INTERMODAL TRANSPORT IN BELGIUM: WHAT WITH THE PORT OF ZEEBRUGGE?

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ABSTRACT

This paper describes a geographic information system-based location analysis model, developed to analyse the characteristics of the Belgian intermodal terminal landscape. The model, which originally takes the port of Antwerp into account, is extended to include the port of Zeebrugge. Based on the transportation costs, the model compares intermodal transport with unimodal road transport. After visualising the current intermodal terminal landscape, the model handles various scenarios. Highlighting the market areas of intermodal terminals, the model is used as a policy support tool to come to an integrated vision on the future development of intermodal transport in Belgium.

Keywords: intermodal policies, intermodal terminals, GIS model

INTRODUCTION

Due to the globalisation of the economy and the associated growth of international trade, the increase in freight flows became higher than GDP growth. From the sixties, freight is containerised and transported more and more by containers. As a result, overseas transport substantially become cheaper and more efficient. In parallel to the developments at the maritime side, which include sea ports and container vessels; logistics have also adapted itself towards this containerisation of freight, namely through intermodal transport. Taking a quick look at the major sea ports, one can observe that a significant increase in the amount of containers that were handled especially during the last decade. The sea ports in Belgium including the port of Antwerp and the port of Zeebrugge, for example, faced an annual increase of approximately 10 percent. Of course these containers need to be transported on to the hinterland and this is where intermodal transport plays an ever increasing role.

Intermodal transport is defined as the combination of at least two modes of transport in a single transport chain, without a change of the loading unit for the goods, with most of the route travelled by rail, inland waterways or an ocean-going vessel, and with the shortest possible final journey by road (ECMT, 2003). The movement from one mode of transport to another usually takes place at an intermodal terminal. In Figure 1, a typical maritime based intermodal chain is shown. Containers are being handled in the port, are further transported by barge or rail wagons towards an inland terminal, from which the containers are transported by road to the end destination.

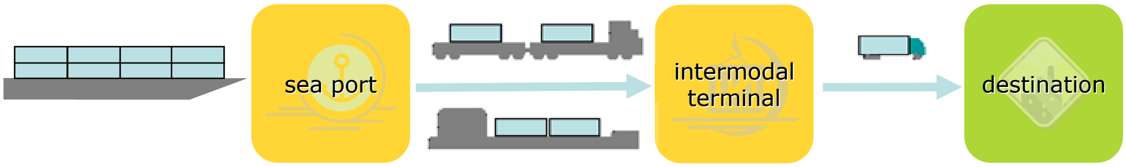

Figure 1: Intermodal transport chain

Source: Own setup

Providing various socio-economic benefits, transport also generates adverse effects and the growth in transport use is likely to make these impacts much more dense. Since the 80's, the road transport increased its market share, following technological and economic developments. Today, road transport is widely included in transport systems and constituting a more liberalised market, it is highly competitive with its flexibility. On the other hand, the problem of congestion in the road network decreases its reliability and increases the transportation costs. In this setting, intermodal transport receives an important attention. Therefore intermodal transport is promoted through policies being addressed at all political levels. Policy measures may include amongst others, provision of intermodal infrastructure, subsidies for new services, research and development activities etc.

This paper aims to evaluate the impact of a major infrastructure project, which constitutes a potential for further growth of intermodal transport in Belgium. To this end, a geographic information system (GIS)-based intermodal transport model, called the LAMBIT (Location Analysis Model for Belgian Intermodal Terminals) is developed. The paper focuses on the port of Zeebrugge and the Seine-Scheldt-West (SSW) project, the large-scale European transport project enhancing sustainable development, improving accessibility of regions and raising economic efficiency. The paper analyses the possibilities and impact of the SSW project on the intermodal terminal landscape. Current policy measures directed towards intermodal transport such as subsidy schemes are also incorporated into the scenario-based analyses.

In section 2, intermodal transport in Belgium is introduced. Section 3 explains the policies towards the port of Zeebrugge, whereas section 4 presents a scenario-based analyses for the port of Zeebrugge. Finally section 5 draws conclusions for this paper.

INTERMODAL TRANSPORT IN BELGIUM

Belgium has an extensive transport network to distribute containers arriving at the ports of Antwerp and Zeebrugge. During the last decade, new volumes handled at the sea ports have lead to further possibilities for intermodal transport in Belgium. From a social point of view, intermodal transport took a growing political interest especially for its environmental performance. Intermodal transport is in most cases more environmental friendly than road transport (Kreutzberger et al., 2006). As a result, the number of intermodal terminals increased considerably during this period. In 2009, there are 19 intermodal terminals in Belgium of which there are 13 barge (inland waterway) and new projects are coming. The rail/road terminal landscape has not evolved as rapidly, but new services were nevertheless set up. In 2004, the railway company B-Cargo decided to set up the Narcon (National Rail Container Network) concept in order to offer intermodal transport by establishing rail/road services between the port of Antwerp and the port of Zeebrugge and various inland terminals. For international routes, specialised direct trains are scheduled. Figure 2 indicates a concentration of terminals near the Flemish waterways. At the moment, new terminals are planned for Wallonia. It has to be noted that most of the barge terminals are offering daily services to the ports of Antwerp and Rotterdam but some of them have a small scale such as terminals in Herent and Mol.

