# Improving port hinterland connection capacity: a comparative study of Polish and Belgian cases

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## 1. Port hinterland connection – the European perspective

Europe is currently in a situation where the pressure from increasing goods flow rises. The road network is congested during peak hours and on crucial stretches, the rail sector is struggling to increase freight transport capacity, and the existing land based infrastructure cannot readily cope with the increase in traffic volume at the pace at which it is now growing, mainly due to bottlenecks. The alternative for land traffic may be inland navigation. However, this form of freight requires adequate technical conditions. In Flanders navigation is hampered in some locations by too shallow waters, while in Pomorskie Region (Gdansk/Gdynia case) it plays a marginal role due to years of degradation of the existing water ways network. As European freight volumes might increase with as much as 50% by the year 2020[1], the situation will continue to worsen unless action is taken.

Solution of the freight problem across the continent is largely depending on policies pursued at national, regional and even municipal level. A number of EU documents is aimed at unifying and changing local approaches to transportation management and development. General perspective on transport development is presented in White Paper on European

[1] Institute of Shipping Analysis, Göteborg, Centre for Maritime Studies Turku, BMT Transport Solutions GmbH, Swedish Maritime Administration, Ministry of Transport and Communications of Finland, Tallinn Port Authorities, Klaipeda State Seaport Authorities, Ministry of Infrastructure of Poland, Danish Maritime Authority, and Norwegian Coastal Administration. (2006). *Baltic Maritime Outlook 2006.*

Transport Policy for 2010[2]. The document proposes emphasizes linking up the modes of transport and unblocking the major routes as the key courses of action. Considering the inland freight it proposes improving quality in the road sector and revitalising the railways. Short sea shipping has been indicated as form of freight which makes the transport system in Europe more sustainable.

The most significant project dedicated to improvement of inland transport quality is construction of the TEN-T network. In case of Antwerp - the network axis with most impact to the E313 motorway is rail axis nr. 24 Lyon/Genova – Basel – Duisburg - Rotterdam/Antwerpen, which includes the Iron Rhine Rheidt - Antwerp railway and inland waterway axis nr.18 Rhine/Meuse-Main-Danube with sub-section Albert canal. Other TEN-T network links have little or no impact on the E313 motorway. In case of Gdansk – Gdynia – it is planned to strengthen the north-south corridor consisting of road route Gdansk – Torun – Katowice - Vienna/Bratislava and railway line Gdansk – Warszawa – Vienna/Bratislava. Regarding waterway, the network covers only a short section of the Vistula River.

The Marco Polo program[3] aims to shift freight transport from road to short sea shipping, rail and inland waterways, as well as to support innovative projects. Using the proven mechanisms of the current program, Marco Polo II[4] includes two new activities:

- Greater geographical coverage solutions for intermodal transport and alternatives to road transport, also outside the EU
- The motorways of the sea, which are to encourage the shift towards short sea shipping.

A change in existing freight model is also expected due to promotion of inland waterway transport. The multi-action program for the development and promotion of inland waterway transport (NAIADES)[5] contains recommendations for actions to be taken between 2006-2013 in order to fully exploit the market potential of inland navigation and more efficient use of spare capacity in inland waterway transport bandwidth. The program includes a series of measures relating to legislation, coordination and funding. It focuses on five strategic areas:

- Creating favourable conditions for the provision of services and development of new markets
- Incentives for the modernization of the fleet

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[2] European Commission (2001). White paper – 'European transport policy for 2010: time to decide', (COM(2001)370). Brussels.

[3] European Parliament and Council, Regulation (EC) No 1382/2003 of 22 July 2003 on the Marco Polo.

[4] European Parliament and Council, Regulation (EC) No 1692/2006 of 24 October 2006 on the Marco Polo II.

[5] The European Commission. (2006c) A multi-action program for the development and promotion of inland waterway transport (NAIADES) (COM (2006) 6.). Brussels.

- Measures related to the lack of skilled workers
- Promotion of inland waterway transport as a valuable partner in business
- Ensuring adequate infrastructure through the expansion and maintenance of a European network of waterways.

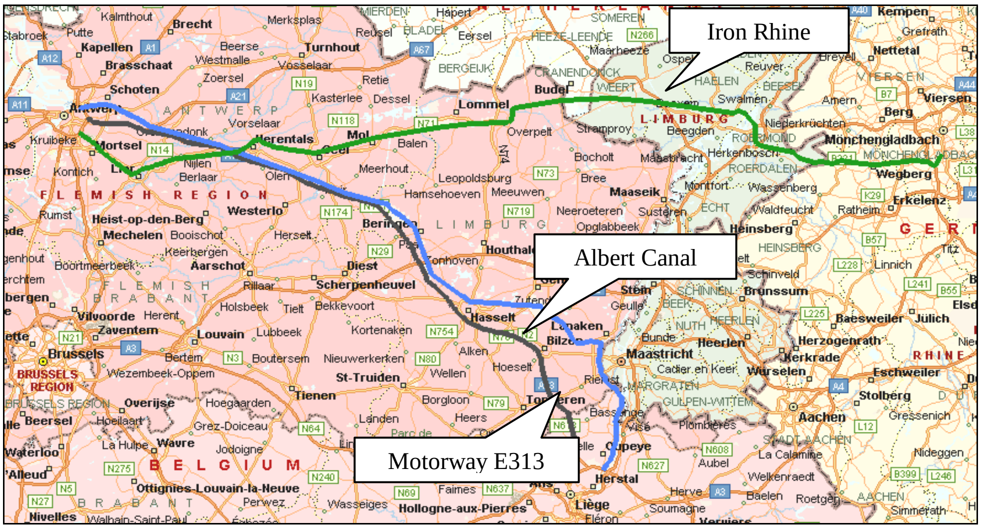
# 1. The case of Antwerp

## 1.1. Preface

For the Antwerp case we analyse the situation of the E313 motorway, which is approximately 120 kilometres long. It connects Antwerp to Liège and is a link to the Ruhr area in German, as can be seen in

Figure 1. For most of its length, it has two lanes in each direction.

