities of the countries.

Implementing the investment in shipping revitalisation on E40 waterway (including the Vistula waterway) Poland may obtain a number of other benefits in terms of: energy, water retention and drought prevention and flood protection. Developing inland waterways Poland would more easily achieve the environmental objectives set by EU in terms of atmosphere emissions, production of clean energy and energy efficiency in transport. The investment would also extend hinterland of modernized seaports of Gdansk and Gdynia.

Belarus may gain opportunities to accelerate the development of its Southern areas and gain access to the world markets through seaports for its goods. In Ukraine, the revival of transport on the Dnieper would give impetus to the development of the whole economy and would promote its transformation and integration with the European Union. Analysis of the social situation in Ukraine did not show any obstacles to the implementation of the project. Implementation of the project in Ukraine can bring a

range of social benefits and contribute to the improvement of the economic and social situation. Additionally, it can also support the process of transformation of the Ukrainian economy and integration with the European Union.

Development potential of the border regions and areas influenced by E40 waterway is based primarily on favourable economic and geographical position - the main road and railway transport routes, location on the border of the European Union, natural resources, internal demand of the whole area and individual regions. In addition, the border area, located at the crossroads of major transport and energy routes represents a significant potential for economic development. Improvement of transport accessibility is a precondition for ensuring effective use of the development potential of the area. The key factors determining the internal cohesion and attractiveness of the area include transport infrastructure: road and rail and in the future also waterways. Cross-border cooperation of Polish, Ukraine and Belarus regions should be concentrated mainly on the implementation of the selected joint initiatives for the entire area. Such initiatives include the revitalization of the Dnieper connection with the Vistula with the aim of bringing back full navigability the entire E40 waterway.

Social analysis showed that the revitalisation project of E40 waterway on Polish territory could become an opportunity for the economic development of large areas of the country, provide new attractive jobs, contribute to the growth of incomes and thereby also improve the living conditions and in long term, demographics of these areas. No social arguments against this investment were found, nor any social costs of its implementation. From the social point of view, revitalization of IWW E40 section in Poland is beneficial and highly desirable.

Implemented research and studies does not conclude on any negative impacts of the planned investment in any aspect of socioeconomic life of the regions influenced by E40 waterway, neither on the Belarusian side, nor on the Ukrainian side. Positive impact on key socioeconomic areas of the regions will have long-term effects and will contribute to the sustainable development of the whole area.

Potential of Polish economic cooperation with Belarus and Ukraine is currently not sufficiently recognised nor utilised.

Implementation of the project on revitalisation of E40 waterway is an opportunity for the economic development of large areas of the country, will enable the creation of attractive jobs, contribute to the income growth and improve the wealth of residents and influence favourable demographic development in the regions along E40. The least developed and affected areas by problems of negative natural growth would gain new impetus for development, because the revival of the waterway will have a direct impact on the economy and the operation of enterprises, the labour market, wealth and improvement of life quality. Competitive position of regions located in the area of development of the waterway will also increase and it will be possible to include inland waterways in the European transport network as an alternative transport mode, especially in transport services for goods of east-west-east. Analysis of socio-economic situation showed no negative impact of the revitalization of the trail on the social aspects in the countries and selected areas. On the contrary, the revitalization of the route E40 would be an important factor in socioeconomic development of regions.

2. Environmental impact assessment (EIA)

2.1. Basic preconditions of environmental impact assessment

Analysis of the environment of IWW E40 route was carried out with regard to the following elements:

- sedimentary and geomorphological conditions; including the state of sediment quality,

- water quality,
- flora, including protected species,
- animals - invertebrates, fish, mammals, birds, including protected species and migration corridors for fish and birds,
- protected areas;
- landscape,
- acoustic climate,
- atmospheric air,
- historical and archaeological sites.

There were selected habitats and species occurring in the vicinity of the three variants of the waterway, as well as of areas linked hierologically and dependent on coastal processes, which if changed could cause a significant impact on their condition. There was adopted a 10 km buffer (5 km on each side of the waterway), taking into account environmental conditions, including hydrological. A buffer having a width of 10 km is considered appropriate because it is adapted to the average width of the river valleys typically occurring in the area and allows for inclusion of all the protected areas lying directly adjacent to the valleys into the report analysis. Including into the buffer the entire width of the river valley is important because of their leading role in increasing and maintaining biodiversity, and possibility to refer to a large area of the ecological corridor which width is different for different organisms.

Given the nature of the assessed project an important criterion used in assessing the impact on species and habitats was the extent of their sensitivity to changes in water conditions. The assessment took into account both the construction and operation phase of the waterway. Also positive and negative, direct and indirect impacts were taken into account. Due to the time of influence of impact, short-term and long-term impacts were defined.

The impact assessment considered during the construction phase the following actions:

- construction of the channel,
- partial modification of a natural watercourse (at intersections of channel with a natural watercourse)
- construction of locks,
- construction of ports,
- construction of reservoirs,
- construction of supporting infrastructure (f. ex. access roads, etc.).

At the operation phase there were analysed:

- channels supply in the water,
- movement of vessels,
- modernization of the existing sections of the waterway (dredging, straightening of waterway, etc.),
- modernization of the existing locks,
- modernization of existing ports,
- modernization of existing reservoirs,
- maintenance of the waterways,
- maintenance of the technical infrastructure.

2.2. Polish section of IWW E40

Natural and landscape advantages of Lublin and Mazovia regions make these areas one of the most valuable areas in Poland (Fig. 17 and Tab. 31). Their specific location influences the diversity of the landscape and the wealth of flora and fauna, which is reflected in a developed system of protected areas. The most significant role in the existing wildlife in Mazovia and Lublin region play river valleys of the Vistula and the Bug and the Narew and Pilica rivers. Vistula and Bug are important ecological corridors in the European Biodiversity Strategy called Pan-European ecological corridors. They belong to the few large rivers in the region of Central Europe, which have not been completely regulated. Along with Narew river they form in the Warsaw Valley the largest in the country and one of Europe's largest water junctions.

Based on the conducted analysis of the state of the environment and impact assessment it should be stated that the implementation of measures envisaged in the project in some sections of waterways may be contrary to the prohibitions of activities in protected areas (according to the Act of April 16, 2004 on conservation of nature). Given the number of protected areas in conjunction with the considerable scale of the project revitalization of E40 waterway Dnieper-Vistula section and possible actions to be implemented (see Technical Report), there is a possibility of conflict between the provisions concerning prohibitions on protected areas set out in the above Act, and investment actions.

These conflicts may involve the following prohibitions:

- changes in water relations and regulation of rivers and streams, if these changes do not serve to protect nature,
- noise emissions,
- earthwork permanently deforming terrain,
- locating buildings in the belt width of 100 m from the banks of rivers, lakes and other bodies of water, with the exception of water equipment and facilities for conducting rational agriculture, forestry or fishing,
- transformation of water reservoirs, oxbow lakes and wetlands,
- activities leading to the deterioration of natural habitats or habitats of species of plants and animals for which the Natura 2000 protected areas were designated (including the implementation of projects that may significantly affect these areas).

It should also be noted that some of the actions to be implemented may be in conflict with the provisions of the protection plans and plans of protection tasks of protected areas. This is the case for the Bug Landscape Park and five Natura 2000 areas situated in the area of the planned construction of the navigable channel in Variant I. Similar documents for protected areas located in the area of Variant II and III do not include any records which relate to issues of the waterways (no risks in this respect were also mentioned).

Fig. 17. Natura 2000 areas on the background of planned alternative routes of IWW E40 on the section Vistula – Mukhavets.
Source: Own elaboration of Maritime Institute in Gdansk - Department of Water Ecology

Tab. 31. Summary of numbers and area (in km^2) protected sites located in the area of 3 variants of canal

Route	Natural reserves				Landscape parks				Protected landscape areas				Natura 2000 sites				Overall			
Location[1]	Direct, quantity	Area, km^2	Other in 10-km buffer, quantity	Area, km^2	Direct, quantity	Area, km^2	Other in 10-km buffer	Area, km^2	Direct, quantity	Area, km^2	Other in 10-km buffer, quantity	Area, km^2	Direct, quantity	Area, km^2	Other in 10-km buffer, quantity	Area, km^2	Direct, quantity	Area, km^2	Other in 10-km buffer, quantity	Area, km^2
Variant I	2	1.58	12	9.32	2	1041.23	0	0	2	1907.55	1	303.43	4	1155.67	7	1303.42	10	4106.03	20	1616.17
Variant II	0	0	2	0.43	0	0	0	0	2	850.57	1	20.89	2	354.60	4	672.39	4	1205.17	7	693.71
Variant III	0	0	3	2.49	0	0	0	0	2	486.17	1	20.89	3	436.42	2	0.62	5	922.59	6	24.00

Source: Maritime Institute in Gdansk – Department of Aquatic Ecology, own elaboration

For the section of the Lower and Middle Vistula river, where cascade construction is planned, the analysis of impacts of the construction of the dam on the environment was carried out on the example of the planned dam in Siarzewo near Ciechocinek (below the existing dam in Wloclawek). A cascade, which was analysed in the technical part (II Interim Report), will consist of dams similar to Siarzewo dam and in the first approximation the impact of the dam on the environment can be extended to the whole cascade.

As a result of the implemented analyses and assessments in relation to the Polish section of IWW E40 the following can be concluded:

- The weakest link of IWW E40 is the Vistula – Mukhavets connection, due to environmental protection measures shipping through the valley of the Bug river is not taken into account, which entails the construction of an artificial waterway channel for which three variants were analysed in the project.
- On the given stage of the feasibility study, a waterway variant least harmful to the environment cannot be pointed unequivocally. The least valuable in terms of nature seems to be Variant II. It should be noted, however, that the degree and nature of the negative impacts will depend largely on the scope of the transformation of riverbeds, the choice of technology works and methods of mitigating environmental conflicts, which does not exclude Variant III, which proved to be optimal in other aspects.
- A full analysis of the environmental impact should be made on the basis of complete information about the project and after the environmental tests are done (natural inventory and studies on the quality of soil and water). The analysis should be made with regard to an integrated approach to water resources management, enrolled in the Plan of protection of water resources of Europe (2012) and the legislation in force in carrying out environmental impact assessments. Presented in this study assessment cannot provide a basis for issuing opinions on the implementation of specific actions.
- Analysis of the impact of construction and operation of a cascade in Middle and Lower Vistula river section, carried out on the example of the dam in Siarzewo, showed that in case of violation of the integrity of Natura 2000 sites, compensatory measures will be necessary. Planned activities to minimize the negative impacts and compensation for lost protected habitats and species will cause the Natura 2000 network to remain coherent.
- Smallest impact associated with the loss of arable land is expected in Variant III, due to the fact that the planned route passes mainly through areas in which there swampy and marshy lands and alluvial soils classified as areas with a predominance of permanent grassland. For comparison, the construction of the channel according to the Variant I will lose more than 1,000 hectares of arable land of good quality.
- At this stage it is not possible to clearly identify which of the three variants of E40 will evoke the least impact on the physical and chemical state of waters. The impact of this project on the state of waters in the three variants appears to be similar.
- The scale and nature of the project, including the construction of a waterway channel and / or adjustment of rivers sections along with accompanying infrastructure (such as ports, marinas, hydrotechnical facilities), may contribute to the disorder and lasting changes in the hydrological area and thus lead to the deterioration or even loss of valuable natural and

landscape advantages.

- Impact on flora will be mainly indirect in nature and will result from changes in individual habitats. Particularly at risk there are taxa characteristic for wet, moist and fresh habitats. The degree of their atrophy will be related directly to the degree of conversion of habitat. Construction of multi-kilometre shipping channel, additionally joined by rivers of seaports, increases likelihood of the spread of anthropofits (plants of foreign origin), including species considered invasive. The scale of transformation of vegetation resulting from the construction of E40 waterway at this stage it is not possible to evaluate.
- Impact on habitat diversity will result from execution of excavation for the channel, which will cause irreversible destruction of habitats and plant communities in the zone of a minimum width of 50 m. A much larger area will be included by indirect impacts in that cause disruptions of hydromorphological natural processes and water relations. Digging the channel will probably modify the natural rhythms of different levels of water, which is very important for the proper development of the oxbow lakes, all kinds of meadows and thickets in river valleys and peat swamp forests, riparian and alder forests.
- Impact on fauna of invertebrate animals will depend on the habitat preferences of the animals. The consequence of building the channel will partly reduce the biodiversity of species of invertebrate fauna in the immediate vicinity and then increase the number of hydrophilic and semihydrophilic individuals for which the channel will be a place of breeding, incubation of eggs, living larvae or feeding areas. The scale of this phenomenon is and remains difficult to estimate because of the fragmented research on this group of animals.
- Impacts resulting from the construction of the waterway on the fauna of amphibians and reptiles will be different and depend on the stage of the investment. Infrastructure related to the construction and the traffic of construction vehicles will hamper the movement of species amphibians and reptiles as well as diminish their numbers. When completed, the shipping channel may become an additional place for many species of herpetofauna.
- Impact on fish fauna will result from the loss of part of the natural habitats covered by the work of hydropower and the deterioration of environmental conditions during construction. The degree and nature of the negative impact will largely depend on the scope of the transformation of riverbeds and selection of technology works. It should be noted, however, that based on the data collected the largest number of protected species and valuable, which are sensitive to habitat transformation were identified on the route of Variant I.
- Impacts on birds will result from the loss of part of the natural habitats covered by the hydrotechnical works and the deterioration of environmental conditions during construction. The degree and nature of the negative impact will largely depend on the scope of the transformation of riverbeds and selection of technology works.
- Impacts on marine mammals are mainly due to the loss of natural habitats and the deterioration of environmental conditions during construction. The construction of the channel, but also its subsequent use will result in a significant decrease in species diversity of small mammals and disturbance of medium and large species. The construction of multi-kilometre waterway with a minimum width of 50 m will be associated with habitat fragmentation and discontinuity of ecological corridors (migration) for moving fauna.
- The three variants of E40 waterway are linear continuous objects of considerable dimensions,

which means that the interference of all three variants of the protected areas is inevitable. The largest number of protected areas is located in the area of Variant I.

- The valley of Lower Wieprz river is a valuable area in terms of natural features and landscape, (course of Variant III). The uniqueness of this area is mainly due to the natural character of the river. In the Wieprz valley there are annual spring flooding, supplying habitats with water and creating ideal conditions for large numbers of migrating birds (mainly Anseriformes and Charadriiformes). The dominant habitat in this area are extensively cultivated meadows, slowly overgrown oxbow lakes, the different types of riparian forests and the high slopes which are habitat for grassland. The greater part of the valley is protected under the Natura 2000 (PLH060051 Lower Wieprz River).
- At this stage it is not possible to clearly identify which of the three variants of E40 will affect the acoustic condition the least. The impact of this investment on these components of the environment in all three variants tends to be similar.
- According to the lists of historic sites, the smallest number of monuments bearing the registration number was found in Variant III of waterway. However, at the stage of preparation of the EIA there should be carried out the site inspection of the local areas in the three variants and accurate the risk to the monuments should be determined.
- Balancing benefits and losses resulting from the proposed project in accordance with the principle of sustainable development will be an essential part of the selection of final variant and a decision on accession or withdrawal from the project of revitalization of E40 waterway.

2.3. Belarusian section of IWW E40

In Belarus E40 waterway includes the channel of the Dnieper-Bug and three rivers: Mukhavets that belongs to the Baltic Sea catchment area, Pina and Pripyat that belong to the Black Sea basin. The waterway runs through the Western Polesie and Polesie Prypeckie. Polesie Prypeckie has considerable natural resources of flora and fauna. Its territory is inhabited by about 60 species of mammals, 260 species of birds, 20 species of amphibians and reptiles and 54 species of fish. About 70 species of Polesie Prypeckie is listed in the Red Book of the Republic of Belarus and / or protected in accordance with international obligations. Valuable and rare fauna elements focus on specially protected natural areas, with a total area (from 03.01.2015 r.) of 340 thous. ha, or 18.6% of the territory. The system of protected areas Polesie Prypeckie includes Pripyat National Park, 10 national nature reserves and 13 nature reserves of local importance, as well as 30 natural monuments.

Protected areas of Polesie Prypeckie play an important role in the conservation of biodiversity in Europe and around the world. Middle Pripyat Reserve, directly adjacent to the E40, is recognized as an area of international importance at the Ramsar Convention on wetlands. Along with Pripyat National Park, Middle Pripyat nature reserve has the status of an important territory for the protection of birds. State Radiation - Ecological Reserve, according to the law does not belong to protected areas. In addition Pripyat National Park status is crucial plant protection area - an area characterized by exceptional botanical richness.

In recent years, waters of Pripyat River were classified as "relatively pure". At the same time the Mukhavets River is one of the 10 most polluted rivers in Belarus.

Hydro-engineering indicators

One of the methods for determining the quality of surface water is the analysis of hydro-chemical

indicators of the water based on which we identify chemical indicator of water quality (CIWQ) (Tab. 32). CIWQ parameter is a combination of average annual concentrations of six indicators: dissolved oxygen, biological oxygen demand (BOD), ammonium ions, nitrite ions, phosphate ions and oil products.

Tab. 32. Water quality classification based on hydro-chemical indicators

CIWQ value	Quality class	Quality category
≤ 0.3	I	clear
0.3-1.0	II	relatively clean
1.0-2.5	III	moderately polluted
2.5-4.0	IV	contaminated
4.0-6.0	V	unsatisfactory quality
6.0-10.0	VI	bad quality
>10.0	VII	very poor quality

Hydro- chemical water regime of the Pripyat river is influenced by a large number of peatlands in the basin, especially in its middle section. Anthropogenic sources influencing chemical composition of the river are wastewaters from industrial plants of Pinsk, Mazyr and Naroulia.

According to the analysis made in the years 2002-2006 (Fig. 18), only waters of the Pripyat river below Pinsk city may be categorized as "moderately polluted" (CIWQ 1.6), other sections were "relatively clean" (CIWQ 0.6-1.0). Level of pollution depends on elevated levels of nitrogen, zinc and petroleum products. Based on observations, it was found that the average concentration of the main components and the value of indicators changes insignificantly. At the same time, the average value of BOD and chemical oxygen demand (COD), concentrations of nutrients and heavy metals decreased significantly. According to the stationary observations and adopted system of quality assessment, waters of the Pripyat river before 2003 were classified as "moderately polluted", and in 2004-2006 the overall state of the waters of the river has improved and belonged to the category of "relatively clean" (CIWQ 0.9-1.0).

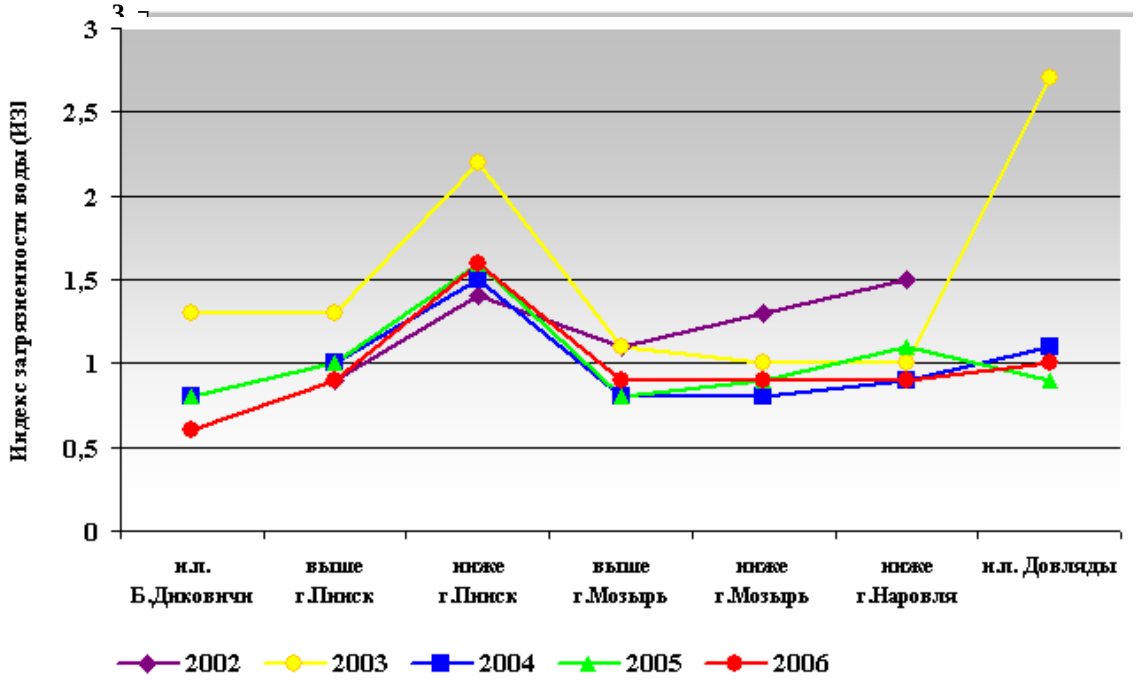


Fig. 18. Distribution of hydro-chemical indicators of water in the course of the Pripyat river in the years 2002-

2006.

In 2013 concentration range of major ions in the waters of Prypyat river were as follows: HCO_3^- 130.0-183.1 mg/dm^3, SO_4^{2-} 15.0-29 mg/dm^3, Cl^- 13.0-22.2 mg/dm^3, Ca^{2-} 50.1-74.0 mg/dm^3, K^- 1,27,4 mg/dm^3, Mg^{2-} 6.1-11.7 mg/dm^3, Na^- 4.2-11.7 mg/dm^3. Average level of mineralisation (244.0-327.0 mg/dm^3) is within a range of values typical for natural waters of average level of mineralisation, range of water hardness (3.4-4.4 mg ekwiw./dm^3) means water is "moderately hard". Annual average pH values (7.0-8.1) of Prypyat waters means neutral and slightly alkaline pH.

Oxygen content in the waters of the river was satisfactory: the amount of oxygen dissolved in the water ranged from 6.05 mg O_2 / dm^3 in June (3.5 kilometers below Pinsk city) to 13.5 mg O_2 / dm^3 in December (0.5 km east of Bolshie Dikovichi). Biological oxygen demand (BOD) in Prypyat river waters ranged from 1.4 mg O_2 /dm^3 up to 3.64 mg O_2/ dm^3. The annual average indicator of BOD does not exceed the standard. COD values ranged from 24.0 mg O_2 / dm^3 in October (in the cross-section from Bolshie Dikovichi to Pinsk) to 46.4 O_2 / dm^3 in July (1.0 kilometers below Mazyr town).

In 2013 throughout the entire research area covering the section of the river there were reported increased levels of ammonium ion. However, there was a slight decrease in annual average concentrations in relation to the previous study period. The highest ion content (0.60 mg N / dm^3) was observed in July of 45.0 kilometers below Mazyr town.

Since 2012, the results of analyses show a rapid decrease in nitrite and phosphorus content in the river below Pinsk city. Average concentrations of these nutrients in 2013 on all sections of the Pripyat river were also within normal limits. The highest concentrations of nitrite (0.018 mg N / dm^3), phosphate (0.012 mg P / dm^3) and general phosphorus (P 0.015 mg / dm^3) was recorded in January at Pripyat below Pinsk city.

The annual average oil content in sections of the Pripyat river (0017 - 0030 mg / dm^3) is almost in line with the results of 2012, and the maximum concentration of component (0.048 mg / dm^3) was registered in March 45 km below Mazyr town.

However, the Mukhavets river, running in the immediate vicinity of the Polish part of the E40, has been classified in recent years as one of the 10 most polluted rivers in Belarus.

Analysis presented in the monograph showed that the evaluation of the quality of the waters of the Pripyat river basin based on the chemical indicator of water quality is generally similar to the evaluation based on the criteria of the Water Framework Directive. However, it must be noted, that classification of water quality by WFD is more representative, and with its help it is easier to identify the main pollutants. For example, increased concentration of ammonia nitrogen in Pripyat river waters is a problem and it is exactly by this component Pripyat on long section is classified as class III by WFD.

Hydrobiological indicators

Evaluation of the quality of surface waters is made using bioindication methods, based on the research of aquatic biocenoses structure and their individual components. In hydrobiological monitoring system of all biotic communities the taxonomic composition is determined, including indicator species, as well as the number and biomass of dominant groups and common species of aquatic organisms. Based on this data you determine Pantle–Buck saprobity index or Woodiwiss biotic index (Tab. 33).

According to research data from 2013 phytoplankton community of the Pripyat river waters has a large taxonomic (175 taxa, including diatoms – 53, chlorophyta - 72, cyanobacteria - 19). During the

summer, at the checkpoints there were observed up to 73 taxa. The structure of communities here is often of rheophile character and does not change over the years, which demonstrates optimum environmental conditions in the river waters for the growth of phytoplankton. All indicators point to the greatest development of the phytoplankton community in the area of Mazyr town. High values in number and biomass are caused by the rapid development of diatoms, chlorophyta and cyanobacteria.

Tab. 33. Water quality classification according to hydrobiologic indicators

Water quality class	Water quality category	Pantle–Buck saprobity index	Woodiwiss biotic index
I	Very clean	< 1.0	10
II	Clean	1.0-1.5	7-9
III	Moderately polluted	1.51-2.5	5-6
IV	Contaminated	2.51-3.5	4
V	Dirty	3.51-4.0	2-3
VI	Very dirty	> 4.0	0-1

Analysis of samples taken at different times of the year, shows the nature of the restructuring of phytoplankton during the year: in winter water is dominated by diatoms and periphyts, in summer at the peak of growing season chlorophyta and cyanobacteria and to a lesser extent diatoms. In the autumn, at the end of the growing season, water is dominated by cyanobacteria. Such variability of the dominant groups testifies to the natural character of the observed seasonal changes in the structure of phytoplankton communities.

Values of Pantle–Buck saprobity index measured at cross-border river stations in 2013 fluctuated in a narrow range from 1.89 (in the Bolshie Dikovichi) to 1.92 (in Dovliady), which corresponds with class III of water quality (moderately polluted).

Pripyat river zooplankton communities is represented by 45 species and forms. The greatest taxonomic diversity (29 species and forms)and the largest amount of zooplankton and biomass was recorded at the checkpoint 1 km below Mazyr town. The peak of zooplankton in this place is due to the predominance of rotifers, among which dominated brachionus calyciflorus (50% of the number and 55% of the biomass), together with five other species of the genus brachionus amounting to high value of saprobity index. Low rates of growth of zooplankton were found at sections of Dikovichi and Pinsk.

In 2013 Pantle–Buck saprobity index throughout the controlled section of Pripyat river ranged from 1.49 at the Bolshie Dikovichi (II class of cleanliness) to 2.05 at Dovliady (III class of cleanliness).

Fitoperiphyton community of the Pripyat river is represented by a smaller number of taxa (121) compared to planktonic algae. Their diversity at the sections ranges from 18 to 44 taxa and without significant changes along the entire course of the river. Periphyton of the Pripyat is characterized by the presence of large number of diatom taxa and also chlorophyta and a few taxa of cyanobacteria. In 2013 saprobity index was well below the level of the previous year and ranged from 1.57 (45 km below Mazyr) to 1.88 (Dovliady), and thus represent a class III of water quality (moderately polluted).

In 2013 the total taxonomic diversity of macrozoobenthos organisms was measured at 118 species and forms, of which 30 belonged to the chironomidae and 15 to Odonata. In the bottom of the river there were observed many organisms – indicator species of water quality, included Ephemeroptera (13 species) and larvae of Trichoptera (11 species). The upper section of the river (from Bolshie Dikovichi to Pinsk), controlled in the summer were characterized by high diversity(37-38 genres and forms), and high stable value of the biotic index (9), which corresponds to II class of water cleanliness. Indicator

species here include 6 to 7 ephemeroptera species and from 2 to 5 trichoptera species.

On the cross -section below the waste discharge point of Pinsk, taxonomic diversity is limited to 17, and biotic index - to 8. In the lower course of the river, near Mazyr, in the summer and autumn diversity of species reaches 28- 39 species and forms. In the bottom communities, there are many indicator species of clean water, and biotic index is 9 (II cleanliness class).

Taxonomic diversity of benthic communities on the cross-border cross-section at Dovliady is 28 species and forms, and the value of the biotic index is equal to 9 (II cleanliness class).

In general, in 2013 according to hydrobiological indicators the state of aquatic ecosystems of the Pripyat river waters at the cross-section of Bolshie Dikovichi to Dovliady was stable and referred to the class II-III (clean - moderately polluted).

Conclusions

In 2013, at all cross-sections, as in previous years, the waters of the Pripyat river were classified as "relatively clean". At the same time, the Mukhavets river located in the immediate vicinity of the Polish section of E40 has been classified as one of the 10 most polluted rivers in Belarus in the last few years.

With regards to the planned revitalization of E40 waterway, and the intensification of shipping on the Pripyat, special attention should be paid to reduction of fish stocks reproduction efficiency observed in recent years, which requires additional measures to be taken. This situation is caused by:

- degradation of spawning grounds (shallow overgrowing bushes and reeds, changes in water quality) due to eutrophication of water bodies, changing their hydrological regime, reducing mowing and grazing on floodplains;
- a significant reduction in spawning grounds of most fish phytophil species (including those of economic value);
- isolation of numerous oxbow lakes from the mainstream of Pripyat river as a result of works aiming at straightening the river and resulting lack of oxygen, leading to a death of fry and adult fish. In addition, in the summer due to the lack of connection with the river the food in oxbow lakes is not utilised;
- growing pressure on commercial fish species as a result of recreational fishing.

Factors influencing wetlands area of Polesie Prypeckie

Natural ecosystems of wetlands are of Polesie Prypeckie, habitats and species are influenced by many negative factors of natural and anthropogenic origin. Natural origin factors include climate change and associated tendency to reduce the humidity of the environment. Climate change and lack of flooding or prolonged flooding of floodplains during the growth season (summer rainfall flooding) cause acute changes in the functioning of riparian ecosystem.

In particular, if before the ice started moving on Prypyat at the end of the first decade of March, at present it starts at the end of the second decade of February. For example, at the section of Pripyat in Prypyat National Park this process now takes place on average 16 days earlier than observed in the years 1955-1965. Temperature threshold for early spawning of fish followed in the middle of the second decade of April, now at the beginning of the second decade (5 days in advance); for late spawning fish at the beginning of the first decade of May, now - in the middle of the third decade of April (6 days earlier).

More often there can be observed such phenomena as winter floods –as a result, most of the flood water flows in winter (outside spawning season), which lowers the level of spring floods, resulting in rapid runoff, and often there is no flooding of polders. This usually leads to the death of eggs and fry, many spawning grounds is not used at all.

The negative impact of climate change in the Polesie is aggravated by the effects of large-scale anthropogenic transformation of the area. Significant changes in the hydrological regime of the Pripyat river and its floodplain occurred as a result of embankment of the river and its tributaries, use of polder lands for human activities, regulation of the flow of the Pripyat river and its tributaries in Ukraine. Construction of oil pipeline "Przyjazn" and a dirt road in the southern part of the floodplain led to a decline in subsurface runoff of waters. This led to a reduction of floodplains, faster, often forced runoff of snowmelt and flood waters to polders and in the redistribution of surface and subsurface runoff waters. Large amounts of water began to flow into the river in shorter time, flooded areas decreased. Usual times of flood occurrence have changed.

Among the factors of anthropogenic origin most significant threat to the wetlands is a violation of the natural hydrological regime as result of drainage, which leads to the degradation of ecosystems and the reduction of biodiversity, overgrowing of large part of the open natural swamps and meadows with bushes and reeds; and the drying of natural wetlands due to peat extraction.

Conclusions

The negative impact of the drainage indicated by the reduction of natural biocenoses areas of floodplains - floodplain meadows and marshes, lakes, oxbows, humid oak and alder forests, which are a refuge for a large group of rare and endangered species of birds. The increase in the amount and duration of spring floods in the space between the embankments adversely affects the diversity and abundance of birds and wetland meadow, leads to a lack of places for nesting, drenching nests, destruction of eggs and chicks in the nests.

A significant threat to the wetland habitat is pollution caused by industry, agriculture and communal wastewaters. Pollution of water bodies and water courses is one of the most important factors affecting aquatic animals. The main source of pollution of rivers and reservoirs is currently agriculture, to a lesser extent - urban and industrial effluents. Inflow of nutrients and organic compounds leads to eutrophication of water bodies and watercourses. Eutrophication in turn leads to increased overgrown of reservoirs, trophic roads changes and restructuring of ichtiocenoses.

As a result of the implemented analyses and assessments in relation to the Belarus section of IWW E40 the following can be concluded:

- the main factor in anthropogenic impacts on aquatic ecosystems will embankment and straightening of rivers and - to a lesser extent - the dredging of the waterway,
- impact on changes in bird migration can be significantly reduced by appropriate mitigation measures,
- improvement in fish migration to wintering, spawning, feeding through the intensification of work of locks,
- there will be a possibility to utilise equipment usually used to maintain the waterway, to improve the efficiency of natural reproduction of fish - to provide free migration of fish on the spawning grounds by deepening and widening ways to the spawning grounds in flood plains, clearing the oxbows by connecting them with the main trough, etc.,
- deposition of soil and creation of sand embankments on the channel banks due to dredging

which will create favourable conditions for birds nesting,

- sand and gravel excavated during dredging may be used in construction,
- impacts on sensitive land are not expected to be irreversible provided that requirements of the EIA are met. There are potential positive impacts of construction projects on sensitive lands and other components of the environment provided that the of the requirements of the EIA are formulated and met during investment realisation,
- provided that the cross-border management and tasks of forecasting the quality of river water is introduced, the negative impact caused by the revitalization of IWW E40 will be minimized. Development of water transport through the revitalization of the waterway creates opportunities for technical solutions of current problems in the polders of Pripyat and the Dnieper-Bug channel: drying connections with oxbow lakes; expansion of low value shrubs; the restoration of the traditional use of nature, reduce the risk of fish kill,
- revitalization of E40 waterway will not lead to problems of irrigation and use of used water. If a comprehensive approach to natural environment on IWW E40 is implemented, it is possible to observe favourable prospects for irrigation,
- revitalization of E40 waterway will provide perspective of the active use of local raw materials for bioenergy,
- with regard to the issues of protection of monuments of the Belarusian part of the route E40 - should pay particular attention to the section of Brest - Zhabinka, where there is located almost half of archaeological sites and in the area of Pinsk, where a fourth of such monuments is located, which also must be taken into account in the planning of the tourist route E40.

2.4. Ukrainian section of IWW E40

On the territory of Ukraine, a waterway on the Dnieper and Pripyat rivers has existed for a long time, passes through the deepest sections of the Dnieper cascade reservoirs and the deepest part of the Pripyat and the Dnieper riverbed. The Ukrainian part of the IWW E40 is outside protected natural areas of Ukraine, in some sections it runs close to these areas.

In the northern part of the Kyiv region along the Pripyat River estuary section near the border with Belarus there is located Chernobyl Exclusion Zone - an area of 2,600 km^2 that is contaminated with radionuclides and not habitable. Currently there are works underway on establishing there radiative-ecological reserve zone. In order to protect Pripyat waters against radioactive contamination, along its banks there were created embankments. The entire supply of water from the contaminated areas has to stand up in ponds and marshes before it falls into the river.

Ukraine's largest regional nature park "Mezhrichsky" with an area of 1,025 km^2 is located between the rivers Dnieper and Desna in Chernihiv region. Its part lies on the left bank of Kyiv Reservoir. "Goloseyevski" National Park (area of 64.6 km^2) is located on the right bank of the Dnieper River on Kaniv Reservoir within the boundaries of Kyiv city. "Trakhtemirov" Regional Landscape Park (107 km^2) is located on the right bank of the Kaniv reservoir, Kyiv and Cherkasy region.

Beloye Lake National Park (70.1 km^2) is located on the left bank of the Kaniv reservoir Kyiv and Cherkasy region. Kanev Reserve in the Cherkasy region is located mainly on the right bank of the reservoir Kremenchuk. The reserve amounts to 2,027 ha; including 10 ha of water area covers Kremenchuk reservoir and 602 ha - of the island.

Nizhnesulsky National Park in the Poltava area of 18,635 ha includes the estuary part of the Sula river, sunken by water of Kremenchuk reservoir, as well as a wide marshy backwaters near the estuary section of Sula Regional Landscape Park "Kremenchuk Plavni" (50.8 km^2) is located on the right bank

of the Dniprodzerzhinsk reservoir in Poltava.

"Nizhnevorskla" Regional Landscape Park (232 km^2) in Poltava was established in estuary of the Vorskla river, sunken by the waters of Dniprodzerzhinsk reservoir. National Park "Velykyi Luh" with an area of 168 km^2 in the Zaporizhia region includes the left bank of the Kakhov reservoir, including the Bolshie and Malye Kuchugury islands. Low Dnieper National Park (802 km^2) is located in Kherson region.

Zalukhovsky Hydrological reserve in Volyn region covers an area of 839.4 ha, including Svyatoye and Volanskoye lakes, wetlands around lakes. Through the reserve water is discharged from Pripyat to power the Dnieper-Bug channel during low water levels. During high water levels through these channels is drained water from the Pripyat river, i.e. they serve as part of the antiflood remedy for Pripyat valley. They require regular cleaning.

Khortytsya Historical and Cultural National Reserve is located on the island of the same name and in flood areas in the upper reaches of the Dnieper river, on Kakhov reservoir within the city of Zaporizhia.

As a result of the implemented analyses and assessments in relation to the Ukrainian section of IWW E40 the following can be concluded:

- restoration of shipping on the entire length of E40 waterway from Kherson to Gdansk will not fundamentally alter the existing environmental conditions in the Ukrainian part of the route, which parameters correspond to the requirements of international waterways, as defined in the AGN agreement. Intensification of traffic should be taken into account, as well as necessary modernization of hydrotechnical structures, marinas for boats and yachts. Improvement can be even expected ecological state of IWW E40 and its surrounding areas,
- channels of Beloye Lake water system will provide water for Dnieper-Bug channel and protect Pripyat valley from flooding, as well as in periods of low water levels it will protect wetland areas of Zalukhovsky Hydrological Reserve;
- other Ukrainian protected areas along the IWW E40 route are not on the waterway and there is no direct impact of shipping on it;
- Navigation does not affect pelagic fish which have adapted to passing vessels, and the spawning grounds are off the waterway;
- the greatest impact on the fish fauna have annual dredging, which lead to a reduction and disappearance of a population of plankton and benthos, which in turn leads to a reduction of fish resources;
- in terms of protection of monuments special attention should be paid primarily to sections: in Kyiv region (approx. 20% of all monuments) and Cherkasy, Dnipropetrovsk and Zaporizhia regions (approx. 10% of monuments).

2.5.The impact of the project on water quality and aquatic organisms

The most important beneficial effects on aquatic organisms, which can be expected in the course of the project E40 realization is restoration of hydro-biological connection between the Bug and Mukhavets river (existed in 1930-1960); the connection between the riverbed and the water bodies with optimal environment in the estuary of Mukhavets river.

It is assumed that during the operation of E40 waterway dredging devices will be regularly in operation, which can be used to solve one of the biggest environmental problems - to restore the

connection between drying oxbow lakes in the floodplains and riverbed in times of droughts.

It should be noted that this problem (drying oxbow lakes in the floodplains) is essential for the reproduction of fish in streams and reservoirs on the current route of E40. The problem has woesened in recent years, especially in 2012-2015, when during the critical dry seasons of spring and summer industrial fish could not reach areas for spawning and fry could not return.

Based on our technical experiment we have shown that this problem can be solved within the framework of activities related to the reconstruction and operation of E40 waterway.

River vessels, as well as other motor vessels, will have a definite negative impact on the environment, in particular on chemical and physical parameters of the aquatic environment. However, in comparison with other sources of water pollution i.e. discharges from residential areas and industrial run-off from agricultural land and communication, the impact is less significant.

A fourfold increase in freight traffic, the creation of accompanying infrastructure, the occurrence of chronic problems of water quality, cross-border contacts between the catchment areas all together create new challenges in the field of environmental protection.

The water quality in the catchment areas of the Pripyat and Mukhavets rivers results from natural and anthropogenic (economic) factors.

The natural conditions for shaping the river waters are associated with wetlands and groundwater. It is the marshes of Polesie that bring to the Pripyat and Mukhavets river basins an increased amount of colored organic substances, considerable amounts of humic acids and metals such as iron. This leads to a general deterioration of the quality of river waters and they are of little use as a drinking water supply.

In the absence of significant discharges of industrial waters in the catchment area among major pollutants can be identified agricultural activities, in particular discharges from large animal farms (Apacki anf others 2003).

Despite the fact that a number of indicators exceed the limits in the waters of rivers and the basins of the Bug and Pripyat rivers, the state of most of the courses can be considered satisfactory in terms of water quality. However, there is a problem of very high concentrations of humic acids, heavy metals and other impurities (chlorides, oils, nitrites, detergents, etc.). Therefore, there is a need for cross-border management and forecasting the quality of river waters. The key to solving these problems could be:

- Development, implementation and long-term reliable operation of the monitoring system of cross-border (ecosystem, hydro-biological, hydro-chemical) on E40 waterway;
- International agreements and harmonization of methods and parameters for determining the state of ecosystems and water quality;
- Regulation of discharges of polluting substances into natural waters, including commission and construction of closed systems;
- Development and implementation of measures to limit (exclude) the penetration of pollutants into waters receivers in drainage systems, especially those that cause biological changes in the regime of natural waters;
- Accurate compliance with Polish, Ukrainian and Belarusian water laws (codes) and strategies, concerning the areas of water protection and use of polders;
- decrease, and in the future and prohibition of the use of poisonous chemicals and fertilizers on eroded catchment areas;

- Increase in investments to modernize wastewater treatment plants in order to improve their functioning and implementation of new, more efficient wastewater technologies (sewage, storm sewer);
- Compliance with environmental standards of operating water transport facilities in the catchment basins of E40 waterway rivers.