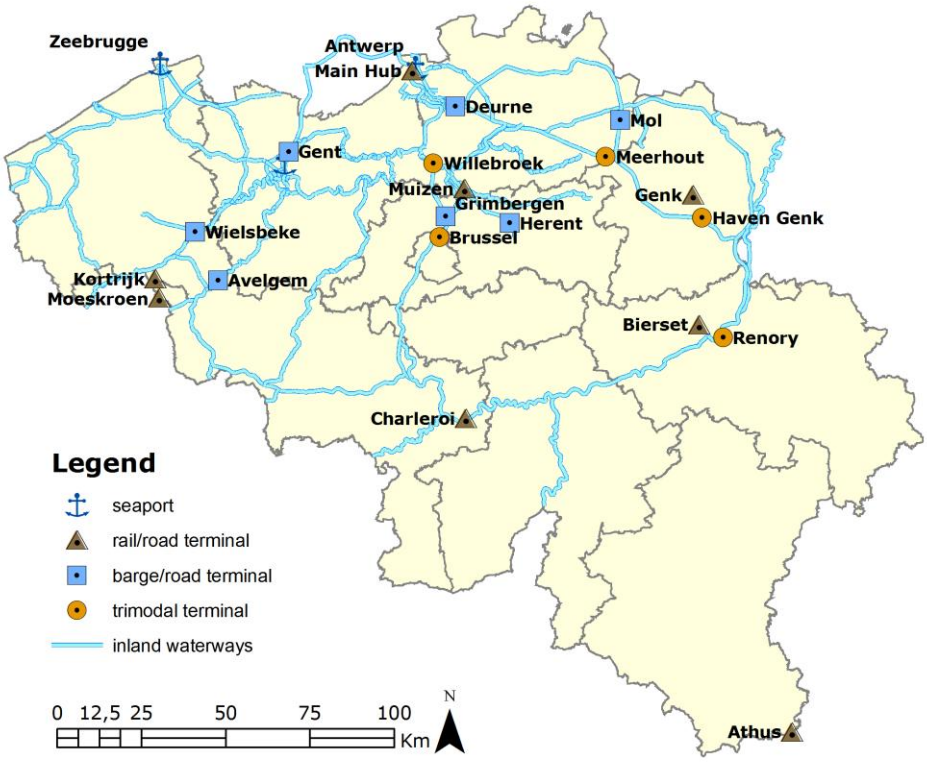

Figure 2: Intermodal terminal landscape in Belgium

Source: Own setup

The modal split of the port of Antwerp indicates a move towards the inland waterways and rail for container transport. In 1996, 70 percent of the containers were transported by road, 6 percent by rail and 24 percent by barge. In 2007 this was already 11 percent by rail, 34 percent by barge, leaving 55 percent for the road sector. Even with this positive evolution, in absolutely terms, there is still an increasing amount of containers that are transported by road every year. Compared to 1996, 2,15 million TEU (twenty-foot equivalent) is transported by road in 2007. This underlines the importance of projects like the Seine-Scheldt-West, which can provide further opportunities for intermodal transport. This project will be explained in the next section.

POLICIES TOWARDS THE PORT OF ZEEBRUGGE

There is a relationship between containerisation and intermodalism. In parallel to the growth in freight transport, there has been a growing use of containers that enabled the operation of intermodal transport systems. Intermodalism can be built upon two phases. First phase is the growth of container transport at the maritime side. Freight is containerised and transported more and more by containers. Figure 3 shows that the containerised traffic has almost tripled from the 1990s to the early 2000s. Focusing on the important northern European ports, an average annual growth rate of 9 percent is seen. The Belgian ports of Zeebrugge and Antwerp have sustained an average of respectively 11 and 9 percent growth between 1980 and 2008. According to Hayuth (1987), the rise of intermodalism can be considered to be the second phase of containerisation, which is characterised by organisational changes resulting in integrated transport concepts (van Klink and van den Berg, 1997). The second phase of intermodalism can be found at the landside, where containerisation is extended to the hinterland of the seaports.

The port of Zeebrugge handled in 2008 a total volume of 2.2 million TEUs. In spite of the economic and financial crises which set in the last quarter of 2008, the container handling has increased by 9.4 percent compared to 2007. In tonnage the total container traffic also increased by 4.3 percent to 21.1 million tons. It has to be noted that the container transport accounts for half of the handled cargo of the port, where Roro transport also takes an important share. One of the key success factor for the port of Zeebrugge lies in the growth registered in the deepsea segment. Focusing on the maritime accessibility, the port enjoys the competitive advantage of being able to handle the largest container vessels (8,500-14,00 TEU).