Figure 1: Motorway E313 (grey), Iron Rhine (green) and Albert Canal (blue)




*Map source: Microsoft MapPoint 2009*

The Port of Antwerp, the second largest port in Europe for international freight shipping, is one of the main generators of heavy goods vehicle traffic for the E313 route. Data for recent years shows that around 40% of all goods flows of the Port of Antwerp are transported to/from the port by road.

The motorway features particular competition from both rail and inland waterways, especially in dealing with port-bound traffic. As to waterways, the Albert Canal, which runs mainly in parallel with the motorway, is currently being subject to capacity expansion through the extension and elevation of a number of bridges that cross the canal. From the rail side, the

Iron Rhine is a potential competitor of the E313 motorway. It is the historic railway line, started up in 1879, that runs from Antwerp to the German Ruhr area. Since 1991, this track is no longer used for international transport. Nowadays, the so-called Montzen route is used, which makes a detour over Liège. The Belgian Government has stated its intention to resume and intensify the use of the Iron Rhine railway line. Restoration, alteration and modernisation (referred to as "reactivation") of the Iron Rhine route will therefore be required. Both Iron Rhine and Albert canal are part of the TEN-T network. The Iron Rhine falls within rail axis nr.24 (Lyon/Genova-Basel-Duisburg-Rotterdam/Antwerpen), whereas the Albert Canal is part of axis nr.18 (Rhine/Meuse-Main-Danube).

Based on an analysis for the period 2001-2007 of the historic data on port turnover for the Port of Antwerp, traffic count data obtained from the Flemish Traffic Centre on heavy goods vehicle traffic, and results from simulations with the Freight Model Flanders, there seems to be a relation between the traffic volumes of those vehicles on the E313 motorway and the port turnover, although not very pronounced. The forecast increase in port traffic may therefore have an effect on the heavy goods vehicle traffic on the E313 motorway.

Capacity optimization seems to impose itself here, in view of the frequent occurrence of congestion and the many accidents featuring the motorway. The severity of the problem shows up also in a survey held among Flemish road transport companies[6]. On the other hand, a number of more general capacity optimization measures are being put in place by the European Commission but more importantly also by the Flemish government. The latter also deploys a mode shift strategy, with the aim of increasing the chances of both inland navigation and rail transport.

## 1.2. Freight model

For the case of Antwerp in order to outline possible future developments, first, a qualitative impact analysis was performed of port traffic evolutions, Albert canal expansion, short sea shipping evolutions, European policy developments, instruments developed within Flanders Logistics, Flanders Port Area and Flanders Inland Shipping Network, the possible re-introduction of the Iron Rhine, road infrastructure bottlenecks, and other important influencing factors on the E313. Those are described in detail in section below. Expanding road infrastructure over part or all of the motorway length was not considered to be a feasible solution at reasonable notice.

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[6] Gevaers, R., Maes, J., Van de Voorde, E., Vanelslander, T., Vergauwen, B. (2009). Capaciteitsbenutting in goederenvervoer, research report.

Based on the findings from the impact analysis, a link was made between the selected influencing factors and scenarios in the Freight Model Flanders. Several scenarios were built to construct a min-max range that describes assumptions on possible developments, which are dealing with the economy, policy, population and household consumption, imports and exports, and inland ports.

Modelling a reference scenario and 12 alternative scenarios for the year 2020 was done with the Freight Model Flanders, which was commissioned by the Flemish Traffic Centre (Vlaams Verkeerscentrum) and developed by K+P Transport Consultants, Tritel and Mint. Each scenario (see Table 1)) is a combination of several assumptions: economic, policy-related, linked to population and household consumption, dealing with import and export, and with inland navigation and ports. Underlying assumptions are explained in the next section.

Table 1: Scenarios

| **Scenario** | **Economic assumptions; assumptions import and export** | **Policy assumptions** | **Assumptions inland navigation** | **Port assumptions** |
|---|---|---|---|---|
| 1 | Low growth | Continuation of current policy | Continuation of current policy | Following economic assumptions |
| 2 | Low growth | Continuation of current policy | Extra measure inland navigation | Following economic assumptions |
| **Reference scenario** | **Normal growth** | **Continuation of current policy** | **Continuation of current policy** | **Following economic assumptions** |
| 3 | Normal growth | Continuation of current policy | Extra measure inland navigation | Following economic assumptions |
| 4 | Normal growth | Moderate transport policy | Continuation of current policy | Following economic assumptions |
| 5 | Normal growth | Moderate transport policy | Extra measure inland navigation | Following economic assumptions |
| 6 | High growth | Moderate transport policy | Continuation of current policy | Following economic assumptions |
| 7 | High growth | Moderate transport policy | Extra measure inland navigation | Following economic assumptions |
| 8 | Normal growth | Internalizing external costs of all modes | Continuation of current policy | Following economic assumptions |
| 9 | Normal growth | Continuation of current policy | Continuation of current policy | 0.5 x results economic assumptions |
| 10 | Normal growth | Continuation of current policy | Continuation of current policy | 1.5 x results economic assumptions |
| 11 | Normal growth | Internalizing external costs of all modes | Continuation of current policy | 0.5 x results economic assumptions |
| 12 | Normal growth | Internalizing external costs of all modes | Continuation of current policy | 1.5 x results economic assumptions |