The above listed tasks correspond to national standards to conduct environmental impact assessment. Belarus possesses for this purpose qualified staff, a proven national system of environmental monitoring. It should be emphasized that there is a need for triple monitoring: of ecosystem, hydro-biological and hydro-chemical.

When assessing the impact of E40 project on water quality and aquatic ecosystems there should take into account the current level of water use and discharges of polluting substances.

In the last five years a tendency to reduce the number of wastewater discharges. Introduction of closed water circuits significantly reduces the volume of discharge of industrial waters, resulting in lower levels of pollution. However, the volume of wastewaters discharged, as major sources of pollution, remains unchanged. Some positive impact of operating the E40 is to increase the amount of water, its turbulence intensity and the "dilution" of water, which is important for the fall of the risk of summer fish deaths and other adverse hydro-biological events.

Conclusions

Provided that the implementation of cross-border management and tasks of forecasting the quality of river water, the negative impact caused by the revitalization of MDW E40 will be minimized. Development of water transport through the revitalization of the MDW E40 provides opportunities for technical solutions to current problems in the polder area of Pripyat and the Dnieper-Bug Canal: drying connections with oxbow lakes; expansion of low value shrubs; the restoration of the traditional use of nature, reduction of the risk of fish kill.

2.6.Changes in the level of noise, the risk of surface water pollution

As shown by direct observation, during the passage of cargo ships through a fairway, effects of shock waves and sound effects do not interfere visibly with living fauna and flora.

On the contrary, small and fast motor vessels which number at Pripyat river has increased over the past 5 years more than tenfold, create a number of environmental problems that should be solved with the help of a administrative and preventive system.

Especially serious adverse effects bring small boats for fish fry *Silurus glanis*, *Lota lota*, and some other animals. The different species of this group of flora and fauna are listed in table 34. When drafting programme of specific measures there should be laid down a detailed rules for the operation of key sections.

Similarly, some of the protected species of flora (Tab. 21) are also sensitive to the wave impact. It is expected that the intensification of cargo shipping will lead to more organized movement of boats and taking into account environmental requirements. The EIA studies for construction projects recommended the designation of areas with limited (in time and in the fairway) motor boats traffic. It should be kept in mind that the areas of construction and operation of hydro-engineering facilities provide favorable conditions for the spread of alien invasive species of fauna and flora. Invasive species can have various negative impacts, including complete displacement of the local community. Some species of this group are listed in table 35.

On the banks of the Dnieper-Bug waterway and Bug river there are no indigenous population of wild animals particularly sensitive to sound, so this factor will not have a negative impact on coastal fauna.

Surface waters of E40 waterway are subject to a relatively high pressure from chemical contaminants. The general list of pollutants in the Pripyat and Bug rivers there are traditionally present "external sources": water discharged from municipal and industrial wastewater treatment plants; sewage from storm water drainage; input of pollutants from agricultural fields.

Among the factors polluting the surface waters of the Belarusian Polesie water transport is not mentioned. However, the development of stationary and moving transport facilities will require specialized hydro-chemical control.

Development of an EIA is required prior to the construction of additional infrastructure on the waterways, including - for the construction of permanent or seasonal tourist and recreation facilities (beaches, marinas for boats, tourist complexes etc.).

Conclusions

The level of noise and vibrations along E40 waterway requires adjustments, both now and in the future - as the new sources of influence occur.

During the construction of technical equipment and operation of E40 waterway there should be taken into account the sensitivity of protected species of flora and fauna on technogenic impacst.

Also during the construction of technical equipment and operation of E40 waterway should the risk of new outbreaks of invasive alien species of flora and fauna be taken into account.

Tab. 34. Selected protected and industrial species of native flora and fauna sensitive to the effects of noise and waves along E40 waterway

No.	Flora / fauna species	Protection status
1.	Lake quillwort *Isoëtes lacustris*	Red book of Belarusian Republic (edition III) IV category
2.	European white water lily *Nymphaea alba*	Red book of Belarusian Republic (edition III) III category
3.	Waterwheel plant *Aldrovanda vesiculosa*	Red book of Belarusian Republic (edition III) II category
4.	Water caltrop *Trapa natans*	Red book of Belarusian Republic (edition III) III category
5.	Spiny water nymph *Najas major*	Red book of Belarusian Republic (edition III) III category
6.	Brittle naiad *Caulinia minor*	Red book of Belarusian Republic (edition III) II category
7.	Lesser water-parsnip *Berula erecta*	Red book of Belarusian Republic (edition III) III category
8.	Characeae family (different species) *Chara, sp.*	Sensitive regional species
9.	Mare's eggs *Nostoc pruniforme*	Red book of Belarusian Republic (edition III) III category
10.	Marimo *Cladophora aegagropila*	Red book of Belarusian Republic (edition III) III category
11	Common barbel *Barbus barbus*	Red book of Belarusian Republic (edition III) III category
12.	Vimba bream *Vimba vimba*	Red book of Belarusian Republic (edition III) III category

13.	Common nase *Chordrostoma nasus*	Red book of Belarusian Republic (edition III) III category
14.	Burbot *Lota lota*	Industrial species
15.	Wels catfish *Silurus glanis*	Industrial species

Tab. 35. Selected alien invasive species of fauna and flora, which sources of reproduction occur on the sandy shore dumps, construction sites along the river, harbors along E40 waterway

No.	Flora / fauna species	Protection status
1.	Crayfish *Orconectes limosus*	Displaces indigenous species
2.	Zebra mussel *Dreissena polymorpha*	Reduces trophic levels
3.	American mink *Mustela vison*	Displaces indigenous species
4.	Canada goldenrod *Solidago canadensis*	Displaces indigenous species
5.	Boxelder maple *Acer negundo*	Displaces indigenous species
6.	Cypress spurge *Euphorbia cyparissias*	Competes with indigenous species
7.	Devil's beggarticks *Bidens frondosa*	Displaces indigenous species
8.	Wild cucumber *Echinocystis lobata*	Displaces indigenous species
9.	Small Balsam *Impatiens parviflora*	Displaces indigenous species
10.	Cocklebur *Xanthium albinum*	Displaces indigenous species
11.	Canadian Waterweed *Elodea canadensis*	Displaces indigenous species

When analysing the state of the natural environment and current use of natural watercourses in Polesie region, the revitalization of E40 waterway version of "Reconstruction of the fairway on the Belarusian-Polish stretch of the Bug river from the village Nowosiółki to Brest with a length of 62 km and modernization of the existing Dnieper-Bug fairway from to Brest region narowelskiego "should initially be regarded as a useful one from the point of view of environmental protection.

Thus, according to preliminary estimates, revitalization of E40 waterway at the Belarusian section should take place provided that scientific and practical recommendations are met and cross-border environmental monitoring of adverse impacts on the landscape and biodiversity, on land resources, water and biological resources will be reduced to the minimum value of parameters.

Conclusion

During the construction of technical and operation facilities of E40 waterway, some changes in the level of external noise, pollution of surface waters and certain other physical and biological consequences will occur. Critical and negative levels of physical and biological agents will be reduced or minimized by specially developed recommendations.

2.7.Volume of expenses for compensatory ecological activities

Compensation expenditures are expenditures independent of the project, including all of the related mitigation activities. They are not intended to enable the implementation of the project but to balance negative investment impact on the environment.

Compensation expenditures are used as last resort and can be used in the absence of alternative solutions and if public interest is overwhelming. At the stage of the preliminary assessment of the project of revitalization of the waterway, it is difficult to propose concrete compensatory measures.

In order to limit the impact of the project on natural habitats there should be used minimizing actions and solutions mainly in the field of:

- reduction in the number of cur trees,
- strengthening of embankments.

With respect to protected species of flora, it is proposed to transfer or replant endangered plants into new habitats.

Measures aimed at mitigating the impacts of the investment on the invertebrate fauna will rely primarily on the transfer of trees, where invertebrates occur.

To mitigate impact on fish there should be avoided, among others:

- works in the riverbed during spawning and fish migration season;
- prolonged excessive disturbance of waters especially during the spawning season.

It proposed to limit the impact of construction works on amphibians and reptiles in the area through:

- appropriate organization of building site facilities, including the use of special protective fencing;
- transfer of amphibians and reptiles occurring within the investment construction site to other temporary place,
- appropriate organization of technological roads, including the use of fences.

In order to fully minimize the investment impact on birds during the implementation, specific types of construction works (especially wood clearing) should be carried out outside the breeding seasons of selected species of birds, and for some species - nest boxes should be used. In the course of the investment ornithological monitoring should introduced, primarily for nesting boxes.

For the protection of surface waters there should be avoided prolonged water disturbance with suspension of slur water where possible, and the water should be discharged to the receivers after pretreatment, and also proper procedures for use and maintenance of construction equipment should be put in place.

Soils - In the course of construction works, turf and fertile soil of the area covered by earthworks should be treated appropriately and those parts of the construction site, where it could be damaged or contaminated, its use for the rehabilitation of the site after construction should be considered. Farmland used temporarily for the purpose of construction works must be restored to its original state. Sealing of the surfaces in squares parking spaces for machinery and transport equipment should be ensured.

Air pollution in the construction phase should be minimized by proper organization of the square and the construction facilities, planning of access roads, the use of appropriate and efficient equipment and constant supervision.

Acoustic climate - Works that emit noise should preferably be carried out between 6.00 am-22.00 pm, and the hardware and material base as well as technological routes for the transport of materials should

be placed at the appropriate distance from residential buildings. Moreover, in the course of work there should be performed periodic monitoring of vibro-acoustic signals in appointed measuring points agreed with the environmental authorities.

During construction there should be respected principles of waste prevention and minimization of their quantity, as well as their use or disposal.

These recommendations represent a contribution to minimizing the environmental impact of the Project. In practice, an amount of compensation assumed is at the level of from 3.5% to 5% of the investment total value[31]. By adopting such estimated value of the compensatory measures for the Belarusian part of E40 International Waterway the figure will range from 2.14 mln EUR to 4.13 mln EUR. For the Ukrainian part, the value of the compensatory measures will shape up at the level of 0.80 mln EUR. In contrast, for the Polish part of E40, the total estimated value of the costs of environmental compensation in the implementation of the assumed Objective 1 and Objective 2, variant 3 the connection between the Vistula and Mukchavets amount to 485.04 mln EUR. The costs to compensate for the possible negative impact of investments on the environment by individual sections of an international E40 waterway are presented in the table below.

Tab. 36. Expenditures compensating possible adverse effects of the investment on the natural environment divided into specific sections of the E40 IWW

Section of E40 waterway/scope of work	Cost of reconstruction, mln EUR	Cost of environmental compensation, mln EUR
Poland		
1. Construction of locks, dredging works, construction of waterway that will meet the requirements of class IV of international classification on the Lower and Middle Vistula: Variant III - on the Gdansk - Deblin section	9972.19	349.03
2. Construction of Vistula - Mukhavets navigation channel that will meet the requirements of class Va of international classification: Variant III - Deblin - Brest	1943	68.01
channel construction	1825.92	63.91
locks construction	117.08	4.10
Total in Poland	**13858.19**	**485.04**
Belarus		
1. Reconstruction of the existing hydrotechnical structures on the eastern section of the DBC	19.5	0.68
2. Hydrotechnical works in the fairway aiming of higher vessel drafts up to 2,4m	5	0.18
3. Construction of new water junctions on the Pripyat river with locks that will meet the requirements of class IV of international classification	19.00-67.00	0.67-2.34
4. Construction of the navigable section of IWW E40 on the Belarusian - Polish border	5.00-15.00	0.20-0.52
5. Modernization of water supply system of DBC, including construction of Zhyrov Reservoir	11.7	0.41
Total in Belarus	**60.20-118.20**	**2.14-4.13**

[31] For the construction of the barrage in Siarzewo the Volume of expenses for compensatory ecological acitivities has been calculated at level of 3,5% of all investment. Information based on ENERGA SA data (2015).

Ukraine		
1. Complete reconstruction of Kyiv lock	2.23	0.08
2. Complete reconstruction of Kaniv lock	2.98	0.10
3. Complete reconstruction of Kremenchuk lock	3.05	0.11
4. Complete reconstruction of Dniprodzerzhinsk lock	3.02	0.11
5. Complete reconstruction of Zaporizhia dam	8.56	0.30
6. Complete reconstruction of Kakhov lock	3.07	0.11
Total in Ukraine	**22.91**	**0.80**
TOTAL	**13941.30-13999.30**	**487.98-489.97**

Source: Own-elaboration of Maritime Institute in Gdansk

2.8.Common conclusions for the entire IWW E40

- Partial shift of cargo from railways and roads to the waterways will help to keep, protect and improve the quality of the environment and human health by reducing overall emissions of air pollutants and noise,
- The negative impact of noise during the hydrotechnical works can be reduced by choosing appropriate work times,
- It is expected that over time as shipping transport intensifies, chemical and other impacts on soil will be reduced due to relieve in land transport in the region,
- the risk of penetration of alien species to the environments where these species can threaten indigenous species will be higher. To reduce this risk, regulations must be strictly followed, f.ex. disposal of ballast waters,
- gradual weakening of river banks as a result of the intensification of the motor vessel traffic cannot be avoided, but it can be prevailed by technical means,
- During the construction of technical and operation structures of E40 waterway there will be changes in the level of external noise, pollution of surface waters and certain other consequences of physical and biological nature. Critical levels and negative influences of physical and biological agents will be minimized thanks to specially developed recommendations,
- Reduced fuel consumption for transport with the same amount of freight loads, lead to a more rational use of natural resources, which can help reduce the anthropogenic impact on the climate,
- Changes to electromagnetic fields caused by the construction of small hydropower plants, construction and modernization of ports and their infrastructure will not constitute a threat to the environment.
- Eichhornia crassipes - the so-called. water hyacinth poses no threat to IWW E40, because it is killed at temperatures below 10˚C and despite the rapid reproduction even in warm periods it does not have time to multiply excessively.

III. TECHNICAL AND NAVIGATIONAL ISSUES

1. Technical and architectural reports from preliminary specification

1.1. General characteristics of IWW E40 along the sections in each country

1.1.1. Ukrainian section of IWW E40

The entire Ukrainian part of E40 waterway meets the conditions for V class waterway. Along the route there are located nine inland river ports: Kyiv, Cherkasy, Kremenchuk, Dniprodzerzhinsk, Dnipropetrovsk, Zaporizhia, Nykopil, New Kakhivka and Kherson. The length of this section is 970 km. The figure 19 presents the schematic description of traffic, the number of locks, navigation characteristics and the distances between ports.

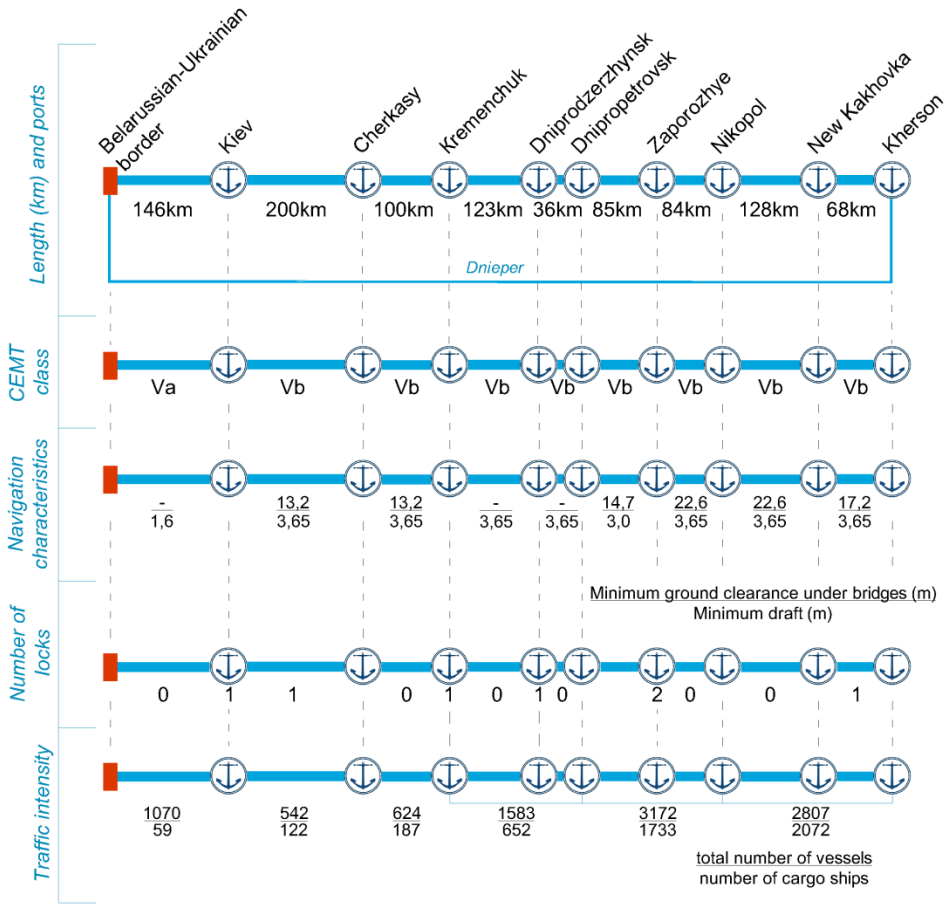


Fig. 19. Scheme of the Ukrainian part of international waterway E40
Source: Own elaboration of Maritime Institute in Gdansk - Department of Economics and Law.

-Dnieper river

The Ukrainian part of the international waterway E40 consists of two rivers: the Dnieper and Pripyat. Dnieper river is the largest river in Ukraine and the third largest in Europe (after Volga River and Danube River). Dnieper River has a length of 2201km, of which the first 485km (22% of the total length of the Dnieper River) flows to the south - west of the Russian Federation in the region of Smolensk. On the territory of the Republic of Belarus has a length of 516km (23% of the total length of the Dnieper). Continue heading south flowing in the vicinity of the town of Orsha. Running further

south flows the city Rechitsa, located near the border with Ukraine, where the Dnieper reaches a width of 200-300m. At high water on the floodplain the Dnieper can reach a width of 3-5 km. On the territory of the Ukraine section of the river Dnieper belonging to an international waterway E40 reaches a length of 1200km, acting in 55% of the total length of the river. The Dnieper Basin covers 504 000 km^2, of which 289 000 km^2 are within Ukraine (48% of its area). The basin occupies 42% of the territory of the Ukrainian state and 36% of Ukrainian ethnic territory.

The Dnieper flows south through the centre of Ukraine and bisects its natural zones—forest, forest-steppe, and steppe—interconnecting them and connecting them with the Black Sea. Of the long-settled principal areas of Ukraine, only Galicia, Western Volyn, and Transcarpathia lie beyond the basin of the Dnieper. Travel is easy from the Dnieper Basin to basins northwest of it —the Vistula River, the Neman River, and the Daugava River—but difficult to other basins, such as the basins of the Dnister River, the Boh River, the Volga River, and the Don River. Easy communications between the Dnieper River, the Pripyat River, and the Bug River by means of the Vistula facilitated the expansion of Poland into Ukraine. The Dnieper's role as a unifying force and gateway to the sea was, however, weakened by a 70 km stretch of rapids in the steppe belt. In spite of this obstacle, the Dnieper was the main axis of the first Ukrainian state—Kyivian Rus'. The nucleus of a second state—the Zaporizhian Sich—arose on the Dnieper. The river is the artery of Ukraine, its main highway, and its source of hydroelectric power.

The river can be divided into three sections: the upper Dnieper from the source to Kyiv (1,333 km, of which 255 km are within Ukraine); the middle, from Kyiv to Zaporizhia (536 km), and the lower, from Zaporizhia to the sea (331 km).

From Kyiv to Dnepropetrovsk the Dnieper flows along the boundary between the Dnieper Upland and the Dnieper Lowland. The river valley is asymmetrical here: the right bank rises to 100–150 m above the river, is deeply dissected by valleys and gullies, and is covered with forest. Kyiv lies in these 'Dnieper Mountains.' Below Kyiv, in the Kaniv Hills, is located the grave of Taras Shevchenko. The left bank of the river is low, sandy, and often covered by pine forest. It rises towards the east in broad terraces. The river valley is wide—6–10 km, and at Pereiaslav-Khmelnytskyi and Cherkasy, 15–18 km—while the river is 200–1,200 m wide. Below Cherkasy the Dnieper splits into sidestreams and creates islands. Its depth varies frequently, from 1.5 to 12 m. The tributaries that empty into the middle Dnieper are smaller than those in the upper Dnieper and carry much less water. The tributaries on the right side—the Stuhna River (68 km), the Ros River (346 km), and the Tiasmyn River (194 km)—flow in short, narrow beds carved in granite. The tributaries on the left originate usually in the Central Upland and cross the whole Dnieper Lowland. They are longer and wider, with low banks and terraces. The rivers are the Trubizh River (113 km), the Supii River (130 km), the Sula River (310 km), the Psol River (692 km), the Vorskla River (425 km), and the Samara River (311 km). They do not greatly increase the water volume of the Dnieper.

The slope of the Dnieper between Kyiv and the mouth of the Tiasmyn River is very gentle—6 cm/km. It becomes steeper where the Dnieper enters the Ukrainian Crystalline Shield. The river dissects the massif for 90 km between Dnepropetrovsk and Zaporizhia. Originally it flowed through a narrow, deep (100 m), chiselled valley and formed a typical granite landscape. The riverbed narrowed here to 300–800 m, and at the village of Kichkas near Zaporizhia it contracted to 175 m. Here the renowned Dnieper Rapids rested on a firm, granite foundation. There were 9 rapids and 60 small barriers. The slope of the river reached 50 cm/km, and the current sometimes attained a velocity of 6 m/sec. When a dam was built on the Dnieper above Zaporizhia in 1932 (see Dnieper Hydroelectric Station), the rapids were submerged under Dnieper Reservoir, and the landscape changed completely.

Below Zaporizhia the Dnieper enters the steppe belt, the dry (300–400 mm of rainfall) Black Sea Lowland. Near Kichkas the Dnieper split into two branches, which encircled a large, steep, granite island – Khortytsya Island – on which the Zaporozhian Sich once stood. The valley here was 4 km wide. Farther on the valley widened to 20 km before the Kakhivka Reservoir was built, and the river divided into many branches as it flowed through the muddy flatland, which became flooded in the spring and during heavy summer rains. This floodplain was covered by islands of deciduous forests, wet meadows, lakes, and swamps, which were overgrown with reeds and bulrushes. The largest floodplains – the Velykyi Luh (20 km wide by 60 km long) – stretched from the Dnieper to its left-bank tributary the Konka River and were separated from the broad Bazavluk River floodplains by a narrow stretch of floodplains near Nykopil. Then the Dnieper again became narrow (floodplain 3-7 km wide, whereas it is 10 km wide at the Dnieper's mouth). Both banks were high down to Kakhivka, and then the left bank became low. The Dnieper Valley above Kakhivka changed after a second large dam was constructed on the Dnieper near Kakhivka, and the large Kakhivka Reservoir (2,155 km^2) was created. It inundated all the floodplains.

The final stretch of the Dnieper begins below Kakhivka, 106 km above the Dnieper Estuary. Here the water flows on thick (up to 70 m) alluvial deposits, which resulted from the depression of the coastal strip of the Black Sea Lowland in the Quaternary period. This depression also led to the inundation of the Dnieper's mouth (and the mouths of other rivers) and the formation of lagoons and marshy floodplains along the coast. From Kherson (32 km from the estuary) onward the Dnieper splits into branches and forms a large delta (350 km^2) with numerous islands and lakes. Two-thirds of the delta is floodplain, and one-third is water. The Dnieper empties into the Dnieper-Boh Estuary through several shallow mouths, the main ones being Zburiv, Kizylmyk, and Bokach or Rvach. The dredging of the Bokach mouth has made Kherson accessible to sea vessels. The tributaries of the lower Dnieper are small steppe rivers: the Konka River (140 km), Bazavluk River (150 km), Bilozerka River (88 km), and the larger Inhulets River (550 km). The slope of the lower Dnieper is 45 mm/km. The current's velocity depends on the slope and water level. At the rapids the current reached 5 m/s and more, while it is almost unnoticeable in the low Dnieper. The upper and middle Dnieper has a velocity of about 1.5 m/s. [32]

- Dnieper cascade

The construction of the Dnieper Cascade of hydroelectric power stations and reservoirs from the mouth of the Pripyat River to the town of Kakhivka (the Kyiv Reservoir, the Kaniv Reservoir, the Kremenchuk Reservoir, the Dniprodzerzhinsk Reservoir, the Kakhivka Reservoir, and Dnieper Reservoir) has led to great changes in the riverbed. The natural riverbed has been preserved only along short sections of the Dnieper: above the mouth of the Pripyat, above Kyiv, below Kaniv and Dniprodzerzhinsk, and below Kakhivka.

According to the report drawn up after the inspection of the locks on the Dnieper river, technical condition of a large number of locks was evaluated as "unfit for normal use". This applies primarily to estuary section of the Pripyat and the upper sections of all reservoirs of the Dnieper Cascade. In order to ensure sustainable and safe use of Dnieper locks, a total investment and operating costs in 2016 should amount to 7.6 mln USD, and replacement capital expenditures over the next five years should amount to estimated 27.2 mln USD. Further delay in restoring the proper technical condition of the locks of the Dnieper river can lead to emergency stop in their operations and, consequently, creating obstacle to navigation on a large

[32] V. Kubijovyč, I. Teslia: *Dnieper river*. Encyclopedia of Ukraine 2012.

part of E40 waterway. There is also a need to build a cargo port for handling vessels of various deadweight on the Pripyat River and the Kyiv Reservoir.

Dnieper Cascade consists of a system of 6 dams with bays and hydroelectric power stations attached to them. These are:

- Kyiv Hydroelectric Power Station (Vyshgorod dam, Kyiv Reservoir),
- Kaniv Hydroelectric Power Plant (Kaniv dam, Kaniv Reservoir),
- Kremenchuk Hydroelectric Power Station (Kremenchuk dam, Kremenchuk Reservoir),
- Dniprodzerzhinsk Hydroelectric Power Station Dniprodzerzhinsk dam, Dniprodzerzhinsk Reservoir),
- Dnieper Hydroelectric Power Station (Zaporizhia dam, Dnieper or Zaporizhia Reservoir),
- Kakhov Hydroelectric Power Station (Novaya Kakhiv dam, Kakhiv Reservoir).

The biggest of them is the Dnieper Hydroelectric Power Station.

The total area of water reservoirs created by the dams is 6950 km², and the volume of accumulated water supply - 43.8 km³.

Adjusting the river by a cascade of Dnieper reservoirs, built for energy, shipping, water supply and irrigation purpose, have a significant impact on the water of Dnieper and conditions for navigation on it. Some parameters of reservoirs are given in the table below.

Tab. 37. Parameters of Dnieper Cascade reservoirs

No.	Parameters		Reservoirs					
			Kyiv	Kaniv	Kremenchuk	Dniprodzerzhinsk	Dnieper	Kachov
1.	Year of built		1965	1974	1961	1964	1932; 1951	1956
2.	Catchment area	km^2	239	336	383	424	463	482
3.	Long-term average flow	m^3/s	1050	1390	1510	1520	1590	1650
4.	Long-term average outflow	km^3	33.1	43.9	47.6	47.9	50.1	52.0
5.	Ordinates of the dam: - NPP	m	103.0	91.5	81.0	64.0	51.4	16.0
	- The level of the dead volume	m	101.5	91.0	75.75	63.0	49.0	14.0
6.	The volume of the reservoir for the NPP	km^3	3.73	2.62	13.52	2.45	3.03	18.2
7.	Adjustable working volume	km^3	1.17	0.33	9.00	0.52	0.72	6.80
8.	The water level at NPP	km^2	922	675	2250	567	298	2150
9.	The length of the reservoir along the river	km	110	123	149	114	129.7	230
10.	The nature of regulation		seasonal	Weekly and daily	annual	Weekly and daily	Weekly and daily	annual
11.	High outflow regulation		nie	nie	tak	nie	nie	tak

Source: Państwowa Agencja Zasobów Wodnych Ukrainy, Państwowy Regionalny Instytut Projektowo – Badawczy „Dniprodiprovodgosp"

On the Dnieper part of the international waterway E40, each dam is equipped with navigation lock, except Zaporizhia dam, which is equipped with 2 locks – 3-chamber and single chamber.

Technical condition of this seven navigation locks at the dams of the Dnieper reservoirs is bad due to their long period of use. All of tchem need general renovation.

The Ministry of Infrastructure of Ukraine planned to finance the Dnieper locks reconstruction from the budget funds with EU funds suport in the amount of 105 mln UAH (about 3.66 mln EUR). The decision was made after the publication of the American engineers who have completed technical inspecion of five Dnieper locks (Kyiv lock, Kremenchuk lock, Dneprodzerzhinsk lock, Zaporizhia lock and New Kakhivka lock). They noted the poor state of locks and urgent need of reconstruction.

Currently the Ministry of Infrastructure together with international financial institutions and partners develope and action plan for long-term locks reconstruction program.[33]

The scheme below presents the technical conditio of the Dnieper locks in the opinion of the USACE expert group.

Fig. 20. Technical condition of the Dnieper locks in the opinion of the USACE expert group 31.
Source: Ministry of Infrastructure of Ukraine: mtu.ua/news/27422.html

Due to the limited internavigational period and the inability to perform substantial amounts of reconstruction in a single season, the required capital investments are planned to be allocated for 5 years.

The table below shows the costs of bringing the Dnieper locks to good and safe operating conditions.

Tab. 38. The costs of Dnieper cascade locks repair.

No.	Name of the lock	Total cost in thous. UAH	Costs in subsequent years				
			1	2	3	4	5
1	Kyiv lock	63 480	18 380	17 820	6 680	9 600	11 000
2	Kaniv lock	84 750	6 800	10 850	18 600	29 000	19 500
3	Kremenchuk lock	86 770	15 320	20 000	25 400	12 950	13 100
4	Dniprodzierzhynsk lock	86 120	8 520	25 000	21 050	17 450	14 100
5	Zaporizhia dam	243 870	616 701	52 100	54 350	42 600	33 500
6	Kachov lock	87 410	10 110	20 250	15 450	26 300	15 300
Total:		**652 400**	**120 800**	**146 020**	**141 530**	**137 900**	**106 150**

Source: Państwowa Agencja Zasobów Wodnych Ukrainy, Państwowy Regionalny Instytut Projektowo – Badawczy „Dniprodiprovodgosp"

-Section of E40 waterway on the Upper Dnieper

In order to ensure efficient transport of goods from the river ports and seaports of Ukraine to the Republic of Belarus and back, a construction of cargo handling port is planned in the vicinity of Niznij Zary village (Belarus, 22 km up the Dnieper River from the mouth of the Pripyat river). The port could

[33] Ministry of Infrastructure of Ukraine: mtu.ua/news/27422.html

accept vessels with maximum draft of up to 3.0 m, and smaller feeder vessels would transport the cargo further transhipment.

The given section of the waterway at almost its entire length runs along a sunken riverbed of the Dnieper, and only in the area of the Pripyat river mouth to Dnieper there was made Rossoch correction at the length of 1.6 km.

The section of the waterway in the Upper Dnieper River from the mouth the Pripyat up to Niznij Zary village is situated within the area of water accumulation of the Kyiv Reservoir. Physical processes at the bottom in this area are similar to those in riverbeds. A characteristic feature of this section and Pripyat river as well is a steady flow of suspensions and movement of sandy bed material, resulting in the formation of peninsulas and islands along the river, followed by sanding of fairways. It is characteristic that fairways are each year sanded in the same places. This process is particularly intense during the spring floods.

According to the letter of the State Waterways Enterprise "Ukrvodput" dated. 03.30.2015 No. 02-08 / 41 annual dredging work are necessary in the six most sended places of the Upper Dnieper. The annual volume of dredging material in the Ukrainian part of the waterway in the Upper Dnieper River are presented in table 39.

Tab. 39. The annual volume of dredging works in the sections of the Upper Dnieper

No.	Name of the section	Waterway km	Volume of dredging works, thous. m^3
1.	Lower Zary 4th	964.6	40
2.	Upper Limanowski	962.5	150
3.	Limanowski 1st	961.2	50
4.	Teremtsy 1st	954.4	90
5.	Teremtsy 4th	948.5	70
6.	Rossokha rectification	944.7	80
	Total dredging works:		480

Source: Państwowa Agencja Zasobów Wodnych Ukrainy, Państwowy Regionalny Instytut Projektowo – Badawczy „Dniprodiprovodgosp"

-Section of E40 waterway on the Kyiv Reservoir

The Kiev Reservoir is the first in a cascade of the Dnieper reservoirs, it takes in the entire unregulated water inflow from the upper part of the Dnieper basin (including the Pripyat river). In the reservoirs settles the majority of debris, so the pace of send accumulation of Kyiv Reservoir is higher than in case of other reservoirs. Also sand accumulation on the fairway is more intense than on other sections of the Dnieper river. However, the sediments are deposited mainly in the shallows on both sides of the river. T riverbed is regularly washed by unregulated waters of spring floods. There can be observed a processes of shore abrasion of the reservoir and bottom sediment movement.

The Kiev Reservoir covers an area of 922 km^2, with water capacity of 3.73 km^3, an average depth of 4.0 m. Retention of the reservoir is seasonal, flow control is carried out during the spring floods.

The usual level of water damming of the Kyiv Reservoir is 103.00 meters above sea level, the minimum level for shipping is 102,00 m. Guaranteed depth of the fairway with minimal navigation requirements is 265 cm, width 80 m, radii of curvature of the fairway 800 m. Waterway length at the mouth of the Kiev Reservoir from Pripyat to the dam of the Kiev Hydroelectric Power is 66.5 km.

At the Kiev Reservoir there are indicated four most sanded sections of the waterway. The annual size

of the dredging material at the section of Kiev Reservoir are presented in the table 40.

Tab. 40. The annual volume of dredging works in the sections of the Kyiv Reservoir

No.	Name of the section	Waterway km	Volume of dredging works, thous. m^3
1.	Area of buoy no 51	940.5	15
2.	Area of buoy no 40	928.2	8
3.	Area of buoys no 17 and 20	911.1	30
4.	Area of buoys no 15 and 18	910.0	15
	Total dredging works:		68

Source: Państwowa Agencja Zasobów Wodnych Ukrainy, Państwowy Regionalny Instytut Projektowo – Badawczy „Dniprodiprovodgosp"

-Section of E40 waterway on the Kaniv Reservoir

The Kanev Reservoir was built in 1974 as the last one of the cascade reservoirs of the Dnieper river. The area of the reservoir covers 591 km^2 with capacity of 2.50 km^3, an average depth of 3.9 m. Reservoir retention has daily and weekly character. Regulation is intended to cover peak loads in the power system.

The upper part of the reservoir within the boundaries of Kiev city possesses river characteristic. At this location flows into the Dnieper one of its largest tributaries, Desna, which introduces a large volume of debris into the Dnieper - up to 2 million m^3 per year of sediments. Sanded fairways occur mostly at this sections.

Middle and lower part of the reservoir are deeper, but mostly within the limits of the flooded riverbed of the Dnieper. On the left bank there are extensive shallow areas. In addition, apart from extensive sediment shifts there is also wave abrasion of the shores.

The usual level of water damming of Kanev Reservoir is 91.50 m. Guaranteed depth of the fairway is 365 cm, width 80 m, radii of curvature of the fairway 800 m. The length of the waterway on the Kanev reservoir from the Kiev dam to Kanev dam is 150 km.

At the Kanev Reservoir there are indicated six most sanded sections of the waterway. The annual size of the dredging material at the section of Kanev Reservoir are presented in the table 41.

Tab. 41. The annual volume of dredging works in the sections of the Kaniv Reservoir

No.	Name of the section	Waterway km	Volume of dredging works, thous. m^3
1.	Vyshgorodsky 1st	868.4	50
2.	Nebishovsky	860.3	80
3.	Lower Darnytskiy	846.5	30
4.	Osokoryanka 1st	843.0	15
5.	Area ob. Buoys no 81 and 83	815.,2	10
6.	Area of buoy no 36	778.,1	10
	Total dredging works:		195

Source: Państwowa Agencja Zasobów Wodnych Ukrainy, Państwowy Regionalny Instytut Projektowo – Badawczy „Dniprodiprovodgosp"

-Section of E40 waterway on the Kremenchuk Reservoir

Kremenchuk Reservoir was built in 1961 and is the second largest (after Kakhov Reservoir) of the reservoirs of the Dnieper cascade. The area of the reservoir covers 2,252 km^2 with water capacity of 13.52 km^3 and average depth of 6.0 m. Retention of the reservoir is of annual character, it is designed to control spring flooding and the creation of water reserves during summer low water levels.

Due to the depth of the riverbed and the river valley, shallows, the nature of currents and waving, the reservoir is divided into three sections: the upper, middle and lower section.

In the upper section from Kanev to Cherkassy currents poses lake-river characteristics. The water flow takes place through the flooded riverbed, there is a usual sediment shift from existing peninsulas and islands. At this section can be found the highest number of sanded fairways.

Middle and lower sections of the reservoir are a lake-like with greater depths and width. Speed of currents here is low, dominates by the impact of the waves on the shores and shallows, lifting the suspension and bottom sediment shift. Abrasion of the embankments is intense.

A characteristic feature of Kremenchuk Reservoir is the largest adjustable height of all Dnieper reservoirs; difference exceeds 5 m. Draining of the reservoir starts in late autumn and reaches its minimum at the end of winter or in March. During the summer fluctuations do not exceed 2 m.

The usual level of water damming of Kremenchuk Reservoir is 81.00 m above sea level, the minimum level for shipping is 79.00m. Guaranteed depth of the fairway with minimal navigation requirements is 365 cm, width 80 m, radii of curvature water 800 m. The length of the waterway on Kremenchuk Reservoir is 171 km.

At the Kremenchuk Reservoir there are indicated 16 most sanded sections of the waterway. The annual size of the dredging material at the section of Kremenchuk Reservoir are presented in the table 42.

Tab. 42. The annual volume of dredging works in the sections of the Kremenchuk Reservoir

No.	Name of the section	Waterway km	Volume of dredging works, thous. m^3
1.	Lower approaching channel of Kaniv dam	726.5	20
2.	Lower Shevchenko	716.4	110
3.	Pekary	715.0	50
4.	Shevchenko Lower	711.3	40
5.	Prokhorovsky 3rd	709.0	70
6.	Kreschatikskoy 1st	705.7	60
7.	Kreschatikskoy 2nd	702.5	100
8.	Bubnovsky 1st	700.0	60
9.	Bubnovsky 2nd	699.2	70
10.	Tubiletsky	693.0	20
11.	Upper Stanovoi	690.5	40
12.	Lower Stanovoi	689.0	80
13.	Olshansky	685.9	40
14.	Sokirnyansky	684.3	100
15.	Lower Sokirnyansky	680.8	90
16.	Area of buoy no 66	675.5	20
	Total dredging works:		970

Source: Państwowa Agencja Zasobów Wodnych Ukrainy, Państwowy Regionalny Instytut Projektowo – Badawczy „Dniprodiprovodgosp"

-Section of E40 waterway on the Dneprodzerzhynsk Reservoir

Dniprodzerzhinsk Reservoir was built in 1964. The area of the reservoir covers 567 km^2 with water capacity of 2.46 km^3 and average depth of 4.3 m. Retention of the reservoir is a weekly and daily, regulation has to cover peak loads in the power system.

Processes taking place in riverbed of the upper part of the reservoir from Kremenchuk dam to the Derijewka village are of lake-river character, with an intense movement of sediments from sandbanks, peninsulas and islands. Here are located the main sand sediments in the fairway.

Middle and lower part of the reservoir from Derijewki to Dniprodzerzhinsk dam are of lake character with greater depths and width. Speed of currents here is low, dominates impact of the waves on the shores and shallows, lifting the suspension and bottom sediments. Abrasion of the embankments is intense.

The usual level of water damming of Dniprodzerzhinsk Reservoir is 64.00 m above sea level, the minimum level requirements for shipping 63.80 m. Guaranteed depth of the fairway with minimal navigation is 365 cm, width 80 m, radii of curvature of the fairway 800 m. The length of the waterway at the Dniprodzerzhinsk Reservoir is 122 km.

At the Dniprodzerzhinsk Reservoir there are indicated nine most sanded sections of the waterway. The annual size of the dredging material at the section of Dniprodzerzhinsk Reservoir are presented in the table 43.

Tab. 43. The annual volume of dredging works in the sections of the Dneprodzerzhynsk Reservoir

No.	Name of the section	Waterway km	Volume of dredging works, thous. m^3
1.	Lower approaching channel of Kremenchuk dam	555.3	20
2.	Area of buoy no 120	550.4	40
3.	Verbotsky 4th	545.6	35
4.	Verbotsky 5th	544.4	40
5.	Kagamlitsky	540.2	40
6.	Kovalevsky 1st	539.4	80
7.	Kovalevsky 3rd	536.9	15
8.	Demurovsky 2nd	532.5	90
9.	Area of bouys no 62, 63 and 65	524.4-526.0	50
	Total dredging works:		410

Source: Państwowa Agencja Zasobów Wodnych Ukrainy, Państwowy Regionalny Instytut Projektowo – Badawczy „Dniprodiprovodgosp"

-Section of E40 waterway on the Dnieper Reservoir

Dnieper Reservoir was built as the first in a cascade of the Dnieper reservoirs, filled for the first time in 1932. The reservoir flooded 13 river treshholds and about 30 rock unilateral narrowings of riverbed. The reservoir suffered twice a catastrophic water discharge on 18 August 1941 and September 1943.

Dnieper Reservoir area covers 298 km^2 with water capacity of 3.03 km^3 and average depth of 10.2 m. Retention of the reservoir is a weekly and daily, regulation has to cover peak loads in the power system.

The lower part of the reservoir below the city of Dnepropetrovsk to Zaporozhye sity is deep water, maximum depth of 62.0 m. Above Dnepropetrovsk, to Dniprodzerzhinsk dam the nature of the flow is close to the river, with significant speeds currents, sediment movement and the creation of mobile sediment forms at the bottom. Tributaries of other rivers bring a small amount of debris because of the presence of estuarine bays. The main deposits come from sediment shifts and abrasion of the embankments as well as from the discharge of industrial wastewater.