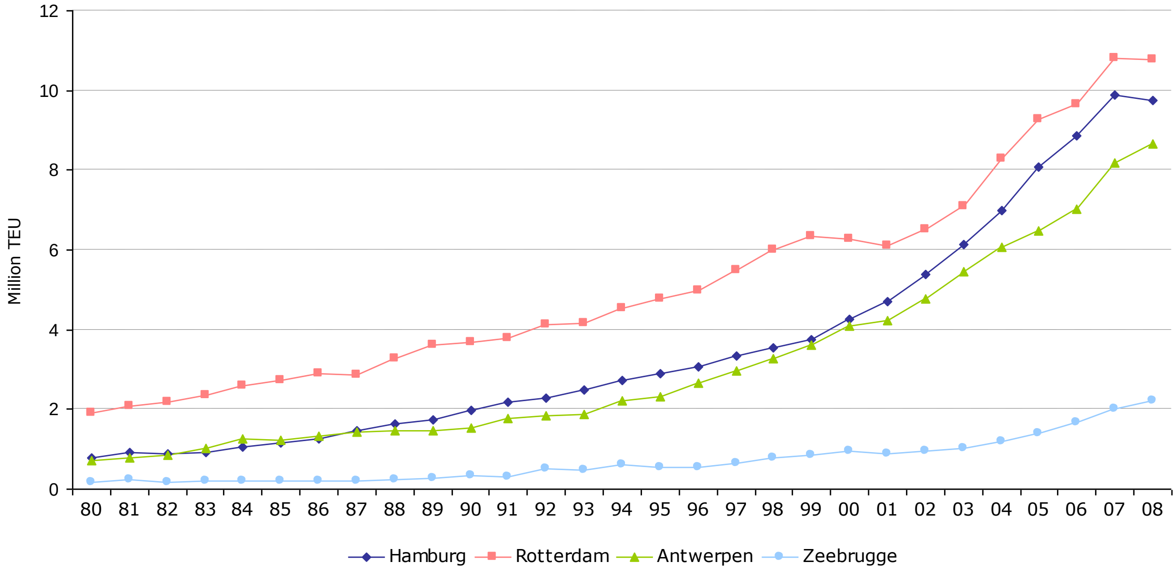

Figure 3: European container traffic growth

Source: Own setup – data based on the statistics of the Antwerp port authority

The port of Zeebrugge also evolved into a strong container hub thanks to various container feeder services. In this context, a special attention was paid to rail and waterway connections towards the hinterland of the port. In Figure 4 the modal split of containers for the inland traffic of the port of Zeebrugge is presented. Estuary shipping has been established in 2008 to ship containers from Zeebrugge via the sea to the Scheldt estuary. During this period, considerable cargo volumes from and to the Antwerp region and to the Albert Canal have been realised. Special inland ships were developed with have loading capacities of 250 and 350 TEU respectively to reach the Scheldt estuary by sea. The ships with the smaller capacity connects the port with the inland waterway terminal in Meerhout through the Albert Canal. It has to be noted that it takes 15 hours to cover the distance between Zeebrugge and Meerhout. The larger capacity ships on the other hand establishes an intensive connection to Antwerp region. However, substantial cargo volumes are transported by rail especially with Germany, France and Italy. As explained in previous section, national rail transport between the sea ports of Antwerp and Zeebrugge is also established. Road transport accounts higher share in the modal split due to the truck combinations that are used in roro transport and the port of Zeebrugges' leading position in the world in the handling of new cars. Considering the growth rate of container transhipments for the port of Zeebrugge, Figure 4 can conclude that estuary shipping and inland navigation should further be promoted for achieving a sustainable modal split. In this respect, the port of Zeebrugge aims to expand the usage of inland navigation by upgrading the existing diversion canal of the river the Leie within the Seine-Scheldt project.

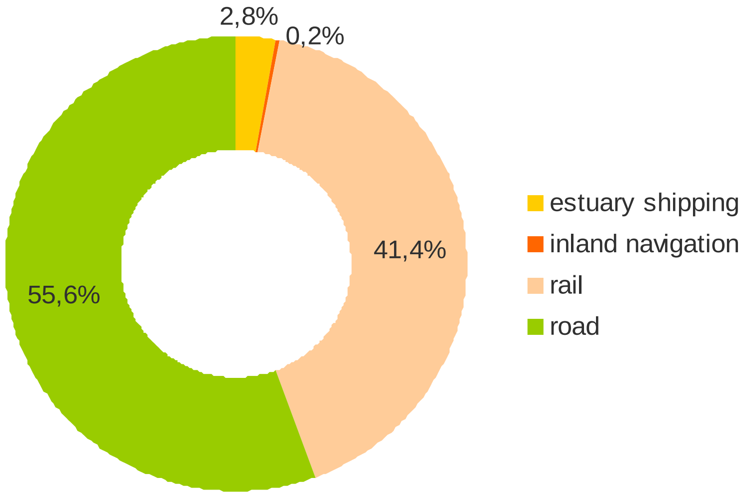

Figure 4: Modal split of container for inland traffic of the port of Zeebrugge

Source: Own setup – data based on the statistics of the Zeebrugge port authority

The entire Seine-Scheldt project consists of different sections in Belgium and Northern France which, once linked together, will link Paris and Ile-de-France to the north-western European waterway network. This will give a lot of advantages which are listed below.

- This connection will provide a solution for logistic players by linking large economic centres. The existing and planned multimodal platforms near the waterways bundle and distribute goods, attract industrial and logistics activities and create added value for the regional economy and population by penetrating into the heart of urban areas.
- The link Seine-Scheldt will relieve the north-south axis because it will carry large volumes of bulk and high value goods as well as exceptional and outsize convoys.
- The project is an example of sustainable development as inland navigation is the most environmentally friendly mode of transport. According to Inland Navigation Europe the Seine-Scheldt connection will be more eco-efficient than other ways of transport.