Source: own composition

Based on the freight model, it is possible to simulate future freight flows, split up by mode (road, rail and inland waterways) and NST freight category. A classical 4-step model has been used:

- Generation of flows: determines the flows leaving from (or arriving in) zone *i* (*j*) in a period. For freight transport, this means that for freight category *k* it is calculated how many tons are leaving from (arriving in) zone *i* (*j*);
- Distribution of flows: the generation of flows serves as input for this stage. The freight flows are determined between zones *i* and *j*;
- Mode choice: analyses which mode is used to move tons from zone *i* to *j*;
- Assignment: comprises route choice, after translating the tonnages into number of vehicles in a traffic conversion section.

Transport Logistic Nodes (TLN) are also included in the model. A TLN zone is a transfer point where loads change the means of transport, which is not necessarily the mode, simultaneously with a re-consolidation of the shipment. The Freight Model Flanders takes into account the so-called decided infrastructure changes of the Flemish government.

**Economic, import and export assumptions**

In *European Energy and Transport Trends to 2030 – update 2005*[7], a yearly economic growth of 2% until 2020 in Belgium is reported. This economic growth represents the yearly evolution of the Gross Domestic Product (GDP) in real terms, adjusted for inflation. This leads to 3 economic assumptions in this research project:

- Economic assumption 1: low growth (growth GDP – 0.5% = 1.5%)
- Economic assumption 2: normal growth (growth GDP = 2%)
- Economic assumption 3: high growth (growth GDP + 0.5% = 2.5%)

For foreign zones, the evolution of GDP is used as a proxy for the magnitude of freight flows between Flanders and those zones. We also refer to the forecasting report of the European Commission[8].

The growth of the import and export flows in value also serves as an explaining variable in the freight model. Both import and export flows follow the economic assumptions described above. Based on Federaal Planbureau[9], it is assumed that the import and export flows will

[7] European Commission. (2006b). *European Energy and Transport Trends to 2030 - update 2005*. Viewed 5 December 2008.
[8] *Ibidem*.
[9] Federaal Planbureau. (2008). *Economische vooruitzichten 2008-2013.* Brussels.

grow by 4.3% yearly when we have a normal growth in the economic assumptions, 3.8% if economic assumptions indicate a low growth, and 4.8% in case of high growth.

**Policy assumptions**

A distinction is made between a continuation of the current policy, a moderate transport policy, and a policy where the external costs of all transport modes are internalized.

In the **assumption of continuation of the current policy**, a growth of 0.1% per year of the costs of road and rail transport is assumed to exist. A growth of the costs of road transport is considered as probable given the far advanced deregulation of the road freight transport sector, where the largest cost advantages from deregulation have already been gained. For rail freight transport, the persistent dominance of national railway companies is assumed. A deregulation leads to a reduction of national subsidies and will cause an upward pressure on the prices[10]. These growth percentages should be seen as relative percentages. In other words, road transport and rail transport will have a slightly bigger cost increase compared with inland navigation. In this analysis, it is not necessary to look up the actual growth percentages. Growth percentages respecting the relative position between the modes, which are much easier to obtain, are sufficient.

**The moderate transport policy** differs from the continuation of the current policy in the assumptions made for the evolution of the costs for road and rail[11]. It is assumed that road pricing is introduced on the highways in the Benelux. The amount is set to be €0.15 per kilometre and it will replace the traffic tax and the Euro-vignette. On the non-highways, this value is set to be €0 per kilometre[12,13]. For rail, it is assumed that a higher user fee will be introduced: in total €3.30 per train-km).

**Internalizing external costs of all modes** starts with the assumptions from the scenarios on continuation of current policy and of moderate transport policy. It is now assumed that the internalization of external costs will apply to all modes of ground transport.

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[10] NEA Transport research and training and Universiteit Antwerpen. (2007) *Vervoersprognoses IJzeren Rijn*. Rijswijk.

[11] The values mentioned in this text refer to NEA Transport research and training and Universiteit Antwerpen (2007).

[12] In theory, a difference should be made between Belgian, Dutch and Luxemburg trucks on the one hand and other trucks. Given the fact that the traffic tax and Euro-vignette will disappear for the Belgian, Dutch and Luxemburg trucks, the other trucks have still a cost per kilometre different from zero. However, in the freight model, it was not possible to make this distinction.

[13] It is advised to calculate whether this measure is budget neutral.

According to NEA Transport research and training and Universiteit Antwerpen[14], the following values were used in the model and applied to all types of infrastructure:

- Road: €0.075 per tonkm
- Rail: €0.005 per tonkm
- Inland waterways: €0.005 per tonkm

**Specific assumptions for inland navigation**

In order to simulate cost advantages for inland waterway transport, specific assumptions have been introduced:

- Continuation of current policy;
- Extra measure for inland navigation: a yearly cost reduction of 2% of the cost of inland navigation, e.g. as a result of more efficient use of inland waterways.