The usual level of water damming of Dnieper Reservoir is 51.40 m. Guaranteed depth of the fairway

at is 365 cm, width 80 m, radii of curvature of the fairway 800 m. The length of the waterway at the Dnieper Reservoir is 128 km.

At the Dnieper Reservoir there are indicated seven most sanded sections of the waterway. The annual size of the dredging material at the section of Dnieper Reservoir are presented in the table 44.

In order to improve shipping safety within the area of Dniprodzerzhinsk gate, 30 thous. m^3 of rock material should be dredged.

Tab. 44. The annual volume of dredging works in the sections of the Dnieper Reservoir

No.	Name of the section	Waterway km	Volume of dredging works, thous. m^3
1.	Lower approaching channel of Dneprodzerzhynsk dam	433.0	10
2.	Dneprodzerzhynsk Gate	426.8	6
3.	Gruzsky 1st	416.0	50
4.	Gruzskie Gate	411.7	45
5.	Taromskie Gate	409.8	40
6.	Sukhachevskoye	407.7	40
7.	Novokaydaksky	395.8	5
	Total dredging works:		196

Source: Państwowa Agencja Zasobów Wodnych Ukrainy, Państwowy Regionalny Instytut Projektowo – Badawczy „Dniprodiprovodgosp"

-Section of E40 waterway on the Kachov Reservoir

Kakhov reservoir is the largest in the cascade of the Dnieper reservoirs. Construction of Kakhov water junction was completed and the reservoir filled in 1956.

The area of the reservoir covers 2,150 km^2 with water capacity of 18.2 km^3 and average depth of 8.5 m. Retention of the reservoir is of annual character, regulation has to cover low water levels in summer.

Processes taking place in riverbed of the upper part of the reservoir from Zaporohse dam to Bieleńkoje village are of lake-river character, with an intense movement of sediments from sandbanks, peninsulas and islands. Here are located the main sand sediments in the fairway.

Central part of the Kakhov Reservoir was located in a palce of sanken Bazawłuckich and Konskich floodplains, the former Great Cossack Meadows. This area is of lake character with large widths (up to 25 km). Speed of currents runoff are small, outweighs the impact of waves on the shores and shallows on turbidity and sediment transport. Abrasion of the embankments is intense.

The lower part of the reservoir is deep, with widths of 3-7 km. Coastline is well- developed, the banks are steep, often rocky. The abundance of large bays in the mouth of the ravines and small rivers.

At the Kakhov Reservoir there are indicated four most sanded sections of the waterway. The annual size of the dredging material at the section of Kakhov Reservoir are presented in the table 45.

Tab. 45. The annual volume of dredging works in the sections of the Kachov Reservoir

No.	Name of the section	Waterway km	Volume of dredging works, thous. m^3
1.	Area of bouys no 128 and 165	300.0	30
2.	Are of bouy no 141	285.0	20
3.	Are of bouy no 108	283.3	20
4.	Are of bouy no 135	280.5	60

	Total dredging works:		130

Source: Państwowa Agencja Zasobów Wodnych Ukrainy, Państwowy Regionalny Instytut Projektowo – Badawczy „Dniprodiprovodgosp"

-Section of E40 waterway on the Lower Dnieper

Lower Dnieper (below the Kakhov dam) has a natural riverbed. Hydrological processes of the river in this section are highly modified by the cascade of the Dnieper reservoirs, energy requirements of Kakhov dam and by the environmental conditions of the Lower Dnieper. This stretch of river is influenced by the changes of water levels caused by Limani wind on Dnieper and Bohu wind in the Black Sea – if there are no adequate release of water from hydroelectric power plant, it can lead to high salinity of the Lower Dnieper. In accordance with the performance standards during low water levels, the sanitary flow should not be lower than 500 m^3 /s, and during fish spawning - 1500 m^3 /s. Water quality in the Lower Dnieper also affects the consumption of water for Ingulecki Irrigation System that takes water from the Dnieper River upstream the riverbed of the Ingulec river.

At the Lower Dnieper there are indicated two most sanded sections of the waterway. The annual size of the dredging material at the section of Lower Dnieper are presented in the table 46.

Tab. 46. The annual volume of dredging works in the sections of the Lower Dnieper

No.	Name of the section	Waterway km	Volume of dredging works, thous. m^3
1.	Lower approaching channel of Kachov dam	92.0	20
2.	Lvov	75.7	30
	Total dredging works:		50

Source: Państwowa Agencja Zasobów Wodnych Ukrainy, Państwowy Regionalny Instytut Projektowo – Badawczy „Dniprodiprovodgosp"

-Pripyat river

Pripyat River is the major right-bank tributary of the Dnieper River. It is 761 km long (the second-longest tributary of the Dnieper, next to the Desna River) and drains a basin area of 121,000 sq km (the largest in the Dnieper watershed). Most of it passes through Ukrainian ethnographic territory and its borderland in Belarus. Its upper reaches (185 km) and lower reaches (80 km) as well as 57% of its basin are in Ukraine (nearly 75% is in Ukrainian ethnographic territory). The river flows slowly, meandering through wide floodplains, frequently breaking into and rejoining branches. In its upper course it is 30–40 m wide, in the middle, 200–250 m wide, and in the lower, 200–500 m wide. The large homogeneous floodplain of the river consists of oxbows, marshes, bush, and coppice. The river freezes in mid-December and thaws in late March. Its average annual discharge is 14.5 km^3, 60% of its flow coming in the spring. Spring floods last well into the summer.

Pripyat River's principal tributaries include (right bank) the Horyn River, the Slovechna River, the Stokhod River, the Stviha River, the Stir River, the Ubort River, the Uzh River (Polesie), the Vyzhevka River, the Turia River, and the Zholon River, and (left bank) the Lan River, the Pina River, the Ptich River, the Sluch River, and the Yaselda River. The Prypiat is connected to the Vistula River by the Dnieper-Bug Canal. It is used for shipping, log rafting, and water supply. The river contains a wide variety of fish (pike, carp, perch, catfish, bream, and others). The main centers along the river include Pinsk, Petrykov, Mozyr, and Chernobyl.[34]

[34] V. Kubijovyč, I. Teslia: *Dnieper river*. Encyclopedia of Ukraine 2012.

The Pripyat River in the upper section flows through the Ukrainian area of Volyn and Rivne regions, in the middle section - through the territory of Brest and Gomel regions in Belarus, in the lower sections - the Kyiv region in Ukraine. Source of Pripyat is located 2 km from the Gorokhovische village in the Lubomel area (Volyn region) at a height of 173 m above the Baltic Sea. In the upper section, the river flows to the northeast, on the middle section through the region of Pinsk turns east. In the lower sections from Mozyr to the mouth of the river the course is directed towards the east. The river flows into the Dnieper (Kyiv Reservoir) on the right side at a distance of 970 km from the mouth. The estuary of the river was flooded by the waters of the Kyiv Reservoir and is located 20 km east of Chernobyl. The height of the river mouth corresponds to the normal level of damming of the Kyiv Reservoir - 103.0 m.

The total length of the river according to modern measurements is 775 km, of which in Ukraine its length amounts to 274 km, on the territory of Belarus to 488 km on the border of Belarus and Ukraine 13 km. The hydrographic length of the river (from the most distant source of the river from the river mouth at Horyn) is 1073 km. The catchment area of the river is 121 thous. km^2, of which the Ukraine accounts for 70.1 thous. km^2, Belarus 50.9 thous. km^2. In terms of catchment area and conductivity, Pripyat river is the largest tributary of the Dnieper river. According to the classification of the Water Code of Ukraine, Pripyat belongs to a large rivers class.

According to the document of the State Company Waterways "Ukrvodput" dated 03.30.2015 No. 02-08 / 41 is required to deepen the river Pripyat on 13 shallows. The annual volume of dredging in the Ukrainian part of the river is given in table 47.

Tab. 47. The annual volume of dredging works in the sections of the Pripyat river

No.	Name of the section	Waterway km	Volume of dredging works, thous. m^3
1.	Usovsky plyos	63.0	50
2.	Usovsky 2nd	61.3	25
3.	Benovsky	59.0	30
4.	Proran Kosharovsky	57.6	25
5.	Kosharovsky 2nd	56.,8	25
6.	Shepelitsky 1st	55.7	15
7.	Syrovatsky 2nd	48.6	70
8.	Syrovatsky 3rd	48.0	65
9.	Chernobyl slots	26.7	70
10.	Herman Shynok 1st	25.2	70
11.	Herman Shynok 3rd	21.3	30
12.	Plyutovische 1st	17.8	50
13.	Ostrorozhskoe rectification	6.5	55
	Total dredging works:		580

Source: Państwowa Agencja Zasobów Wodnych Ukrainy, Państwowy Regionalny Instytut Projektowo – Badawczy „Dniprodiprovodgosp"

From the Ukrainian-Belarusian border up to Chernobyl (32.5 km) the guaranteed depth of the Pripyat waterway is 150 cm, width of the fairway 35 m, radii of curvature of 300 m.

From Chernobyl to its river mouth, the river is located in the zone of damming of the Kiev Reservoir (30 km). The depth of the fairway with minimal navigation is 180 cm, width 60 m, radii of curvature of 400 m.

From the mouth of the Pripyat river (in the flooded riverbed of the Dnieper River by the Kiev Reservoir) to the Ukrainian-Belarusian border the length of the waterway along the Pripyat River is 64.5 kilometers. Practically the whole section is artificial; it underwent a number of changes, due to the construction of the Kiev Reservoir as well as construction of the cooling reservoir for Chernobyl power plant, construction of protective structures along the river after the disaster of Chernobyl and in connection with the operation of the waterway.

A characteristic feature of estuary section of Pripyat river is a constant flow of suspensions and movement of sediment material, resulting in the formation of peninsulas and islands along the river, followed by sanding fairways. This process is particularly intense during the spring floods.

Kyiv- Pripyat River in the area of impact of the Chernobyl disaster

Pripyat River is the largest water reservoir in the exclusive zone of Chernobyl. The river cuts through a restricted zone, from north to south and on the border 30 kilometre zone flows into the Kyiv Reservoir. In the area of nuclear power plant in Chernobyl this river has been artificially modified. Navigable channel was built with a length of 11 km. The river bed is routed so as to avoid cooling reservoir, built for the needs of Chernobyl. The river Pripyat passes 200-400 meters away from the cooling reservoir, which is separated from the river with an artificial dam. In this section of river width ranges from 100 to 160 meters, and has an average depth of 3-4 meters, and sometimes reaches 8 m. Of the total length of the river Pripyat – 780 km along the Chernobyl exclusion zone runs over a length of 50 km. This is the distance from the village Dovlyady to Kyiv Reservoir. The catchment area of the river in this section is 2000 km^2.

Cooling reservoir Chernobyl nuclear power plant is located on the right bank of the Pripyat River, 1.5 km below the railway bridge Chernihiv - Ovruch. This reservoir was running out of momentum starting of power unit No. 1 in 1976. At the start the reservoir was the cup-shaped structure filled with water and was half the size of current. With the commissioning of the power units No. 3 and No. 4 in 1983, the reservoir was expanded from 12.7 to 22.9 km^2.

The purpose of this reservoir is the release of heat into the final absorber in the process of electricity production. Since the last shutdown of power plant equipment, cooling reservoir no longer fully its target function, and the existing area (22.9 km^2) is now many times greater than current demand. In connection with the liquidation of technological systems of power units, the volume of industrial water consumption decreased significantly. Currently, consumption is in the size of 265-1994 m^3/hour in normal mode, and up to 5000 m^3/hour in test mode, and emergency mode taking into account the needs of all customers (simultaneous operation of all customers is almost impossible). Maintain the water level at nominal projected level in a large basin was dictated only by the high-altitude location of water intake pumps so far.

At present, during decommissioning ChNPP, cooling reservoir constitute:

- Water supply source for industry and fire protection systems,
- The subject of environmental protection; safe state is achieved by maintaining the water level at the projected nominal level (111.00 m. above sea level) in order to avoid the spread of radionuclides contained in the sediments produced during the breakdown of a power unit 4.

With the approval of management of the nuclear power plant in Chernobyl and in coordination with the services of sanitary-epidemiological exclusive zone of Chernobyl, there can be research and monitoring carried out on the cooling reservoir in order to assess the ecological status and radiation and safety. To prevent the uncontrolled separation of radioactive particles outside the ChNPP

industrial area, industrial wastewater and rain are directed to the inlet and outlet of the reservoir.

A national program of decommissioning the Chernobyl power plant provides the disabling of cooling reservoir from service. According to the results of studies that have been conducted by various research teams after the accident and which were described in the report "Study of the ecological possibilities of the cooling reservoir decommissioning and preparing output data to carry out technical and economic calculations" it is necessary and possible under certain conditions.

Issues related to the decommissioning of the cooling reservoir and providing technical water required during decommissioning were reviewed with the participation of the project (Kyiv scientific-research, design-engineering institute "Energoproyekt", Institute for Security ChNPP). As a result of the analysis decided to start work after the completion of the preparatory work. This work includes actions aimed at ensuring the technological needs for technical water, reconstruction of water supply network within the existing inlet and outlet power station pumps.

State inspection of nuclear regulation of Ukraine and the Ministry of Health banned Chernobyl power plant to lower the water level in the cooling reservoir below 110.5 m under sea level. This condition may be changed if there will be an appropriate level of water for suction pump, providing the necessary pressure in the pipelines of technical water supply system. Therefore project of creation of the process water reservoir was developed within the existing inlet and outlet cooling reservoir. The creation of the process water reservoir will provide technical water in the ChNPP technology systems, and the fire water system and then the cooling reservoir can be eliminated.

Liquidation of the cooling reservoir will result in:

- Reduction of area occupied by the reservoir to its natural state, determined by the water level in the river Pripyat and the level of radioactive contamination,
- Reduction of groundwater levels in the area of Chernobyl and thus - reducing their negative impact on the foundations of new buildings,
- Changing the direction of groundwater flow in the area of ChNPP, which in turn will increase the time needed to transport radionuclides in Pripyat river.

Reconstruction of the international waterway E40 on the 50 km section adjacent to the area of impact of Chernobyl, can be carried out only when environmental safety will be ensured. No earthworks on this section can be carried out without eliminated elements transported to the cooling reservoir and the Pripyat river after the failure of a power unit no. 4. Works such as dredging or changing the track of the river may cause that bottom sediments will be infringed, with the result that radioactive elements will fall into water again. Therefore the most important at this stage is to eliminate the cooling reservoir and ensuring ecological safety, which can take many years. After realizing these activities on the discussed section of E40 waterway, the fairway will be able to be further revitalized.

1.1.2. Belarusian section of IWW E40

The length of the Belarusian part of an international waterway E40, running along the Mukhavets river, Dnieper – Bug channel (DBC), Pina and Pripyat rivers (Brest and Gomel regions) is 651 km (Belarusian section of IWW E40 is presented in figure 21). Waterway E40 in Belarus meets the parameters of a class IV waterway, with the restrictions on deadweight of vessels. From the Polish - Belarusian border to Belarusian – Ukrainian border there are four inland river ports of Brest, Pinsk, Mikashevichi and Pkhov (Mozyr). From Brest along the Mukhavets river and Dnieper – Bug channel there are located nine locks, and between Pinsk and Mikashevichi there are two locks. Clearances under bridges all the way are over 7 m and meet the requirements of class Vb waterway. Depending

on the weather conditions navigation season on a given section of IWW E40 is between 245 to 270 days a year.

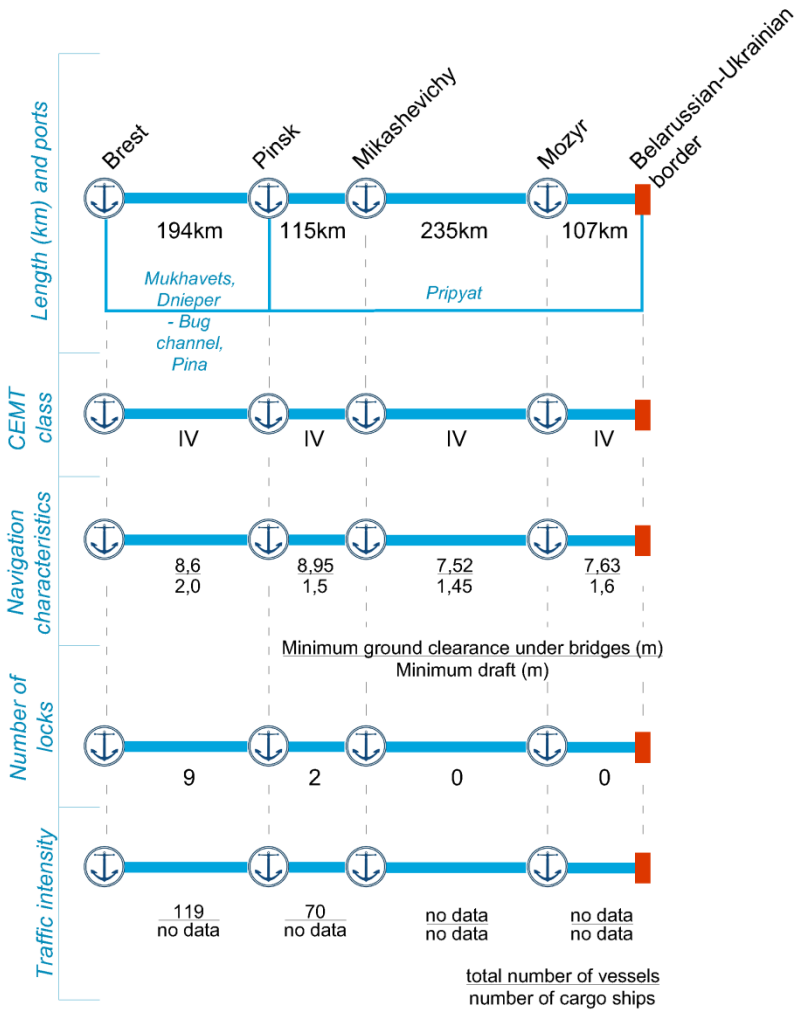


Fig. 21. Scheme of the Belarusian part of international waterway E40.
Source: Own elaboration of Maritime Institute in Gdansk - Department of Economics and Law.

The navigable section of E40 waterway in the Republic of Belarus starts in Brest, where the closed with a dam section of the Mukhavets river flows into the Bug river. At a distance of 61.99 km a river port (Brest) is situated and three navigable lock, located on the water nodes: no. 10 Trishin (Brest), no. 9 NovosadyNovosady and no. 8 Zaluzye (both in the Zhabinets area). As a result of recent reconstruction of these locks they meet the requirements of European standard class Va.

In the years 1775-1783 between Pina and Mukhavets rivers a channel was dug, which was named the Royal Canal. In the nineteenth century another straightening channel was dug with improved parameters of shipping - Dnieper-Bug Channel (DBC), and the Royal Canal began to serve only as a mean to evacuate flood waters and supply water to the navigation channel. DBC joins with Mukhavets river in Kobrin, and further runs along the sparsely populated agricultural areas. The length of the section from the Mukhavets junction with DBC to water junction no. 2 Pererub (Ivanovo area) is 92.42 km.

A section of Pina river from the water junction no. 2 Pererub to Pripyat river mouth is channelled.

Waterway passes to the south through Pinsk city, and the length of this section is 40.8 km. Pina River after 74 km flows into the Pripyat River, which connects to the Dnieper River in Ukraine. The total length of Pripyat is 755 km. Source of Pripyat is located in the north-western part of Ukraine, the river flows northeast over the border with Belarus, from Mozyr further southeast flows back to Ukraine before the city of Pripyat, and after a few kilometres flows into the Dnieper.

According to the "List of the most important barriers and missing links in the network of waterways category E" (Resolution No. 49 dated October 24th 2002 of Working Group on Inland Water Transport of UN European Economic Commission) section of E40 route Brest - Dnieper-Bug channel - Pinsk - Pripyat to the border with Ukraine belongs to the "strategic barriers", i.e. sections, which parameters comply with the basic requirements of class IV but should be modernized to improve the structure of the network.

- Border section of E40 waterway on the Polish-Belarusian border

The study of the Belarusian part of an international waterway E40 paid a particular attention to the connection of the Mukhavets - Bug. On the Polish-Belarusian border between Mukhavets and the Bug is a fortress of Brest with high historic and cultural value to the most outstanding fortification objects of XIX/XX century. The route of the section connecting Polish part of the waterway with the Mukhavets river must be done so as not to violate the fortifications.

Because of the objections to modernisation of Bug river on Polish territory, within the framework of this project, it was decided to opt out of this for environmental reasons, the section should be treated as a link of the new channel (Vistula - Terespol) with Mukhavets. Currently, this section is navigable only in Belarus - a port of Brest.

Construction of the waterway with the required parameters along the whole length of route is possible by implementing one of the three technologies:

- Construction of a new bypass channel around Brest,
- Construction of a new channel through Brest,
- Carrying out repair work on the existing channel.

The specific location of the link to the given section with the new channel (Vistula - Terespol) on Polish territory would be determined at the stage of project documentation, after the final of the route of the new channel is determined.

Despite the final variant, the analysed section should have dimensions corresponding to the minimum values for the new channel Vistula - Terespol: depth - 4 m; width - 50 m, the radius of curvature – 650 m. This is due to the possibility of creating a multimodal logistics center in Brest: river vessels with a draft of 2.8 m along the restored waterway would reach Brest from Warsaw, where handling operations would take place, cargo would be shifted on to the trucks, wagons or smaller vessels - up to 2 m draft in order to further be taken by water in the direction of Kyiv and Kherson.

Construction of a new bypass channel around Brest would be pointless, since:

- This would require a wide range of investments, such as:
  - construction of an additional shipping channel with min. length of 20-30 km,
  - reclassification of large land areas, including agricultural land,
  - construction of at least 3-5 bridges,
  - construction of various types of hydrotechnical infrastructure.

- existing infrastructure, that may allow for future organisation of multimodal transport would not be used effectively:
  - Brest is a big transportation hub, connecting road and railway transport (normal and wide-gauge tracks), through which a large cargo volumes are handled,
  - Brest water infrastructure is well-developed (navigable route on Mukhavets river, port of Brest, lock on water juncture no. 10 Trishin reconstructed in 2012 with the most lockages on the Dnieper-Bug channel).

On the other hand, construction of a new water channel through Brest admittedly requires lower expenditures, but in this case it is necessary to make significant changes in the general plan of city infrastructure development. The most realistic variants seem to be two such a connection extending outside the complex of Brest Fortress.

The first variant envisages that the channel will be connect to the Bug River in the vicinity at 284 km, about 350 meters north of the republican road no. 2 (RR2). Further the channel will run between Brest Fortress and RR2 and turn to the Mukhavets river near the Brest river port.

If the first variant of the route channel Vistula - Terespol is chosen, in order to completely bypass the Brest Fortress there will be a need to perform an additional bypass on the Polish side.

The first variant is presented in figure 22.

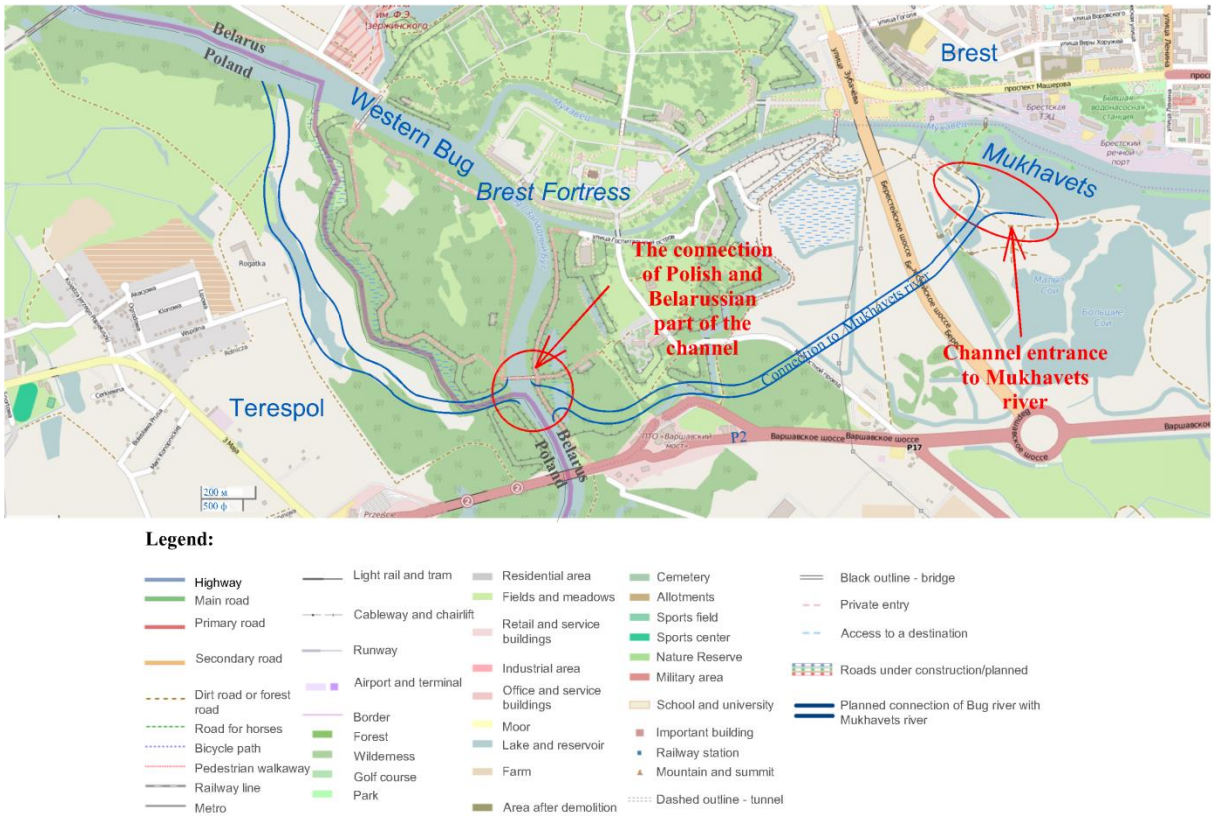


Fig. 22. First variant of Vistula – Mukhavets channel connection.
Source: Maritime Institute in Gdansk - Department of Economics and Law, own elaboration based on OpenStreetMap and materials of the National Academy of Sciences of Belarus.

The route of the second variant begins at the entrance to the Bug river, about 200 meters south to the RR2. It runs between buildings and RR2, which it also intersects, and creates the need for construction

of a hydrotechnical buildings, e.g. bridge for RR2 or water bridge for channel. It ultimately joins the Mukhavets river approximately 1 km east to the first connection variant.

The second variant is presented in figure 23.

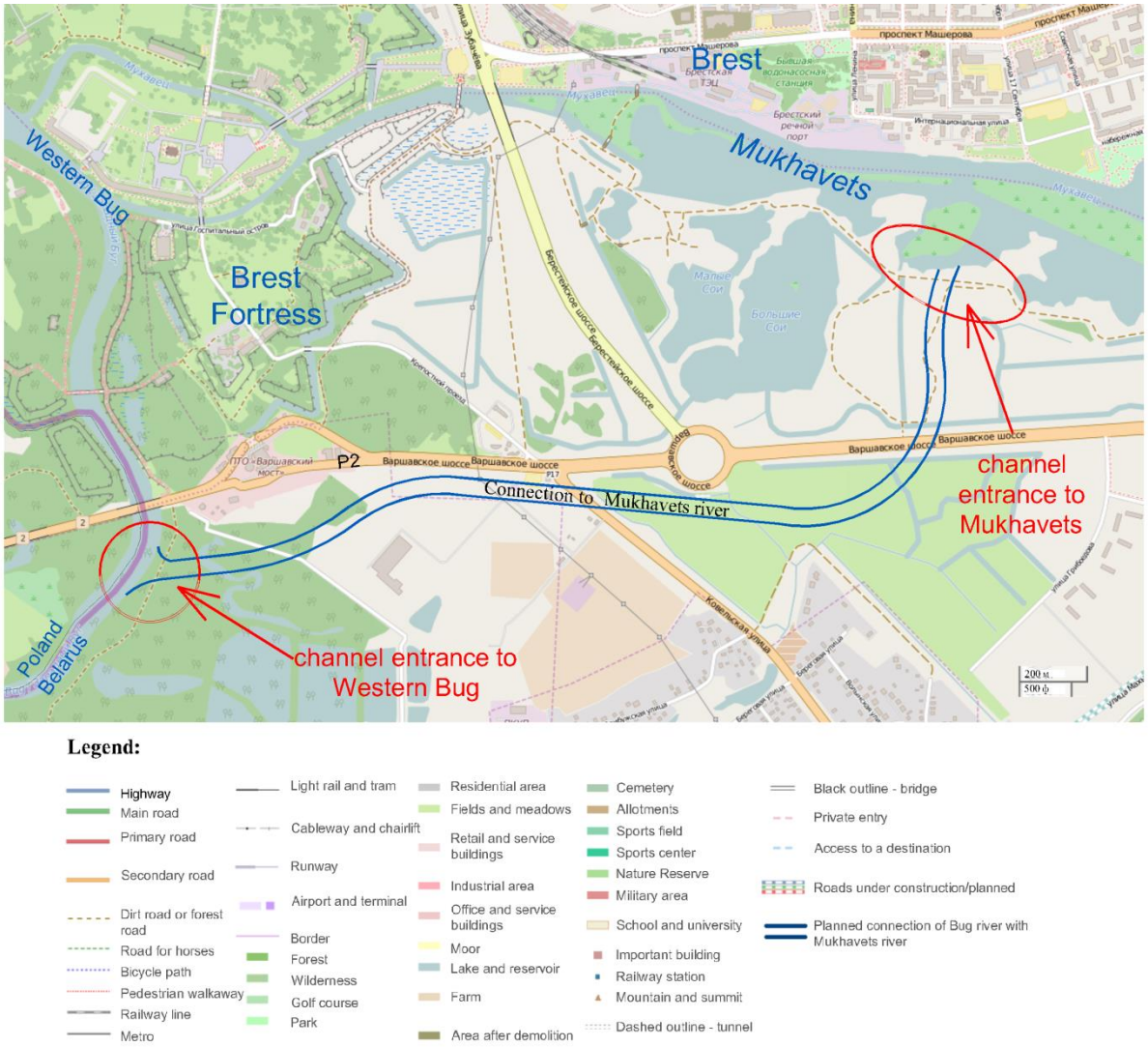


Fig. 23. Second variant of Vistula – Mukhavets channel connection.
Source: Own elaboration of Maritime Institute in Gdansk - Department of Economics and Law.

During the second meetings of E40 Commission in Brest on November 17, 2015 a new variant of the connection of the Bug River with the Mukhavets river was presented (Fig. 24)[35].

The concept assumes to carry out the required hydrotechnical works to revive shipping on E40 waterway passing through Brest area on historically formed waterway: from the Mukhavets river – with existing riverbed - to Bug river. According to the Commission proposed variant is optimal in terms of planning, and in terms of necessary investments expenditures.

The decision on the route variant of the connection between Vistula-Bug channel with Mukhavets river requires further analysis. The final decision should be taken at the preparation stage of investment implementation.

[35] The concept was recommended for further investigation, according to the minutes of the meeting of representatives of organizations concerned and with the participation of Deputy Chairman of the Brest Regional Executive Committee V. Ye. Sakovskiy held in Brest on November 6, 2015.

Fig. 24. Scheme of Bug river and Mukhavets river connection through historical area of Brest – Brest Fortress
Source: Materials from second proceedings of the E40 Commission Meeting in Brest, November 17, 2015

- Dnieper – Bug channel

Dnieper-Bug channelDBC, crosses the watershed between the two rivers, is divided into three distinct parts:

- western section with a length of 64 km from Brest to Kobrin,
- watershed section with a length of 58 km from Kobrin to Lyakhovichi in the Drogichin area,
- eastern section with a length of 47 km from Lyakhovichi to Duboy village.

The main part of the channel has a length of 156 km and a catchment area of 8,500 km^2. A channel width of 40 m, at a depth of 2.4 m in normal operation, changes it cross-section into half trench - half embankment.

Currently there is no direct connection by inland waterway between Dnieper-Bug channel with Western Europe. The reason for this is the location of a fixed lock on the Mukhavets river in Brest. For the successful implementation of the revitalization project along E40 waterway it is necessary to solve the problems of reconstruction of DBC and necessary hydrotechnical structures as well as provide adequate water supply.

The need to improve water relations in DBC is due to problems of technical and ecological nature. Periodic shortages of water on the watershed are strictly connected with water collection in dry years from the upper Pripyat river in Ukraine by the Power System of Beloye Lake (PSBL).

- Reconstruction of Dnieper – Bug channel on the section from Duboy water junction up to Lyakhovichi junction

Reconstruction of hydrotechnical structures of DBC requires upgrading water junctions located to the

east of the channel. Particular attention should be paid to the section from junction no. 1 Duboy till junction no. 5 Lyakhovichi.

Developed outline of Dnieper - Bug channel reconstruction on a given section is focused on the reasons for the reconstruction of the eastern stretch of DBC and defining actions to improve water relations for shipping on DBC, which is a basis for complex system of water management that affects the economic activity and the natural balance of the upper part of Pripyat river basin in Brest region[36].

Shipping locks and culvert at the water junctions on eastern section no. 2 "Pererub", no. 3 "Ragodosch", no. 4 "Ovzichi" and no. 5 "Lyakhovichi" do not meet the technical parameters for shipping or water flow conditions due to their total poor state, thus their reconstruction is required. Technical parameters are presented in table 47.

It is necessary to reconstruct infrastructures (locks, culverts) on all four water junctions of DBC section and maintain required technical parameters. It is assumed, the reconstructed of hydrotechnical facilities will comply with the requirements of international waterway - class Va. Water junctions no. 10 ”Zaluzye" was adopted as example of such reconstruction.

Reconstruction of the eastern section of DBC is necessary also because hydrotechnical and navigational facilities were built in the years 1938-1941 from the unsound wooden structures, not suitable for modern automatic control. Continued use of these structures will require continued substantial investments in maintaining their operating capacity.

At the water junctions two types of overflow devices were adopted: weirs and floodgates (Poirée system); retention "peak" (20 m^3/s) during spring floods in Zhyrov reservoir was taken into account.

In order to improve the technical parameters the following sequence of actions is advised:

- reconstruction of water junction Ragodosch,
- reconstruction of water junction Pererub,
- reconstruction of water junction Ovzichi,
- reconstruction of water junction Lyakhovichi,
- Zhyrov reservoir.

The proposed technical solutions must take into account environmental protection requirements.

36 Authors used for materials on water relations on DBC and PSBL: operation studies, design studies and analyses of the Republican Unitary Enterprise Operation and Construction "Dneprobugvodput" (RUEOC "Dneprobugvodput") and the Republican Unitary Enterprise Central Scientific Research Institute of Complex Use of Water Resources (RUECSRINCUWR) made during operation, as well as the materials of Ukrainian specialists on upper Pripyat river.

Tab. 48. Technical parameters of shipping locks on the waterway Dnieper-Bug

Name of water node	**Year of construction**	**Node elements**	**The dimensions of the building**				**Working capacity, m^3**	**Type of closure**	**Material of heads and wharf abutments**
			Length of the lock chamber between the abutments (serviceable), m	Width of the lock chamber, m	High of fall, m	Depth at the threshold, (top/ bottom), m			
№1 Duboy	2006	Lock	120	12.7	2.4	2.75 2.6	3680	flap gatese, double doorse	Reinforced concrete
№2 Pererub	1938	Lock	80.00	11.26	2.10	3.9 1.76	3920	double doors	Reinforced concrete Wood
№3 Ragodosch	1941	Lock	79.95	11.10	1.8	3.85 1.95	3560	double doors	Wood Wood
№4 Ovzichi	1941	Lock	78.85	11.06	1.8	3.8 2.0	3560	double doors	Wood Wood
№5 Lyakhovichi	1941	Lock	79.80	11.10	1.90	4.1 2.17	3825	double doors	Wood Wood
Kobrin	2009	Lock	120	12.7	5.35	2.7 2.55	8640	flap gatese, double doors	Reinforced concrete
№8 Zaluzye	2015	Lock	120	12.7	2.35	2.7 2.5	3638	double doors	Reinforced concrete
№9 Novosady	2003	Lock	120	12.7	2.4	2.75 2.5	3658	double doors	Reinforced concrete
№10 Trishin	2011	Lock	120	12.7	1.4	2.50 2.70	2462	double doors	Reinforced concrete
№11 Kachanovichi	1954	Lock	110	11.93	2.2	4.4 2.2	5970	double doors	Coarse concrete Wood

*Source:*Ministry of Transport and Comunication Republic of Belarus - *RUPEB "Dneprobugvodput"*, Pinsk2015

The above concept is being implemented since 2015. In particular, there are carried out design and preparation works for construction of the shipping lock no.3 Ragodosch. The total cost of the work on the reconstruction and locks construction on the eastern section will amount to 19.5 mln EUR.

- Pripyat river

The Pripyat river running through the territory of Belarus on the length of 456.7 km is mostly a free-flowing river. On the canalised section of Pripyat from Pinsk to Stakhovo (50 km) there are two locks on the water juncture no. 11 Kachanovichi and no. 12 Stakhovo. Hydrotechnical facilities allow for water level increase at the given section providing navigation for vessels of a draft up to 1.8 m. Condition of water junctions is satisfactory, but modernization of a dam and weir on the Stakhovo junction is necessary. Approximate cost of the investment will amount to 1.7 mln EUR.

In order to maintain the navigability of the rest of the Belarusian section of Pripyat river, programme of annual works is in operation: dredging, strengthening of river banks, cleaning of riverbed, trawling, as well as the maintenance of shipping facilities on the waterway. Keeping the above works allows to keeping the depth of 1.45-1.6 m (maximum draft - 125-1.4 m). Such significant restrictions have a great impact on transport profitability, both of internal and international transport on IWW E40.

In order to create the conditions to ensure the water level appropriate for the organization profitable transport, it is necessary to conduct comprehensive regulatory works in the basin of the Pripyat river, including:

- Works aiming at creating and maintaining adequate parameters of the waterways – additional dredging works, strengthening banks, cleaning of riverbed, trawling, as well as alignment and straightening of some Pripyat river sections.
- construction of additional dams - construction of new water junctions with shipping locks, corresponding to the parameters of class IV according to the international classification.

Works on the waterway relate mainly to dredging and an additional volume of dredging depends on the number and location of dam. Three variants for the construction of new hydrotechnical facilities at the Pripyat river are presented below. Depending on the selected variant the volume of dredging works on the section will be from 6.3 to 9.0 million m^3. The cost of these works will amount to 2-3 mln EUR (Tab. 49).

Tab. 49. Amount of work comparison on the Dnieper-Bug channel (DBC) in order to ensure a guaranteed depth 2.6 and 3.0 m

Section of the waterway	Length, km	Total volume of dredging works, thous. m^3		Realization period in years	Annual volume of dredging works, thous. m^3	
		3.0 m	2.6 m		3.0 m	2.6 m
Port Brest – node Trishin	4.5	54.0	32.4	15	3.60	2.16
n. Trishin – n. Novosady	19.5	468.0	280.8	15	31.20	18.72
n. Novosady – n. Kobrin	38.6	926.4	555.8	15	61.76	37.06
n. Kobrin – n. Duboy	104.7	2 512.8	1 507.7	15	167.52	100.51
n. Duboy – port Pinsk	18.6	446.4	267.8	15	29.76	17.86
port Pinsk – n. Kachanovichi	32.2	772.8	463.7	15	51.52	30.91

Section of the waterway	Length, km	Total volume of dredging works, thous. m^3		Realization period in years	Annual volume of dredging works, thous. m^3	
		3.0 m	2.6 m		3.0 m	2.6 m
n. Kachanovichi – n. Stakhovo	25.1	602.4	361.4	15	40.16	24.10
Total along DBC:	**243.2**	**5 782.8**	**3 469.6**	**15**	**385.52**	**231.32**
n. Stakhovo – Horyn estuary	53.8	2 421.0	2 098.2	15	161.40	139.88
Horyn estuaryi – Canal Mikashevichi Canal estuary	11.1	499.5	432.9	15	33.30	28.86
Mikashevichi Canal estuary – port Mikashevichi	7	315.0	273.0	15	21.00	18.20
Total along Pripyat	**71.9**	**3 235.5**	**2 804.1**	**15**	**215.70**	**186.94**
Total:	**315.1**	**9 018.3**	**6273.7**	**15**	**601.22**	**418.26**

Source: Ministry of Transport and Comunication Republic of Belarus - RUPEB "Dneprobugvodput", Pinsk 2015

In order to improve the stability of the increased dimensions of the waterway and to reduce the volume of dredging works on its maintenance, it is important to timely execute of compensatory works, i.e. work on the construction of compensatory buildings and facilities.

Compensatory buildings depending on their destination should provide:

- transport of sediment on to the aligned sections, outside the waterway,
- dredging of riverbed within the limits of the waterway by improving the speed and direction of the current,
- protection of the waterway banks, material from dredging and special earth structures against erosion,
- preventing changes of riverbed, which affects the conditions of the fairway.

In recent years, the problem of assessing the impact of works on the fairway on the morphology of riverbeds and hydraulics of water flow is particularly significant. In the worldwide practice, buildings as an active protection method affecting the structure of the flows, slowing the flow in the coastal zone that promote the deposition of sediments are widely used.

Only at the section of Pkhov - Usov of Pripyat river at the length of 126 km there are currently 13 shallows that make shipping difficult. In order to ensure guaranteed parameters on those sections, the company responsible for the operation of the waterway (RUPEB "Dneprobugvodput") conducts dredging annually. The volume of works is approx. 360 thous. m^3. The cost of dredging on those sections in the current prices is about 98 thous. EUR per year.