In Belgium the Seine-Scheldt-West (SSW) connection is seen as the logical completion of the international Seine-Scheldt project. To realise the SSW connection, a present alignment is used via the Port of Zeebrugge through the diversion canal of the Leie. The aim of the diversion canal of the Leie is to give the opportunity to the coasting ports to reach the inland vessels within the Trans-European inland waterway network. The enlargement of the inland network is point out to the western part, this is way it is called Seine-Scheldt-West. In Figure 5 a visualisation of the projects is given. The red line represents the Seine-Scheldt project which opens up the Trans-European inland waterways network. The green line is part of the Seine-Scheldt project, called Seine-Scheldt-West which includes maritime traffic to the port of Zeebrugge.

Figure 5: SS and SSW project

Source: Waterwegen en Zeekanaal, 2010

To realise the SSW connection, the diversion canal of the Leie needs to be adapted for inland ships with capacities of 4500 tonnes. Through the project, one million truck movements over the road are reduced which also has a positive outcome on the environment.

The advantages of the SSW are partly on the economic importance of the Flemish ports in terms of employment but it also attracts foreign investments in sectors as industry and logistics (Waterwgen en Zeekanaal, 2008).

The focus of this paper lies on the comparison of intermodal and unimodal road transport specific for the port of Zeebrugge. Therefore the Location analysis model for Belgian Intermodal Terminals (LAMBIT) is used. This model will be extended by including the Port of Zeebrugge in the specific Seine-Scheldt project. In the next section the LAMBIT model is explained.

ANALYSING PORT OF ZEEBRUGGE WITH THE LAMBIT MODEL

In this section the methodology of the LAMBIT (Location Analysis Model for Belgian Intermodal Terminals) model is explained, followed by the results of the scenarios for the port of Zeebrugge.

Methodology

LAMBIT is a geographic information system (GIS)-based location analysis model which makes it possible to conduct ex-ante and ex-post analysis of policy measures in favour of intermodal transport. The LAMBIT model explores the relative attractiveness of each transportation mode through a price (cost) minimisation model. The model develops several scenarios, namely policy measures that are applicable for intermodal transport:

- Location of new terminals
- Price scenarios
- Subsidies
- Internalisation of external costs

Construction of the model

LAMBIT is built on three main inputs: transportation networks, transport prices, container flows from the municipalities to and from the sea port..

1. Transportation networks

LAMBIT is a GIS-based model, consisting of the different network layers (for each transport mode) and the location of the intermodal terminals and the port of Antwerp (as nodes in the network) (Macharis, 2000 and 2004). In this paper, the port of Zeebrugge is added to the model. A GIS network was set up by including four different layers: the road network, the rail network, the inland waterways network and the final haulage network. The geographic locations of the intermodal terminals and the municipality centres are defined and connected to the different network layers.

Figure 6 depicts the different network layers and nodes inclusively three intermodal transport modes. The networks for Belgium were built by merging the following digital databases:
- Road layers and municipalities are obtained from the MultiNet database of Tele Atlas
- Rail and inland waterways layers are extracted from the ESRI (Environmental Systems Research Institute) dataset for Europe

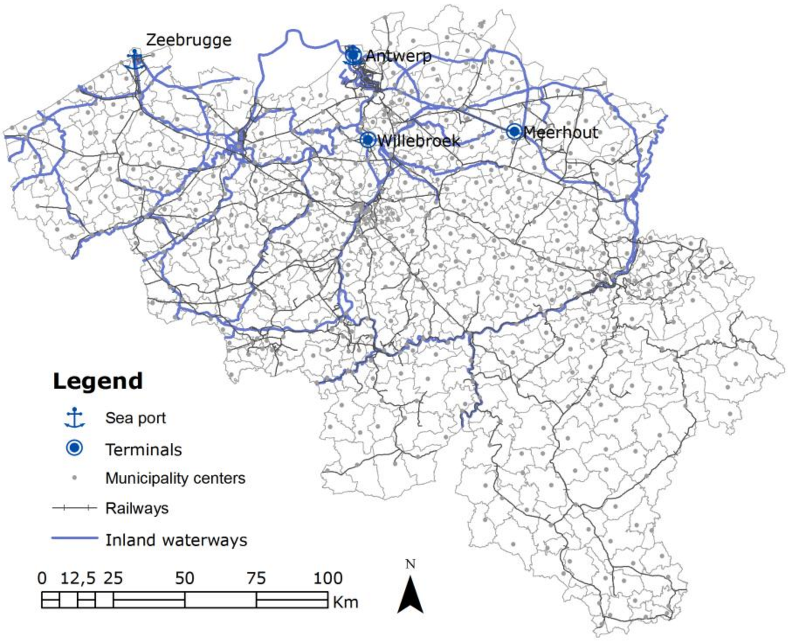

Figure 6: Network layers and nodes

Source: Own setup

2. Transport prices

The LAMBIT methodology is based on two concepts: the intermodal cost structure and the break-even (critical) distance. Considering the total transport prices and the distance travelled, unimodal road transport is cheaper in the short distances but once the break-even distance is achieved, intermodal transport offers a competitive alternative.

The transport prices are calculated based on the real market price structures for each transport mode and they are associated with the network layers. The variable costs are uploaded to the network layers and the fixed costs are attached to the nodes, which also indicate the origin and destination for each path.

The total price of intermodal transport is composed of the transhipment cost in the port of Antwerp to a barge or a wagon, the cost of the intermodal main haul (barge or rail), the transhipment cost in the inland terminal to a truck and the cost of final haulage by truck. The following formula explains the calculation of intermodal transport:

IT = PH + TH + MH

In which:

- IT: price of intermodal transport
- PH: price of pre/post haulage by road transport
- TH: price of terminal handling in intermodal terminals
- MH: price of main haulage by barge or rail transport

The total intermodal transport cost is obtained by adding all of these fixed and variable costs based on the existing market prices.