**Port assumptions**

In scenarios 9-12 (see Table 1), explicit assumptions about the port of Antwerp are taken into account. Scenarios 1-8 and the reference scenario comprise a basic growth path for the port of Antwerp which is based on the different economic assumptions.

Additionally, in scenarios 9-12 some specific growth patterns are considered to simulate a weakening or strengthening of the competitive position of the port of Antwerp:

- In case of a stronger competitive position it is assumed that the incoming and outgoing flows in tonnage for the port of Antwerp are 1.5 the initially estimated values;
- In case of a weaker competitive position, it is assumed that the incoming and outgoing flows in tonnage for the port of Antwerp are half the initially estimated values.

Scenarios 9-12 therefore allow for changes in port competition within the freight model.

### 1.3. Simulation results

A three-level approach has been adopted to interpret the simulations results. The full simulation results themselves are available in the report by Aronietis *et al.*[15]. Three types of output were produced:

- Calculation of total tonnages and growth figures for every scenario. For some specific points on the E313 motorway the tonnages (and hence vehicles) passing by are analyzed.

[14] NEA Transport research and training and Universiteit Antwerpen. (2007), *Op cit.*

[15] Aronietis, R., Grosso, M., Meersman, H., Markianidou, P., Pauwels, T., Van de Voorde, E., Vanelslander, T. and A. Verhetsel (2009). *Tactische studie E313 - doorrekening toekomstscenario's en goederentransport - onderzoeksrapport*. UA

- Evaluation of route changes based on difference plots.
- Mode shift analysis.

Figure 2: Measurement locations on the E313/A13 motorway


*Map source: Microsoft MapPoint 2009*

- In all simulation results, the base year is 2004, while tonnages in the scenarios refer to 2020. Results of the first type of output refer to specific locations on the E313, as illustrated in

**Figure 2**. In particular, locations 1 and 2 are close to Antwerp and are selected to illustrate the direct effect of the port of Antwerp. Locations 3 and 4 are selected in order to give a view on the tonnages after the split between the E313 and E34. Finally, locations 5 and 6 are important because they are located in the vicinity of the intersection Lummen (E313 and E314).

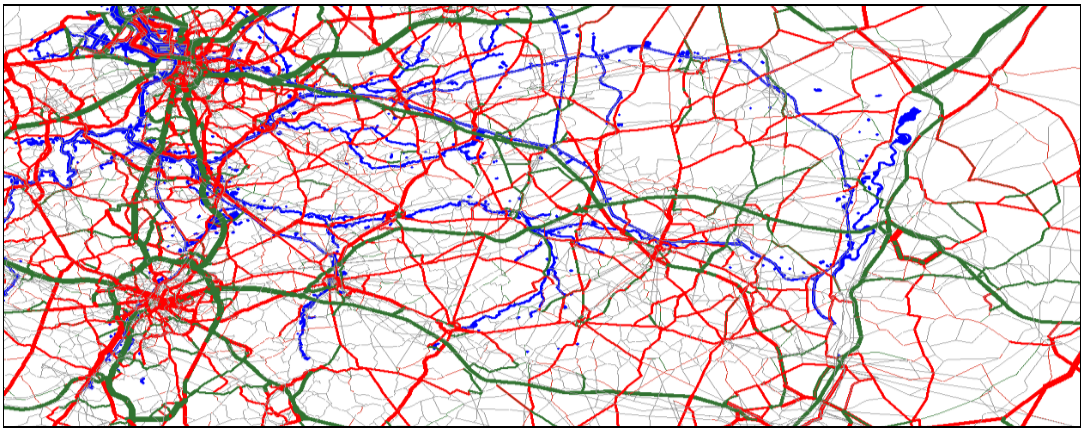
As the second type of output route change investigation is done using a difference plot, an illustration tool of the Cube software. The purpose of this application is to illustrate the different scenarios in both colour and thickness. Hence, the scenarios for which this analysis was deemed necessary are benchmarked with the reference scenario, showing whether an increase or decrease in tonnages took place.

In particular, what is shown by the different colours could be summarized as follows:

- Red lines show an increase of more than one hundred tons;
- Green lines show a decrease of more than one hundred tons;
- Grey lines show minor differences, indicating that the scenarios have an insignificant effect on the tonnages transported on the specific network link;

On the other hand the thickness of the lines represents the volume of tonnages for each link. An example of a difference plot output is presented in Figure 3.

Figure 3: Scenario 4 versus reference scenario



*Source: Own composition based on Freight model Flanders*

As the third type of output, a mode shift analysis was done. Four regions were selected to analyze the mode shift effects of the scenarios: the port of Antwerp, county of Antwerp (excl. Port of Antwerp), the Turnhout region and the Hasselt region. The E313 passes through all the aforementioned regions.

For each region, the total incoming and outgoing flows in tonnage have been calculated for road, rail and inland waterways. This enabled the calculation of the mode split for the base year 2004, the reference scenario and the specific scenarios for the year 2020.

Based on the three-level approach that has been adopted to interpret the simulation results, a list of observations was made.

On a general level we found that:

- The results of the simulations show that combinations of measures with similar consequences have a bigger effect. Therefore, for practical implementation, a combination of measures is more advisable.
- A specific scenario may have different, even adverse effects on the traffic volumes in different points and directions of the road network.