To maintain adequate water levels and to form proper flow structure, RUPEB "Dneprobugvodput" uses spurs of different length. One of the desired effects of these structures is to narrow watercourses and concentrate flow in the narrower cross-section. The result of this action is an increase of the flow velocity, and thus increase the lifting of debris, which causes a decrease in the level of the bottom of the river. In addition, these structures are designed to protect the shore from the destructive action of water.

Fig. 25. Example of a side-spur on the Pripyat river
Source: National Academy of Sciences of Belarus

In the years 2013-2015 the company implemented compensatory works on five existing shallows on the discussed section of Pripyat river by building spurs with long-effect (fig. 23). Operation of protective structures is calculated for long term and with proper maintenance they are able to perform their functions for 15 years.

With the construction of spurs it is not necessary to carry out dredging work on those sections, which will allow saving expenditures of up to 1.4 mln EUR. The cost of construction of compensatory structures at the Pkhov - Usov section of Pripyat river, including design-research works, will amount to 2.5 mln EUR.

There is a need to carry out works on straightening the fairway on some strongly meandering stretches of the river. In particular, work on of the following shallows are required:

- 67-68 km - "Trebukhovo-5", "Trebukhovo-6" shallows
- 75-78 km (outlet of Tsna river) - " Vertyachi-2", "Kozan-Gorodok-1", "Kozan-Gorodok-2" shallows,
- 93-95 km - "Yevreyskaya Yama -2" shallows,
- 100-102 km - "Polyanka-1", "Polyanka-2" shallows.

Straightening of the above-mentioned sections of the Pripyat river will allow for:

- reduction of the total length of the waterway - reduction in transport costs and delivery time,
- reduction of operating costs associated with a significant reduction in the volume dredging works on the straighten section of the river.

The hydraulic calculations indicate that theoretically the greatest possible water depth at the 95% confidence level on the section Stakhovo - outlet of Vyetlitsa river amount to 1.35 m, at Mozyr - Usov section - 2.8 m.

In 1981-1990 it was planned to build a transport water junction near Nogortsy, Ukraine. Since it was not allowed to build the water junction in the excluded Chernobyl zone, currently existing stepped character of the riverbed in Ukraine should be eliminated by the compensatory and dredging works. Moreover, the company responsible for the operation of the relevant section of the waterway (DP "Ukrvodshliah"), since the disaster at the Chernobyl NPP, does not perform on this stretch any operations to improve the navigation conditions and to eliminate "bottlenecks". It should be pointed out, that if no compensatory works are implemented, deep-water transport artery is impossible to be created.

Analysis of longitudinal profile of Pripyat river indicates that even full implementation of hydrotechnical works required to improve the fairway will not allow full use of vessel capacity during low water levels. To ensure the depth of the fairway through entire navigation season of for fully loaded vessels, a comprehensive regulatory works in the basin of the Pripyat river should be implemented, including construction of dams with lockages of individual sections.

The need for construction of new hydrotechnical facilities on the Pripyat river has been repeatedly considered. Detailed evidence supporting regulation of Pripyat river basin, taking into account the needs of the national economy for water and improvement of shipping conditions, were developed in 1981 by the institute called Republican Unitary Enterprise Design and Research "Belgiprovodkhoz".

The study of "Belgiprovodkhoz" consideres two possibilities to improve navigation conditions on the Pripyat river:

- Construction of 7 water junctions with 3 to 6 m of water height of fall (lock chambers size 180x15x3 m), that provide a shipping depth of 3 m for vessels with 1,250 tons capacity. Approximate cost of the investment will amount to 67 mln EUR.

- Construction of 6 water junctions with 3 to 6 m of water height of fall (lock chambers size 120x12x2 m), ensuring the maintenance of the current dimensions of the fairway with a depth of 1.5 m. In this version of the seventh water junctions is not foreseen, study takes into account the existing "Kachanovichi" and " Stakhovo" water junctions.

The third variant is based on the design of "Belgiprovodkhoz" Institute, however it contains a number of adjustments, taking into account the currently existing conditions. In particular, this variant takes a more balanced approach, considering both the need to create conditions on the Pripyat river to maintain the parameters for shipping, allowing for economically efficient transport of goods throughout the navigation season, and the need to minimize the possible negative impact on the environment, primarily within the protected areas of Pripyat Polesyee. With regard to the issue of biodiversity of flora and fauna, section Pripyat within Pripyat National Park was considered, in the Gomel region, in the area between Stviha and Ubort rivers, as well as the area of nature park of national importance "Middle Pripyat" between Pinsk and Turov (Pripyat river flooding areas). In addition, adjustments also include hydrological conditions of navigation, analysis of Pripyat riverbed, the negative impact of dredging caused by Chernobyl NPP disaster.

The creation of dams and carrying out hydrotechnical works on the river will allow at the Belarusian section of Pripyat to create conditions to ensure the permanent parameters of the fairway during the entire shipping season for fully loaded vessels. Implementation of the project will affect the distribution of water flows and regulate the use of transboundary waters, which is particularly important in conditions of severe droughts.

The project gives priority to the third variant, which is focused not only on the development of transport waterways, but also on the need to minimize the impact on the protected areas. The cost of building water junctures in this case will amount to 19 mln EUR.

To conclude, it is necessary to progressively create the conditions for the operation of vessels with higher drafts along the entire IWW E40. Based on the analysis of cargo streams, the following minimum parameters are proposed:

- in short -term (within 5 years) – up to 2.0 m depth,
- in the medium-term (15 years) - 2.4 m depth (on the western stretch of the DBC - 2.3 m depth).

The total volume of dredging works on DBC and the Pripyat river (the route length - 315.1 km), required to ensure a guaranteed depth of 2.6 m, will be approximately 6.3 million m^3. The cost of such works in current prices is 2 mln EUR. It is worth mentioning, that in the case of sufficient funding the time of these works can be significantly reduced.

According to preliminary calculations, the increase in the minimum depth of the fairway to the parameters corresponding to the requirements of AGN agreement to Class IV (conditions for passage of vessels with a draft of 2.8 m) is possible due to adequate water supply and will contribute to improving the attractiveness of transport on IWW E40. Analyses indicate that currently there is no need to achieve this parameter in short time, and it requires a separate study. This is due to several factors:

- lack of a vessel fleet of draft exceeding 2.1 m (maximum draft of barges popular in Belarus - a draft barge-platform No. 775)
- limitations of already reconstructed water junctions on the western stretch of the DBC,
- a wider range of investments needed to ensure increased volume of work on the fairway, reconstruction and construction of hydrotechnical structures and also a significant amount of compensation measures to protect the environment.

When planning improvement of the channel parameters, the need to ensure additional water supply for the waterway was taken into account. This role can be performed by the planned Zhyrov reservoir. It can be assumed that the costs of dredging will be at levels similar to those adopted for the Polish part of the channel.

While planning works on gradual increase of the permitted vessels drafts in the Belarusian part of the IWW E40, adequate technical conditions for a possible further increase in the guaranteed depth of 3.0-3.5 m should be foreseen. The cost of the whole action aimed at improving the attractiveness of the Belarusian part of the IWW E40 will amount to:

- 19.5 mln EUR- reconstruction of the existing hydrotechnical structures on the eastern section of the DBC,
- 5 mln EUR - hydrotechnical works in the fairway aiming at higher vessel drafts up to 2.4 m,
- 19-67 mln EUR - construction of new water junctions on the Pripyat river with locks that will meet the requirements of class IV of international classification,
- 5-15 mln EUR - construction of the navigable section of IWW E40 on the Belarusian-Polish border,
- 11.7 mln EUR - modernization of water supply system of DBC, including construction of Zhyrov Reservoir.

The total cost of all these activities, excluding the costs of environmental compensation will amount to approx. 60-120 mln EUR.

1.1.3. Polish part of IWW E40 at Vistula–Terespol section

In Poland the section of IWW E40 connecting the Vistula river with the mouth of Mukhavets river (Belarus) on most maps run through lower Narew and Bug rivers to the area of Terespol and Brest (Fig. 26). This part of the route in its present state does not meet any requirements of waterway and does not provide conditions for shipping. Bug valley within Polish borders is almost at entire length protected and is part of the European network Natura 2000, thus, any investment into transport function of the waterway is a serious problem. Choosing different route is more promising variant. However, this involves construction of a new waterway channel linking the Vistula and Bug rivers, which can be routed through the area of the Mazovia and Podlaskie regions, and Polesie.

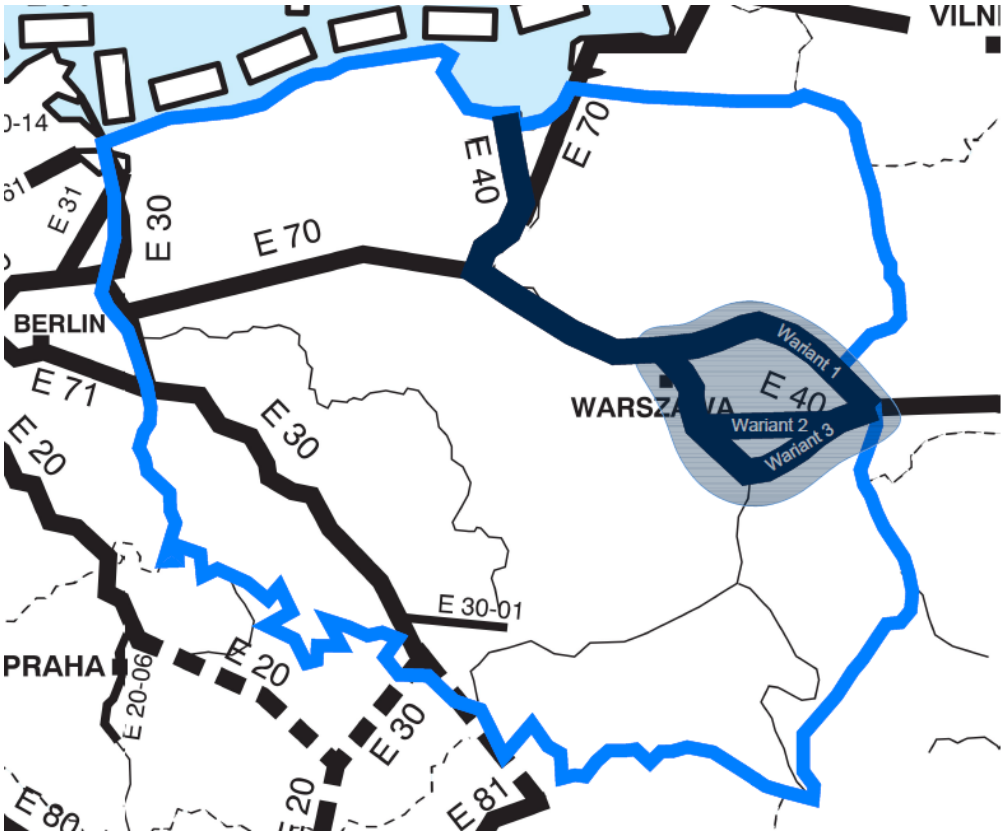


Fig. 26. Polish part of the international waterway E40
Source: Maritime Institute in Gdansk - Department of Economics and Law, own elaboration basen on: *Map of the AGN network*, White paper on Efficient and Sustainable Inland Water Transport, Inland Transport Committee. UNECE New York and Geneva 2011.

Along the international waterway E40 at the section Gdansk - Warsaw there are located 11 inland ports: Gdansk, Przegalina, Tczew, Korzeniewo, Grudziadz, Chelmno, Bydgoszcz, Torun, Wloclawek, Plock and Zeran near Warsaw. The figure 27 presents a diagram of the distribution of inland ports on this route.

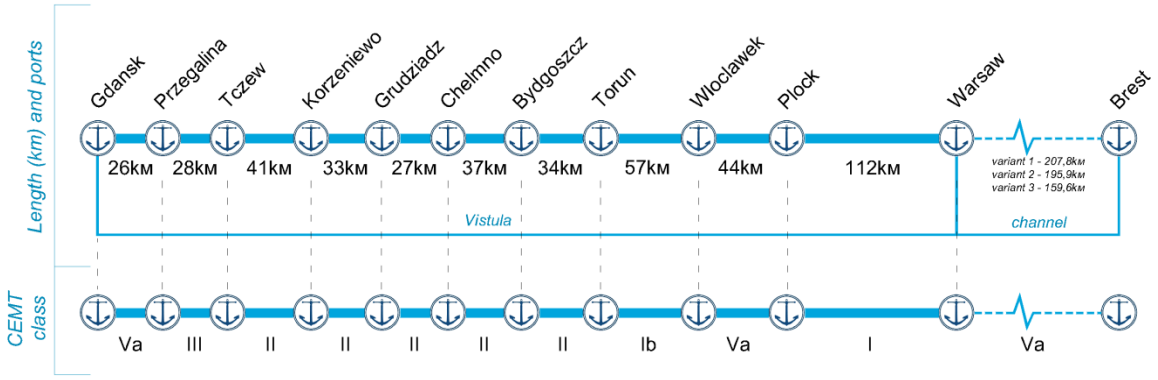


Fig. 27. Scheme of an international waterway E40 on the section Gdańsk – Brest
Source: Own elaboration of Maritime Institute in Gdansk - Department of Economics and Law.

Due to the natural obstacles and hydrotechnical conditions cargo and passenger shipping on the entire stretch of the Vistula waterway is impossible. One of the main reasons is the limited depth of the transit, which is a result of formation of landslides into the riverbed and silting of outer harbours. Years of neglect and lack of new investment and modernization do not allow rapid improvement in technical conditions which would provide transport services on the Vistula River.

In order to enable navigation along IWW E40 route it is necessary to build a channel between the Vistula river and Terespol. In addition, it is necessary to construct a series of dams in Lower and Middle Vistula (this problem is the subject of numerous studies that goes beyond the scope of this project).

- Lower Vistula river[37]

Lower Vistula includes a stretch of the river with a length of 391 km from the mouth of the Narew river (at km 550) to the mouth of the Vistula River at the Baltic Sea (at km 941). Catchment area of the river is 34.3 thous. km^2. Narew river including its tributaries: the Bug and Wkra rivers is the largest tributary of the Vistula and fundamentally affects the formation of the water flow in the riverbed.

On the section from the mouth of the San river (at km 280) to the Wloclawek reservoir (Plock at km 632) Vistula is essentially unregulated, there are numerous sandbanks, shallows, banks are often high and precipitous. In the section from Wloclawek reservoir to the Wloclawek dam (km 675) fairway has parameters of class Va. Section from the Wloclawek dam to the mouth of Tazyca river in Silno (km 718) Vistula only fulfils the conditions of class Ib, and from Silno to Tczew (km 909)- class II, in Biala Gora (km 887) at connection with the Nogat river - class II, and from Tczew to the mouth of the Gulf of Gdansk (km 941) class III.

Lower Vistula waterway has always been one of the basic elements of all the concept of the Lower Vistula Cascade (LVC), and after the construction of water reservoirs it was supposed to have a minimum class IV according to international classification. Currently, it is assumed that it should meet the conditions of class Va.

Flows and states characteristic for Lower Vistula determined in gauge cross-sections, as well as in cross-sections corresponding to the location of the planned dam cascade (Tab. 49).

Tab. 50. The volumes of flows and characteristics level in cross-sections of water gauge and location of planned barrages in Lower Vistula

[37] Elaborated based on: *Hydrodynamiczny model dolnej Wisły z uwzględnieniem kaskady stopni piętrzących.* Gdansk Technical University, Land and environment engineering faculty, Gdansk 2014.

Km Vistula	Cross-section	SSQ [m^3/s]	SNQ [m^3/s]	SSW [cm]	SNW [cm]
504.1	Warsaw	549	233	345	238
551.5	Modlin	872	339	405	376
586.9	Wyszogród	886	340	358	326
606.5	Kępa Polska	948	340	272	170
632.4	Płock	942	333	589	545
679.4	Włocławek	911	293	153	66
707.9	Siarzewo	914	313	-	-
734.7	Toruń	983	356	318	179
762	Solec Kujawski	986	358	-	-
806.8	Chełmno	1013	382	314	178
835	Grudziądz	1027	394	321	180
876.3	Gniew	1037	404	-	-
908.6	Tczew	1046	411	384	223
938.7	Świbno	1080	411	519	458

Source: Hydrodynamiczny model dolnej Wisły z uwzględnieniem kaskady stopni piętrzących. Technical Univercity of Gdańsk, Faculty of Civil and Environmental Engineering, Gdańsk 2014.

- Lower Vistula Cascade (LVC)

The concept of LVC assumes construction of eight new dams along the section of Lower Vistula river (Fig. 28), forming reservoirs limited by natural high river banks of the valley and the current line of anti-flood embankments. In addition, it is assumed that due to the need for a creating a waterway to Warsaw a dam at Warsaw will be located above the mouth of the Narew river.

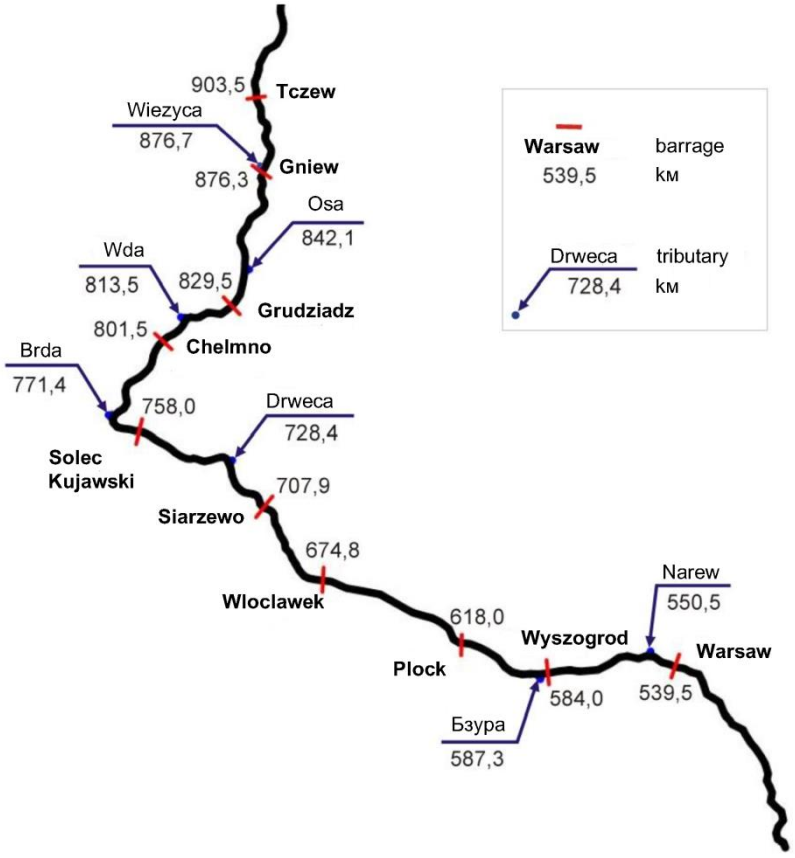


Fig. 28. Scheme of the Lower Vistula river indicating dams of Lower Vistula Cascade
Source: Hydrodynamiczny model dolnej Wisły z uwzględnieniem kaskady stopni piętrzących. Politechnika

Gdańska, Wydział Inżynierii Lądowej i Środowiska, Gdańsk 2014.

This takes into account also alternative solutions to regulate of the Lower Vistula using coated weirs, existing Wloclawek dam and the planned dam in Siarzewo. In the section of the Lower Vistula there were designed, apart from these two dams, 16 weirs of small water declines.

-Middle Vistula

Water region of Middle Vistula river includes Vistula river basin from the mouth of San river to Wloclawek, catchment of Wieprz, Bug and Narew, Skrwa, Kamienna, Radomka and Bzura rivers. The surface area is 111 thous. km^2 (i.e. approx. a third of Polish territory) and is located within the administrative boundaries of the 10 regions. The length of the Vistula River from the mouth of San river to the hydrological profile Korabniki in Wloclawek is 388.8 km, while its catchment area is 121 708 km^2, including within Polish borders 101 053 km^2.

Due to the intensity of the regulatory facilities having significant impact on (possible) shipping conditions, section of the Middle Vistula between Deblin and the mouth of the Narew river can be divided into three sections:

- Section I, from km 391 + 800 Deblin to km 498 + 000 Zawada.

  The this section regulation structures are fragmentary and are situated in the vicinity of the Kozienice power plant km 426 + 000. On this stretch often occur numerous shallows and in winter numerous ice blockages. Waterway does not meet the parameters of Class Ib.

- Section II, from km 498 + 000 Zawada to km 526 + Buraki

  Section regulated in 75% including Warsaw agglomeration with all technical equipment associated with the river. The width of the regulatory route is 223 m. Unfinished regulation at km 504 + 507, 521 + 526 causes difficulties in navigation and does not meet shipping conditions class Ib. At km 520 + 000 Zeran there a shipping lock of 85 meters x 12.4 meters x 2.5 meters.

- Section III, from km 526 + 000 Buraki to km 558 + 000 Zakroczym.

  Section is unregulated, prone to blockages. Riverbed and banks are neglected. Lack of regulations means that the riverbed is unstable and does not provide the depth of transit for class Ib, i.e. 1.6 m depth for 240 days a year. The width of the regulatory route between 223-250 m.

- Concept of Middle Vistula Cascade

The concept of Middle Vistula Cascade was first introduced in 1963 and is still valid. Cascade consists of five water dams (Fig. 29):

- Warsaw North dam- km 539 + 500,
- Warsaw South dam - km 504 + 000,
- Gora Kalwaria dam - km 473 + 700,
- Ostrow dam - km 440 + 000,
- Piotrowice dam - km 411 + 000.

Fig. 29. Scheme of the Middle Vistula indicating dams
Source: Maritime Institute in Gdansk - Department of Economics and Law, wn elaboration basen on the Middle Vistula cascade concept from 1963.

Like in the case of LVC, to regulate Middle Vistula plans also foresee the use coated weirs In this case the cascade consist of 11 degrees with low water fall.

1.2. Barriers and missing links on IWW E40

AGN Agreement defines barriers and missing links, as these sections of the European network of waterways of international importance, the parameters of which are much lower than expected.

Core barriers are referred to the sections of European waterways, the parameters of which does not meet the conditions of waterways of international importance of class IV.

Strategic barriers are sections which meet the conditions of IV class, however should be modernized in order to increase the economic potential od inland navigation.

Missing links are referred to non-existing sections of the European network of inland waterways.

The most important barriers and missing links are shown in figure 30. Missing links referred to non-existing sections of the European network of inland waterways.

E40 in Belarus:

- Mukhavets river at the section from Brest city to Kobrin city - small permissible maximum draft (1.60 m).
- Dnieper - Bug channel section from Kobrin city to the village of Pererub - small permissible maximum draft (1.60 m).
- Pina river on the stretch from the village Pererub to Pinsk city - small permissible maximum draft (1.60 m).

- Pripyat river on the stretch from the Stakhovo village to the port of Pkhov (Mozyr) - small permissible maximum draft (1.30 m).
- Pripyat river on the section from the port of Pkhov to the Belarusian-Ukrainian border - a small maximum permissible draft (1.50 m).

E40 in Poland:

- Vistula river on the section from Biala Gora to Wloclawek and from Plock to Warsaw - required modernization of the waterway from class I and II to class Va.
- Zeranski channel section from Zeran to Zegrzynskie Lake - required modernization of the waterway from class III to class Va.
- Bug river on the section from Zegrzynskie Lake to the city of Brest - requires upgrading to class Va. Currently, the depth of the river in 210 days per year is limited to 0.8 m (taking into account the current routing of E40 international waterway section Vistula - Brest).

E-40 in Ukraine:

- Insufficient depth from the outlet of Pripyat river to the Belarus border.
- modernize of six locks of the Dnieper river is necessary, their condition is unsatisfactory.

2. Reconstruction variants of E40 waterway on Vistula –Terespol section

2.1. Route variants

After completing economic, hydro-engineering, hydrological and social analysis the team of experts defined eight routes which were parameterized in detail. From among them, the Commission of the project together with experts selected three most realistic variants that meet the requirements of the project:

I. Northern route (Variant I): Debe reservoir (Zegrzynskie Lake) - Valley of Lower Bug River - Wolomin plain – Siedlecka elevation - Lukowska plain - Lomaska depression- Kodenska Plain - Polesie Brzeskie - Bug around the Terespol - Estuary of Mukhavets river (length 207.8 km).

II. Middle route (Variant II): the mouth of the Wilga river at Vistula river - Vistula Central valley - Garwolinska plain – Zelechowska elevation - Lukowska plain – Valley of Wieprz river – Bystrica river - Parczewska plain - Wieprz-Krzna channel – Lomaska depression - Kodenska plain - Polesie Brzeskie - Bug around Terespol - Estuary of Mukhavets river (length 195.9 km).

III. Southern route (Variant III): estuary of Wieprz river to Vistula river - Vistula Central valley - Valley of Wieprz river - Parczewska plain - Lomaska depression - Kodenska plain - Bug around the Terespol - Estuary of Mukhavets river (length 159.6 km).

The course of profiles of three variants is presented in figures 31-33, and the map of three variants of the channel routes with location of the proposed locks is shown in figure 34.

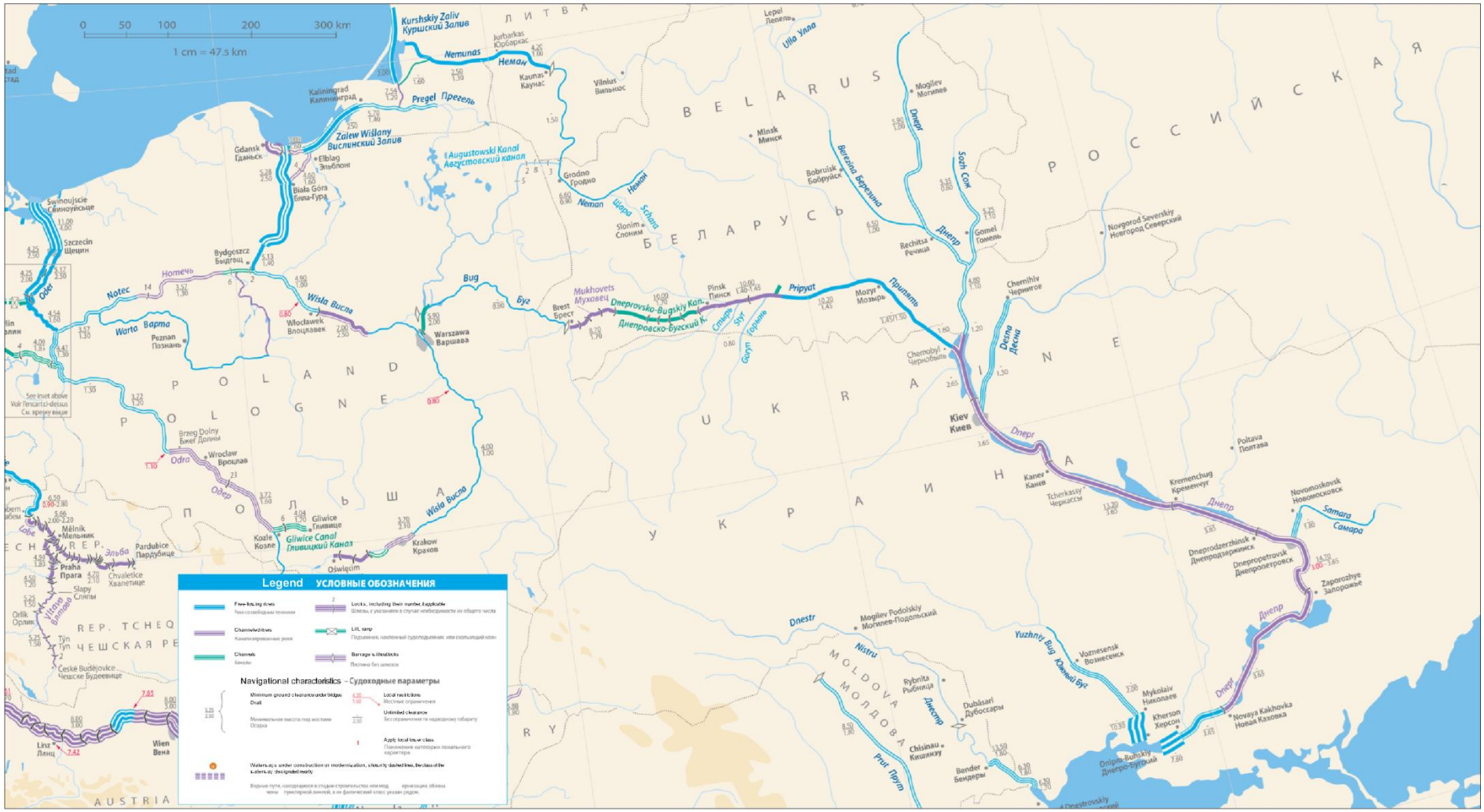


Fig. 30. Map of traffic restrictions on the international waterway E 40

Source: Inventory of Most Important Bottlenecks and Missing Links in the E Waterway Network, Resolution No.49, Economic Commission for Europe – Inland Transport Committee, New York and Geneva 2013.

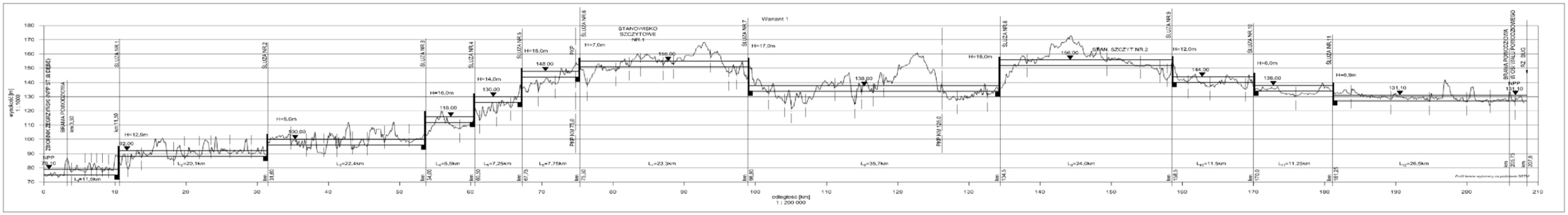


Fig. 31. Proposed dam locations for Vistula – Terespol waterway for Variant I.
Source: Own elaboration of Maritime Institute in Gdansk - Department of Economics and Law.

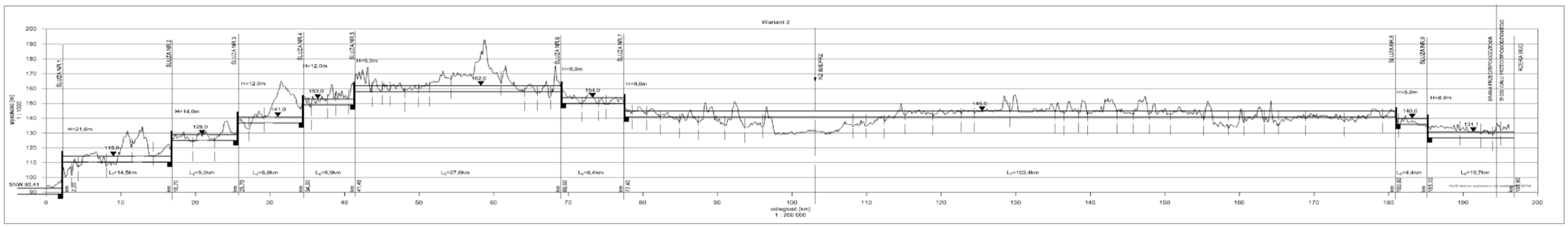


Fig. 32. Proposed dam locations for Vistula – Terespol waterway for Variant II.
Source: Own elaboration of Maritime Institute in Gdansk - Department of Economics and Law.

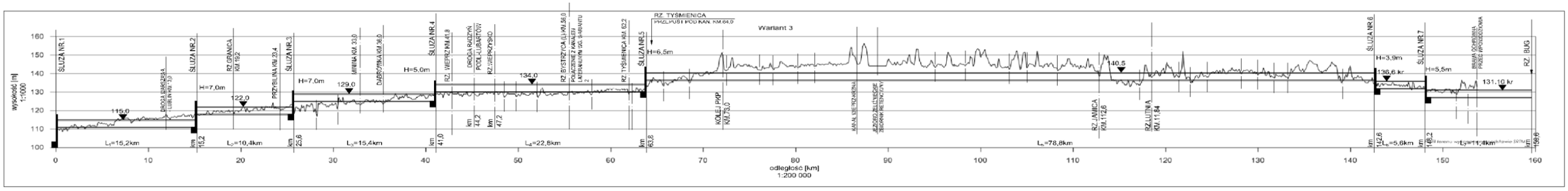


Fig. 33. Proposed dam locations for Vistula – Terespol waterway for Variant III.
Source: Own elaboration of Maritime Institute in Gdansk - Department of Economics and Law.

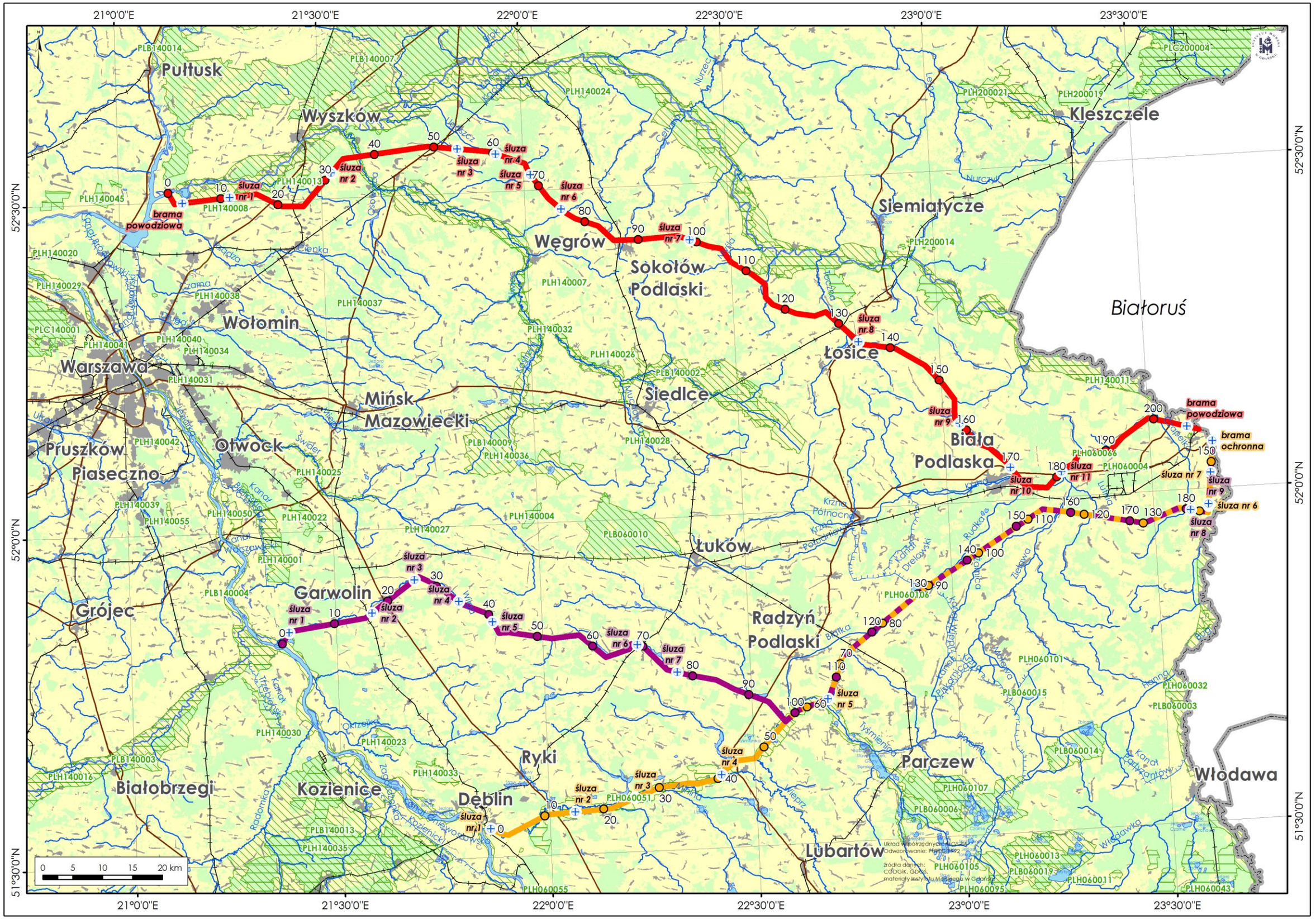


Fig. 34. Locks location for each waterway route in three variants.
Source: Own elaboration of Maritime Institute in Gdansk - Department of Economics and Law.

Variant I of IWW E40 on Vistula – Terespol section

Variant I of E40 waterway connecting Vistula and Bug rivers is the longest route. It starts in the area of the Warsaw basin, in the eastern arm of Debe Reservoir (Zagrzynskie Lake), where Bug waters join. The channel route initially leads to the east, through the areas of the Lower Bug Valley and Wolominska plain, cutting through the numerous tributaries of the Bug river flowing towards the north or north-west (including Fiszor, Liwiec, Dzieciolek rivers). In the vicinity of Sokolow Podlaski channel's route changes its course to the south-east and enters the area of Siedlce plain and Lukowska plains that are part of Polludniowopodlaska lowland.

In Variant I there are two peak positions, which requires the installation of additional equipment to pump water from the lower to the upper positions. In addition, the investment would be more expensive, which further exacerbated the problem of providing water to the channel to maintain uninterrupted shipping in the navigation season.

This variant going along the riverbed, encounters a barrier of Natura 2000 area which make it difficult to implement.

The entire Bug river, from Narew river to Terespol is subject to special protection of natural habitats as well as precious and endangered species. According to the procedure of "Habitat assessment"[38], the investment is permissible if it does not have a significant adverse effect on a Natura 2000 site, or when it affect the site, but there are no alternative solutions. The necessity for investments implementation is due to the imperative of public interest and to make adequate environmental compensation is ensured of losses in the integrity of Natura 2000 and the overall coherence of the network[39]. In this regard the establishment of the waterway along the Bug River valley would not be advisable.

Since the inland waterway transport is the most profitable for large distances, proposed location of the ports in this variant at the beginning and end of the analysed section of the waterway, and in places where there is the greatest potential for generating cargo streams. The same methodology was adopted for other variants. The figure 35 presents proposed location of inland ports on the route of Variant I.

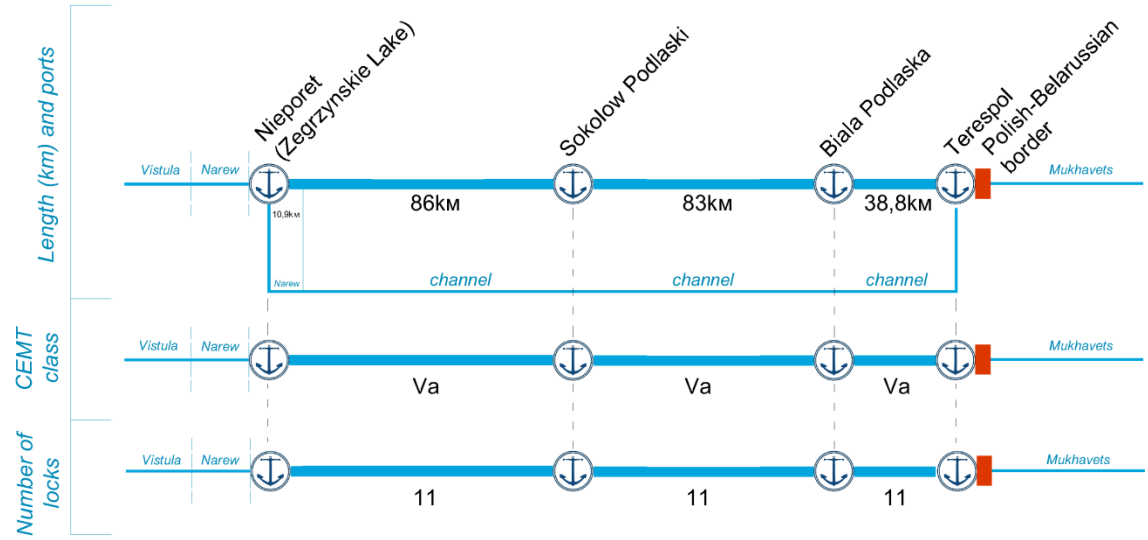


Fig. 35. Scheme of an international waterway E40 on the section Vistula - Terespol: Variant I
Source: Own elaboration of Maritime Institute in Gdansk - Department of Economics and Law.

[38] Art. 6(3) Dyrektywy Siedliskowej
[39] DHV HYDROPROJEKT, Droga Wodna E40 – Przebieg Drogi Wodnej E40 na terenie Polski na odcinku od Terespola do Dęblina, Warszawa 2015

For Variant I starting port is located in Nieporet, where there is already a port on Zegrzynski Lake. The next ports be situated in the vicinity of Sokolow Podlaski and Biala Podlaska cities and the end port in the city of Terespol. Location of new inland ports on the route of the waterway will depend on the future needs of the region, the demand for water transport and the financial capacity of local governments.

Variant II of IWW E40 on Vistula – Terespol section

Variant II of E40 waterway route begins at the mouth of the Wilga river at the Vistula river, in the area of the Vistula central valley. The length of the route in this variant is 195.9 km. Initially, the channel runs in a north-easterly direction, through the plains of Garwolin, and after 26 km, near Garwolin its direction changes to the south-east. The route leads through the Zelechowska elevation, Lukowska plain and Wieprz river valley to Tysmienica.

As in the case of Variant I, future ports could be located in the vicinity of the beginning and end of this section of the waterway, and in places where there is the greatest potential for generating cargo streams. Variant II of the waterway will fulfil its role of provided system of dams (a cascade) on the Middle Vistula is constructed. Then benefits from the inland ports such as Gora Kalwaria, would be enormous. Diagram of the route is presented in figure 36.