3. Containers from the Belgian municipalities

The final input for the LAMBIT analysis is the container flows from the sea ports. In this paper, the statistics of road transport from the Directorate-general Statistics and Economic Information of Belgium was used.

Functioning of the model

Using a shortest path algorithm in ArcInfo, various comparisons are conducted in order to find the shortest path and the attached transport price from the port of Zeebrugge to each Belgian municipality via intermodal terminals and via road only. For each destination, the total transport price for unimodal road, estuary shipping/road, inland waterways/road and rail/road transport are compared and the cheapest option is selected. The output consists of the market areas of each inland terminal are highlighted in the map of the model. These visualisations help us to see how large the market area of each intermodal terminal is. As a further step, the container flows data can be used to show the amount of containers that are currently transported by road to the municipalities within the market area, which gives an indication of the existing potential volume that can still be shifted. This is particularly useful when a new service or location of a new terminal need to be analysed.

The port of Zeebrugge case

The port of Zeebrugge is currently connected with the Flemish hinterland by three intermodal routes: terminals in port of Antwerp, the trimodal terminal in Meerhout and the barge terminal in Willebroek. For the moment, only rail and estuary shipping is possible between the port and those destinations. Concerning rail transport, the port of Zeebrugge is connected with the port of Antwerp through the Narcon network, which is subsidised by the federal government. Narcon network and rail subsidies have already been analysed with the LAMBIT model (see Macharis and Pekin (2008)). In this paper, the main focus will be on inland navigation, which would become possible if the SSW would be realised. In this section first a current situation will be presented. Then a future scenario will be developed to show the situation when the SSW connection is implemented. The analysis will conclude with a subsidy scenario.

Current situation

In Figure 7 the current situation for the market area of intermodal terminals is shown. In this scenario, current market prices (without any subsidies) for rail transport and estuary shipping are used to show the market area of the terminals. The municipalities are highlighted, when intermodal transport has a more attractive transport price compared to unimodal road transport. Only the terminals in Willebroek and Meerhout take market area. For the port of

Antwerp, road transport remains a cheaper option compared to estuary shipping as a result of extra handlings and post-haulage. Rail transport have higher market prices when subsidies for rail transport are not considered. This explains why there is not market area for the rail terminals in Antwerp and Meerhout. However in reality containers are transported by rail to/from the port of Zeebrugge such as the rail shuttles to the Main Hub in Antwerp.

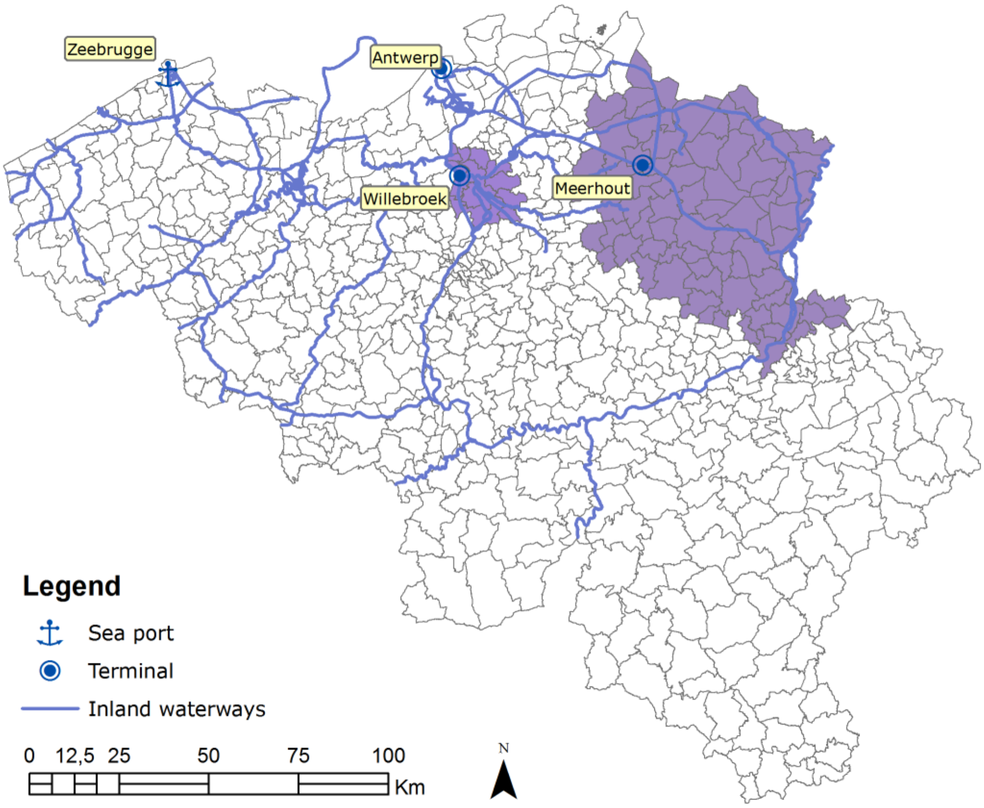

Figure 7: Current situation

Source: Own setup

Estuary shipping from the port of Zeebrugge has initiated in 2008 towards Willebroek, Antwerp and Meerhout and will run for 10 years until 2018. Estuary shipping presents higher depreciation costs (damages to the estuary barges), which will limit their life cycle. Additionally the handlings of estuary barges are difficult. These characteristics of estuary shipping have a negative impact on its competitiveness. This can even be critical when the subsidy enters its fourth year, when minimum container rates will be required from the shipping lines.