With regard to evolutions of port traffic the major conclusion is that :

- Scenarios with port growth variations clearly show the impacts of port turnover dynamics on the traffic on the locations at the E313 motorway. The increased/decreased port throughput has an influence both on incoming and outgoing flows, but the level of effect is different. The incoming flows are influenced less than the outgoing flows. For example, in matrix 8 (in the direction of Antwerp), the assumptions of scenarios 4 to 7 influence the goods flow less than in matrix 7 (same location, but in the direction away from Antwerp).

For inland navigation the following findings can be highlighted:

- In general, scenarios introducing the extra measure for inland navigation lead to an increase of the share of inland waterways with maximum 4% in the port of Antwerp. When internalizing the external costs of all modes, the increase is higher, up to 8%.
- The shift of road transport mainly moves towards inland navigation. For instance, concerning incoming flows to the port of Antwerp, the mode share for inland waterways goes from 40% to 48%.

Pricing policies have the following consequences

- The introduction of a moderate transport policy leads to a decrease of the traffic on the E313, but leads to an increase at the lower network. In practice, it means that route diversion occurs when a moderate policy in terms of kilometre cost charging on the highways is being enforced.
- In the case of charging the entire network with a kilometre cost variable equal to €0.15 together, the results differ substantially, showing that the decrease in tonnage becomes more widespread in the network.
- The introduction of the internalization of external costs policy for all modes creates the same network pattern but with the effects being more pronounced than the scenarios of moderate policy.
- The introduction of the internalization of external costs leads to a significant change in the mode split between road, rail and inland navigation.

Changes in economic and transport growth have the following major impacts:

- The result of low-growth assumptions on the goods flows on the E313 motorway is that, as expected, the volumes of the goods flows and also the annual growth decreases in all the locations on the motorway.
- The model captures the increase (decrease) in economic growth and international trade and links it to the higher (lower) growth of goods flows on the E313motorway.

## 3. Gdansk-Gdynia case

### 3.1. Preface

The Gdansk-Gdynia case we analyze is a fast growing port centre and has connections with the Bydgoszcz Inland Junction, which is located 160 km away. The connections used currently are road network and railway; however, there is also the possibility of creating a waterway along the northern part of the Vistula River.

Considering the period 2000-2009, the annual reloading volume in the analyzed port agglomeration has raised – Gdansk 14%, Gdynia 54%[16]. The fastest growing type of freight is the containers. The Port of Gdynia's Baltic Container Terminal (BCT) has a current annual handling capacity of some 750.000 TEUs, and a potential capacity of 1.200.000 TEUs. In 2007 it has reached the result of 493.860 TEUs[17]. The Deepwater Container Terminal (DCT) Gdansk is currently the fastest growing terminal in the country. In November 2009, Gdansk became a hub as one of the largest container operators (Maersk) opened a regular line to Shanghai. In the first half of 2010, container throughput was higher than in the whole year 2009 – reaching the reload volume of 173.279 TEUs. The maximum annual capacity of the DCT is 600.000 TEUs (since 2007), however according to plans, the complete development will have an annual capacity of 4.000.000 TEUs[18] .

At present the majority of freight is carried by roads although in Poland it is one of the most underdeveloped subsystems of the economy and the progress in construction of new sections is far not satisfying in comparison to growth of traffic[19].

The main road connection between the ports of Gdansk and Gdynia, and Bydgoszcz Inland Junction is the state road nr. 1. Part of this journey (approximately 100 km of 170 km total distance) may be made via motorway A1 section linking Pruszcz Gdanski and Nowe Marzy. The 65 km section linking Nowe Marzy and Torun is planned to be finished by the end of 2011. The journey to Bydgoszcz Inland Junction can be continued via state road nr 80 (approximately 50 km).

So far road pricing is introduced only on motorways. However, the new project of National Spatial Management Concept[20] recommends introduction of road pricing on express roads.

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[16] Actia Forum for Związek Miast i Gmin Morskich (2010). *Diagnoza aktualnych wyników, funkcjonowanie, struktury zarządzania i potencjału rozwojowego polskich portów morskich o podstawowym znaczeniu dla gospodarki narodowej w świetle powiązań regionalnych*.

[17] Baltic Container Terminal (2010). www.btc.gdynia.pl.

[18] Deepwater Container Terminal Gdansk (2010). http://www.portgdansk.pl/about-port/dct-gdansk.

[19] Burnewicz J. (2010). *Nowoczesna infrastruktura transportowa jako podstawowy element identyfikacji procesów rozwojowych w projektowanych dokumentach strategicznych*, expertise for the Ministry of Regional Development, Gdansk University.

The railway route from Gdynia to Bydgoszcz includes parts of two lines - E 65 (from Gdynia to Tczew) and CE 65 (from Tczew to Bydgoszcz). Both of those lines are part of pan-European transport corridor linking the Baltic region with the areas bordering the Adriatic Sea and the Balkans. Within the Polish Corridor VI lines are a combination of Gdynia and Gdansk via Warsaw to Katowice and the southern boundary of the country. At present, works are carried out on both sections parallel to analyzed part of IWW E70: Gdynia – Tczew and Tczew – Bydgoszcz. One of the main aims of the project is to increase freight train velocity up to 120 km/h and the maximum axle weight to 22.5 t., so that the railway would increase its competitiveness to the road transport system.