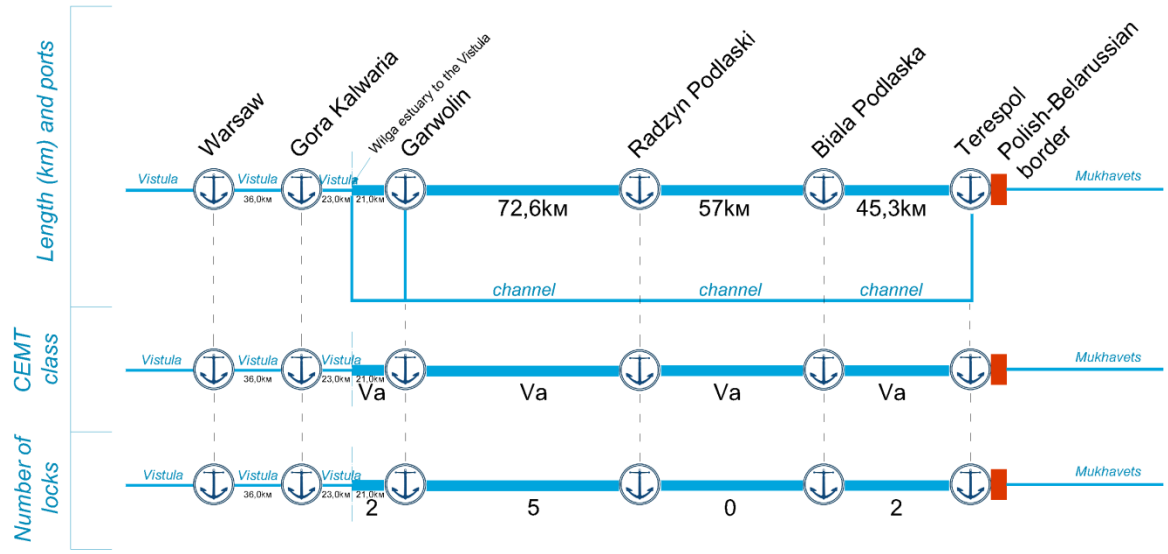


Fig. 36. Scheme of an international waterway E40 on the section Vistula - Terespol: Variant II.
Source: Own elaboration of Maritime Institute in Gdansk - Department of Economics and Law.

For Variant II starting port would be located around the city of Garwolin, and the following ports in the vicinity of Radzyn Podlaski, Biala Podlaska and Terespol.

Variant III of IWW E40 on Vistula – Terespol section

Variant III of E40 waterway has a length of 159.6 km. The route begins in the vicinity of Deblin, the stretch over 40 km runs from the Vistula Central valley to the east along the border of Wieprz river valley and Lubartowska elevation. At the height of the Bystrica river mouth at Tysmienica river, route of Variant III combines with the route of Variant II and later repeats its course. Diagram of the Variant III route and location of the ports is presented in figure 37.

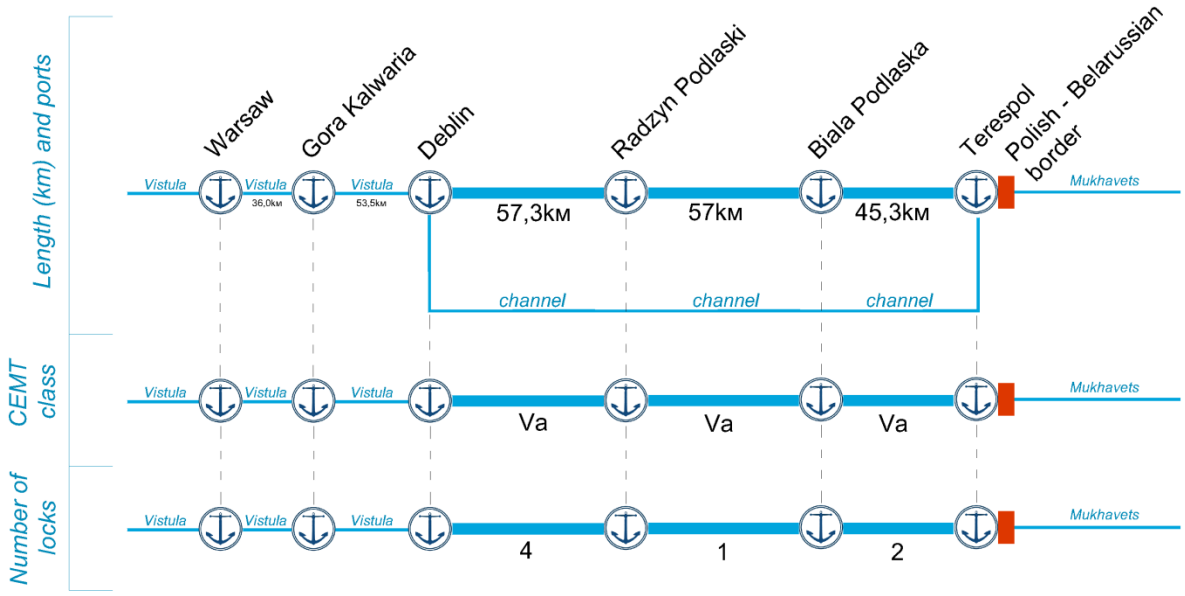


Fig. 37. Scheme of an international waterway E40 on the section Vistula - Terespol: Variant III
Source: Own elaboration of Maritime Institute in Gdansk - Department of Economics and Law.

For Variant III of E40 waterway, the situation is as in the case of Variant II. Ports along the route of this variant would include ports in Deblin, Radzyn Podlaski, Biala Podlaska and Terespol.

2.2. **Dimensioning of the navigation channel**

In order to establish size of the designed channel, a methodology elaborated in the studies of Gdansk Technical University and Wroclaw Technical University used[40]. Detail information regarding the methodology is included in Technical and Navigational Report.

Depth of the navigation channel

In accordance with the binding Regulation of the Council of Ministers of 7 May 2002 on the classification of inland waterways, for class IV and V the smallest required water depth was specified as 3.5 m.

The performed technical analysis of the planned fleet watercrafts, which should correspond, in terms of dimensions and technical solutions, to standards of a typical European fleet, with a possibility of combining into push-tows and with a possibility to use the loading and unloading equipment along the route, leads to the recommended increasing of the planned channel depth to 4 m. In a significant way this will improve the channel maintenance conditions at its planned significant load, in particular through a reduction of the bottom washing away caused by the propellers operation.

However, the water balance is the argument that decides about adopting the depth of 4.0 m for the channel planned in the Polish part of the E40 waterway, showing a significant threat for the channel operation in the low water periods. The channel depth increased to 4.0 m under normal operating conditions, carrying out a proper water management, will enable its operation at the preserved minimum required depth of 3.5 m in the dry periods, when the greatest evaporation losses and water shortages in the catchment area occur.

The increased design depth for the Polish section of the channel will allow:

[40] Metodologia wymiarowania na podstawie materiałów Politechniki Gdańskiej, Katedry Hydrotechniki and Kulczyk J., J. Winter: Śródlądowy transport wodny, Wrocław 2003.

- reducing the size of retention reservoirs supplying the channel with water in dry seasons, for which a limited land availability as well as high social and natural costs are the barrier
- improvement of conditions of the channel bed maintenance.

The design depth of 4.0 m, adopted for the channel between the Vistula and Bug rivers in the vicinity of Terespol, does not need to be preserved in other sections of the E40 waterway.

Width of the navigation channel

When designing the shape of the channel cross-section the dimensions - the minimum depth *h*, the reliable width *b*, and the usable width *b'* - are very important. The usable width of a waterway is understood as the width at which the minimum depth (*h*) will be secured in any place. Instead, the reliable width (*b*) is taken as the width at the level of fully loaded barges bottom.

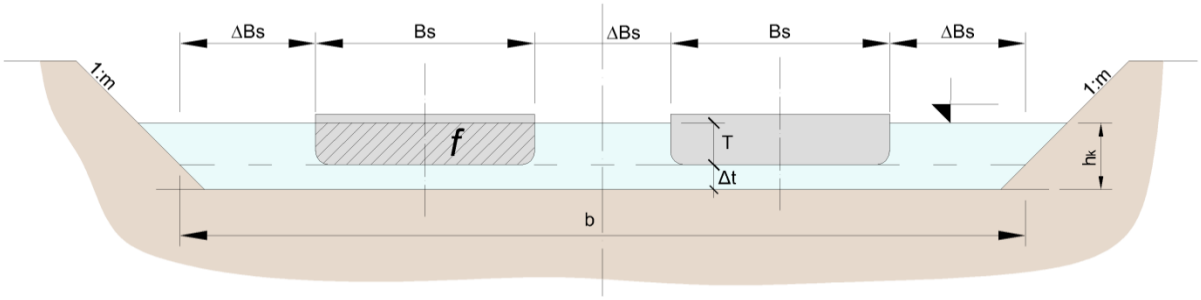


Fig. 38. Trapezoidal cross-section of the navigable channel
Source: Maritime Institute in Gdansk - Department of Economics and Law, own elaboration basen on: Regulacja rzek i drogi wodne, Instytut Geotechniki, Wydawnictwo Politechniki Wrocławskiej, Wrocław 1988

The safe value ΔB_s depends on vessel types. An assumption was made that for international waterways of class IV or higher it should not be smaller than 5 m.

$$\boldsymbol{b} = 2 \cdot 11.4m + 3 \cdot 5m = \mathbf{37.8\ m}$$

An assumption was made that the navigable channel width would be 50 m.

Curve radius of the navigation channel

The cross-section on curves will slightly differ, because on curves the stiff sets make by their extreme points circles of radii, which difference is the larger than the own width of the set, the smaller is the curve radius and the greater the set length; that depends among other things on the velocity.

$$R_{min} = 5 \cdot L = 5 \cdot 115 = 575\ m < 650\ m \rightarrow minimal$$
$$Radius\ of\ navigation\ channel\ for\ class\ Va\ waterway\ \ \boldsymbol{R_{min} = 650\ m}\ was\ taken$$

Assuming the minimum value of the navigable channel curve radius R = 650 m and the length of the target craft, i.e. a 115 m push-tow, the minimum channel widening on a curve will be:

$$\boldsymbol{B'} = \frac{L^2}{2R} = \frac{115^2}{2 \cdot 650} = \mathbf{10.17\ m}$$

The minimum width of a two-way channel on a curve will be:

$$\boldsymbol{b_ł} = B + b_ł = 50 + 10.17\ m = \mathbf{60.17\ m} \rightarrow \mathbf{62\ m\ was\ taken}$$

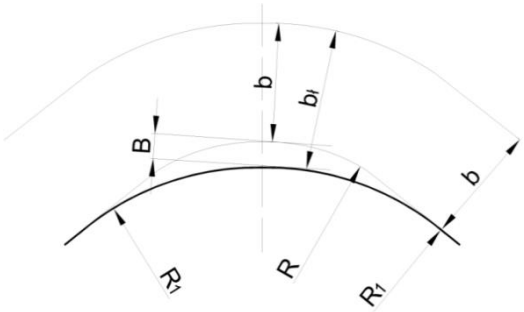
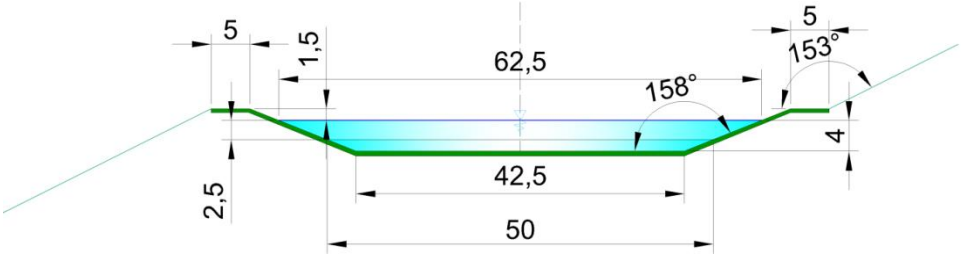


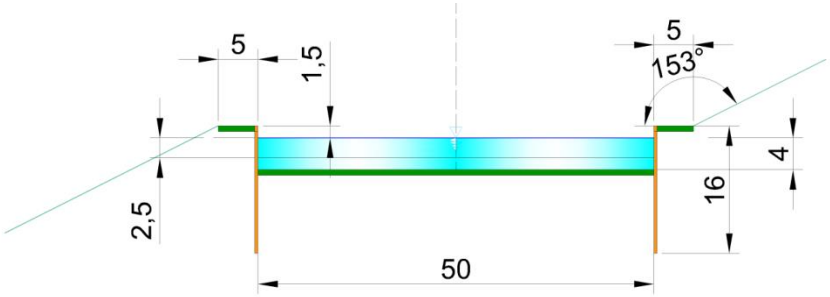
Fig. 39. Increase in the traffic lane width on a curve
Source: Own study based on: Regulacja rzek i drogi wodne, Instytut Geotechniki, Wydawnictwo Politechniki Wrocławskiej, Wrocław 1988

Figure 40 presents cross-section of a channel on straight sections with a slope protection, channel with sheet piling protection and with a slope protection on a curve.

The cross-section of the channel with a slope protection on a straight section



The cross-section of the channel with a sheet piling protection on a straight section



The cross-section of the channel with a slope protection on a curve

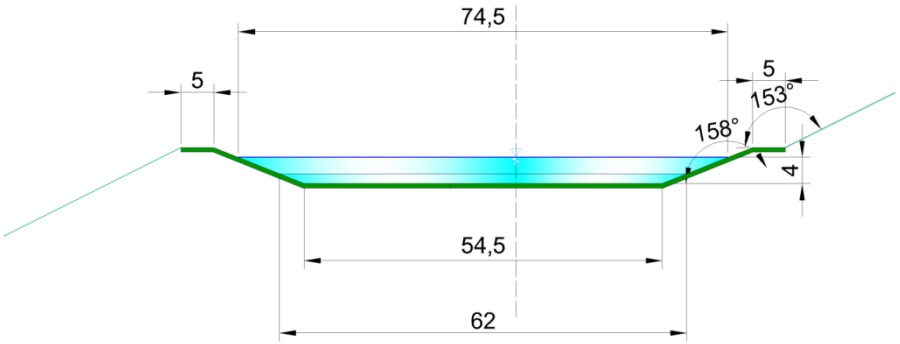


Fig. 40. Typical navigational channel cross-sections
Source: Maritime Institute in Gdansk – Department of Economics and Law

Cargo throughput of a channel lock

In order to determine cargo capacity of locks located in specific variants of the projected waterway defined by the ratio of number of water stock, number of lockings during a day, duration of navigational season and capacity of water stock, the following variables were assumed:

- navigation period,
- number of shipping stock locking at the same time,
- number of lockings per day,
- capacity of one vessel set,
- duration of locking (single and cross -locking).

Cargo throughput of channel lock s for each variants are presented in table 51, where:

H – height of fall,
t_{pI} - duration of a single locking,
t_{pII} - duration of a cross-locking,
t_p - duration of a single locking,
s - number of locking cases per day.
P_t - theoretical capacity of a channel lock,
P_e - operational capacity of a channel lock.

Tab. 51. Load throughput of a channel lock for Variant I, Variant II, Variant III - calculation results

No channel lock	Variant I						
	H	t_{pI}	t_{pII}	t_p	s	P_t	P_e
	m	min	min	min	-	mln t/year	mln t/year
1	12.9	37.83	57.33	33.25	43.00	21.5	10.04
2	8.0	32.39	51.89	29.17	49.00	24.5	11.72
3	16.0	41.28	60.78	35.83	40.00	20.0	9.20
4	14.0	39.06	58.56	34.17	42.00	21.0	9.76
5	18.0	43.50	63.00	37.50	38.00	19.0	8.69
6	7.0	31.28	50.78	28.33	50.00	25.0	12.00
7	17.0	42.39	61.89	36.67	39.00	19.5	8.97
8	18.0	43.50	63.00	37.50	38.00	19.0	8.69
9	12.0	36.83	56.33	32.50	44.00	22.0	10.32
10	6.0	30.17	49.67	27.50	52.00	26.0	12.56
11	6.9	31.17	50.67	28.25	50.00	25.0	12.00
No channel lock	**Variant II**						
	H	**t_{pI}**	**t_{pII}**	**t_p**	**s**	**P_t**	**P_e**
	m	min	min	min	-	mln t/year	mln t/year
1	22.0	47.94	67.44	40.83	35.00	17.5	7.85
2	14.0	39.06	58.56	34.17	42.00	21.0	9.76
3	12.0	36.83	56.33	32.50	44.00	22.0	10.32
4	12.0	36.83	56.33	32.50	44.00	22.0	10.32
5	9.0	33.50	53.00	30.00	48.00	24.0	11.44
6	8.0	32.39	51.89	29.17	49.00	24.5	11.72
7	9.0	33.50	53.00	30.00	48.00	24.0	11.44
8	5.0	29.06	48.56	26.67	54.00	27.0	13.08
9	8.9	33.39	52.89	29.92	48.00	24.0	11.44
No	**Variant III**						

channel lock	H	t_{pI}	t_{pII}	t_p	s	P_t	P_e
	m	min	min	min	-	mln t/year	mln t/year
1	12.0	36.83	56.33	32.50	44.00	22.0	10.32
2	7.0	31.28	50.78	28.33	50.00	25.0	12.00
3	7.0	31.28	50.78	28.33	50.00	25.0	12.00
4	5.0	29.06	48.56	26.67	54.00	27.0	13.08
5	6.5	30.72	50.22	27.92	51.00	25.5	12.28
6	3.9	27.83	47.33	25.75	55.00	27.5	13.39
7	5.5	29.61	49.11	27.08	53.00	26.5	12.80

Source: Maritime Institute in Gdańsk – Economics and Law Department - own calculations

Determination of operational throughput of the route

$$P_e = P_t \cdot \alpha_1 \cdot \alpha_2 \cdot \alpha_3 \cdot \alpha_4 \, [\frac{mln\ t}{year}]$$

- α_1 – the coefficient of traffic intensity unevenness due to different vessel speeds, α_1=0.6÷0.8; **α_1=0.7** was taken
- α_2 – the coefficient of ports operation unevenness, α_2=0.7÷0.9; **α_2=0.8** was taken
- α_3 – the coefficient of the cargo carrying capacity limitation, **α_3=0.75**
- α_4 – the coefficient of the two-way traffic influence, **α_4=0.90**

$$\boldsymbol{P_e} = 75.16 \cdot 0.7 \cdot 0.8 \cdot 0.75 \cdot 0.9 = \boldsymbol{28.41}\ \boldsymbol{\frac{mln\ t}{year}}$$

Since operational throughput of the route does not depend on the number of locks or route length, for every analysed variant we assume a value of 28.41 mln tons per year.

Earthworks

During the channel construction it will be necessary to carry out mass and labour consuming earthworks, featuring a high degree of mechanisation. The following sequence will be the basic scheme of earthworks: soil debonding, replacement of the debonded soil and placing it in the embankment, putting it aside or transporting outside the construction site. The earthworks will also include such processes, apart from the aforementioned scheme, which implementation will significantly affect an efficient course of the basic earthworks, such as [41]:

- preparatory works,
- basic works,
- finishing works.

The preparatory works will be carried out before starting the basic earthworks. They will be divided into such stages as the land cleaning, removing the turf and the plant soil, removing stones and rubble as well as the construction site drainage. Earthworks for Variant III is presented in table 52.

Tab. 52. Balance of earthworks for Variant III

Balance of earthworks				
Place	Section of the route [km]	Excavation [mln m^3]	Embankment [mln m^3]	Balance
1	0.000-15.200	4.993	0.1788	4.8139
2	15.200-25.600	2.244	0.0279	2.2158
3	25.600-41.000	1.372	1.6224	-0.2501
4	41.000-63.800	0.564	1.8236	-1.2595

[41] K. Michalik: *Zasady obliczania mas ziemnych w wykopach budowlanych",* Katowice.

Balance of earthworks				
Place	Section of the route [km]	Excavation [mln m^3]	Embankment [mln m^3]	Balance
5	63.800-142.600	47.892	1.0305	46.8619
6	142.600-148.200	0.992	0.0042	0.9876
7	148.200-159.600	5.029	-	5.029
total:		**63.086**	**4.687**	**+58.3986**

Source: Maritime Institute in Gdańsk – Economics and Law Department - own calculations

2.3. Hydrotechnical infrastructure of IWW E40 on Vistula – Terespol section

When preparing an inventory of the road network, national roads were adopted as base. Location of road bridges is presented in figure 41. Most bridges should be built if Variant I was chosen. Route of this variant intersects with six national roads, i.e. 2, 8, 19, 50, 62 and 63, and with two of them (2, 62) twice. Presented data shows that the cost of Variant I in road respect would be almost three times higher than in the case of Variants II and III.

Route of Variant II intersects with only three national roads, i.e. 17, 19 and 63. The same is true in case of Variant III, which also will require construction of three bridges at the intersection with national roads no. 17, 19 and 63.

Railway bridges are presented in the same way as road bridges (Fig. 41). Variant I is also characterized by the highest number of railway bridges. Its route crosses with four railway lines, i.e. line no. 6, 29, 31 and 55.

Route of Variant II intersects with three railway lines, i.e. 7, 26 and 30, and variation III will require construction of only one railway bridge over the line no. 30.

European experience of building channels indicate that on average every 1 km there is one object hydrotechnical structure, such as a footbridge for pedestrians, crossing for animals, culvert, road bridge, etc. With this in mind, and with respect to the three analysed variants, it can be stated that:

- Variant I route has a length of 207.8 km, which means that along its course there will be located approximately 207 hydrotechnical facilities, including 8 road and railway bridges,
- Variant II route has a length of 195.9 km - about 195 hydrotechnical facilities, including 3 road bridges and 3 railway bridges,
- Variant III route has a length of 159.6 km - about 159 hydrotechnical facilities, including 3 road bridges and 1 railway bridge.

Minimum clearances under bridges over navigable water level will meet parameters of class Va waterway, i.e. 5.25 m.

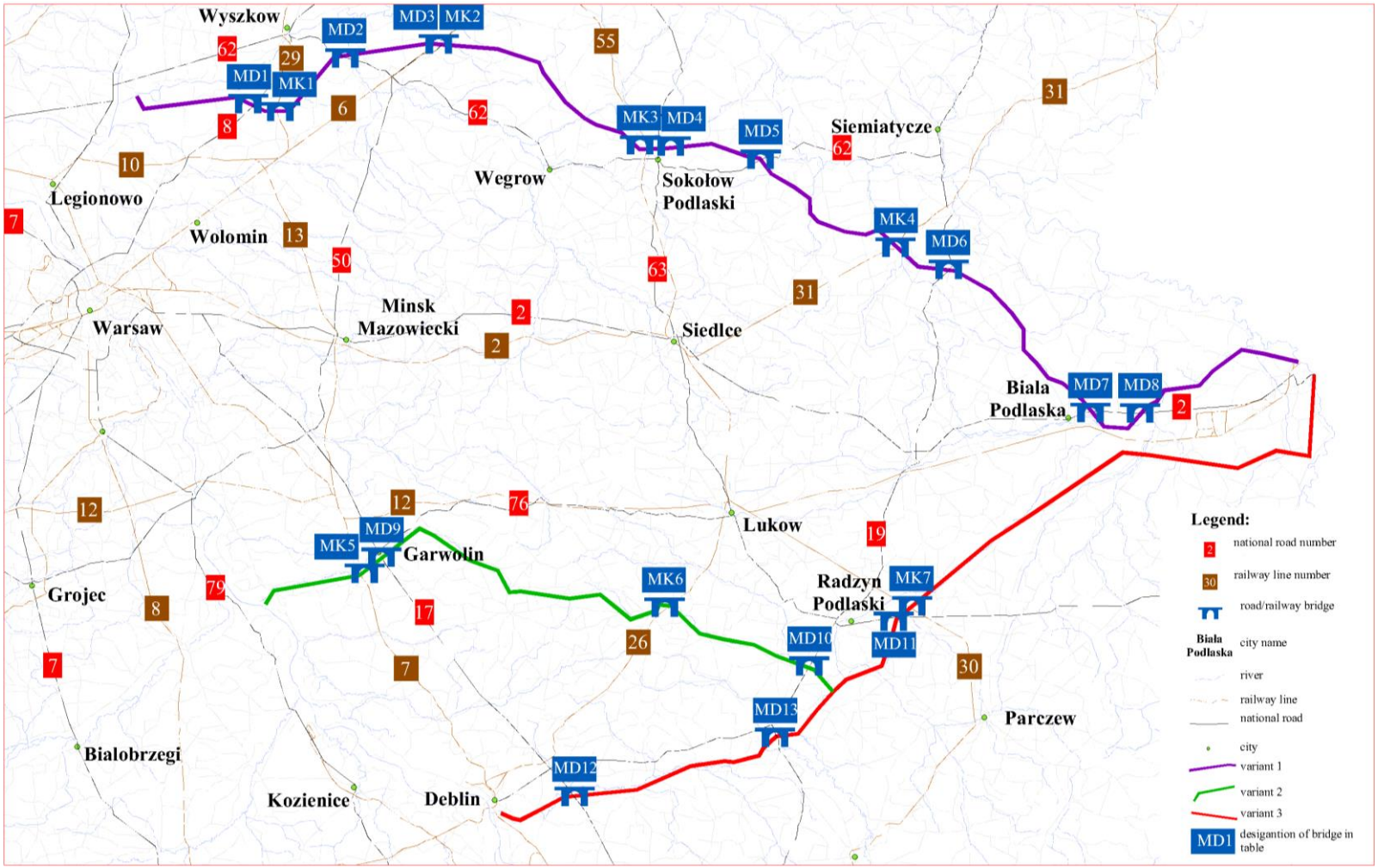


Fig. 41. Road and railway bridges along the routes of waterway variants.
Source: Own elaboration of Maritime Institute in Gdansk - Department of Economics and Law.

2.4. Technical characteristics of vessels on revitalised section of IWW E40

For an international waterway E40 Vistula-Terespol section, due to the need to adopt minimum draft parameter of class Va, of at least 2.5 m, the maximum length of vessel should be approx. 76 m, which is in line with the European standard.

After obtaining the minimum recommended parameters for waterway of international class Va, the basic types of cargo vessels would characterise with the parameters presented in table 53.

Tab. 53. Fleet - self-propelled barges, tugs, barges pushed

	Self-propelled barges				Tugs		Barges pushed		
Ship parameters	**BM 1500**	**BMZ1 300**	**BMAIII**	**GMS**	**BAWÓŁ II**	**2·120 kW**	**BP 1700**	**BPZ 1600**	**BP Ro-Ro**
Length (m)	82.0	82.0	82.0	110.0	25.0	11.7	76.5	76.5	80.0
Width (m)	11.4	11.4	11.4	11.4	11.4	8.7	11.4	11.4	9.2
Side height (m)	3.0	3.9	3.0		2.4	1.7	2.8	3.9	2.6
Draught (m)	2.5	2.5	2.5		1.8	1.6	2.5	2.5	2.4
Height (m) indecomposable	5.0	5.0	5.0		5.3	4.2	4.5	5.0	5.3
Tonnage (t)	1500.0	1285.0	1410.0		-	-	1720.0	1600.0	1300.0
Containers (t) 20"/ (TEU) pic.	1220/ 61	-	1220/ 61	1920/ 96	-	-	1220 61	-	1300 65
Power kW	2·300	2·300	1·620		2·600	2·120	-	-	-

Source: Development of transport services and transport forecast inland waterway transport, HYDROPROJEKT Warsaw Sp. z o.o., May 1993.

2.5. Cargo and passenger terminals

2.5.1. Concept of a multimodal river port

In this study it was assumed that functions and parameters of the multimodal river port on the E40 waterway route will similar to those proposed in the concept of river port in Solec Kujawski[42].

Multimodal river ports should be capable of handling both the container cargo, the general cargo and the oversized cargo. This study presents a concept of a multimodal container terminal to simplify assumptions and calculations, to present examples of the river infrastructure development possibilities. The infrastructural solutions to service all cargo types may be developed during the phase of detail designing of individual components of the Vistula - Terespol channel.

The main multimodal tasks of the container base will comprise reloading and gathering the containers delivered by the road, rail and inland water transport. Handling of containers delivered by the road, rail and inland water transport. In the water transport the containers will be handled in the LO-LO (Lift On - Lift Off) system.

Detail cargo forecast was presented in the First Interim Report and in Component 1 of this report. The implementation of the first construction stage will meet the demand for handling of 70,000 TEU annually. In the second stage the number of storage yards will be increased, which will ensure handling capacities of around 140,000 - 150,000 TEU per year. The construction of a multimodal river ports is assumed to be an impulse for further investments in the region.

The estimate share of individual container groups:

[42] Na podstawie: Leśniewska M.: Projekt multimodalnej bazy kontenerowej w Solcu Kujawskim, Politechnika Gdańska, Gdańsk 2015

- universal: $Q_u = 75\% \rightarrow Q = 52\,500\,TEU$,
- reloaded: $Q_{prz} = 25\% \rightarrow Q = 17\,500\,TEU$,
  - refrigerated: $Q_{ch} = 12\% \rightarrow Q = 8\,400\,TEU$,
  - dangerous: $Q_{ch} = 6\% \rightarrow Q = 4\,200\,TEU$,
  - empty: $Q_{ch} = 7\% \rightarrow Q = 4\,900\,TEU$.

- Technical depth of the harbour

The depth of the harbour is the sum of maximum draft of barges and required depth of water under the keel of the vessel (according to the regulations it may not be less than 0.25 m). In the calculation of depths, there must be considered nine different depths reserves, which include:

- reserve for hydrographic inaccuracy of depth measurement. For a channel with a depth of 4 m, this reserve is 0.1 m,
- navigation reserve - 0.3 m,
- reserve for low water levels - 0.6 m,
- reserve for shollowing of the channel bed - 0.5 m,
- reserve for water waving, reserve should be considered first and foremost when determining the depth of waters outside exposed breakwaters - 0 m,
- reserve for increased depth in fresh water - 0.062 m,
- reserve for longitudinal trim and side roll of the vessel - 0.275 m,
- reserve for pitch of stern of a vessel in motion - 0.05 m,
- reserve for settling of the entire vessel in motion - 0.05 m.

The sum of the above reserves is 1.937 m. Therefore, the depth of the harbour will be equal to 4.5 m.

- Number of mooring posts for simultaneous use

For the calculation of indicator for inequality of annual cargo handling, the following variables were used: variable for inequality of monthly cargo turnover (1.65), variable measuring possibility of increasing handling capacity by increasing number of shifts (1.66), variable for time loss on operations other than cargo handling (1.65), variable for vessel cargo hold utilisation (1.15) and variable for port availability during the year (1.46).

Considering the above mentioned variables, indicator for inequality of annual cargo handling is 2.77.

When calculating the annual throughput, there were taken into account: the number of months of port work per year (12), the number of days of port work per month (28), number of shifts per day (2), the duration of one shift (8 hours) and productivity per post (20 TEU/h). As a result, the annual capacity of the port is 107 520 TEU.

On the basis of set parameters, it was calculated that the port will have two mooring posts for simultaneous use.

Development plan of the container base

The development plan of the container base site was prepared based on the determined parameters. The location of individual components was specified, including:

- the entry channel to the port, 64 m wide,
- the flood protection gate,
- outer port, 250 m long,
- outer port, 100 m long,

- the port water region with a turning basin, 200 m in diameter,
- the container berth with two stands for simultaneous mooring, 14 m wide and with the mooring line 300 m long,
- storage yard areas for universal, refrigerated, hazardous and empty containers,
- a railway siding,
- circulation and internal roads,
- a collection - distribution warehouse,
- a gantry crane complex,
- a logistic centre, consisting of:
    - administration-welfare buildings,
    - an equipment wash,
    - a workshop,
    - filling stations for the container moving equipment.

The equipment indispensable for the port operation was selected based on the existing multimodal container terminals, considering reloading of around 70,000 TEU per year at the first stage of the investment.

The quay equipment:

- 1 quay overhead crane of 50 t lifting capacity,
- 1 wheeled crane of 100 t lifting capacity,
- 1 level luffing jib crane of 50 t lifting capacity.

The storage yards servicing equipment:

- 2 rubber tyre gantries of 50 t lifting capacity,
- 2 reach stackers of 10 t lifting capacity,
- 4 terminal tractors,
- a straddle carrier of 40 t lifting capacity,
- 2 forklift trucks of 25 t lifting capacity.

The following assumptions were made:

- the port basin and areas will be situated on the land separated from the river by a flood bank, due to which the port operation will not depend on changes of levels and flows of water in the channel,
- the water level in the port basin was assumed as permanent, protected by a flood gate situated on the flood bank. The ordinate of the flood bank was taken as the groundwater level,
- the entry channel will cross the bank at the maximum permissible angle of 30˚.

2.5.2. Concept of passenger inland shipping terminal

The concept of the passenger terminal was adopted on the basis of materials of Technology University of Gdansk, particularly, of the project: A new generation of environmentally friendly vessels for Polish inland and coastal waterways system in east - west relations, which presents advanced concepts for multimodal terminal with internal infrastructure and with reference to the national transport network and its development trends and includes development of project in Kepa Bazarowa in Torun[43].

[43] Projekt InCoWaTrans w ramach programu EUREKA E!3065 pod kier. prof. K. Rosochowicza „Nowa generacja przyjaznych środowiskowo statków śródlądowych i przybrzeżnych dla polskiego systemu dróg

The planned terminals of passenger inland waterways navigation among others will be fulfilling two basic areas of designing:

- a solution for a passenger berth adapted to water table fluctuations,
- a transport connection of the harbour with the existing infrastructure.

Terminals will create integrated nodes of water tourism, combined with the construction of back-up facilities. The implementation of such nodes will have a number of advantages, such as:

- an increase in the tourist attractiveness of the areas adjacent to the terminal as well as their revitalisation,
- creation of possibilities for attractive forms of active recreation in the region,
- a possibility to attract a private investor, who would finance the construction of the inland harbour and would manage the back-up facilities, where the creation of an accommodation, catering and trade functions is planned,
- an increase in the investment attractiveness of the region,
- the possibility to situate small service companies in the terminal surroundings will result in development of the tourist sector, will create additional jobs.

Apart from small watercrafts, like kayaks, the terminals will also be adapted to service hotel vessels and long-distance vessels.

Regular lines of inter-city transport nature could be created, serviced by water trams, or interregional and international tourist voyages, serviced by pleasure boats, café boats etc. An assumption is made that terminals will have connections by bus transport lines, travelling to and from adjacent towns or regions attractive from the tourism point of view.

The harbour is designed as a building in the shape of an elliptical cylinder with a glass façade, covered with reinforced concrete arches. The arches of mooring - fender function on the water side will be supported by a steel soldier piling, while on the land side by an underground car park wall. Because of the basic assumption, to enable mooring of vessels and to service the passenger traffic within the entire range of water levels fluctuation, a ribbed retaining wall was designed on the water side. Horizontal reinforced concrete platforms with vertical spacing of 1.70 m are installed between the retaining wall ribs and the reinforced concrete arches. The platforms, 5 m x 10 m in size, are connected with each other by means of reinforced concrete ramps of the same dimensions in the vertical projection.

The designed system will ensure a possibility of simultaneous service of two vessels, each 100 m long. Simultaneous mooring of a long-distance Eureka type vessel and a water tram is planned as the basic arrangement. The design allows separating short- and long-distance terminals. The passage between terminals will be through a shopping centre.

wodnych relacji wschód–zachód" oraz Bolt A., Derek J.: Koncepcja zabudowy Kępy Bazarowej w Toruniu, Politechnika Gdańska.

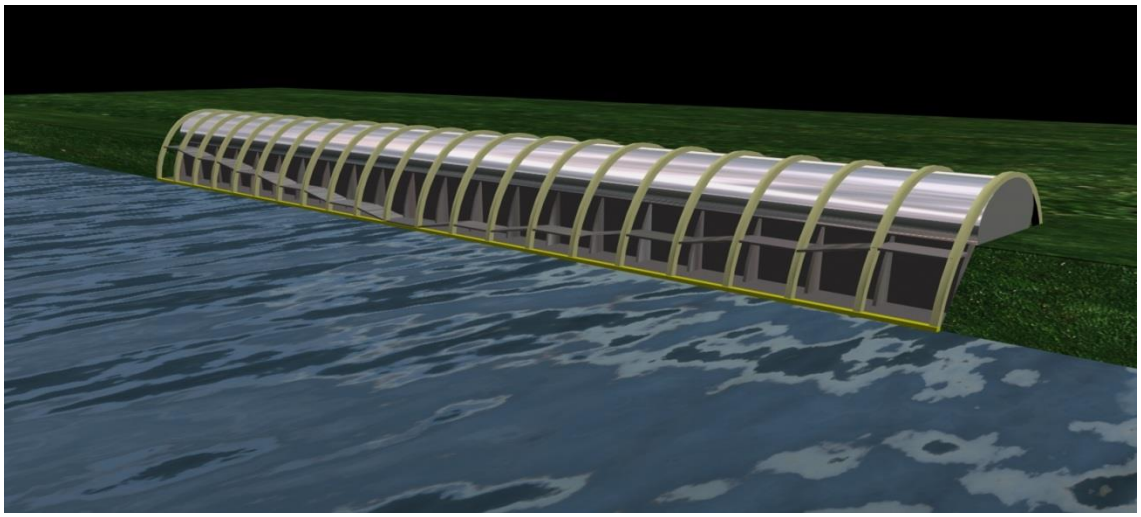


Fig. 42. Visualization of the marina building.
Source: Derek J.: Koncepcja zabudowy Kępy Bazarowej w Toruniu

2.6. Glacial phenomena

Various Glacial phenomena occur outside the navigation period thus they were not analysed in detail in the reports. Frazil ice on rivers is generally short-lived and usually disappear in a few or several days after their creation up. However a mixture of frazil ice and hard ice usually persist throughout the winter. According to the regional water boards glacial phenomena on rivers statistically begin in December and end in March. Economic analysis, investments profitability and estimation of waterway capacity on Vistula - Terespol section will be based on the navigation season, which is free of any ice phenomena on rivers. Therefore, preparation of a detailed analysis of ice phenomena goes beyond the needs of the analysis.

3. Hydrographic and hydrologic research

3.1. E40 waterway in the territory of Ukraine

Water regime of Dnieper river

The Dnieper Basin receives on the average 235 km^3 of precipitation per year. Scarcely 52 km^3 (22%) of this gets to the sea; the rest evaporates. About 75% of the precipitation evaporates in the basin of the upper Dnieper, 87% in the basin of the middle Dnieper, and over 90% in the basin of the lower Dnieper. Snow is the principal source of the Dnieper's water; groundwaters are second in importance; and rainfall comes third. In the upper Dnieper about 50% of the water comes from snow, 25% from rainfall, and 25% from groundwaters. Farther downriver the proportion of rainwater decreases while the proportion of meltwaters and especially groundwaters increases (33% in the middle and 42% in the lower Dnieper). Thus, the highest proportion of water (55–57% of the annual volume) is received in the spring (March to May), and the lowest proportion (12%) in the winter, when ground waters are the main source. Of the annual volume 17–21% comes in summer (June to August) and 12–14% in the fall (September to November). The divergence from these average figures can be quite large; for example, the springtime water volume at Kyiv varies from year to year from 46 to 78% of the annual volume. Most of the water that flows into the sea is supplied by the upper Dnieper above Kyiv; the upper Dnieper with the Berezina River and the Sozh River provides 35%; the Pripyat River, 26%; and the Desna River, 21%. Thus, the water regime of the Dnieper is determined in the basin of the upper Dnieper and is not enriched downstream. At Kyiv the average flow rate is 1,380 cu m/sec (at Loyev on the border above the Desna River and the Pripyat River it is 590), and it increases slowly to 1,480 cu

m/sec at Kremenchuk and 1,670 cu m/sec at the estuary. The highest flow rate comes in spring: 7,000 cu m/sec is the average rate at Kyiv. During the great flood in the spring of 1931, the flow at Kyiv was 23,100 cu m/sec. The difference between the winter and spring water level depends on the area of the basin and on the morphology of the riverbed and valley. In Ukraine it varies from 2 m to 5 m.

In winter the Dnieper freezes over, usually after a 20-day spell of subzero temperature. The average freezing and thawing dates for Kyiv are 17 December and 24 March; for Cherkasy, 23 December and 22 March; for Zaporizhia, 5 January and 9 March; for Kherson, 3 January and 3 March. The ice regime is not stable: sometimes the Dnieper freezes for short intervals, and sometimes it does not freeze at all. Ice jams and floods resulting from them are rare because the freezing moves southward and the thawing northward.

The Dnieper is not particularly turbid. The water becomes less turbid as it flows downstream; for example, the average amount of suspended silt near Mahiliou is 82 g/cu m of water; near Kyiv, 42.5 g/cu m; near Verkhnodniprovske, 27.5 g/cu m (because of the reservoir); near Kherson, 13 g/cu m.

The waters of the Dnieper have a moderate mineral content that varies with location and season. At Kyiv the mineral concentration is 70–100 mg/l in summer and 250–350 mg/l in winter. From Kyiv to the estuary the concentration does not change.

The water regime of the Dnieper has undergone significant changes because of the new reservoirs. The river has turned into a series of artificial lakes separated by dams and man-made falls from the natural segments of the river. Canals with locks run alongside these segments. The reservoirs have stabilized the regime of the Dnieper: the low-water level of summer and winter has risen remarkably. The duration of ice on the river has been shortened below the dams: for example, the Dniprohes dam causes earlier thawing on a 30 km stretch of the river.[44]

-Hydrologic characteristic of the Dnieper river basin

The Dnieper river and its tributaries are the largest rivers of the basin including right - and left Pripyat – Desna rivers. Both of these tributaries are cross-border rivers. The Pripyat, the most abundant tributary in water, has its source in the territory of Ukraine, passes through the territory of Belarus, and again reaches Ukraine. Currently, the river flows into Kyiv reservoir. In turn, the Desna river - the longest tributary of the Dnieper - originates in Smolensk region and flows into the Dnieper on the outskirts of Kyiv (or the Kaniv reservoir). Data on the hydrographic network of the upper Dnieper river is presented according to the publication "Water Resources of Ukraine" in the table 54.