Implementation of the SSW connection

In the long term, connection of the port of Zeebrugge to the Flemish inland waterway network, namely through the SSW-project, can provide benefits for inland navigation. In this section, a hypothetical future scenario is developed with the SSW connection. Once this connection is established, inland waterway barges departing from the port of Zeebrugge can access the Belgian inland waterways. Therefore main barge terminals in Belgium are also added to the LAMBIT model.

A Container flow analysis is performed to verify hinterland potential of the port of Zeebrugge. Figure 8 shows the container flows from the port of Zeebrugge, based on the national statistics. The container flows density indicate that the terminals in Meerhout, Willebroek and Renory are located in the network, where there are higher freight volumes from the port of Zeebrugge. The figure also points to the flows to the port of Antwerp (as often the bill of lading is in Antwerp).

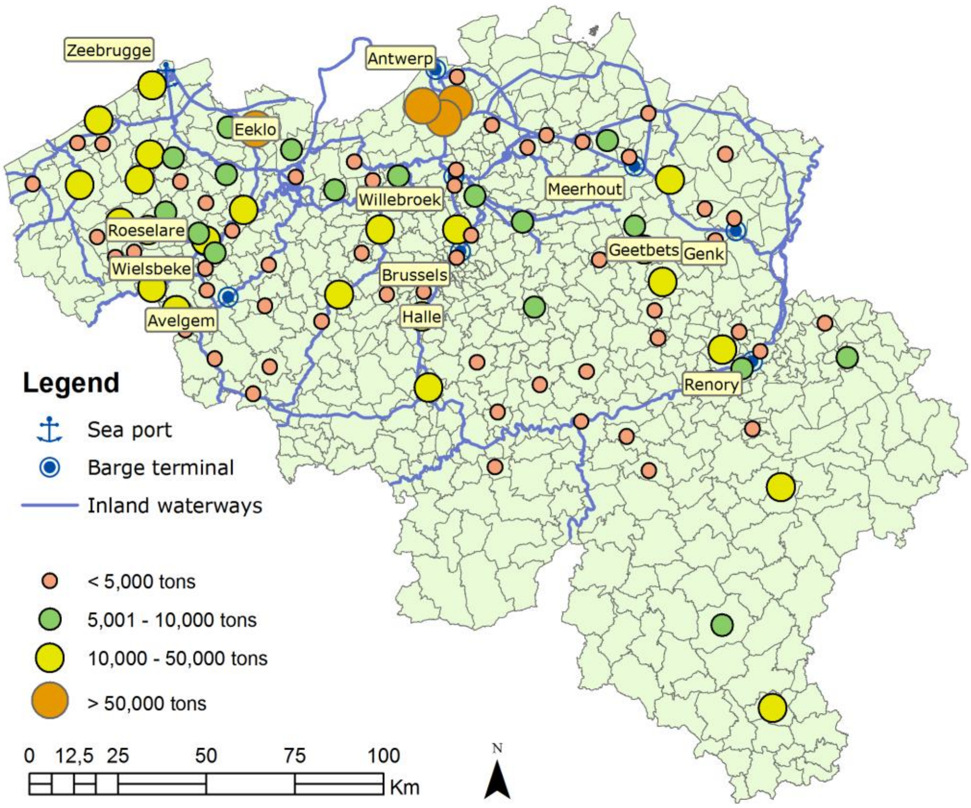

Figure 8: Container flow analysis from the port of Zeebrugge

Source: Own setup

The implementation of the SSW connection is shown in Figure 9. Considering the current market prices for barge transport, inland waterway transport is competitive in 182 municipalities. The terminals which are located far from the port of Zeebrugge (Renory, Brussels, Meerhout, etc.) benefit more from the lower variable costs of intermodal transport compared to unimodal road transport and so they have larger market areas. This is explained by the intermodal cost structure. The longer the distance travelled, the greater the extent to which the lower variable costs of intermodal transport can compensate for the extra transhipment costs at the terminals.