The IWW E70 connects Rotterdam, through the Berlin junction of inland waterways and northern regions of Poland, with the region of Kaliningrad and the system of the Niemen (Pregola) and Dejma to Klaipeda. The Polish section runs along the Warta and Notec Rivers, through Bydgoszcz Canal and the Brda, and then it joins the Vistula (and the IWW E40) in the Bydgoszcz Inland Junction. Then the route follows a section on the Vistula, Nogat Rivers and the Vistula Lagoon to the Polish-Russian border.

The E70 and E40 waterways along the Bydgoszcz-Gdansk link the multimodal north-south transport corridor with the multimodal west-east corridor. To become a part of European inland waterway system, the Polish parts of IWW E 70 as well as part of E 40 on the Lower Vistula have to upgrade from II and I class to IV class. This would enable safe navigation of vessels with a capacity up to 1.500 tonnes during about 300 days a year. In 2007, the representatives of six regions located along Polish part of IWW E 70 declared their will of cooperation on its improvement. The result of this cooperation is a study inventorying the list of investments which are necessary to reach the level of IV class. However, the expected time of starting the project and the sources of founding are still not decided.

### 3.2. Methodology

The case of Gdansk/Gdynia is slightly different than situation in Antwerp. The huge part of loads is transferred to or from ports by road transport. Railways are much less important, but they are also commonly used. Despite the large potential, the role of waterways is minimal. This situation could change in the future after the revitalization of the part of International Waterway E70 and improving its capacity.

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[20] Ministry of Regional Development (2010). Project of National Spatial Management Concept presented on 25 January 2011, Warsaw.

In the light of Marshal's Office plans[21] significant part of transported freight could be moved from roads to the revitalized waterway. The most important advantage for the development of this way of transportation is the costs level. Taking into account only the energy consumption the cheapest branch of freight transport is water transport. In the INERSEA Final Rapport[22] it is concluded that the distance covered with the same amount of fuel and with the same load is 3.7 to 5 times larger for barges and freight ships than for lorries.

According to Freight Modal Choice Study[23] and INTERSEA Final Rapport[24], not only economical cost should be taken into account. Very important are external costs which could be divided into four groups[25]:

- Environmental costs (air and water pollution, noise, climate changes)
- Congestion costs (time and money loss, recycling costs, degradation of architectural and historical heritage)
- Infrastructure usage and maintenance costs
- Accident costs.

Studies conducted in Germany in 2003 are showing that in road transport external costs are almost a half of the total costs. In rail and water transport they are responsible only for 10-15% of the total costs[26]. The most money-consuming are activities in the field of air protection and climate change (48% of the external costs) and accidents recovery (29%). On the basis of the same study the relation of the total costs between road, rail and water freight transport is like 5 : 3,5 : 1[27].

[21] Urząd Marszałkowski Województwa Pomorskiego (2010). Rewitalizacja śródlądowej drogi wodnej relacji wschód – zachód obejmującej drogi wodne: Odra, Warta, Kanał Bydgoski, Wisła, Nogat, Szkarpawa oraz Zalew Wiślany (planowana droga wodna E 70 na terenie Polski), Gdansk.

[22] Finish Maritime Administration, Swedish Maritime Administration and Maritime Office in Gdynia (2010), *Inland waterway shipping in Finland, Sweden, Poland and Germany, INTERSEA I* – final rapport.

[23] *Freight Modal Choice Study: Addressable Markets* (2010) Transport Studies Department, University of Westminster, London.

[24] Finish Maritime Administration, Swedish Maritime Administration and Maritime Office in Gdynia (2010), *op cit.*

[25] Kulczyk J., Winter J (2003). Śródlądowy transport wodny, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław

[26] *Ibidem.*

[27] Tanczos K.; Duma L., Rónai P. (2001) *External costs and benefits of waterborne freight transport in Europe*. European Inland Waterway Navigation Conference, June, Budapest, Hungary.

Table 2: Costs of transport – evaluation for Germany (2003)

| | **Rail transport** | **Road transport** | **Water transport** |
|---|---|---|---|
| Transport activity, billion ton*km | 64.5 | 132.2 | 48.2 |
| Incomes, MM Euro | 882.5 | 3447 | 52 |
| Expenditures, MM Euro | 2204.5 | 4191 | 487.5 |
| Subsidies, % | 60 | 17.8 | 89.3 |
| Subsidies, Euro/ton*km | 0.002 | 0.0055 | 0.009 |
| External costs, Euro/ton*km | 0.0048 | 0.0215 | 0.0011 |
| Total costs, Euro/ton*km | 0.038 | 0.053 | 0.011 |

*Source: Kulczyk, Winter (2003)*

The future development of the water freight transport in Poland is dependant from many factors, but one of the most important are costs benefits. Based on the German calculations it was constructed two scenarios for the future freight transport situation in the north of Poland. First of them (Scenario 1) refers to the situation without the usage of the International Waterway E70 and the second (Scenario 2) involves the water freight transport on it (situation after revitalization). It was assumed that the total costs (including external costs) will be analyzed and the relation between costs of the different transport modes will be fixed. In studied scenarios combined transport possibilities (road+rail transport, road+water transport, rail+water transport) were taken into account. The reload points were localized in the nine main freight train centres in the region and in the six freight river ports situated on the analyzed part of the waterway E70.