Tab. 54. Hydrographic data of the Dnieper river

Main rivers	Surface of the catchment basin, km^2	River length, km	Number of small rivers		Łączna długość małych rzek, km		Density of river network, km/km^2
			total	Rivers with length shorter than 10km	total	Rivers with length shorter than 10km	
Dnieper	291400/504000	1121/2201	15381	13998	67156	35041	0.23
To Kyiv reservoir	1300	111	47	43	178	82	0.22
Kyiv reservoir	90090	107	6616	6066	27971	16457	0.31

[44] V. Kubijovyč, I. Teslia: *Dnieper river*. Encyclopedia of Ukraine 2012.

Pripyat	69140/121000	290/761	4429	4010	20075	11304	0.29
Turya	2800	184	136	121	654	433	0.29
Stokhid	3150	188	149	137	690	476	0.28
Stir	12370/12900	424/494	581	525	2936	1684	0.27
Ikva	2250	155	70	63	304	192	0.20
Horyn	27010/27700	577/659	2255	2010	9366	5175	0.37
Sluch	13800	451	1643	1529	6136	3765	0.48
Stvyha	2620/5440	178	112	93	754	367	0.31
Lva	1750/2400	172	63	53	343	154	0.25
Ubort	3900/5820	172/292	261	236	1129	610	0.33
Slavechna	2670	40/138	27	24	189	89	0.38
Uzh	8080	256	479	435	2220	1224	0.31
Teterev	15100	365	1788	1686	6446	4229	0.45
Irsha	3070	136	269	252	946	555	0.35
Irpen	3340	162	379	356	1321	892	0.44
Do KHPP dam	91420	218	6663	6107	28149	16527	0.35
Kanev reservoir	41920	164	1729	1535	9440	4871	0.23
Desna	33820/88900	575/1130	1328	1172	7610	3948	0.24
Seym	7400/27500	228/748	264	232	1485	695	0.23
Kleven	2660	120	112	100	576	291	0.26
Snov	5380/8700	200/253	183	155	1346	715	0.29
Oster	2950	199	65	57	509	382	0.24
Trubiezh	4700	113	106	94	623	260	0.16
To Kanev HPP dam	133340	382	8392	7642	37589	21398	0.29

Source: План управления пилотным речным бассейном Верхнего Днепра на территории Республики Беларусь и Украины (верхняя часть), компонент А – анализ речного бассейна, Проект «Охрана окружающей среды международных речных бассейнов», март 2013.

The elevation of the water table of the Dnieper river in the vicinity of Kyiv is about 133 m lower than the elevation at the river source. Under medium river flow conditions, average drop it is much lower thanks to the influences of Kaniv reservoir. Pumped hydroelectric energy plant Kyiv HPP affects the water level in Kyiv which is constantly changing. The amplitude of the change decreases from the upper to the lower section of approximately one and a half.

The average long-term flow at "Kyiv" station is 1 370 m^3/s, the maximum (on 02.05.1931) - 23 100 m3/s, the minimum 93.0 m^3/s (on 11.19.1921).

Currently, the water flow rate of the upper Dnieper river is determined at Nedanchitsy station (located above the Kyiv reservoir), as well as sections of Kyiv and Kaniv HPP. In addition, there are a few hydrological stations working on tributaries of the Dnieper (Tab.55).

Tab. 55. Hydrological stations on the Dnieper river and its tributaries

River – station	Distance from river mouth, km	Surface of the catchment basin, km^2
Dnieper – Nedanchitsy	1041	103000
Dnieper – Kyiv HPP	903	239000

Dnieper – Kaniv HPP	739	336000
Sozh – Gomel	105	38900
Pripyat – Mozyr	171	101000
Teterev – Ivankov	39	12400
Irpen – Mostische	28	2840
Desna – Chernihiv	205	81400
Desna – Lyotki	36	88500
Trubizh – Pereyaslav Khmelnytsky	6.0	3430

Source: План управления пилотным речным бассейном Верхнего Днепра на территории Республики Беларусь и Украины (верхняя часть), компонент А – анализ речного бассейна, Проект «Охрана окружающей среды международных речных бассейнов», март 2013.

Average flow of the Dnieper river at the Nedanchitsy station (catchment area of 103 000 km^2) in the period of its existence (1973-2011) amounted to 569 m^3/s (17.9 km^3/year) and the maximum flow measured 4,150 m^3/s (on 12.04.1979).

The Nedanchitsy station is characterised by a high wave of snowmelt. Studies conducted in the Central Geophysical Observatory in Kyiv show that spring flooding makes half of the total Dnieper river runoff. Typically, there is a high compatibility between the confluence of the total river runoff and spring floods, however, is not always so. The largest volume of flood waters (15.8 km^3) at the Nedanchitsy station was recorded in 1994. In the same year, its share in total confluence reached 66%. In turn, in 1997 Spring runoff was abnormally low, 4.22 km^3, making only 35% of the total annual runoff.

At the Kyiv HPP station (catchment basin area of 239 000 km^2) average long-term flow (1966-2011) is equals 1 070 m^3/s (32.8 km^3/year). The significant increase in flow through this station of the Dnieper in comparison to the Nedanchitsy station is linked with the inlet of the Pripyat river and several smaller rivers, and in particular Teterev and Irpen. Maximum flow at the station (10 700 m3 / s) was recorded during the passage of high spring floods on 04.18.1970.

Average flow of Dnieper waters near Kyiv can be determined on the basis of observations from the years 1881-1974 and data from neighbouring stations. After 1974, the flow of the Dnieper may be defined as the sum of the flow rates at the Kyiv HPP section and flow of Desna river at the Lyotki station. The total catchment area for these stations is 327 500 km^2 (respectively 239 thous. km^2 and 88.5 thous. km^2), which is only about 0.5 thous. km^2 or 0.2% less than for the basin of the Kyiv section (it equals 328 thous. km^2). The flow rate for the years 1881-2011 amounts to 1 380 m^3/s (43.5 km^3/year). The highest flow rate of the Dnieper river (2490 m^3/s) took place in 1970, the lowest (600 m^3/s) in 1921.

The flow rate of the Dnieper river at the Kaniv HPP station is practically the same as at Kyiv. In the years 1973-2011 it was equal to 1 390 m^3 / s. The similarity of the flow rates is a result of the similar catchment areas: in Kyiv it equals 328 thous. km^2 for the Kaniv HPP section - 336 thous. km^2. Among the rivers flowing into the Kaniv reservoir, except Desna, it is worth mentioning only the Stugna and Trubizh rivers (Tab.56).

Tab. 56. Characteristic water flows of the Dnieper river and its largest tributaries

River – station	F, km^2	Survey period	$Q_{śr}$, m^3/s	Maximal flow		Minimal flow	
				m^3/s	date	m^3/s	date
Dnieper – Nedanchitsy	103000	1972-2011	565	4150	12.04.1979	93.1	08.12.1975
Dnieper – Kyiv HPP	239000	1966-2011	1070	10700	18.04.1970	12.0 23%	01.01-24.02. 1980 (11 measurements)
Dnieper – Kaniv HPP	336000	1973-2011	1390	9980	17.04.1979	3.00 17%	01.01-31.12. 1977 (11 measurements)
Sozh – Gomel	38900	1900-1940 1944-2011	202	6600	27.04.1931	16.4	13.11.1900
Pripyat – Mozyr	101000	1881-1917, 1919-1940, 1944-2011	393	5670	22 - 24.04.1895	22.0	12.11.1921
Teterev – Ivankov	12400	1985-2011	33.2	591	09.04.1996	5.40	18-20.09.2009
Irpen – Mostische	2840	1953-2011	7.85	258	03.04.1956	0.20	14, 15.05.1964
Desna – Lyotki	88500	1973-2011	354	2400	19.04.1979	56.1	28.11.1975
Trubizh – Pereyaslav Khmyelnitsky	3430	1962-2011	5.96	87.4	24.03.1971	0.00 23%	27.05-12.10. 1963 (102 measurements)

Source: План управления пилотным речным бассейном Верхнего Днепра на территории Республики Беларусь и Украины (верхняя часть), компонент А – анализ речного бассейна, Проект «Охрана окружающей среды международных речных бассейнов», март 2013

-Hydrologic characteristic of the Pripyat river basin

Catchment basin of Pripyat river is part of the Dnieper basin (catchment area of the Black Sea). The catchment area is located in the regions of Volyn, Rivne, Lviv, Ternopil, Khmelnytsky, Zhytomyr and Kyiv in Ukraine and Brest, Gomel, Mogilev and Minsk in Belarus.

The hydrographic network of Pripyat river is highly developed. Directly into the river falls 70 tributaries of the first order (in relation to Pripyat - the zero order) with a total length of 5537 km. The number of tributaries second, third and higher orders on the Ukrainian, right bank of the catchment basin is 443, and their total length is 9753 km. On the left side of the river the number and length of the tributaries of the second, third and higher order has not been established. In the basin, there are 16 medium-sized rivers - various orders of the Pripyat tributaries.

Pripyat river basin is sufficiently examined in hydrological terms. In the upper reaches of the river and in tributaries on Ukrainian part of the basin there are 29 measuring stations, including two on the Pripyat river. In the Belarusian part on the river there are 7 hydrological measuring stations. Data from major hydrological stations of the Pripyat basin are presented in table 57.

Tab. 57. Characteristics of basic hydrological measure stations of the Pripyat river basin

River	Name of station	Distance from the estuary [km]	Catchment area, [km^2]	Duration of action	
				from	to
Ukraine					

Kyiv region					
Ush	Polesskoye	87	5690	07.07.1915	active
Volyn region					
Pripyat	Lyubyazh	604	6100	20.07.1922	active
Pripyat	Rechitsa	677	2210	22.10.1928	active
Turya	Kovel	82	1480	08.07.1922	
Stokhid	Lyubeshiv	15	2970	20.07.1922	
Rovenskaya region					
Stir	Mlynok	113	10900	09.08.1924	active
Goryn	Dubrovytsya	117	12000	19.08.1922	active
Sluch	Sarny	42	13300	25.03.1945	active
Zhytomyr region					
Ubort	Perha	173	2880	16.09.1924	active
Belarus					
Gomel region					
Pripyat	Slovechna estuary	120	102900	08.06.1877	
Pripyat	Narovlya	153	98520	26.09.1930	active
Pripyat	Mozyr	192	97190	03.06.1876	active
Pripyat	Petrikov	277	83450	08.06.1930	active
Brest region					
Pripyat	Turov	358	71430	01.09.1930	
Pripyat	Koroby	466	35720	08.1922	
Pripyat	Kachanovichi	504	31970	1877	active
Pripyat	Pinsk	521			active

Source: The State Agency for Water Resources of Ukraine, the State Regional Institute of Design and - Research "Dniprodiprovodgosp"

Parameters and location of water reservoirs in the basin of the Bug river in Ukraine presents table 58 and figure 43.

Tab. 58. Basic parameters of water reservoirs and the resources needed for their implementation

No.	Name of reservoir, dam location (city, administrative region)	Name of watercourse	Area [ha]	Max. volume [mln m^3]		Restoration costs [thous. hryw.]
				total	net	
1	Korteliskoe reservoir, Kortelisy, Ratne region	Lyubovel lake	180	4.2	3.45	5000
2	Turske lake, Tur, Ratne region	Zabolottya channel	1357.3	21.5	21.5	50000
	Total in Volyn oblast:		**1537.3**	**25.7**	**24.95**	**55000**
3	Dobrotvir reservoir, Old Dobrotvir, Kamenka – Bug region	Bug	696	14.65	12.4	25600.0
4	Sokal reservoir, Sokal, Sokal region	Bug	490	4.92	2.72	1689.8
5	Solokiya reservoir, Korchiv, Sokal region	Solokiya	136	4.32	2.99	3883.6
6	Nedalchinskoe reservoir, Zashkov, Zhovkva region	Niedalchinskoe	44.3	1.01	0.9	200.0
7	Zolochiv reservoir, Zolochiv, Zolochiv region	Zolochivka	115	1.46	0.8	65000.0
8	Gamaleevskoe reservoir, Gamaleevka, Pustomyty region	Yarychevka	81	1.7	0.89	Building in good condition
	Total in Lviv oblast:		**1562.3**	**28.06**	**20.7**	96373.4
	Total in Bug catchment:		**3099.6**	**53.76**	**45.65**	**6 mln EUR**

Source: The Management of Volyn Oblast Water Resources

The water flow rate of the Pripyat river, which is the largest tributary of the Dnieper, on the Mazyr hydrological station (catchment area of 101 thous. km^2, years 1882-2011) is 393 m^3/s. The flow rate of water in the Pripyat at the mouth, taking into account the relatively large flow of the Uzh stream, is 450-451 m^3/s.

The largest flow of the Pripya waters usually takes place in April and the lowest in September. The largest measured flow (5 670 m^3/s) was recorded at the Mazyr station on 04.24.1895. The largest flow is usually observed in May, the smallest in September. Maximum flow (2 400 m^3/s) was recorded on 04.19.1979. It can expected that flows in a given section may be much larger. This is proven by measurements conducted at the Chernihiv station, where the flow rate has reached 8 000 m^3/s.

-Ground waters

Ground waters are an important part of rivers water system, especially in case of low water levels. At the same time they constitute a resources often uses commercially.

Catchment area of the Upper Dnieper river (Ukraine) is located in the north-west part of Dnieper-Donetsk artesian basin, which is characterized by the presence of a system of aquifers and sediments of the Paleozoic, Mesozoic and Cenozoic era, which depth increases towards the north-east and east, to submerged crystalline rocks . The deposits of the Cenozoic and Mesozoic partially contain rich aquifers with good water quality.

In the 70's of the last century in the Dnieper-Donetsk basin there were conducted a regional assessment of groundwater resources for centralized, large scale water consumption system. As a result, the following levels and water-bearing complexes were identified:

- aquifer complex of Quaternary sediments (in the Dnieper erosion valley),
- aquifer sediments complex of Oligocene-Miocene period,
- Eocene Aquifer sediments (Kaniv-Buchach),
- aquifer sediments complex of early Cretaceous and Cenomanian periods,
- aquifer sediments complex of Callovian and Cenomanian periods,
- Middle Jurassic aquifer sediments (bajos),
- early Triassic aquifer deposits.

Expected resources of deep ground waters with potential for their collection within the basin of the Upper Dnieper river in the Ukrainian territory are estimated at 4 126.34 thousand. m^3/day.

The degree of the identified groundwater resources is determined by a document approved by the Chief Reserves Commission of the USSR and the Ukraine Main Resources Commission. As of 01.01.2013 total resources of operational and technical drinkable groundwater are estimated at 1 137.99 thous. m^3/day, and therefore only 28% of foreseen water resources were examined.

Predicted groundwater resources by levels (complexes) of aquifers amount to:

- aquifer sediments complex of Oligocene-Miocene and Quaternary - 1,097.81 thous. m^3/day,
- Eocene aquifer sediments (kaniowsko-buczackich) - 1804.4881 thous. m^3/day,
- aquifer sediments complex of early Cretaceous and Cenomanian - 348.9581 thous. m^3/day,
- aquifer sediments complex of Callovian and Cenomanian - 586 981 thous. m^3/day,
- aquifer sediments of Middle Jurassic (bajos) - 288 281 thous. m^3/day.

The share of groundwater in the water supply of Kyiv city is 10-12%.

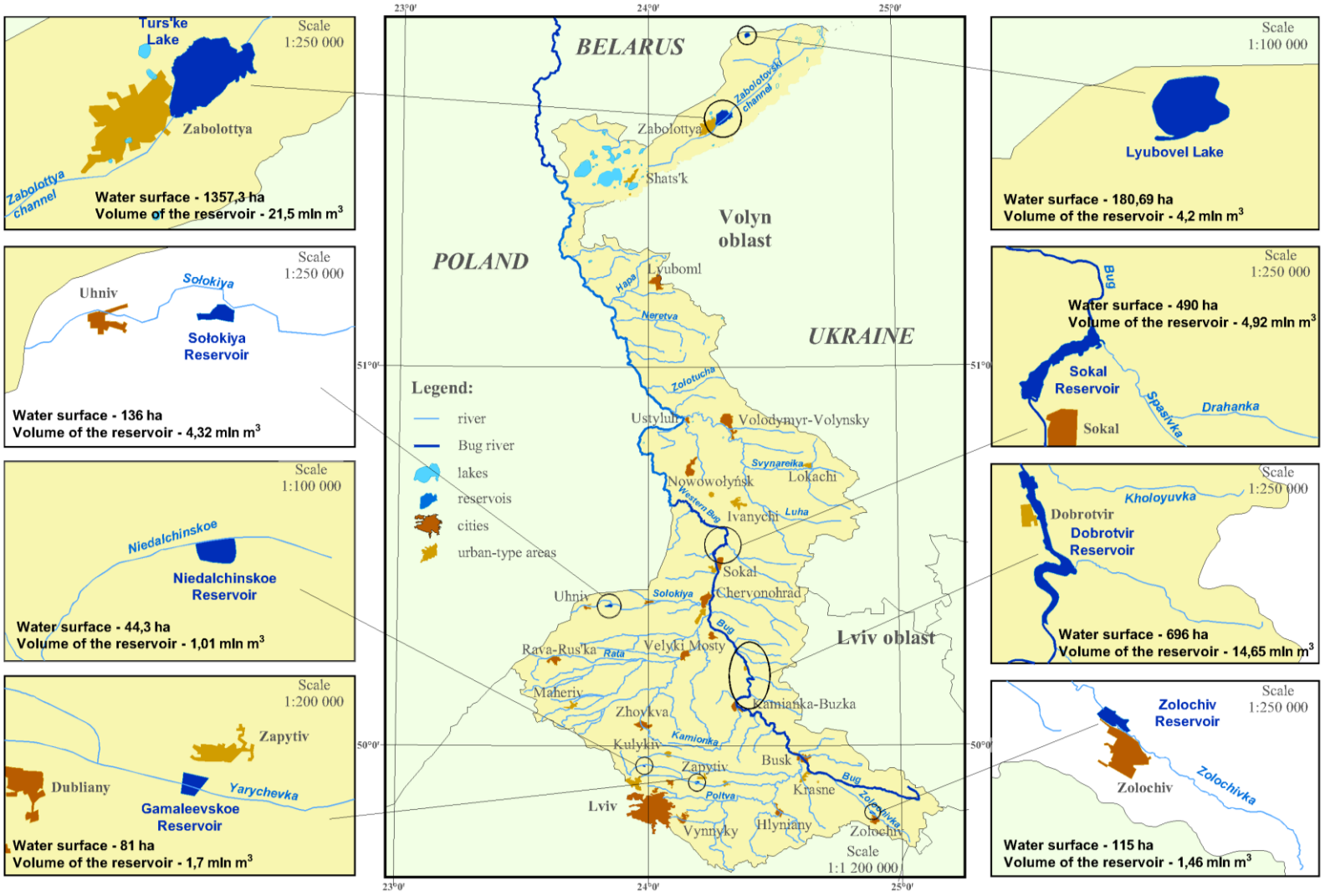


Fig. 43. Schematic layout of water reservoirs in the catchment basin of the Bug in Ukraine.
Source: The Management of Volyn region Water Resources

3.2. E40 waterway in the territory of Belarus

3.2.1. Water relations in Dnieper – Bug water system

The water relations of Dnieper - Bug water system is determined by the flows shaped in the catchment basin and supply from other catchments into supply system of Dnieper – Bug channel. The weak link in the system is the uneven distribution of water resources throughout the year on the watershed: excess in spring and deficiency during the dry season. It should also be noted that the greatest volume of water runs from the upper Pripyat river and the cascade of lakes: Svyatoye, Volyanskoye and Beloye, located in the territory of Ukraine.

Beloye Lake water system is used to supply water for Dnieper - Bug channel on the watershed during low water and to drain water from the upper Pripyat river from the territory of Ukraine.

The system consists of the Vyzhev channel extending from the Pripyat river near Pochapy village in Volyn region in the Ukraine to Svyatoye lake, from the cascade of lakes: Svyatoye, Volyanskoye and Beloye linked by Volyansky channel, as well as 15 km -long Beloye Lake channel, which connects to D-BC for its watershed section. The main part of the water supply system is received from the upper Pripyat river. Basic data on lakes and channels are presented in table 59.

Tab. 59. Basic data on lakes and channels of Beloye Lake Supply System

L.p.	Name of lake / channel	Parameters			
		Area, km^2	Maximum depth, m	Total volume, mln m^3	Serviceable volume (146.8-147.2 m asl.), mln m^3
1	Svyatoye Lake and Volyanskoyee Lake	0.106	**1.5**	-	-
2	Volyansky channel	6.2	16	5.5	0.48
3	Beloye Lake	0.09	**1.5**	-	-
4	Beloye Lake channel	5.9	10	38.9	2.44
5	Svyatoye Lake and Volyanskoye Lake	0.306	**1.5**	-	-

Source: Rekonstrukcja Kanału Dniepr-Bug na odcinku od węzła wodnego „Duboy" (km 26) do węzła wodnego „Lyakhovichi" (km 73) z poprawą warunków żeglugi, Ministerstwo Transportu i Komunikacji Republiki Białoruś, Krajowe Unitarne Przedsiębiorstwo Eksploatacyjno-Budowlane „Droga wodna Dniepr-Bug", Pinsk 2010

Specific requirements of Ukraine regarding the nature of fluctuations and operation of above-mentioned lakes is motivated by their status as protected areas, which is defined in the Rules of operation of Beloye Lake water system and DBC, approved by the representatives of the Government of the Republic of Belarus and the Cabinet of Ministers of Ukraine in the framework of the Agreement on joint use and protection of transboundary waters. The primary requirement within the framework of this agreement is to reduce fluctuations of the water level of Volyanskoye Lake to 147.20-146.80 m.

DBCIn general, in the area of watershed and eastern section, DBC receives water directly from a variety of courses, from more than 46 drainage systems regulating water relations in the area of over 20 thous. ha.

On the northern bank of the eastern section, DBC receives water from natural watercourses and lakes: from Nyeslukha and Filipovka rivers, from Lyakhovichi and Dyiatlovichi channels and others, in the south from Beloye, Plotsichne and Pyeschanoye lakes, and also from Zubrov, Zhyrov and Zaozerny channels.

Places and economic organisations dependent on the water relations of east part of DBC include

Drogichin and Ivanovo cities and villages: Zarechnoye, Kublik, Ovzicchi, Ragodosch, Pererub and others. From water relations of DBC depend two fish farms: Novoselki and Polesie, as well as a significant amount of surface water intakes, including those currently used.

- Status and role of DBC during floods

During floods through Beloye Lake water system and DBC passes waters from upper Pripyat river, on the territory of Ukraine in the catchment area of 8500 km^2. Waters pass through Vyzhev sluice, Beloye Lake channel and Zhyrov channel to Mukhavets and Pina-Pripyat which provides control over flood in this parts of Ukraine. In addition, water discharge during floods is also facilitated by Beloye, Svyatoye and Volyanskoye lakes, which prevent waters from becoming contaminated.

Given the outlook for the development of river transport on DBC, it is assumed that the volume of water required for shipping is 48.7 mln m^3, which will provide traffic of more than 3.8 mln tons of cargo (adopted by analogy to previous years) in the season from March to November. The volume of 48.7 mln m^3 was obtained from calculations that assumed 7,684 lockages during a season (movement of vessel sets loaded with a capacity of 1 thous. tons.

- Water balance of DBC

In the catchment basin of DBC the main receivers of surface waters include:

- Agriculture,
- fish farms.

The main users of surface water are:

- water transport,
- nature protection (use for sanitary and domestic purposes).

Water supply for industrial and communal living is accomplished primarily by groundwater extraction.

Current quantitative assessment of intake and discharge of water in the catchment basin of DBC is only approximate, because the last inventory was carried out in 1990 and now there is an urgent need for new inventory of water users dependent on DBC. Results of water balance calculations for the watershed section show that water shortage in the navigation season (95% confidence) amounts to 19.11 mln m^3.

3.2.2. Water management in Dnieper - Bug channel

The project of reconstruction of E40 waterway is expected to increase freight traffic, which will result in a significant increase in water spending on lockages in the navigation season. Additional expenses arise in connection with the postulated works to improve parameters of the fairway on the Belarusian section of IWW E40, and the construction and reconstruction of hydrotechnical structures. Therefore, additional sources of water supply should be considered. The need to improve water relations on DBC is also caused by complex technical and ecological condition, periodic water shortages on the watershed, limited water supply in the dry years from the upper Pripyat river in Ukraine through Beloye Lake water system, or inadequate water capacity during the floods.

As the most promising solution to these problems is considered: construction of Zhyrov reservoir in the vicinity of Malinovka city in the Drogichin region and supplying it with waters from the upper Pripyat river through the cascade of lakes (Svyatoye, Volyanskoye and Beloye) to the rebuilt Zhyrov channel. Filling the reservoir will be carried out by gravity through a notch in Beloye Lake. Zhyrov channel with a length of 18.25 km from the source (Beloye Lake) to the reservoir passes through

forest land.

In order to supply water from the reservoir to watershed section and eastern section of DBC (lower water of Lyakhovichi water junction) a culvert will be constructed in the body of a dam including distribution well and a supply channel and valve channel.

The location of the reservoir was decided on the basis of preliminary agreements with agricultural and geodetic service of Drogichin region, Drogichin Forestry Board and the district inspectorate for natural resources and environmental protection. The future reservoir will be located on land reserve (465 ha) and forest land (204 ha). Land reserves were previously drained through an open network of canals and in 2009 were reclassified as low-productivity non-agricultural land since the exisitng peat layer was fully exploited. Forest resources consists of a forest of thin pine trees on an area of about 30 hectares, the rest of the area is grown by birch, alder and willow on wetlands.

The reservoir construction project has also been reviewed and approved at the meetings of the Belarusian-Ukrainian working group on Operation of Supply System of Dnieper-Bug channel from Beloye Lake as part of the agreement between the Government of the Republic of Belarus and the Cabinet of Ministers of Ukraine on joint use and protection of transboundary waters dated 13.08.2010 and 23.11.2012. The architectural project was agreed with Ukraine (letter no. 2024 of 14.11.2012).

The project includes parameters of Zhyrov channel assuming projected water flow rate of 12 m^3/s and a gravitational filling of the future reservoir. Reservoir parameters were adopted for water storage during floods of 21.0 mln m^3 of water needed to ensure guaranteed parameters for shipping on the DBC in navigation season and guarantee the necessary environmental conditions on the cascade of lakes. In this way, scarcity of water in navigation season in the amount of 19.1 mln m^3 will be eliminated.

Zhyrov Reservoir occupies an area of 669 hectares (gross), in accordance with the need to retain required water and needs of the environment. The length of the reservoir dam is 11.27 km. Parameters of the dam were adopted assuming its construction using a suction dredging machine: talus of the upper part of the slope 1:17 lower 1: 3, crown width of 6.5 m. Level of the water was calculated at 146.10 m. Detailed technical data are presented in table 60.

Tab. 60. Technical and economic indicators of Zhyrov reservoir and channel

Name of indicator	Unit of measure	Value
Zhyrovskyi reservoir		
Normal level of damming (NLD)	m	146.1
Reservoir area at NLD	ha	618
Average depth of the bottom	m	3.5
Retention capacity of the reservoir	mln m^3	21.0
Length of levees	km	11.27
Volume of earthworks with levees	thous. m^3	3184
Drain devices	m^3/s	20.0
Construction cost	thous. EUR	11 680
Zhyrovskyi channel		
Length	km	18.25
Width at the bottom	m	15
Average depth	m	2.2
Retention volume of water in channel	mln m^3	0.895
Area under channel and levees	ha	151

Source: Rekonstrukcja Kanału Dniepr-Bug na odcinku od węzła wodnego „Duboy" (km 26) do węzła wodnego „Lyakhovichi" (km 73) z poprawą warunków żeglugi, Ministerstwo Transportu i Komunikacji Republiki Białoruś,

Krajowe Unitarne Przedsiębiorstwo Eksploatacyjno-Budowlane „Droga wodna Dniepr-Bug", Pinsk 2010

The sluice is situated in the wall of the reservoir. It will be made of steel tubes with a diameter of 1200 mm and a length of 60 m. In the lower level of the sluice there will be a distribution well, from which it will be possible to let water into the supply channel of the watershed section of DBC and the delivery channel to the eastern section of DBC. Control of water supply is carried out through a dumper installed in the well.

The supply channel (SC) with a length of 6.9 km will be carried out in halftrench-halfbank. Channel parameters were calculated based on the water flow of 1.75 m^3/s: the width at the bottom of 2 m, the talus of the slopes of 1:2.

Delivery channel (DC) with a length of 4.4 km will be carried out the trench. Channel parameters were calculated based on the water flow of 1.75 m^3/s: the width at the bottom of 1 m, talus of slopes 1: 2.5.

Implementation of these tasks will allow for:

- ensuring guaranteed water relations for shipping on Dnieper-Bug channel in dry years,
- significantly reduce pressure on Beloye Lake water system and DBC in the discharge of flood waters in years with high rainfall.

3.3. E40 waterway in the territory of Poland

The methods to meet the water demand

The analysis shows that it is not advisable to combine functions of the shipping channel with the function of water supply of deficit areas (where water is scarce). For this reason, it is proposed to solve these problems separately.

The configuration of the existing water network located between the Vistula and the Bug rivers indicates that from the point of view of the demand for water, the most appropriate area for the construction of the shipping channel connecting the Mukhavets and Vistula rivers the route proposed by Variant III.

The water demand for lockage was calculated based on:

- lock length $L_{śl}$=120 m,
- lock width $B_{śl}$=12 m,
- max fall H_{max} depending on the variant,
- vessel length L_s=115 m,
- vessel width B_s=11.4 m,
- vessel draft h_s=2.5 m,
- vessel displacement

$$V_s = L_s \cdot B_s \cdot h_s = 115 \cdot 11.4 \cdot 2{,}5 = 3277.5\ m^3$$

- real number of lockage cycles in one direction s = 22,
- losses on pairing p=5 l/s/km.

For these assumptions, there were identified: demand for single lockage, daily demand, losses on filtration and pairing, losses for leaks, the average daily spending, capacity of required reservoirs, power supply channel of water, power pump, the average energy consumption per year and annual cost of lockage in each variant. The water demand was calculated for options with and without saving reservoirs.

Results of the calculations are presented in table 61.

3.4. Summary

Comparison of disposable flows in the average low hydrological conditions of the river, with water demand of the projected channel specified in Tab. 43, indicates:

- (theoretical) possibility to meet the water demand for projected channel from the Bug, river at the section to km 248 + 000 (to Niemirow) for the channel without saving reservoirs, and at the section to km 294 + 000 (to Grabara) for channel with saving reservoirs
- (theoretical) possibility to meet the water demand for projected channel in variation III with saving reservoirs, from the Wieprz river at the stretch from the influx to Bystrica, i.e. to km 144 + 000.

It should be noted that these rankings do not include other uptakes by valid water permits. In addition, to ensure a continuous supply of water in the channel, regardless of the adopted variant, it will be necessary at a later stage of design – concept to:

- analyse duration and probability of low flows, smaller than SNQ in cross-sections sections,
- develop detailed water balances taking into account existing permits and prospective demand for water in the catchment basin, including the current priorities of meeting demand,
- determine the optimal location and size of the reservoirs, with reference to water management across the catchment basin,
- determine cross-sections of water intakes and necessary water transfers, including the optional water supply from the Vistula river.

Given the above it should be assumed that the balance of water in the catchment basin does not exclude any of the options. However, considering the water demand and the location of reservoirs resulting from the profile of channel route in different variants, for each of them the final solution of channel water supply must be preceded by additional, in-depth analysis of water resources and water management in the catchment basin.

The analysis shows that it is not advisable to combine functions of the shipping channel with the function of water supply of deficit areas (where water is scarce). For this reason, it is proposed to solve these problems separately.

Tab. 61. Lockage calculations

L.p.	Variant	Locks lenght L	Locks width B	Hight of fall H max	Displacement, V	Demand for one lockage	Daily demand	Channel lemght	Losses on filtration and evaporation	Gross fall	Losses on leaks	Total	Average daily expenditure	The 3 - day capacity of the reservoir	Supply	The high of rising	Pumping station power	Average power consumption per year	1 MWh cost	Annual cost
		m	m	m	m^3	m^3	m^3	km	m^3	m	m^3	m^3	m^3/s	thous. m^3		m	kW	MWh	zł	thous. zł
1	1 optimal	120	12	18	3277.5	29197.5	642345	207.8	89769.6	102	40800	1415259.6	16.38	4246	Bug river and reservoirs	22	7856	50907	500	25453.4
2	1 optimal with stilling basins	120	12	9	3277.5	16237.5	357225	207.8	89769.6	102	40800	845019.6	**9.78**	2535	Bug river and reservoirs	22	4691	30395	500	15197.7
3	2 optimal	120	12	14	3277.5	23437.5	515625	195.9	84628.8	100	40000	1155878.8	13.38	3468	Bug river and reservoirs	30	8749	56696	500	28347.9
4	2 optimal with stilling basins	120	12	7	3277.5	13357.5	293865	195.9	84628.8	100	40000	712358.8	**8.24**	2137	Bug river and reservoirs	30	5392	34941	500	17470.6
5	3 optimal	120	12	7	3277.5	13357.5	293865	159.6	68947.2	40	16000	672677.2	7.79	2018	Wieprz – Krzna channel and reservoirs	0	0	0	500	0
6	3 optimal with stilling basins	120	12	3.5	3277.5	8317.5	182985	159.6	68947.2	40	16000	450917.2	**5.22**	1353	Wieprz – Krzna channel and reservoirs	0	0	0	500	0

Source: Maritime Institute in Gdansk, Department of Economics and Law

Tab. 62. Catchment basin areas and indication of disposable water flow volume in water-gauge cross-sections in average hydrologic flows (SNQ) - Wieprz and Krzna rivers[45].

Km of river	Water gauge	Catchment area	Characteristic flows [m^3/s]					Calculation period	Body of surface water		k-factor for closing profile	Minimum acceptable flow Qn	Dispositional flow $Qd^{**}_{(SNQ)}$
			WWQ	SWQ	SQ	SNQ	NNQ		Code	Name			
km	-	km^2	m^3/s					*years*	-	-	-	m^3/s	m^3/s
Wieprz													
306+86	Zwierzyniec	392.61	28.70	8.00	2.10	1.13	0.40	1951÷2010	PLRW2000924159	Wieprz river from Jacynki to do Nielisz Reservoir	0.00	0.00	**1.13**
289+17	Michalow	568.60	NDA	NDA	NDA	NDA	NDA	NDA	PLRW2000152435	Wieprz river from Nielisz Reservoir to Zolkiewki	0.00*	NDA	**NDA**
278+87	Nielisz	1 343.77	38.10	22.69	7.70	2.92	1.15	1996÷2010			0.00*	1.15*	**1.77**
265+94	Wirkowice	1 998.93	75.80	32.81	9.28	4.25	2.78	1976÷2010			0.00*	2.78*	**1.47**
233+45	Krasnystaw	3 010.29	300.00	53.21	12.19	5.95	3.49	1951÷2010	PLRW200019243931	Wieprz river from Zolkiewki to Wieprz-Krzna channel	0.00*	3.49*	**2.46**
191+12	Trawniki	3 545.41	134.00	41.34	11.90	3.89	1.35	1976÷2010	PLRW20001924513	Wieprz river from Wieprz-Krzna channel to Staroscice	0.00*	1.35*	**2.54**
105+86	Lubartow	6 389.88	458.00	79.24	22.49	10.19	4.99	1951÷2010	PLRW2000192479	Wieprz river from Bystrzyca river to Tysmienica river	0.00*	4.99*	**5.20**
19+33	Kosmin	10 292.67	591.00	129.84	36.52	15.60	7.35	1951÷2010	PLRW20001924999	Wieprz river from Tysmienica river to estuary	0.00*	7.35*	**8.25**
Krzna													
45+18	Porosiuki	1 214.66	NDA	NDA	NDA	NDA	NDA	NDA	PLRW200024266459	Krzna from South Krzny to Klukowki			
8+45	Malowa Gora	3 041.93	133.00	58.00	10.50	2.43	1.00	1951÷2010	PLRW200024266499	Krzna from Klukowki to estuary	0.00	0.00	**2.43**

Source: M. Kubiak, Przedsiębiorstwo Projektowo Wykonawcze „EKOSOFT", Gdańsk 2015

[45] According to Annex 1 of the report on the implementation of flood hazard maps and flood risk maps; ISOK Project - Completion Report of the task 1.3.2. - Preparation of hydrological data to the extent necessary for hydraulic modeling.

4. Total cost of reconstruction of the E40 international waterway

The costs of reconstruction of the international waterway E40, at this stage of planning, can be estimated only approximately. It is not possible to determine in detail the cost of the modernization of the waterway on individual sections. This will be possible only at the stage of execution poject for each of the objects and each planned action. Table 63 presents the estimated costs of the reconstruction of particular sections.

Tab. 63. Cost of reconstruction of the E40 international waterway on the particular sections

Section of E40 waterway/scope of work	Cost of reconstruction, mln EUR
Poland	
• Construction of locks, dredging works, construction of waterway that will meet the requirements of class IV of international clasification on the Lower and Middle Vistula	
Variant I - on the Gdańsk - Warsaw section	6648.12
Variant II - on the Gdańsk - Wilga river estuary section	8310.16
Variant III - on the Gdańsk - Dęblin section	9972.19
• Construction of Vistula - Mukhavets navigation channel that will meet the requirements of class Va of international clasification	
Variant I - Nieporet - Brest	
channel construction	2721.85
locks construction	183.99
Variant II - Wilga river estuary - Brest	
channel construction	2415.07
locks construction	150.54
Variant III - Dęblin - Brest	
channel construction	1825.92
locks construction	117.08
Belarus	
• Reconstrucion of the existing hydrotechnical structures on the eastern section of the DBC	19.50
• Hydrotechnical works in the fairway aiming of higher vessel drafts up to 2.4m	5.00
• Construction of new water junctions on the Pripyat river with locks that will meet the requirements of class IV of international clasification	19.00-67.00
• Construction of the navigable section of IWW E40 on the Belarusian - Polish border	5.00-15.00
• Modernization of water supply system of DBC, including construction of Zhyrov Reservoir	11.70
Ukraine	
• Complete reconstruction of Kyiv lock	2.23
• Complete reconstruction of Kaniv lock	2.98
• Complete reconstruction of Kremenchuk lock	3.05
• Complete reconstruction of Dniprodzerzhinsk lock	3.02
• Complete reconstruction of Zaporizhiya dam	8.56
• Complete reconstruction of Kakhov lock	3.07

Source: Own elaboration

The final cost of the modernization of the waterway E40 varies depending on the variant of the reconstruction and the choice of technology. On the Polish part of the waterway E40 variable costs

will be generated by the differentiated costs of construction of the channel section Vistula - Mukhavets. The cost of Variant I - Nieporęt - Brest amounts to 2,905.84 million EUR, Variant II - 2565.61 million EUR and Variant III - 1,943.00 million EUR. Selection of one of the variants will have an impact also on the scope of work and costs on the lower and middle Vistula. To show the scale of the cost of modernization of the entire waterway E40, it was calculated in a base of Variant III.

Starting with the Vistula river etuary to the Baltic Sea, construction of locks, dredging works, construction of waterway that will meet the requirements of class IV of international clasification on the Lower and Middle Vistula will be costed 9,972.19 mln EUR. Construction of Vistula - Mukhavets navigation channel that will meet the requirements of class Va of international clasification is amounted to 1,825.92 mln EUR and the cost locks construction on this section is estimated at level of 117.08 mln EUR. Further waterway E40 goes throught the territory of Belarus starting with construction of the navigable section on the Belarusian - Polish border, which will cost from 5.00 to 15.00 mln EUR. Modernization of water supply system of DBC, including construction of Zhyrov Reservoir is a cost of 11.70 mln EUR, construction of new water junctions on the Pripyat river with locks that will meet the requirements of class IV of international clasification – from 19.00 to 67.00 mln EUR, hydrotechnical works in the fairway aiming of higher vessel drafts up to 2.4 m – 5.00 mln EUR and reconstrucion of the existing hydrotechnical structures on the eastern section of the DBC – 19.50 mln EUR.

Waterway E40 in the Ukrainian part is in good condition, instead of 6 dams in Kyiv, Kaniv, Kremenchuk, Dniprodzerzhinsk, Zaporizhia and Kakhov. They need to be completely reconstructed and in the following order the modenization costs will amount: 2.23 mln EUR, 2.98 mln EUR, 3.05 mln EUR, 3.02 mln EUR, 8.56 mln EUR and 3.07 mln EUR. Dneper river is in good condition and meets the requirements of class Va and Vb of international waterway classification. There need to be done dredging works every year, but these are exploitation costs, not reconstruction so they are not added to the final cost of reconstruction. The serious bottleneck of Ukrainian part of the E40 waterway is Pripyat river especcialy in the area of Chernobyl. There are some actions undertaken to revitalize this section of river, but estimation of these cost are not possible on this stage.

Summarizing costs mentioned above, the reconstruction of E40 waterwar on its entire lenght, taking into account the third variant of channel between Vistula and Mukhavets and the highest costs of construction of new water junctions on the Pripyat river with locks and construction of the navigable section on the Belarusian - Polish border, the final cost will amount to 12,056,3 mln EUR.

IV.FINANCIAL, LEGAL AND INSTITUTIONAL ASPECTS

1. Financial feasibility study

1.1. Impacts assessment of the current financial crisis on the costs of borrowing; financial viability of the project

1.1.1. Influence on interests rates and credit cost

The financial crisis in Europe and the world, according to the authors of the accompanying assessment of the impact of the financial crisis on the cost of credit and thus on financial viability[46], has been overcome, but his influence is still an important factor in shaping the financial markets. The best way to estimate its impact on the E40 waterway project, is to investigate the reference (primary) rate EURIBOR[47], set by the ECB (European Central Bank). The interest rate for companies one of the key factors taken into account when deciding on investments. Interest rate, which is a price paid for borrowing capital, directly affects the interest rates of all banks in the European area.