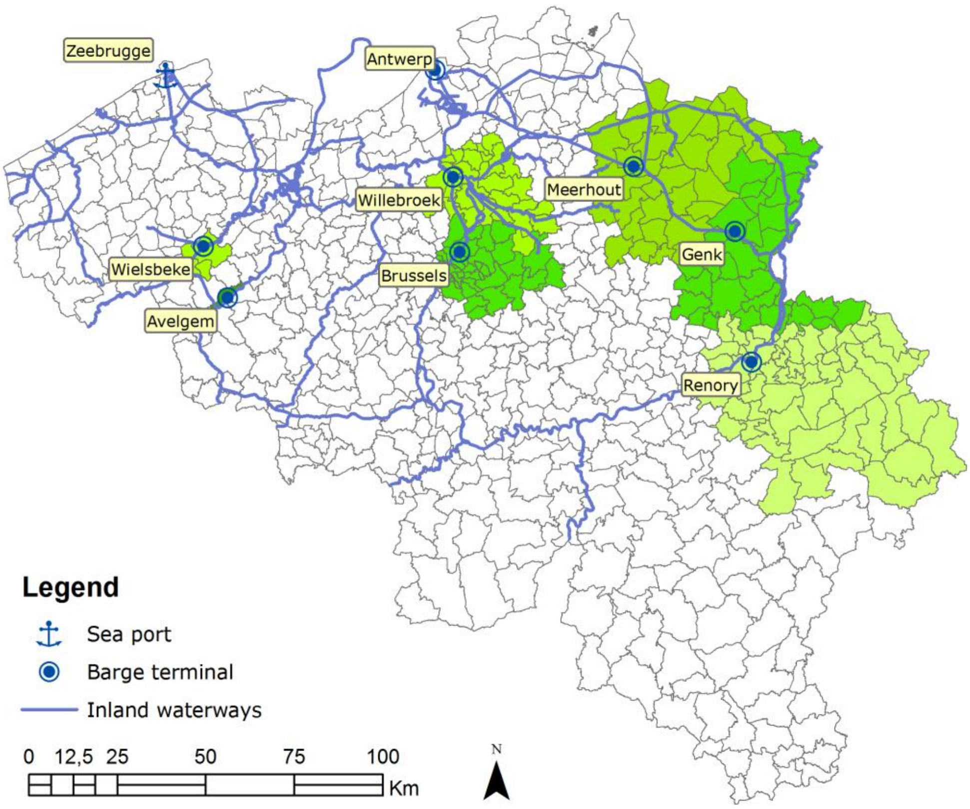

Figure 9: Barge connection - SSW project

Source: Own setup

As illustrated in Figure 9, the SSW project can lead to a modal shift from road transport to barge transport. The market areas for intermodal terminals increase considerably when the port of Zeebrugge is connected to the inland waterway network. The number of municipalities gives already an indication of the potential of barge transport. However, this analysis should be completed with an idea on the amount of containers that are transported from the port of Zeebrugge to all these communes. Taking the national statistical data into account, the addition of the canal results in an over three-fourths potential increase in intermodal transport meaning a modal shift of 98,509 tons. This tonnage is a potential modal shift from road transport. In order to calculate total potential for barge transport, the flows that go now via estuary shipping and even rail transport should also be considered. Overall the barge terminals sum up to 227,515 tons. Table 1 presents the changes in the market potentials for the intermodal terminals with respect to the current situation.

Table 1: Market area of intermodal terminals when the SSW connection is implemented

Intermodal Terminals	Estuary shipping		Barge transport	
	The number of municipalities	Volume in ton	The number of municipalities	Volume in ton
Meerhout	74	117,135	31	90,463
Wielsbeke			4	18,719
Willebroek	15	11,871	28	20,145
Avelgem			1	0
Genk			30	9,102
Renory			52	66,251
Brussels			36	22,835
Antwerp	0	0	0	0
Total barge terminals	89	129,006	182	227,515
Total road transport	500	1,753,864	407	1,655,355
Total	589	1,882,870	589	1,882,870

Source: Own setup

Subsidy scenario

An option that can be used to stimulate intermodal transport is to decrease the costs linked to the infrastructural development and to transport operations at the terminals. As mentioned, the inland navigation from the port of Zeebrugge could be subsidised. This could be done by two subsidies: estuary subsidy and barge subsidy. The estuary shipping aid scheme (N 53/06) aims:

- to achieve the modal shift from road to inland waterway navigation;
- to compensate the external costs that road transport does not incur;
- to generate sufficiently large amounts of traffic of goods after the expiry of the start-up period so that regular container service lines between the Flemish coastal ports and the hinterland can be operated without any state intervention necessary.

The subsidy is composed of investment (building of estuary ships) and exploitation (estuary services). For the first three years maximum amount of € 4.4 per TEU is foreseen. Subsidies are also granted for each container handled by an intermodal barge terminal. This kind of measure for inland waterway transport is applied in Belgium in both Walloon, Brussels and Flemish regions but at different tariffs for each. In May 2007, the EC authorised a Flemish measure to grant a subsidy of € 17.5 per each container transhipped to a Flemish inland container terminal from or to an inland waterway vessel (N 682/06). Similar initiatives are also developed in Wallonia and Brussels. According to the government decision of December 2004, the Walloon government foresees a subsidy of € 12 for the containers that are transhipped to a Walloon inland container terminal from or to an inland waterway vessel (OPVN, 2006). In 2008, this subsidy is extended for the period 2008-2013. An identical subsidy scheme is also valid for the Brussels region for the period 2007-2009 (N 720/06).

From the perspective of this paper, these subsidies were included in the model. In Figure 10 the results of this scenario is shown. Compared to Figure 9, the subsidy scenario shows that intermodal transport grows substantially thanks to the inland waterway subsidies. The subsidy enables the terminal in Antwerp to compete with unimodal road transport. An interesting finding from this scenario is that it visualises the impact of the regional differences in the degree of subsidies for inland navigation. This can be illustrated with the terminals in Willebroek and Brussels. The terminal in Willebroek will enjoy the subsidy scheme of the Flemish government (€ 17.5), which is more than the subsidy scheme for the terminal in Brussels (€ 12). As a result the terminal in Willebroek takes market area from the terminal in Brussels. It has to be noted that the subsidy scheme for barge transport depends on the type of container. The Flemish subsidy considers intermodal loading units (containers). The subsidy scheme for Brussels on the other hand makes a distinction for the size of containers hence subsidy of € 12 is applicable for twenty-foot containers. The subsidy gradually increases to € 18 for thirty-foot containers and € 24 for forty-foot containers. Overall, the subsidy scenario decreases the market area of unimodal road transport by 108 municipalities. Taking the volumes in to account, the subsidy schemes can lead to further potential increase of 319,434 tons for intermodal transport. In Table 2 the market areas of terminals are summarised.