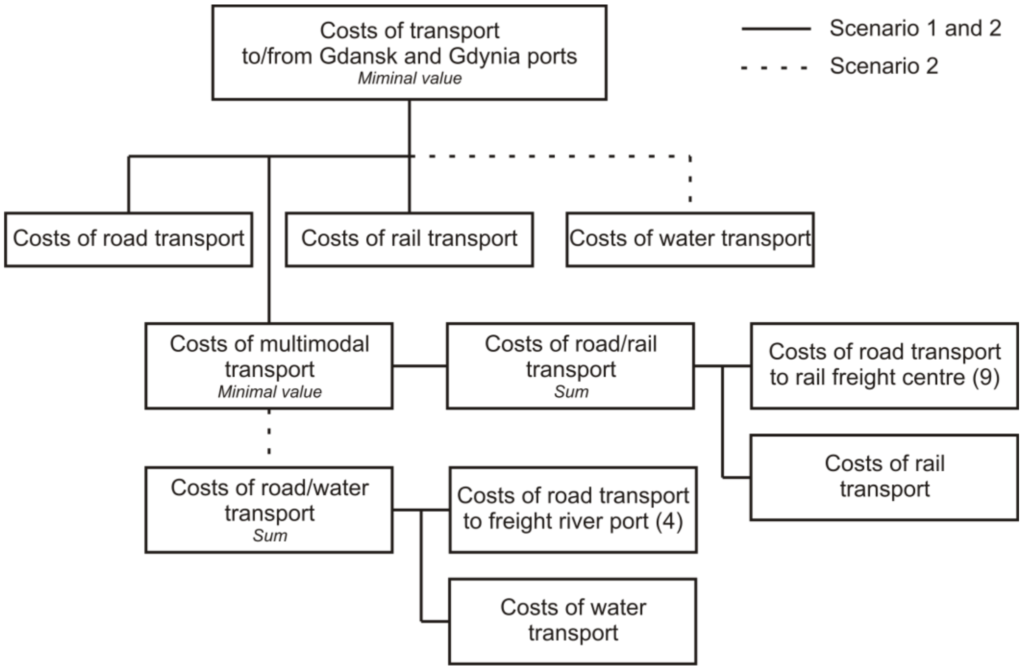
In both scenarios two different freight transport possibilities were compared:

- Costs of road transport to/from Gdansk/Gdynia ports
- Costs of road transport to/from rail freight centres and the costs of rail transport to/from Gdansk/Gdynia ports.

In the scenario with the use of the International Waterway E70 the third freight transport possibility was added:

- Costs of road and rail transport to/from freight river ports and the costs of water transport to/from Gdansk/Gdynia ports.

Figure 4: Data workflow



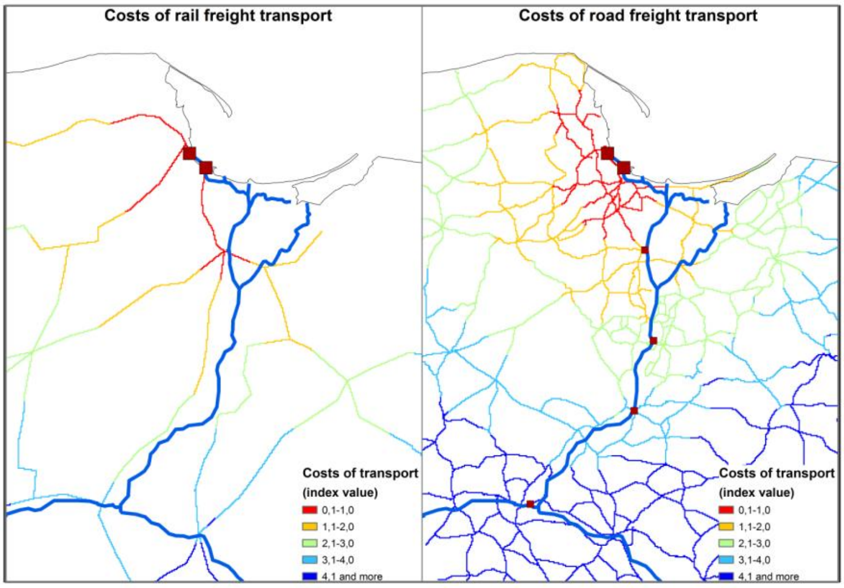

*Source: own compilation*

### 3.3. Simulation results

The analysis was performed using GIS software. In the first step the costs of road and rail transport were estimated (see Figure 5). The main transport corridors such as national and regional roads, as well as train lines were taken into account. The costs were considered as the simple function of distance.

The second part of the research was the estimation of the multimodal transport costs. There were summed the cost of transport to the main rail centres by lorries with the costs of rail transport to Gdansk/Gdynia ports. In the Scenario 2 the same procedure was implemented in the case where freights were transported to river ports by road transport and then shipped to Gdansk/Gdynia ports by barges and freight ships. In the end the minimal costs of these two possible ways of transportation were chosen.