The reference interest rate is an important element for large infrastructure projects, such as "Revitalization of the E40 waterway Dnieper-Vistula section" as a whole, and especially for the financial implementation of this type of project. The financial needs of infrastructure projects are generally very high, therefore higher interest rate generates significantly higher costs. This in turn can lead to delays or, in the worst case, to cease the implementation of large projects.

The level of reference interest rate may cause active or passive effects. The active effect in interest rates affect the cost of bank loans (both private and state[48]). With regard to state banks, a low interest rate can lead to a very low rate for an individual project, allowing to save millions of euros, especially considering the usually long credit period.

The passive effect influences the willingness of private companies to participate in major infrastructure projects. Many of the statistics show that in periods of high interest rates significantly reduce investment of companies, while in periods of low interest rates willingness to invest money and/or participate in risky investments is much higher. Therefore, a low interest rate not only increases the willingness of companies to invest in infrastructure projects, but also determines the expected rate of return on investment. This situation shows the importance of interest rate not only for credit conditions, but also for the general attraction of further investments in large investment projects and the return on investment from private companies.

The global financial crisis that began in 2008 and lasted for several years, has led to serious disruption on the European market. A manifestation of this is "Euro-crisis" that began in 2010 and is still not fully overcome (as seen in the example of the current problems of Greece). To save the European market and improve the situation of countries that found themselves in a serious economic crisis (eg. Ireland, Spain, Portugal, Cyprus, Greece, Italy), the European Central Bank has taken drastic measures. Realistically, the financial crisis did not include directly France, but economic indicators and forecasts for the country have not been promising. This contributed to the overall uncertainty of the European economies, due to the considerable economic significance of France.

[46] The assessment made the European-Ukrainian Business and Innovation Agency (EUA) from Brema, which is a partner of the consortium involved in the feasibility study of the restoration connection Dnieper-Vistula waterway E-40 project.
[47] EURIBOR (Euro Interbank Offered Rate) – The reference interest rate on deposits and loans on the euro area interbank market.
[48] For example, the European Bank for Reconstruction and Development, European Investment Bank, francuski Caisse des Dépôts or German KFW (Credit Institute for Reconstruction).

In order to tackle the uncertainty in the financial markets, to support struggling European economy, stimulate the development of a common European market and to enable the transfer of aid to the affected by the slowdown of economies, the ECB significantly reduced the base interest rate.

Basic rates decreased dramatically since the beginning of the financial crisis in 2008 - from nearly 4.2% to 1% in 2009 and almost 0.0% in 2015. Last reference rate set by the ECB is 0.05%. Fluctuations of interest rates for small and medium-sized enterprises (for the period of 1 to 5 years and up to 1 mln EUR), in the case of loans granted by private banks, shown in the chart below.

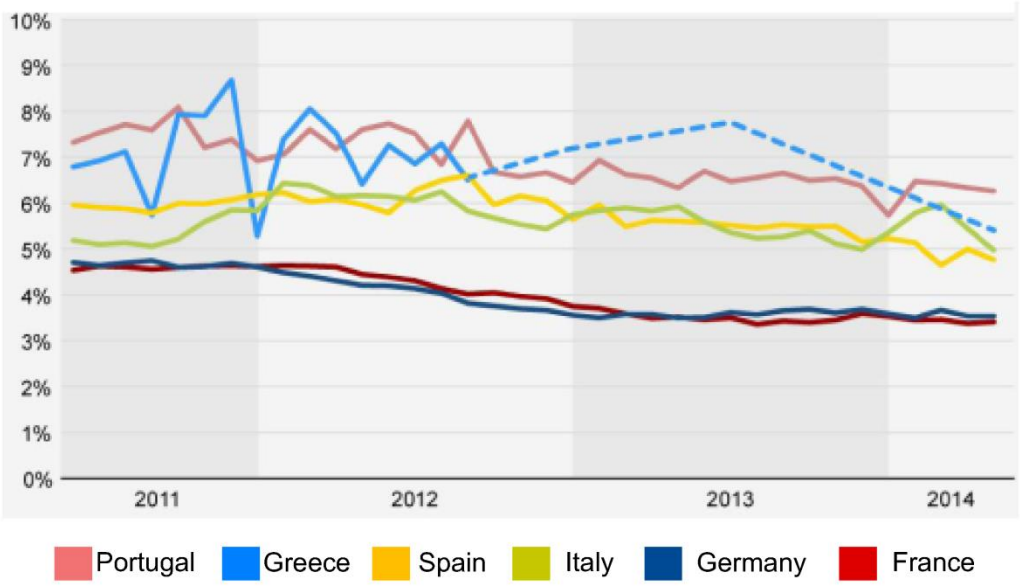


Fig. 44. Level of interest rates of loans for enterprises in 2011-2014
Source: European Central Bank

Each of the mentioned countries has different credit terms, depending on the individual economic situation. The decrease in interest rates at a lower basic interest rate and the difference is quite substantial. Private banks, depending on the country, maintain a margin of a few per cent. The interest rate on state-owned banks is much lower. The current level depends on several factors, including such as the value and term of the loan, repayment terms and conditions for individual bank.

1.1.2. The impact on the E40 project

The whole development on the financial market is very much in favour of the E40 project. The current situation offers a great chance for the project to borrow money from the government-owned banks and to get it for a historically low interest rate. This means a great reduction of the costs for the project which also reduce the financial risks significantly. Additionally, there is the possibility to borrow on the American Financial Market as well, because the key interest rate is still very low. In the end, this is more a political decision then a financial one.

Moreover, there is the possibility to borrow money from private banks that will naturally offer worse terms then government-owned banks (since the private banks have to make a margin from lending money). Such a decision is a strategic one:

- Is there the intention to borrow money from private banks at all?
- If so, how will be / should be the ratio between ”government-owned“ and ”private“ borrowings?

Another source of funding is the sector of private companies. The long lasting period of low interest

rates make it easier to approach these group and offer them to participate at the E40 project. There are two main groups of possible private partners for the project.

One group consist of companies who are interested in making a profit from the participation at the E40 project. This could be achieved by different ways. For example, by an agreement that includes some kind of income return or by a dividend. Another possibility would be some kind of stake in the project for the companies. Again, this is a strategic decision if to involve such partners and to which extend. However, the expectation of any kind of return on investments will be moderate due to the long-time low interest rate and the absence of possibilities to invest money with high return on investments.

The second group is probably more eligible for the project. It consist of companies who are interested by themselves in the realization of the E40 project. For example, this could be the companies who would like to use the new waterway for their business (all kind of logistics companies/logistics providers etc.). This could be companies who hope to improve their business or cut their costs through the waterway operation (the grain traders or inland waterway shippers). Another field are companies from the tourism branch and others.

All these companies are potential partners and investors in the E40 project. The participation can be organized in different ways and it is reasonable to make a decision individually. For these partners the return on investment might be from low interest or even without interest. These companies might see their participation in E40 as investment in their own business. There is a good chance that the motivation of these firms to invest in the E40 project is much higher than from other companies.

1.1.3. Interest rates forecast

Taking into account that the time of the realization of large infrastructure projects, such as the E40 project, will take many years and even the next phase of the project will need some time to be started, a brief forecast for the future development of the key interest rate is needed. Naturally, this forecast is short termed and there are no guaranties of the following development in the coming month. However, based on the past experiences, the very conservative way of acting from the side of the ECB and the current economic situation there is a good chance that the key interest rate will develop as forecasted.

Since the beginning of 2015 some experts have warned about a possible raise of the inflation rate, especially in the Eurozone, due to the low key interest rate. In the early summer 2015 there were signs by the side of the ECB that there might be a small increase of the rate in autumn 2015. However, the situation has changed in the past 3 month:

- The dramatic price reduction of oil and gas (with the perspective to stay on the low level) have reduced the inflation rate in Europe significantly,
- The prognoses for the development of the world economy have been declined ("Global economy faces low growth in next year" (OECD)[49]) which leads to further needs to boost European economies (-> cheap money through low key interest rate). Especially the decline of China's growth is one of the main drivers,
- The current refugee wave from the Arabic area and Africa demand for increased investments and rising costs for European economies,

[49] www.theguardian.com/business/2015/sep/16/global-economy-faces-low-growth-in-next-year-says-oecd

- On 17.09.2015 the FED (Federal Reserve - American counterpart of the ECB) has decided not to raise the key interest rate for the American market (a step that was announced and expected by most experts and analysts).

All these developments reduce the inflation rate on one hand and on the other hand increase the demand to support the economies with fresh and cheap available money. That results in the prognosis that the ECB will probably not raise the key interest rate throughout this year and it is very likely that we will not see a clear rise in the first half of 2016. This favours the E40 project to a great extent.

Based on the estimate of the capital investments required for the project, the Contractor should undertake a review and consultation with the various financial institutions, both the commercial and the development institutions to assess the appetite for the project and the likely lending terms, applicable to similar projects in the region

1.2. Review of financial institutions

The review of the financial institutions is divided into two parts. The first part lists the development institutions while the second parts reviews the commercial institutes. At the beginning a short description presents the institute, followed by the terms of borrowing, and finally the contact data. The information is based on personal interviews with several institutions on telephone and desk top research.

- European Investment Bank

The EIB is the European Union's bank. It is the only bank owned by and representing the interests of the European Union Member States. It works closely with other EU institutions to implement EU policy. As the largest multilateral borrower and lender by volume, it provides finance and expertise for sound and sustainable investment projects which contribute to furthering EU policy objectives. More than 90% of its activity is focused on Europe but it also supports the EU's external and development policies. One field of priority is Infrastructure. In 2014, the EIB provided 20.5 billion EUR to support infrastructure projects in Europe.

The EIB lends to individual projects for which total investment cost exceeds 25 mln EUR. These loans can cover up 50% of the total cost for both public and private sector promoters, but on average this share is about one-third. The project must be in line with its lending objectives and must be economically, financially, technically and environmentally sound. Financing conditions depend on the investment type and the security offered by third parties (banks or banking syndicates, other financial institutions or the parent company).

Interest rates can be fixed, revisable or convertible (i.e. allowing for a change of interest rate formula during the lifetime of a loan at predetermined periods). Repayment is normally on a semi-annual or annual basis. Grace periods for capital repayment may be granted for a project’s construction phase.

- European Bank for Reconstruction and Development

The EBRD offers financial products tailored to each client. Prospective clients have to demonstrate that their proposed project or business meets the minimum requirements to be eligible in order to be considered for EBRD involvement. EBRD financing for private sector projects generally ranges from $5 million to $250 million, in the form of loans or equity. The average EBRD investment is $25 million.

EBRD loans are based on current market rates and are priced competitively. Following a successful enquiry and once a project has been presented to the Bank, financial terms can be discussed in detail

with banking staff. The Bank offers both fixed and floating interest rates: fixed rate basis, linked to a floating rate such as LIBOR and floating rate basis with a cap or a collar. A margin is added on to the base rate. The margin is a combination of country risk and project-specific risk. This information is confidential to the client and the Bank. Full lending terms are negotiated with the client for each project.

- KfW IPEX-Bank (Kreditanstalt für Wiederaufbau)

KfW IPEX is responsible for international project and export finance. It provides tailored medium to long-term financing solutions as its core product and offers its customers reliability and in-depths industry expertise. The objective of the financings is to preserve and enhance the competitiveness and internationalisation of German and European export enterprises. The bank also finances economic and social infrastructure in Europe, helps to secure the supply of raw materials and supports the realisation of environmental and climate protection projects - all over the world.

The KfW IPEX is one of the leading providers of financing for vessels, aircrafts and rail vehicles as well as for investments in the construction and development of airports and seaports. There is no information about terms that is public available. All conditions are to be clarified in confidential consultations between the bank and the E40 project.

- „Marguerite" European Fund for Climate Change

The 2020 European Fund for Energy, Climate Change and Infrastructure ("Marguerite") was established with the backing of six major European financial institutions to make capital-intensive infrastructure investments and will target attractive long-term and stable risk-adjusted returns. Each of the six Core Sponsors has committed EUR100 million to the Fund. In addition, three further investors (including the European Commission) have committed an incremental EUR110 million to the Fund, bringing current commitments to EUR710 million.

There is no information about terms that is public available. All conditions are to be clarified in confidential consultations between the bank and the E40 project.

- Private banks

Not all private bank groups participate in the funding of infrastructure projects. However, the information that are available freely is often very limited. For that reason the following listing contents all freely available information. When there is only the name of the bank that means the bank do work in this filed but all information are only available in high-ranking direct contacts. The following banks have confirmed interest in investment projects: **HSBC Holdings, Royal Bank of Scotland (RBS), Santander Bank, Deutsche Bank.**

Deutsche Bank is one of the world's leading investment banks, the German Bank offers the entire range of integrated investment banking products and a comprehensive industry-specific consulting for institutional and public companies with capital needs.The offer ranges from simple bank loans to tailor-made and capital market-related financing solutions. There is no information about terms that is public available. All conditions are to be clarified in confidential consultations between the bank and the E40 project.

What's more, additionally to banks some experts[50] point out that infrastructure investments are an interesting field for big investment funds and there is the readiness to participate. This could be a further source for the project. Regarding the importance of the participation by the side of

[50] E.g. Daan Schalck, manager przystani Gent i Philippe De Backer, członek komitetu drogowego Parlamentu Europejskiego

governments and the financial demand it seems to be reasonable to get in contact with the governments of Poland, Belarus and Ukraine and clarify if there is the possibility of financial involvement. Surely, the best case would be financial participation of each government however all kinds of support for the project will enhance the chance for lending money under favourable conditions for the E40 project.

To sum up, the deep study on financial institutes has the results that only a few and limited information about possible lending terms are available. It is expected to establish personal contacts with the banks on high level and to discuss these conditions in this surrounding. Additionally the banks expect to be provided with a wide and deep amount of information concerning all parts of the projects (e.g. completed feasibility study). At the current stage of the E40 project it is not possible to start in-deep negotiations with the banks (neither from the point of the project's progress nor from the point of responsibility in the project).

Realisation of such important project as revitalisation of E40 inland waterway requires involvement of Belarusian, Polish and Ukrainian governments and defining the scope of needs in order to assess E40 project financing. The most favourable solution would be the highest possible governmental financing since it would attract further financing form European institutions.

1.3. Comparison to similar projects in Europe

One of the project to compare the E40 project with is the only canal construction in Europe in recent time - the "Canal Seine - Nord Europe" in France. This channel connects the Seine (down to Paris-Île-de-France) with the northern coast of France. That means it connects the wider area Île-de-France with the large ports in the north such as Le Havre and Antwerp. The total length of the canal is 106 km. The main difference between the Canal Seine - Nord Europe and the E40 project is not only the total length but also that the Seine-Nord Europe is situated in France only while the E40 project covers three different countries (Poland, Belarus and Ukraine).

This new connection will decrease the costs and the time needed for transport significantly. Especially the French farmers hope to benefit from the newly build Canal as it reduces the time and costs clearly and allows them to service the European market more easy and be more competitive.

The original building costs were estimated with the amount of 4.4 billion EUR in June 2012, but after new estimates in 2014 assumed total costs of at least 7 billion EUR. The original model was to establish a Public Private Partnership (PPP) but after the dramatic increase of the costs this option was lost. As a result, the main expenditures are funded by the government. Almost 30% of the total costs are taken over by the European Union. Finally, the changes had to be made in the construction of the canal which reduced the cost down to the original amount of 4.4 – 4.7 billion EUR. 2 billion are taken over by the European Union, 1 billion by the French government, another billion by the side of local governments and the rest of 500 million are covered by a credit with low interest rates from the Caisse des Dépôts.

The private companies who were interested to participate in the project are not part of the canal construction. Their role is to invest and build the infrastructure along the canal (for example the construction of multi-modal terminals).

The below figure shows the area of construction of the Seine Nord Europe Canal in the northern area of France.

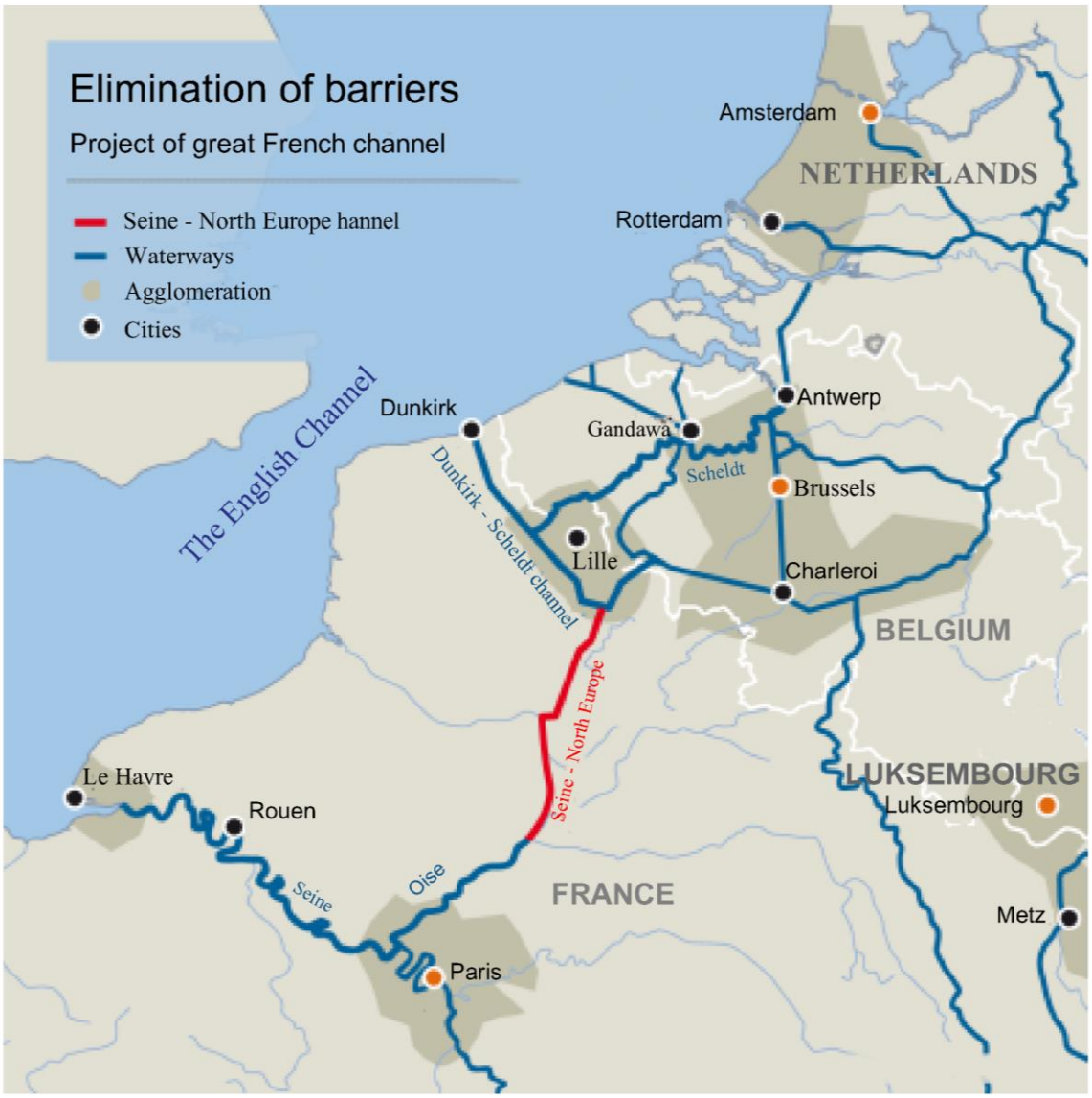


Fig. 45. The Seine – Northern Europe water channel
Source: VNF i DVZ

The example of the Canal Seine Nord Europe shows the importance of governmental participation in such large infrastructure projects. This concerns not only the financial part of the project but also the institutional one.

1.4. Participation of private companies in the E40 project

As part of the financial feasibility study –Component 4 of Terms of References a survey was conducted. The object of the task was to consult the potential private investors, stakeholders, multiplications and other experts in order to assess the interest on this project and promote the project of E40 reconstruction among them. The information was obtained through expert interviews and surveys of leading potential investors –logistics and shipping companies, infrastructure management companies and private investors. For this purpose the questionnaires have been designed to select the information about private investment conditions of the project. They include questions concerning:

- importance of the waterway for the region and for the companies own business;
- interest to invest in the project and possible conditions (the required returns on equity);

- own comments, propositions, and recommendations.

The are different potential investment groups: national owners and operators of terminals and ports, (e.g. TIS[51]), national and international logistics providers operating the alternative land corridors (e.g. PLASKE and DB Schenker), investing companies and private investors in logistics, especially waterborne, infrastructure and cargo owners (e.g. TIS, BMC[52]).

The main interest group in Ukraine is represented by grain and metal export companies located at the river ports. The main market players are Nibulon, Hermes –Trading and Nobel. From the foreign investors the private investors from China are ready to invest in Ukrainian grain logistics. The Ukrainian government supports the development of the national export capability in the agriculture sector regarding the National Program of Agriculture Development. The development of the import of goods from Poland and Baltic States to Belarus and Ukraine such as German building materials etc. can create the next potential investor group.

The conducted research and surveys confirm that the poor road conditions in the region lead to the necessity of alternative ways of transportation. This urgent demand and underinvestment in land infrastructure motivates the regional business to invest in the revival of the inland waterway connections. An example of such business activity is the restart of operating the passenger connection between Kherson and Kakhivka via Dnieper River, for the first time after a 20 years break. The river transport is two times more expansive then by bus but three times faster and is a good substitution for the public bus transport system. The private investments include a special fast fleet of old type and will be extended as far as the passenger flow grows.

Survey results also indicate a competitive position of the PETC 7[53] against the E40 in terms of the transport service providing to Europe. The E40 waterway is seen by infrastructure and transport chain providers on the Danube as a competitive logistics corridor. Therefore these companies try to strength their business positions and take maximum advantages from the time till the operation of the E40. It concerns e.g. the previous cargo shipping destinations Turkey – Germany or Ukraine – EU via Black Sea –Danube.

The typical problem identified is the absence of a holistic view on the waterway E40. It means that the business representatives take the focus on their national shares of the waterway E40 and accordingly identify the whole corridor with the corresponding part. This ”national view” favours local interests that are not obligatory negative while supporting the development of at least some selected waterway sections.

Also it is a common opinion of the interviewed experts that the private investments must be implemented in their countries under national state support. They are not ready to invest in foreign parts of the waterway without an appropriate legal basis at international level. The interest to invest in the Polish part of waterway reconstruction has not been identified by the foreign investors.

All of interviewed private investors confirm a short-term interest (no longer then 2-3 years) in return on investment as well as high (over the industry norm) interest rates to mitigate currently high business risks. That is an evident obstacle for the E40 project.

The project is considered to be rather long-termed in its realization. At the moment the investors and international logistics companies cannot recognize a sufficient logistics demand to make a project

[51] Transinvestservice (TIS) – the largest ports terminal operator in Ukraine
[52] BaltMarketConsult (BMC) is consulting on the problems of entrepreneurship and support programs financed from the EU structural funds.
[53] Danube waterway

feasible. They expressed the opinion that the cargo flow development along the corridor is not sufficient to make investments today.

Another barrier for the project realisation that is being emphasised by the investors is the dredging works on the Dnieper River from the Ukrainian side that has not been approved by the government yet. Another influential factor to be taken into consideration is a new tax reform and state budget plan for the next year; according to the interviewed experts, it could restrict the investment activity. This issue is even more visible in E40 section running through Polish territory.

Another hurdle for the business is the inefficient tariff system for the river shipping including charges for operation of locks and hydrotechnical equipment. However, there are some investors who are interested to participate in the national and local parts of the waterway restoration in order to open new business opportunities. The most attractive areas for investment are consider to be the passenger and bulk shipping transportation via Dnieper. The construction of cargo centers in urban areas remain a promising business.

The private company Nibulon[54] even developed a program to the revival of the navigation of national waterways with the proposition for financing the maintenance of infrastructure and hydrotechnical equipment through the increase of cargo transport volumes. The company builds its own fleet, invests in river terminals and transshipment equipment. The company made a proposition to the government to invest $2.5 million USD in the Deeping works on the Dnieper River. The duration of the works will not exceed 2 months and the period of return on investment will be between 3 and 4 years. The effect is an increase of the draft of vessels and thus shipping volumes and as a result the shift of over 500 trucks with grain from the roads to river.

On the other hand, the international experts consider the waterway as a great chance for socio-economic development of the region. Their own interest is primarily in the participation on the EU part of the waterway with the hope for the guaranteed co-financing and other incentives from the side of the EU. Some of them, based on the experience with European waterways projects, emphasize the importance of logistics planning – analysis of the origin and destination and the volume of cargo in detail before the capital investments could take place.

The members of the national logistics associations – the representatives of business are feeling not to be strongly enough involved in the project and provided with sufficient information. The logistics providers and investors requested more detailed information about the volume of reconstruction works along the whole waterway as well as the demand on special vessels in order to assess the opportunities to invest in fleet. They asked for the data to the required investments for the whole waterway, not only the estimation of the capital investments required for the construction of the Polish part, as well as the reliable forecasts for the cargo volumes for the waterway in order to make their business plans. The clear understanding of project output is needed.

One of the expert assessments of the project financing resulted in recommendation to choose the concessions as a form of PPP. In this case the return on investment is guaranteed by the state and investment risks, which are estimated for E40 as rather high, can be shared. That is why the return on equity must be as high as possible.

Financial security is an essential topic of concern by the side of the investors. The main obstacle is the absence of trustful relations between the business and government and effective regulations of these relationships. As to the interviewed private companies, the governments should provide incentives to

[54] Nibulon Ltd. Ukrainian company involved in production and export of agricultural products.

the investment in the project including preferences in land tenure and in PPP regulation that has been not effective and is expected to be reworked recently.

One of the best practice of PPP implementation is the project Dry Port in Odessa designed among others by EUA. The construction of the fly-over connected container terminal with the dry port was financed partly from the State Enterprise "Odessa Sea Commercial Port" (at the territory of the sea port and city) and partly from the private investor (at the territory of the dry port and in proximity). The construction was conducted in several phases. The project succeeded due to support of state and municipal authorities. It was included in the priority direction of port development and in the target development program for the Odessa city.

During our consultations some investors and stakeholders tried to interconnect with the national Ministries of Belarus and Ukraine with the aim to organize a constructive communication process between all parties. Therefore, among recommendations of the interviewed companies to the project is an advice to build an international interest group in form of a cluster. It should consist of the State Ministries of Transport, Waterways Commissions and other governmental authorities, key business representatives and research institutions. It was also recommended to organize public consultations, high level forums and further promotion of the E40 project in order to attract more attention of business and public authorities. It would be a solid foundation for the future, when sufficient cargo basis for the profitable project realization will exist.

All of the consulted private investors and experts were excited about the project idea. They are sure that without private investments the realization of the project would be hardly possible. First of all the ratification of international waterway regulation of navigation and services along the whole corridor is expected. More governmental support in the form of incentives and preferences as well as enhancement of risk sharing financing schemas and upgrading legal framework of PPP are required. These will surely contribute to the improvement of the investment situation. Currently, the business risks are assessed as high and desired return on equity period should not exceed 2-3 years.

Despite numerous efforts to greater use of inland waterways, the issue of maintaining the state of the rivers within the required standards, as well as political and environmental considerations existing in the various EU strategies have not been sufficiently considered. Without further investment in the TEN-T network, GDP in the European Union area will be lower by 27,294 billion EUR and the number of jobs will be reduced by 733,000. On the other hand, each EUR invested in TEN-T will bring 6 EUR revenue and 1 billion EUR investments will generate 20,000 new jobs. These analyses indicate the importance of economic policy and regional development of the European TEN-T corridors, together with the key element which is inland waterway transport..

1.5. Source of financing of Dnieper – Vistula channel

There are different models and competencies in the field of investment financing and maintenance of infrastructure on the rivers. Since the proposed revitalization of E40 IWW concerns mainly the Polish section of the waterway, a financing model presented by Polish Ministry of Maritime and Inland Shipping may be analysed here. The model is defined in the development strategy of inland waterway transport in Poland[55].

[55] Założenia do planów rozwoju śródlądowych dróg wodnych w Polsce na lata 2016-2020 z perspektywą do roku 2030, Ministry of Maritime Economy and Inland Shipping, document adopted by the Cabinet on 14 June 2016

Investment financing will come from many sources. Ministry assumes the financing will come from the European Fund for Strategic Investments (EFSI), local and regional authorities, energy companies and also financial institutions, insurance companies and other European funds[56].

Investments of energy companies may have a significant importance. In Poland water-energy potential is 68% and it occurs in the Vistula river catchment area, of which over half is the potential of Lower Vistula from the Pilica river to the Baltic sea.

Energa Ltd. company plans to construct in village of Siarzewo a second dam on the Vistula river and a water energy plant with accompanying infrastructure. Planned capacity of the water plant is 80 MW and annual energy production will reach 400 GWh. Estimated value of the project including the accompanying infrastructure is 3.5 billion PLN, of which investment part focused on energy production will consume 25% of total costs.

The main barrier in improving shipping conditions on E40 waterway is missing connection between Vistula and Dnieper rivers. Investments related to the construction of the proposed shipping channel to the Mukhavets river in the area of Polish-Belarusian border to the Vistula river in the area of Deblin (or Warsaw) are essential for the commissioning and integration of this system of waterways and transportation network in Europe. The missing link is primarily a section of the route located in Poland and it is channel on this section that needs funding in the first place.

Investment activities related to inland waterway transport in Poland and other sectors involved in the regulation of rivers and water management may be financed primarily from the following sources:

- national funds,
- EU budget (from the Community, national and regional level),
- preferential loans of international financial institutions,
- Polish Investments Programme,
- from the private sector.

To shorten the time of the investment implementation, as well as to reduce the cost, shortening the procedures related to the preparation of documentation and obtaining administrative decisions has significant influence.

-National funds

In the project of Implementation Document for Transport Development Strategy until 2020 (with outlook until 2030) it was determined the share of funds allocated for inland waterway projects at the level of 1.38% of the total allocation for 2014-2020, which is far from even the possibility of meeting the current needs. From the state budget, tasks related to inland shipping can be implemented within the budget priority: Supporting maritime and inland waterway transport (19.3).

In the period of 2014-2020 from the national and regional level (the EU budget) financial support will be possible from an operational program on low-carbon economy, environment protection, prevention and adaptation to climate change, transport and energy security, Regional Operational Programmes (ROP), the operational program for the development of Eastern Poland and European Maritime and Fisheries Fund (EMFF). The investment activities implemented under these programmes will be financed by the Cohesion Fund (CF) and the European Regional Development Fund (ERDF).

Activities under the Operational Programme may be supplemented by appropriate actions in the regional operational programmes that address the needs of specific territories. Inland waterways can

[56] Ministry of Finance, www.mf.gov.pl, access of: 05.02.2016 r.

benefit from funding under the Regional Operational Programmes for 2014-2020 for the development of Eastern Poland in the framework of the priority investment 7.2. Enhancing regional mobility through connecting secondary and tertiary nodes of the TEN-T infrastructure.

In order to support inland waterway shipowners Minister for Transport created Fund of Inland Shipping and Reserve Fund (SFO)[57]. The Fund was established in Bank Gospodarstwa Krajowego (BGK). This fund is mainly used to provide preferential loans for the purchase or renovation of vessels for the transport of goods by inland waterways.

The revenues of the Fund are primarily:

- Funds transferred from the state budget-in the amount specified in the budget act,
- Grants from the National Fund for Environmental Protection and Water Management,
- contributions from shipowners.

- EU funds

Financing investments by the extension of transport corridors of Ten-T programme is possible thanks to the CEF (Connecting Europe Facility). In the financial perspective 2014-2020, the European Union has allocated significant funding under the CEF instrument (Connecting Europe Facility - CEF) - 24 billion EUR. With this programme may be financed also projects in the inland waterway sector and therefore also E40 waterway.

At the beginning of July 2015, European Commission adopted investment plan for Europe, which provides support to both large infrastructure investments, as well as small and medium-sized enterprises. The investment plan aims to launch a public-private investment in the real economy of at least 315 billion EUR over the next three years (2015-2017). With the implementation of large-scale investments will be possible to reduce the disparities in the development of transport infrastructure between the EU Member States. Also, E40 waterway develop may be financed from CEF which supports improvement of transport infrastructure and sustainable development.

The basis of the investment plan for Europe is to be a European Fund for Strategic Investment (EFSI)[58]. The objective of the Fund is to stimulate economic growth in Europe through the mobilization of private investment by using public funds. The plan consists of three interdependent components: the first component is to run over the next three years, additional investment in the amount of at least 315 billion EUR, in order to maximize the impact of public resources and run private investments. The second element is the focus of initiatives to ensure that these additional investments meet the needs of the real economy. The third element is the introduction of measures to ensure greater regulatory predictability and the elimination of barriers of investment in order for Europe to become more attractive, which would multiply the effect of the plan. The fund is created in the structures of the European Investment Bank (EIB). The project envisages the creation of EFSI also created a list of potential investment projects, which may be supported.

The establishment of EFSI creates new opportunities to support investments related to E40 in Poland. Poland submitted a list of potential projects that could be supported under EFSI. In terms of transport the list includes dozens of projects of which several applies to international waterway E40, although it does not included investments related to the implementation of the connection of the Dnieper-Vistula. Submitted investment proposals along E40 waterway include:

[57] The main objective of the establishment of the SFO is the promotion of inland waterway transport, which consists of financing the modernization of the shipping fleet and other projects designed to improve the environment and safety of navigation.

[58] Komisja Europejska ogłosiła Plan Inwestycyjny dla Europy (Plan Junckera) w 2015 r.

- construction of dam below Wloclawek - the amount of 0.04 billion EUR,
- modernization of the lower Vistula from km 847 + 000 to 772 + 000 - the amount of 0.02 billion EUR,
- modernization of the Lower Vistula from km 772 + 000 to 718 + 000 - the amount of 0.02 billion EUR,
- modernization of the Lower Vistula from km 933 + 000 to 847 + 000 - the amount of 0.017 billion EUR,
- revitalization and reconstruction of the Brda river and Bydgoszcz water junction - 0.01 billion EUR,
- "Vistula" project including preparation of the feasibility study of the project to build a dam and hydroelectric power plant in stage 1 and implementation of investment in stage 2 - expenditures 0.834 billion EUR.

Implementation of the listed investments will lead to improvement on the part of the IWW E40, but will not remove the problem at section Plock - Warsaw or Zegrzynski-Brest.

- Preferential loans from international financial institutions, commercial loans and private capital

Investment activities in the inland waterway will be able to obtain additional financing in a form of loans granted by international financial institutions, such as the World Bank, the European Bank for Reconstruction and Development (EBRD) and European Investment Bank (EIB). These funds will allow to cover national co-financing of EU projects. EIB in particular is active in the area of financing project on transport infrastructure development, co-financed from EU funds. In Poland, a distributor of funds from the EIB is Bank Gospodarstwa Krajowego.

Additionally, the investments covered by the programme, may also be financed with the participation of commercial loans (f.ex. in case of insufficient coverage of own contribution to projects co-financed by the EU) and with the participation or complete financing by external investors, who, as shown by the experience of Western Europe, or the first Polish experience (DCT Gdansk), are increasingly involved in the financing of infrastructure projects.

- Polish Investment Programme

The governmental programme "Polish Investments" is to ensure the preservation of the current growth rate of investments in infrastructure projects with extended time horizon, while using long-term financing, as well as complement the current offer of financial institutions on the Polish market. The program is intended to promote viable projects, among others, in the energy, industry and transport and telecommunications infrastructure, in particular roads, railways and ports. Program resources include a state-owned company Polish Investment and Development (PIR) and Bank Gospodarstwa Krajowego (BGK).

Funding from BGK and PIR, totalling 8 billion EUR, may be used to finance projects eligible for support from the EFSI. These funds will be multiplied by attracting private capital.

- Eastern partnership Programme

Eastern Partnership is an initiative introduced to the system of external relations of the European Union (addressed to Armenia, Azerbaijan, Belarus, Georgia, Moldova and Ukraine). The European Investment Bank has created a financing instrument for projects within the EP (Eastern Partners Facility, 1.5 billion EUR) for investments in EP partner countries and supplementing the existing EIB

external mandate for investments in Eastern Europe (3.7 billion EUR).

2. Legal and institutional Feasibility Study

As part of the institutional setting of E40 IWW revitalisation, it is proposed to appoint a special purpose company in each country along the E40 route, which would include the largest energy companies, banks, insurance companies and ports. This will allow for accumulation of large capital fund that will be built from, among others, future investments into water energy plants on water dams and from selling produced energy.

Potential interested parties in Poland may include:

- Commercial companies –Energa, Enea, Lotos, Petrochemia Płock, Port of Szczecin-Świnoujście, Port of Gdańsk, GTC, North Port, Port of Gdynia, Gaz-System,
- Investment Fund Companies,
- Pension Funds,
- National financial institutions, such as BGK, KFK,PIR and others,
- Economic development agencies.

There are also other potential parties interested in benefiting from existing rivers which poses assets to invest into inland waterways (industrial water consumers, municipal economy, heating energy companies, agriculture and forestry).,

Institutional settings of E40 IWW may also be partly transferred from the experience and existing solutions used in German inland waterway transport, which interests are represented by Federal Association of Inland Waterway Shipping, founded in 1974 in Duisburg[59]. Currently in Germany, new financing scheme of inland transport is being discussed. The mechanism is based on the idea that fees and charges for using the infrastructure should finance investments.

2.1.Programme of Inland waterway shipping in the framework of Global Compact Network

There are four waterways of international importance crossing Poland, including E40, connecting the Baltic Sea from Gdańsk trough the Vistula, to Bug, Royal Channel to Pripyat River and further by Dnieper to the Black Sea.

From among 58 Conventions administrated by United Nations Economic Commission for Europe (UNECE), 11 concerns inland waterway shipping. There have been take actions in favour of increasing the participation of inland waterway shipping in overall transport of goods and passengers. Hydrotechnical investments are admittedly expensive but benefits of including this branch in the transport network surpass the financial cost of development of infrastructure and organisation of transport in this sector.

In the inland waterway shipping, the considerable legal problems are to do with regulations concerning cross-border waters of rivers flowing through different states. For regulating these problems, under ITC UNECE[60] auspices, so-called Water Convention-The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes-Helsinki has been developed. Being based on the net of natural watercourses and extending channels, ITC UNECE offered the network of corridors for international navigation.

[59] (Bundesverband der Deutschen Binnenschiffahrt e.V. (BDB))
[60] Inland Transport Committee of . United Nations Economic Commission

Apart from ITC UNECE other organizations also operate in the field of inland waterway shipping. Among them two commissions are worth mentioning: CCNR-Central Commission for the Navigation of the Rhine and the Danube Commission.

Central Commission for the Navigation of the Rhine operates based on convention of 20 November 1963 from Strasbourg. The Commission is composed of 5 members, of countries which Rhine is running through i.e. Belgium, Netherlands, Germany, France and Switzerland. Poland has an observer status.

The Danube Commission with registered office in Budapest, is operates based on Convention on the navigation on the Danube of 18 August 1948 from Belgrade. The Danube is flowing through 10 states: Germany, Austria, Slovakia, Hungary, Croatia, Serbia, Romania, Bulgaria, Moldova and Ukraine. However there are 11 member states of the Danube Commission: Austria, Bulgaria, Croatia, Germany, Hungary, Moldova, Russia, Serbia, Slovakia, and Ukraine. Intention to access the Commission has been express by France, Turkey and other European countries. The Danube is the only European largest river connecting latitudinally West and East of Europe.

In the framework of the United Nations Global Compact Programme initiative of the Secretary-General of the UN, Global Compact Network Poland, is creating a platform of the cooperation of business, government and self-government administration, non-governmental organizations and the sector of science and coordinates actions of given partners regarding:

- Improvement the significance of Poland in transport services as a part of the European Union by including Poland in the system of the European Transport Network,
- Ratification of the AGN Convention,
- Development of green transport corridors,
- Integration of inland waterway transport with other means of transport,
- Expansion and modernisation of national infrastructure of the inland waterway transport as environmentally – friendly.

Inland Waterway Shipping Programme is a long-term programme, its first stage will be implemented in the years 2015-2020.

2.2. Waterways in strategic UE documents

The European Union is also involved in the regulations concerning the inland water shipping, strongly supporting this sector of the transport. From the beginning of the process of European unification transport is a basic development factor of the European integration. The development of the modern and efficient transport infrastructure is the basis of EU transport policy. It finds its reflection in the strategic documents concerning the transport. The European Union in its strategic documents and programmes encourages development of the inland waterway shipping and inland waterways. Thus, special financial programmes have been developed for all member states in order to support waterways development..

On the other hand, EU has implemented a sequence of regulations reducing the possibility of implementing new investments into waterways. The NATURA 2000 is creating the package of directives comprising significant legal and financial barriers for modernisation and construction of new hydrotechnical structures.

”EUROPE 2020” Strategy

”EUROPE 2020 A strategy for smart, sustainable and inclusive growth” taken on by the European

Commission in 2010, for mid-term development of EU is a crucial document. The strategy presents actions which realisation will hasten way out of the crisis and will prepare the European economy to the challenges of the future. The strategy names priorities, of which the realisation will take place on the European and domestic level.

The ”EUROPA 2020” strategy uses 7 instruments of implementation, a leading projects called flag initiatives, and 10 integrated guidelines for the economic policy and the employment in member states. Member states are obliged to implement priorities of this strategy in a form of legal regulations and national policies..

EU 2011 White Paper

The European Commission includes the transport policy priorities in political documents, called white papers. The crucial document at present regarding the future of waterway transport is ”White Paper 2011, Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system”. This strategic document appoints aims of the transport development in the EU until year 2050.