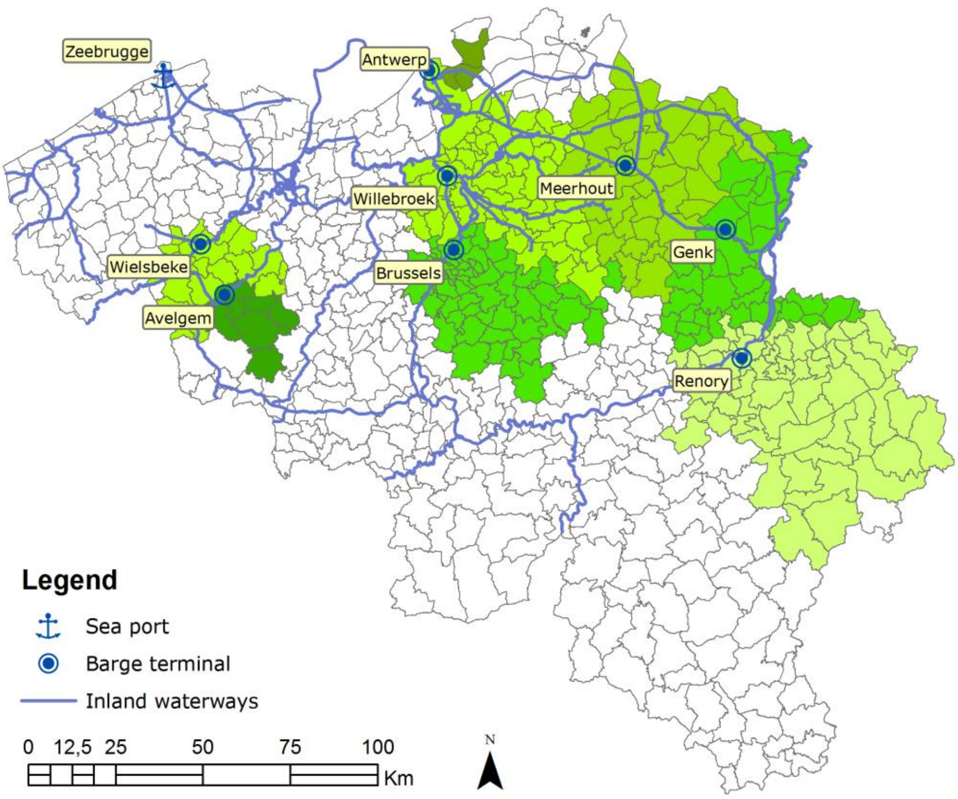

Figure 10: Subsidy scenario

Source: Own setup

Table 2: Market area of intermodal terminals when the subsidy schemes are introduced

Intermodal Terminals	Barge transport	
	The number of municipalities	Volume in ton
Meerhout	38	102,377
Wielsbeke	21	62,120
Willebroek	63	282,280
Avelgem	9	4,103
Genk	36	9,102
Renory	58	66,251
Brussels	62	18,875
Antwerp	3	1,840
Total barge terminals	209	546,949
Total road transport	299	1,335,921
Total	589	1,882,870

Source: Own setup

CONCLUSIONS

From the perspective of society, intermodal transport can help in reducing the environmental harm and congestion problems caused by our transportation system. By shifting freight and especially containers to barge, rail or estuary shipping and only use road transport for the pre and final haulage, congestion and exhaust emissions can be reduced. From the perspective of transport users, intermodal transport can be a cost-efficient option compared to unimodal road transport as the cost per unit decreases in barge and rail transport when economies of scale are experienced. These lower unit costs on the long haul should compensate for the extra handling costs at the inland terminal. This is possible if the distance between origin and destination is long enough (the so called critical distance).

In this paper, the intermodal transport network in Belgium is investigated. Focusing on the port of Zeebrugge, the main goal of the paper is to evaluate the potentials for intermodal transport from this sea port. To this end, the SSW project is analysed with the LAMBIT model.

LAMBIT is a GIS-based location analysis model which makes it possible to conduct ex-ante and ex-post analysis of policy measures in favour of intermodal transport. The LAMBIT model explores the relative attractiveness of each transportation mode through a price (cost) minimisation model. The model develops several scenarios and visualises the market area of intermodal terminals.

The scenarios described in this paper show that the current hinterland connections for the port of Zeebrugge to the terminals in Antwerp, Meerhout and Willebroek are exposed to certain limitations such as higher rail subsidies or difficult handling for estuary ships. In other words, without any rail subsidies shuttles between the port Antwerp and the port of Zeebrugge were not possible. Furthermore the estuary shipping constituted certain operational constraints and costs. Therefore the model took the SSW-connection into account to evaluate the potential for barge transport. The future scenario showed positive developments for intermodal transport. When the subsidies on inland navigation were considered as well, the potential benefits of the SSW project were even more emphasised.

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