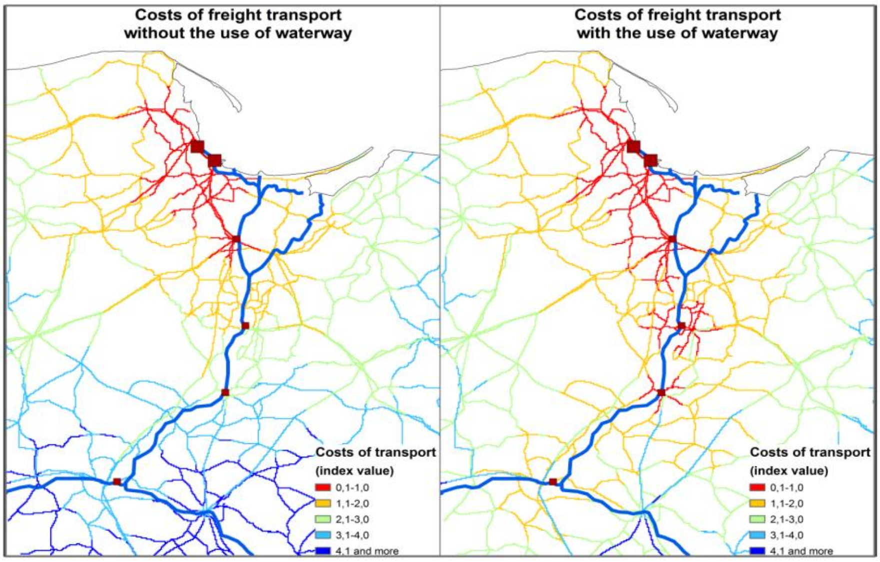
Figure 5. Gdansk/Gdynia case – costs of road and rail transport




Source: Own *composition*

The final stage of the research involved the estimation of the minimal possible costs among all analysed situations – in Scenario 1 including road, rail and road-rail transport and in Scenario 2 also water and road-water transport. The results of this procedure are presented in Figure 6.

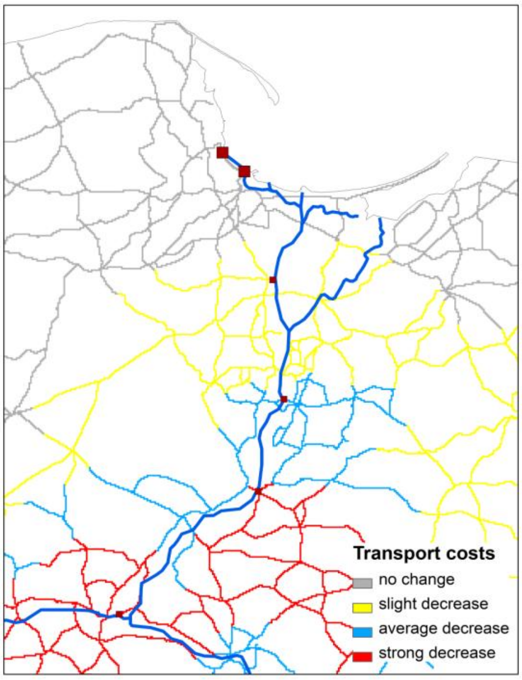
Figure 6. Gdansk/Gdynia case – costs in analyzed scenarios




*Source: Own composition*

The second output of the Gdansk/Gdynia study is the comparison between analyzed scenarios. The percentage differences between freight transport costs in particular parts of the transportation network are showing the possible cost savings after the waterway revitalization. The possible decrease in freight transportation costs is presented in Figure 6.

Figure 7. Gdansk/Gdynia case – scenarios comparison




*Source: Own composition*

Implemented analysis shows the great benefits resulting from inclusion the waterway to the freight transport system in the northern part of Poland. The economical advantages would be important both for private transporters and local authorities and societies. The benefits would be also on social and environmental levels – the greater role of water freight transport would help in improving air quality, reduce the interfering noises and limit the risk of road accidents.

## 4. Conclusions

In the light of development forecasts and EU transport policy a modal shift is a necessity. However, an effective implementation of such a change requires the belief of local public administration bodies that the proposed innovation will prove to be beneficial also in their environment.

Both analyzed cases have comparable geographical environments - the existence of an important port centre and availability of three forms of freight transport. Also, the analyzed distance of connection with hinterland is similar. However, the methodologies are different due to the varying degrees of availability of data and tools for analysis. The freight transport model for Flanders is an advanced tool which allows analysing in detail the transport situation and building future scenarios. The time schedule for development of the road system in Poland as well as the road pricing policy is very vague, so it is impossible to propose reliable detailed scenarios for the future. Nevertheless, even the simplified model, which does not consider potential new fees for road transport, proves that inland water freight can be highly competitive with road and railway transport – not only in terms of international transport, but also interregional, which is an important reference for decisions of above mentioned authorities. The results may also become an impulse for all involved entities to strengthen their efforts towards implementation of the EU transport and environment policies.

Due to expected growth of reloading volume in the ports of Gdansk and Gdynia, an introduction of IWW as an alternative for interregional transport appears to be the necessary. As the IWW E70 will be upgraded, the Belgian experience and used methodology can become a tool for Polish authorities, which will help them find the best solution to optimize the performance of the new multimodal freight system.

In the case of Gdansk and Gdynia, however, waterways - the cheapest and most environmental friendly way of freight - remains unused. Adaptation of the existing river system to the standards of IWW will require investments in its channel as well as infrastructure on land like ports, warehouses, links with local and the super-local transport network. Implementation of such a complex project should involve the state authorities as well as the local governments of the regions linked with IWW E70. The costs of revitalization of the waterway and the need of new infrastructural investments in Poland would be the most serious problem for quick inclusion of the waterways in transport system. In Belgium, improving the role of water transport is one of the transport policies of the government.

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