The White Paper is underlining the need for development of ”base network” corridors, which would provide transport of large, consolidated quantities of goods and passengers. The legal base for concrete actions in this respect are the regulations of the European Parliament and Council 1315/2013 (TNT-T2 regulation) establishing guidelines for the trans-European transport network (TNT-T) and 1316/2013 (CEF3 regulation) establishing the fund for financing investments in the transport network (Connecting Europe Facility - CEF).

The transport policy accepted by the Community refers to three levels:

transport infrastructure investments,

Deregulation of the transport services market,

Quality of transport services.

The European Commission took on in the White Paper of 2011, the action plan including 40 initiatives for creating efficient and competitive transport system in EU, noticing the need of the unification of transport systems of the western and eastern part of Europe. The effects of implementing these initiatives should be: increase in the transport mobility, elimination of main development barriers in the crucial areas, an increase of employment, reduction of Europe’s dependence on oil import, as well as reduction of the emissions of the carbon dioxide in the transport by 60% till 2050 (the year 1990 the base year).

Among these initiatives there are those which directly regard waterway transport:

1. Initiative No. 5 regards creation of favourable conditions for inland waterway shipping. It proposes creating conditions for the optimization of the international transport on inland waterways, removing barriers limiting its growth, the evaluation and definition of tasks and mechanisms that would function in the wider European context.
2. Initiative No. 18 proposes creation of the EU shipping register and flag, also for the inland transport. It would guarantee high quality and the safety of the vessels.
3. Initiative No. 34 proposes determining TNT-T new guidelines defining the base network for European infrastructure that would integrate its western and eastern part and shape the European area of transport. They propose concentrating actions on these TNT-T elements which will bring the biggest ”European added value” (missing cross-border connections, intermodal

connections, major barriers).

The White Paper EU 2011 contains postulate to shift 30% of transport for distance longer than 300 km from road to railways or water transport until 2030 and by 50% till 2050. Close integration of water transport and seaports is also being postulated.

Programme TNT-T (Trans-European Networks)[61]

The TNT-T programme was funded based on chapter XV of Treaty Establishing the European Union. The programme is aimed at stimulating infrastructure investments in order to create integrated transport network, including all EU countries and all branches of transport.

The EU gives much importance to the development of multimodal transport networks. Within the framework of the TNT-T programme, the development of the transport infrastructure was transferred from the national to the EU level, to improve integration and increase the efficiency of the transport and economy. This policy is also of importance to the countries bordering EU.

A flexible links between different branches of the transport is a part of ”sustainable development” concept which is the underlying reason for European transport policy. On the basis of these assumptions, base network was drawn up, linking essential nods and routes creating ”transport corridors”. Within European transport network 9 corridors were proposed to create a backbone network of the European transport, having a strategic importance for the European transport as well as comprehensive network were suggested. In the framework of TNT-T programme, EU countries will get the possibility of integrating the domestic network with the European network through the development and improvement of the quality of the transport infrastructure.

Corridors are particularly important for dynamic development of Polish Baltic ports. Baltic location of Poland is supporting the trade exchange through the sea and intermodal transport, with the use of inland waterway. Ports Gdansk and Gdynia are categorized as base ports of TNT-T networks, which is creating the additional development potential but also requires efficient connections with hinterland, both by rail and road transport, as well as inland waterways. For so far unappreciated inland waterways shipping has a possibility to be effectively included in the network of inland connection of ports and their hinterlands.

- **NAIADES Programme**

In 2006 European Commission announced the NAIADES Programme with the aim of promotion of the development of the inland waterway shipping, in particular of supporting the process of including inland waterways in the European transport network. The programme is concentrating on creating favourable conditions for providing transport services by the inland waterway shipping, for acquiring new markets, supporting modernization of the fleet, implementing innovating solutions in construction and exploitation of the fleet, preparation of personnel, promoting the knowledge connected with the inland waterway shipping, improvement of infrastructure. The NAIADES II Programme is a continuation for the period 2014-2020.

Agreement on conditions of the navigation on E40 waterway

As a part of the study a draft of the international agreement was drown up ”Agreement about conditions of the navigation on the waterway E40”. The draft, modelled at the Convention of rules of the navigation on the Danube stipulates that:

[61] Trans-European Transport Network

- An international agreement will be signed between the governments of Poland, Belarus and Ukraine, concerning uniform rules of the navigation along the entire length of E40 waterway;
- navigation on E40 is supposed to be free and open for every state. Every country should provide the navigability on its part of the waterway;
- The Commission, being composed of representatives of signatory countries, one of each country, will be appointed. The Commission will have an appropriate secretariat and registered office. The Commission will have wide entitlement and duties. Within its competence will be, among others:
    - Putting up the general plan of basic works in the interest of navigation,
    - Carrying out works in the event that some of states will not be able to carry them out,
    - Establishing the uniform system of navigational conditions,
    - Standardization of river supervision,
    - Publishing guides, maps, pilot handbooks,
    - Drafting and approving budget and collecting fees;
- Decisions of Commission will be taken unanimously;
- On the area of each country an executive authority cooperating with the Commission will be appointed. It will be responsible for hydrotechnical works and governing the navigation in this state.

The draft agreement contains extensive chapter determining fundamental regulations concerning rules of navigation on waterway E40, issuing of the documents, principles of the border and customs checking, sanitary and police regulations. Also acting in the case of violation of the law by crew members or passengers are being described. Provisions determine also rules of conduct in case of ship accident or damage.

The regulations concerning the pilot services were included in the next section of the draft agreement.

The draft agreement is also regulating principles of covering expenses for providing the navigation. Amount of navigational fees are established by individual states in agreement with the Commission. However expenses on performing essential works providing the navigation are covered by each government on its section of E40 waterway.

In final provisions of the draft agreement principles of settlement of disputes as well as ratification of the agreement are determined.

2.3.Other EU regulations

Regulations presented below concern those EU member states which accepted the entire body of EU legal system. In case of this study, Poland incorporated these regulations to the system of domestic law through the series of acts and undertook to follow them. Remaining countries lying alongside E40 waterway can apply their own regulations separate from EU.

- Water Framework Directive (WFD)

Directive 2000/60/EC of the European Parliament and Council from 23 October 2000, is establishing the framework of the joint action in the field of water policy, heading towards the better protection of waters by establishing integrated European water policy, based on transparent, effective and cohesive legislative frameworks. Through the implementation of the provisions of the Directive reaching the appropriate security level and improvement in conditions are presumed, and at least keeping the current state of water, land and wetlands, directly dependent on aquatic ecosystems.

Moreover Directive should support a completion of other important tasks so as:

- Propagating sustainable water use based on the long-term protection of available water resources,
- undertaking an improvement in the state of the cleanness of the water environment. These undertakings should lead to limiting discharges, emission and losses of priority dangerous substances, and in the more distant prospect to cease or gradual eliminate this type of activities,
- Gradual limitation of polluting the underground waters and preventing their further degradation,
- Aspiration to reduce effects of floods and droughts which will allow for the realization of goals, such as: supplying better quality of surface and underground waters, reduction of underground waters pollution and preservation of territorial and sea waters.

The Water Framework Directive implemented a new administrative unit – area, preferring ”catchment area management” of the area of the one group of rivers, containing detailed guidelines concerning appointing mentioned above units and classifying water-bearing layers. The strong emphasis was put on international catchment areas, which management should be implemented as coordination of activities of all neighbouring countries.

Directive 79/409/EEC on protection of wild birds (Birds Directive)

The main aim of Birds Directive is keeping the population of bird species on the level which meets environmental, scientific and cultural requirements.

The Directive is indicating the minimum standard of the bird conservation on areas that belong to the EU countries, which means that individual member states can apply more rigorous methods. From a point of view of needs of the water management a sequence of the derogation to protective discipline included in it, is a crucial element of the Directive.

Directive enumerates 6 specific derogations:

1. In the interest of public health and safety,
2. In the interest of safety of the air movement,
3. In order to prevent the serious damage to crops, farmed animals, in forest, fish farming and waters,
4. In order to protect flora and fauna,
5. On account of needs of research works and teaching and another setting necessary for reintroduction and reproduction,
6. In order to allow, on condition of the close supervision and on the selective principle, to catching, keeping or other prudent using of some birds, in small amounts.

The scope of reasons for the derogation is extensive, however the Directive demands their mindful application and determines that it is possible to apply them in case that ”there is no other satisfying solution”. Every case of applying the derogation must be an individual decision of authorized body, indicating the species which the derogation is regarding, the scale of its use, acceptable means and methods of use, with precise description of the circumstances, the time and the place and entities entitled to it.

Council Directive 92/43/EEC from 21 May 1992 on the conservation of the fauna and the flora

natural habitats (Habitat Directive)

Habitat Directive with the Birds Directive constitute the European system of conservation of the nature, NATURE 2000. The Directive on the protection of natural habitats is more detailed, as well as is regarding more issues than included in the Birds Directive. The Directive is mentioning ”important in European scale” species of plants, animals and natural habit types:

- For which member states are obliged to appoint areas of their protection (areas NATURE 2000),
- Which member states are obliged to protect through the rigorous species protection,
- Which are an object of interest of the Union, are subject to an economic use, however which can be subject to control.

Complex of directives forming the network of NATURE 2000 areas

The concept and principles of creating the network of NATURE 2000 areas introduces the Habitat Directive. However it refers in many places to the Birds Directive, in which the part of provisions is included, especially concerning principles of selection of protected habitats important for birds.

NATURE 2000 is a cohesive European Ecological Network comprising:

1. Special areas of conservation (SAC) created for conservation of:

   a) Natural habitats,
   b) Habitats of species of plants and animals;

2. Special protection areas (SPA), created within the framework of the Birds Directive for the preservation of birds habitats, connected as far as possible with fragments of the landscape developed in the way to enable the migration, spreading and the genetic exchange of species.

Network NATURE 2000 is being shaped individually by authorized bodies of public administration, of the country where it is located. It is also important that this body is also authorized for possible corrections of its borders if such a need occurs.

Flood Directive (FD)

Directive 2007/60/EC of the European Parliament and the Council from 23 October 2007 on the risk assessment of flood and its management. The Flood Directive (FD) is of equal status as the General Water Directive and its content is consistent with the RDW content. FD supplements EU law in the field of the water management. Establishing framework for the risk assessment of floods and its management is the aim of FD, in order to reduce negative effects for the human health, for the environment, the cultural heritage and the business activity on areas prone to floods.

On the basis of preliminary risk assessment, member states for every area of the river basin, the unit of management or the section of international area of river basin, which is laid on their territory, determine such areas, on which they determine flood risk. Member states also prepare flood hazard maps and flood risk maps in the most adequate scale for defined areas.

RIS Directive

The directive on ”harmonized services of river information (RIS) on inland waterways in the European Union”, requires from member states establishing the information system on waterways

based on technical guidance included in the Directive, The Directive constitutes European framework for harmonized implementation of RIS concept and compatibility and interoperability of present and new RIS systems in Europe.

The RIS implementation will not only improve the safety of navigation and environment protection, but also will serve to increase efficiency and safety of transport as well as improve its competitiveness. The RIS implementation can also bring major benefits for the whole of society through shifting a part of road traffic to inland waterways, improvement in the safety of navigation, decreasing environmental pollution, as well as the reduction of transport costs.

Even though at present there are no accessible research results, which would describe global benefits in entire Europe, the evaluation carried out on the stretch of Dutch part of the Rhine is confirming benefits from the RIS implementation to the society as a whole.

2.4.Other international regulations

- **AGN Agreement - European Agreement on the Main Inland Waterways of International Importance**

After acceptance in 1996 by Economic Commission UN in Geneva convention a network of European system of waterways was established in the framework of European transport network (TNT-T), the classification of international waterways and principles of co-funding by the EU works associated with leading waterways in individual countries was determined. Based on existing data the waterways having European importance were selected, and their modernisation and inclusion into the European network of waterways was suggested.

The Convention admits the significance of inland waterway shipping resulting from ecological and economic benefits from using this branch of the transport in comparison to other branches, which is contributing to reduce public transport costs and reduce its negative environmental impact. In the framework of Convention the network of inland waterways of European importance (marked with letter ”E”) and the most important ports serving them were determined.

In the annex 1 to the Convention there are shown the waterways of international importance, also those on Polish territory:

1. E30 from Świnoujście through Szczecin, then by Oder waterway to Wrocław and further to Koźle, including the connection with river Danube and with branch from Gliwice E30-01.

2. E40 Gdańsk-Warszawa-Brest-Pinsk-Kiyv-Kherson. On this waterway two branches have an international aspect: E40-01 from the outlet of Desna River to Chernikhov in the Ukraine and with Boh River from the outlet to Mykolaiv-E40-02.

3. E70 Rotterdam-Berlin-Kostrzyn-Bydgoszcz-Elbląg-Vistula Lagoon-Kaliningrad.

The Convention describes and categorises technical parameters of the main waterways and channels in EU. It constitutes a starting point for further provisions and development programmemes of the inland waterway transport. The waterways of international importance according the annex 3 to the Convention should meet minimum standards from IV to VII class. The parameters which should fulfil the waterway in the specific class are also determined.

The inventory of international waterways includes Polish segment of E40 which was classified as

missing link, which means, that the waterway at present does not exist, however constitutes the element of the future network of international importance. This fact is determining the minimum class, which must have this waterway. The minimum required standard for international waterways class IV is accepted, however for a new connections a Va class is recommended. The Convention is essential for the development of the inland waterways shipping in the European context. Ratification of the Convention does not impose any obligation to implement a particular investments, however it imposes an obligation to coordinate with other partners, signatories of the Convention, planning and realization of undertaken actions.

The Convention was ratified also by Belarus and Ukraine. Poland[62],although it is a country of huge transit potential on West-East axis, has not signed an AGN convention so far, placing herself automatically outside the European network of waterways.

2.5.Selected strategic documents and studies of the Republic of Belarus

It is important to emphasize that Belarus in its strategic documents recognises the significance of E40 and effort has been taken for the modernization of hydrotechnical devices and channels in the last years.

- National Strategy for Socioeconomic Sustainable Development of the Republic of Belarus till 2020

In the Strategy[63] it is stated that ”a permanent increase of prosperity level of the society, cultural and moral enrichment of society are the strategic aims of sustainable development of Belarus with the use of the intellectual and innovative development of economy, the social sector, spirituality and the environmental protection for current and future generations”.

The transport infrastructure in Belarus is sufficiently developed but outdated and does not meet the needs of the economy and society at appropriate level. Therefore, in the sustainable development in the area of transport, a flexible revival and modernization of means of transport, flexible rate policy, increase of export and import volumes and transit of cargoes and passengers by Belarus as well as ensuring the biosecurity of the transport is necessary. In order to create modern transport infrastructure in the country and to provide long-lasting operation of the sector, the following are required:

- Applications of the new technologies,
- Extension and improvement of quality of transport services,
- Reduction of operating costs,
- Development of broadcasting (television and radio).

The document is fairly general, and it does not include any regulations concerning inland waterways or international waterways.

[62] The Convention was ratified by: Austria, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Hungary, Italia, Lithuania, Luxemburg, Moldova, The Netherlands, Romania, Russia, Slovakia, Ukraine.

[63] National Strategy of Social and Economic Sustainable Development of the Republic of Belarus till 2020, approved by the National Commission of Development of the Republic of Belarus and by the Presidium of the Council of Ministers of the Republic of Belarus in 2004.(protocol N 72-P of 11. 08. 2011)

Strategy of the Environmental Protection of the Republic of Belarus till 2025[64]

The document contains the list of directions of activity aimed at reducing the pressure on the environment and its protection. It is put down in the very general way without indicating any concrete decisions and their schedule.

The strategic aim of environmental protection till 2025 is improvement of its quality, ensuring the environmentally friendly living conditions, promoting global and regional solutions to environmental protection and the socio-economic sustainable development of Republic of Belarus.

Water Strategy of the Republic of Belarus till 2020[65]

The strategy establishes essential principle of the national policy concerning the use and protection of water resources in the Republic of Belarus. Basic aims carried out by strategy include:

- Reaching a good state of surface and ground waters,
- Ensuring the water supply for population, industry and rural areas,
- Reducing negative effect of floods and droughts,
- Wider use of water areas for recreational purposes.

Chapter 10 of document contains the records concerning the inland water transport. The priority problems of water transport are:

1. Inability for transporting goods between different regions of country because of existing missing links in inland waterway infrastructure,
2. Insufficient number of transit waterways.

National Programme for Inland and Maritime Transportation Development of the Republic of Belarus for the period of the 2011-2015[66]

The aim of the programme is: meeting the needs of the economy and population of the Republic of Belarus for transports by inland waterways and sea, ensuring its stable development and increasing the competitiveness. In the document such tasks are predicted as:

- Development of domestic water transport;
- Modernization of domestic water transport;
- Improvement in the legislative base in the field of water and maritime transport;
- Improvement in the management structure and development of the competitiveness on the market of transport services;
- Creating the Belarusian merchant fleet;
- Integration of the domestic internal water transport with the European water transport system;
- Reduction of import of works and services;
- Improving the ecological situation along waterways.

[64] Document approved with resolution of Collegium of the Ministry of Natural Resources and Environmental Protection (protocol N8-P of 28. 01. 2011)

[65] Strategy was developed according to provisions of the Water Code of the Republic of Belarus and with Act fom 14. 11, 2005.

[66] Program approved with Act of Council of Ministers of the Republic of Belarus from 24. 12. 2010. Original document is in Russian.

The programme forecasts:

- Increasing year–to-year volume of transported mass of cargo by inland waterway transport by average of 12%;
- Increasing passenger transport by 14%;
- Increasing the transport work output by 60-65% toward 2010 as base year;
- Improvement in the profitability of the production carried out, works and services by 16%;
- Reducing the import about 15.5%.

In the years 2011-2015 there will be modernisation of 60% of navigational hydrotechnical structures at the Dnieper-Bug Channel which will allow to improve navigational conditions and the water management at the channel, as well as make better use of its hydroenergy potential. Also additional 130 km of waterways will be modernized. In comparison with the previous period 2005-2010 the investment value in waterways will increase 4.5 times. In 2014-2015 the project of reconstruction E40 waterway at the section Dnieper-Bug was planned.[67]

2.6.Selected agreements between Poland and Belarus

1. Treaty between the Republic of Poland and the Republic of Belarus on the good neighbourhood and friendly cooperation, signed in Warsaw on 23 June 1992 (Dz. U. 1993, No. 118, pos. 527). According to the text of the document the special attention is paid to the improved transport accessibility in border areas, the development and modernization of the infrastructure of border crossing points, organization and cooperation on combating of organize crime. Moreover, much attention was paid to the cooperation between states in the protection and supporting of investments and creation of common commercial bank – both these subjects constitute a case of separate agreement.

2. Agreement between the Government of the Republic of Poland and the Republic of Belarus on the economic cooperation of 24 April 1994 (MP No. 26, pos. 286). Parties are committed to support the economic cooperation in all fields and sectors on the basis of equality, partnership and respect for the law of each Party. The cooperation is supposed to concern, among others, implementation of projects in the transport and border infrastructure.

3. Agreement between the Government of the Republic of Poland and the Republic of Belarus on border crossing points, drafted on 24 April 1992 (MP 23 July 2003, No. 37), which concerns regulations aiming at creating favourable conditions for the development of border traffic between the Republic of Poland and the Republic of Belarus, possibilities of the adaptation of the infrastructure for conducting the joint border checking and opening new, conveniently situated crossing points for the international traffic.

4. Agreement between the Government of the Republic of Poland and the Republic of Belarus about main principles of the cross-border cooperation of 24 April 1992 – under the agreement self-governmental bodies of the local and regional level are authorized for taking action being used for realization clauses of contract in the subjective defined scope, without obtaining approval of the central rank.

[67] Act of the Council of Ministers No. 862 from 03. 09. 2014, introducing changes in the Program.

5. Agreement between the Government of the Republic of Poland and the Republic of Belarus about the inland waterway transport of 12 January 2012 (MP 10 December 2012, pos. 930). Parties are obliged to cooperate in the inland waterway transport, granting the right to use waterways, ports and piers of the other party and to carriage of goods and passengers. Vessels and crews of the second country will be treated on the same principle like own.

2.7.Polish strategic documents

The national system of strategic documents was established in the act of 6 December 2006 on principles of conducting the development policy. The basic group of documents defining the development strategy of the country includes: long-term development strategy of the country, spatial planning concept, the mid-term development strategy of the country and the number of integrated strategies, among them the development strategy of transport.

It should be mentioned, that in Polish strategy documents and plans, inland waterways and the inland shipping are not perceived as the important means of transport and an intense development of this branch is not planned. From the end of 70s a participation of the navigation in freight transport is falling in Poland and at present it is taking about 0.4% of the volume of cargoes and the transport work.

Long-term Development Strategy of the Country[68]

Long-term Development Strategy of the Country (LDSC) – ”Poland 2030. The third wave of the modernity”, determines main trends, challenges and the concept of development of the country and necessary actions in the long-term prospect. The main aim described in LDSC is: ”improvement of quality of life of Poles”. Achievement of this aim should be measured, with the level of gross national product (GDP) per capita and with increase of social cohesion, reduction of the irregularity of territorial character as well as scale of the civilizational jump of society, as well as the innovation of the economy in relation to other countries.

In order to fulfil the vision, there are proposed three areas of strategic intervention:

1. The competitiveness and the innovation,
2. Balancing development potential of Polish regions,
3. The effectiveness and efficiency of the state.

Issues of the strategic development of the transport are in the second area, including strategic aim No. 9 – Increasing the territorial accessibility of Poland by creating sustainable, coherent and user friendly transport system. Actions concerning road and railway infrastructure and airports were emphasised. There is not any record concerning inland waterways.

Concept of Spatial Development of the Country (CSDC)

CSDC is the most important strategic document concerning spatial planning of the country, which also refers to LDSC.

CSDC presents the vision of the spatial planning of the country in the perspective till 2030 as well as determines aims and directions of the spatial policies with the action plan of the legal nature and

[68]Poland 2030. The third wave of modernity, Long-term Development Strategy of the Country, Monitor Polski, Warsaw, 01. March 2011, pos.121

institutionally essential for its realization. Indicates the principles and the way of coordination of public development policies having significant territorial influence.

The goals of spatial development policy in CSDC include:

1. Increase of competitiveness of main Polish urban centers in the European space, through their functional integration, while keeping the polycentric settlement structure system that favours cohesion;
2. Improvement in the internal cohesion and territorial balancing the development of the country, by promoting functional integration, creating conditions for the development of rural areas and exploiting the internal potential of all territories;
3. Improvement of territorial accessibility of country in different spatial scales by developing the transport and telecommunication infrastructure;
4. Forming the spatial structures supporting the achievement and maintenance of high quality of the natural environment and a landscape in Poland;
5. Increasing resistance of spatial structures to natural risks and loss of the energetic security and forming of spatial structures supporting defence capabilities of the state;
6. Restoring and strengthening Polish spatial system.

The inland waterway shipping and waterways did not find, according the opinion of navigational circles in Poland, an appropriate place in CSDC. Existing records ignore the inland waterway shipping as the significant branch of transport, in particular concerning Vistula and its connections, including E40.

Mid-term Development Strategy of the Country till 2020 (MDSC)

The main aim of Mid-term Development Strategy of the Country 2020 – Active Society, Competitive Economy, Efficient State[69] is a reinforcement and exploration of economic, social and institutional potentials, ensuring the sustainable development of the country and improvement of quality of life of the society.

MDSC indicates 3 areas of strategic intervention:

1. Efficient and effective state;
2. Competitive economy;
3. Social and territorial cohesion.

The goal 7, in the second strategic area, includes increasing the effectiveness of the transport, including action – the modernization and expansion of transport connections. In MTDS is stated, that ”The most important aim of Poland, in this field, is outside and internal (international and local) territorial availability (…). The second leading goal (…) is creating the consistent transport system, enabling efficient carriage of goods and passengers, using different types of transport, including ecological features of the rail and inland waterway transport”[70]

In case of inland waterway transport, it is stated, that – ”works will be undertaken in the modernization and development of infrastructure of the inland waterway transport (navigation routes

[69] Development Strategy of the Country 2020. Active Society, Competitive Economy, Effective State, Polish Monitor, Warsaw, 21 October 2013, pos. 882.
[70] Idem, p. 103

and ports) which will be carried out as far as financially possible"[71]. This excerpt is the only regulation in MDSC, concerning the matter of the inland waterway infrastructure or inland waterway shipping.

Development Strategy for Transport till 2020 (DST)

DST (with prospect till 2030)[72] is a strategic sectoral document. In DST there are indicated such directions of actions as:

- Continuation of RIS[73] system introduction on main waterways;
- Achieving and keeping navigational parameters determined in the European classification of inland waterways in Polish;
- Improvement of shipping and navigational conditions and the modernization of the infrastructure on waterways of tourist importance;
- Development of infrastructure of inland waterways, along with the improvement in their exploitation parameters as part of increasing seaport accessibility;
- Creating modern infrastructure of inland waterways of stable conditions for local and regional transport;
- Adaptation of infrastructure of selected Polish waterways or their sections to the requirements of European network of waterways;
- Aspiration to creating favourable conditions for using ecological types of the goods transport on the distance above 300 km.

In the long term it is predicted among others that:

- till the year 2020 development of the lower Vistula will be initiated (urgent because of the security of the dam in Włocławek);
- till the year 2030 there will be more inland waterways meeting European navigation classification.

More detailed text is in Implementing Document[74], in which there are proposals of investments which can be carried out, in order to achieve goals presented in the Strategy. It is determined that "the strategic aim for inland waterway shipping is to enable its development by improving parameters of waterways and getting at least III class of waterways at most possible longest sectors and removing the bottlenecks"[75].

There are indicated operational goals of inland waterway shipping:

1. Enabling to conduct the inland waterway shipping on greater distances and minimization of local distance transport;
2. Increasing navigable sectors of waterways for vessels needing at least parameters of III class waterways;
3. Turning away the fall in freight transport.

Investments planned in the document on the stretch of the waterway of the Lower Vistula are supposed to lead to restoration of hydroinfrastructure and in consequence to stabilize the main stream

[71] Idem, p. 107
[72] Polish Monitor, Warsaw 14 February 2013, pos. 75.
[73] River Information System.
[74] Implementing Document to Development Strategy of the Transport to 2020 (with perspective to 2030), Ministry of Infrastructure and Development, Warsaw October 2014.
[75] Idem, p. 27

of the river, constituting the fairway, at the same time, for units of the inland water shipping. It will allow for conducting the navigation on the long stretch of the Lower Vistula.[76]

2.8.Selected legal documents regulating environment protection issues in Ukraine

- Constitution of Ukraine. According to art. 16 the state is obliged to ensure the biosecurity and to sustain the ecological balance on the territory of Ukraine.

- Act on the protection of the natural environment of 25 January 1991. The chapter IV of this act is regulating functions of executive authority in the implementation of policy concerning environmental protection. The general functions of the executive authorities are: observation and environmental impact assessment, control, forecasting and research. The local authorities realize the policy determined by regulations of the central government. Among their competence, concerning environmental protection, e.g. collecting, processing and neutralizing materials harmful to the environment. The National Ecological Inspectorate is responsible for conducting the environmental impact assessment.

- ”Main principles (Strategy) of national ecological policy of Ukraine till the year 2020” of 21 December 2010. One of priorities is an improvement of the situation and of biosecurity of the state of Ukraine. The crucial tasks are: reduction of atmospheric pollutants by 10% till 2015 and by 25% till 2020, introduction of Euro-4 standards for petroleum and gas products till 2015 and Euro-5 till 2020, gradual reduction of norms of acceptable content in the air of dangerous substances and increasing in the energy power system of the state, the sources of a low level of carbon dioxide emission: by 10% up to 2015 and by 20% to 2020.

- ”National action plan for natural environment protection for the years 2011-2015” of 25 May 2011, predicting outputs of tasks for each of priority of the Strategy and assigning it to proper contractors. Moreover, the Plan determines exact dates of their realization and approximate value and sources of financing.

Furthermore in the context of Ukraine aspirations to integration with the EU a process of adapting Ukrainian legislation to EU regulations is progressing. In the last years Ukraine accepted a series of government regulations in the metrology, standardization and certification concerning nature and environmental protection, in order to adapt them to international requirements, especially EU. Formally Ukraine conducted amendments to legislation, which adapted the legal base to the requirements of directive 2001/80/EC of European Parliament and the Council from 23 October 2001 on reduction o emission of some pollutants to air from big objects of energetic burning. The real date of enforcement it are the years 2025-2030.

Generally the Ukrainian legal base corresponds to ecological challenges standing in front of the state. However this fact isn’t transferring it to the fast improvement in the state of natural environment in the Ukraine. The main reasons are a low effectiveness of the state authorities and the high level of corruption.

3. Experiences of other countries

[76] This record show the predicted way of regulation of Lower Vistula, through reconstruction existing there earlier and vandalized buildings in the form of spurs. Nothing is being said about regulation on lower Vistula from Plock to Warsaw, where there was not control buildings of this type.

In Germany, inland waterway transport handles annually 240 million tons of cargo. Transport services for major German centers of industry and commerce include inland waterway system which is also connected with the major seaports of northern Europe. The inland shipping transport work amounts to 65 million ton-km accounting for 75% of rail transport work and road transport amounted to 14 million t-km of cargo transported by rail. German waterways have a reserves capacity across all the corridors. Nevertheless, investment in inland waterways in Germany were disproportionately low compared to expenditure on the main road and rail network in 1991-2004. Uneven development of intermodal infrastructure may have negative consequences for the development of inland shipping. Violation of the proper functioning of the infrastructure caused by deficits in inland transport quality may have far greater consequences than in the road/rail transport due to the lack of alternative routes.

In Germany, as in other European countries, there are differences in the capacity of waterways due to the individual properties of the infrastructure of specified river channel.

The Rhine river and its tributaries is the most developed and well-maintained network of inland waterways in Europe. Shipping on the Rhine river takes place at 85% of its length. The flow of the Rhine is at average of 2200 m^3/s. Rhine is located at much higher altitude than the Elbe and Oder. At the mouth of the Moselle river depth of the fairway in relation to the equivalent water level is maintained at a level of 2.5 m. In the mountains the maintained depth is between 1.90 - 2.10 m.

The Elbe river from the German-Czech border to Hamburg is a part of East-Mediterranean corridor that belongs to the TEN-T network. In the area influenced by Elbe the share of inland waterway freight is 4%. Elbe River catchment basin is significantly different from the Rhine. Elbe river basin is supplied mainly by rainfall. Adjusting the water accumulation above Usti near Laba is for the Elbe and Vltava additional water supply source. Due to the depth of the fairway and tight corners on the Elbe there were developed special river vessels with a maximum draft of 2.40 m. Load capacity of vessels on the Elbe is much smaller than the vessels operating on the Rhine, which makes it possible to maintain a favourable economic flow of goods at the steady water level.

Already in the process of developing Development Plan for the Federal Transport Infrastructure in 1992, depth of the Elbe was set at 1.65 m in 345 days a year with respect to an equivalent state of low water. After the flood in 2002 implementation of the Plan for the Construction and Maintenance of the German part of the Elbe began. Since 2005 there are carried out regular maintenance of the river. However it did not help to achieve the originally set goals. Currently, the depth of the fairway in relation to equivalent low water condition on eight of the nine sections of the middle and upper part of the river is only 1.18 - 1.30 m. This does not guarantee the conditions of regular inland shipping. Arm of the Elbe corridor allows the passage of ships with a draft of 2.80 m. The limiting factor is, however, a Lüneburg lift with a maximum length of 100 m, which does not allow the passage of cargo ships with large engines or it requires time-consuming operations.

With the support of the European Commission the importance of the Elbe has increased, when it was included into TEN-T network. Nevertheless, there has been a halt of investment work on the river. In order to achieve a consensus between the different requirements regarding the use of rivers and related environmental issues, water resources management, use for transport, etc. Under development is a comprehensive strategy for development of the Elbe, which objective is long-term shaping of the river and improving navigation by quickly developing broad social consensus. In case of improving the navigability of the Elbe there should also be taken into account the interests of the Czech Republic, for which the Elbe is the only connection to the sea ports, and the availability of its waterways is guaranteed by international agreements.

Netherlands, due to natural conditions is seen as a country of experts in solving technical problems and maintenance of inland waterways and water management. Since long its fairways were used by the Netherlands as a method of transporting goods to remote locations. Inland waterways still plays an important role in the transport of the country because of its environmental benefits, safety, efficiency and low social costs and a high degree of reliability.

In the Netherlands 4800 km of inland waterways are the waterways suitable for sailing. The total length of the main transport routes and major waterways is 1400 km. Waterways in the Netherlands constitute a complete water system.

Thanks to its location at the mouth of several major European rivers such as the Rhine, Meuse, Scheldt, the Netherlands acts as a kind of gateway for Europe. In the Netherlands, it is typical to involve all stakeholders in the decision-making process: national and local authorities, representatives of the provincial administration of water, academic institutions, the business community and residents. All these groups are invited to the dialogue on the development of waterways and regions located close to them. This action has led to the development of widely supported strategy.

In Moldova in Port Giurgiuleşti on the Danube, a modern port complex is being created, which consists of the Giurgiuleşti International Free Port (GIFP) including a fuel terminal, grain terminal, vegetable oil, container terminal. There are also plans for construction of the roll on / roll off terminal. The complex also includes a passenger and cargo port, whose construction was financed from the state budget. With the construction of Port Giurgiuleşti Moldova gained direct access to the Danube and the opportunity to join the network of international maritime transport.

Development of effective system of inland waterway transport is a problem for the whole EU, because, with few exceptions, the transport sector generally loses with other modes of land transport, despite the high priority by the EU and financial support. Since 2001 support from European funds had little impact on improving the functioning of the inland waterways. In the period 2007-2013 projects support in the inland sector amounted to 1.3 billion EUR.

Many transport problems can be efficiently solved by combining all land transport modes into one complete logistics system. In countries that appreciate the economic importance of waterways, even 300-ton barges handle grain elevators located along the rivers which form network of waterways connected with the international system.

4. Organisational aspects

The condition for profitability of inland waterway transport is greater volume of cargo streams. This is a very important argument in favour of inland waterway in the light of the real possibility of a ban on entry of large trucks to the big cities. It would f.ex. require introduction of obligation to reload on to trucks of up to 3.5 tons, taking into account special permit exceptions. As a result, it could be some re-evaluation assessments of inland water transport, as time-consuming and cost-intensive handling and transport from the sender to the recipient would concern to the same extent inland water transport and rail transport as well as a large truck.

Road carriers lobby is particularly strong in countries along E40 waterway, including Poland. Lobby utilizes a road without incurring the cost of their construction. These costs are handled by society. It is difficult to convince the shipper that inland waterway transport may handle a container on at half the price of road transport, because at the same time the shipper must also cover the costs for the transport to the barge, loading, unloading, etc. Then profitability ceases to be obvious. Therefore, inland water transport must ensure the continuity and security of carriages. However, delivery of small

consignments of goods to different places, and this is an important factor in the supply chain, still gives advantage to road transport.

The issue of frequent shipments of small consignments of goods would help to solve the introduction of liner waterway transport. In this regard, significant benefits would use the Internet to quickly associate shippers with a suitable carrier.

A beneficial option would be the use of the Internet to enable shipowners of inland vessels to transactions related to trade in goods transported in large loads by inland waterway transport, i.e. coal, grain and other agricultural products, wood, stone, ores, fertilizers, building materials, etc.

Reducing road traffic through in built up areas would reduce the devastation of buildings and residential buildings in close proximity to routes with heavy traffic and also would save not only the life and health of the residents, but also domestic animals, not to mention the nature. Construction of new roads and rail routes take up land, which may be used in the future for living and development.

FINAL CONSLUSIONS

Data, analysis and research presented earlier in this report as well as working reports allows for formulating the following fundamental conclusions:

1. The first and most important one is the observation that the restoration of E40 waterway is feasible. It will evidently require a number of conditions, actions and efforts to be implemented, however, close cooperation of all stakeholders at international, national, regional level is essential for the success of the endeavour.
2. The most important condition for the success of the project is increasing fairway parameters allowing the carriage of cargo on the Vistula waterway. This investment should combine the functions of shipping, energy and solve a number of problems of water management, including flood and drought protection, etc. Vistula river is not wild or natural, but a seriously neglected waterway.
3. Analyses of the economy, foreign trade and transport in areas influenced by E40 waterway indicate that there is a prospect of achieving freight volume of over 6 mln tons per year on the inland waterway. It is confirmed by the forecast based on the model of the cargo flow along the E40 route.
4. Calculations of potential economic effects that can be brought by restoration of the E40 waterway shows that the increase of fees for lockage and waterway use but below their level used on the waterways of Western Europe, can in the selected variant of the route help to achieve revenues exceeding the annual operating costs of the waterway in accordance with the "user pays" principle. The calculations also indicate price competitiveness of the transport of goods by water compared to rail transport and road transport. This competitiveness increases with the distance, transported cargo volume and cargo mass per unit.
5. Economic analysis of costs and benefits of proposed variants of the route connecting the Vistula with Mukhavets (Belarus) shows positive indicators (Economic Net Present Values - ENPV and Economic Internal Rate of Return - ERR) for the third variant of the connection.
6. Assessment of the social impact of the revitalization of E40 waterway is clearly positive. Areas in Poland, Belarus and Ukraine influenced by the waterway are relatively less developed in comparison to others. Revitalisation of E40 waterway will bring positive impulses for economic development, demographics and economic activity of the inhabitants.
7. There can also be expected a wide variety of effects of the waterway restoration that are difficult or impossible to determine in the financial values. These in particular include:
    - improved flood protection.
    - improved water supply for population and industry,
    - increase in investment attractiveness of the region,
    - development of industries related to construction, renovation and operation of inland vessels,
    - strengthening transborder co-operation.
8. Comprehensive, but inevitably incomplete environmental impact assessment analysis, showed that the restoration of E40 waterway will have a multiple impact on the environment, especially on NATURA 2000 areas. It was observed, however, that using appropriate technologies, technical solutions and compensation measures, the negative effects can be minimized. Also wide public consultations are required in order to take into account the views

of local communities and environmental institutions.

9. In the report on hydrotechnical and navigational issues of E40 waterway, based on the analysis of the potential route of the channel linking the Vistula with Dnieper river, optimal variant was selected - Variant III. The channel route runs from the entrance to the Vistula River in the estuary to the Wieprz river to Mukhavets in the region of Brest. One cannot exclude small deviations from the proposed routing, in each case, however, the basic condition of its creation is the possibility of shipping on the Vistula waterway. Very careful and sensible approach should be taken to the design of water supply system, with a view of possible climate change.
10. Reports also point to the potential sources of financing for E40 waterway restoration. These include:
    - European Union funds
    - national budgets,
    - preferential loans of international financial institutions,
    - private capital.

    European Fund for Strategic Investment seems to be a particularly promising source of funding, due to its objectives and the volume funds at its disposal. It is also important to enter E40 waterway into a list of investments to be financed during next EU budget perspective.

    Inadequate financing is a major reason of progressing depreciation of the inland waterway infrastructure, f.ex. in Poland resources allocated to finance the ongoing maintenance of waterways are not sufficient to at least ensure restoration of the existing basic infrastructure. Other countries along E40 waterway, namely Ukraine and Belarus, also face the problem of waterways negligence. However, the same can beobserved in countries located on the Danube waterway.
11. There has been done an extensive review of documents and regulations applicable to restore E40 waterway restoration, in particular EU documents, international agreements and national regulations of Poland, Belarus and Ukraine. The analysis showed no significant legal obstacles preventing actions to restore the waterway. These documents emphasize the importance of the development of inland shipping for reduction of external transport costs i.e. low emissions and climate change.
12. In order to deter degradation of waterways and enhance development of inland waterway transport is necessary to define and consistently implement the national policy to support the development of inland waterway transport and to provide adequate financial support.
13. Implementation of such a major project as revitalization of E40 waterway (especially on the section of the Vistula river to Mukhavets) requires involvement of governments of Belarus, Poland and Ukraine, and identification of the extent of the needs and interests as well as the tendencies and possibilities of financing E40 project. The most favourable solution would be the largest possible share of the state in financing the project, regardless of the fact that all other types of support for the project also increase its chance for loan on favourable terms, and increase interest other countries and European institutions in the project.
14. A major problem in the implementation of the revitalization project of E40 waterway is the lack of holistic approach. Usually individual stakeholders and regions (especially in Ukraine and Poland), focus their efforts on national sections of E40. This "national vision" favours primarily local interests, which results in development of at least some selected sections of the

waterway - positive aspects. However, it is not a sufficient incentive to make full use of its potential and efficiently development shipping along the entire E40 waterway and in consequence to include of this route to the European transport network.

15. Inland waterway shipping usually involves a number of countries and regions along the given waterway, thus it is an important factor to stimulate inter-regional integration. The functioning of the international shipping routes requires the cooperation of many public and private institutions, so that it becomes an effective tool to stimulate regional development conducive to the development of various sectors of the economy, including intermodal transport, tourism, logistics and modern sectors of the energy industry: bioenergy, wind power and car industry. Inland waterways can be a part of urban transport while ports and river transport companies are major economic players generating new jobs.
16. From the point of view of sustainability, shifting cargo from road and rail to rivers significantly reduces the pressure on natural environment. Navigability of Baltic-Black Sea transport corridor will create a strategic transport channel complementary to other transport links. Measures to activate the waterway must be carried out with respect for the environment and river ecosystems. The Baltic Sea - Black Sea transport corridor will bring economic and political benefits, for the countries located along the course of E40 waterway and also directly to the adjacent regions. This increases the chances of further possible to use support for investments in transnational projects to increase the capacity of transport networks in the key aspects crucial for European Union area transport cohesion.
17. European waterway routes come to the western border of Poland and further east shipping is is practically impossible. Therefore, east-west-east transit is carried out mainly by truck or railway infrastructure.

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