ANALYSIS OF DIMINSHING SUPPLY ON AND POLICY MEASURES FOR THE SMALL INLAND WATERWAYS

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ABSTRACT

This paper deals with the causes of the decreasing number of small inland ships on the North Western European waterways. Also different policy measures to deal with the diminishing of the small inland fleet are analyzed within the Flemish context.

The average loading capacity of the European inland navigation fleet is increasing through the use of bigger ships. There is a tendency to build more profitable and bigger ships, and as a result lesser small ships are being built. Therefore, the average age of the small inland ships has increased significantly and these ships are threatened to disappear from the market in the near future. Due to the increase in ship size, bigger ships can only sail on the large waterways. Hence, a significant part of the existing inland waterways network can not be served. Without intervention by the government and/or market changes, customers on these small waterways risk to lose their river transport and to be forced to shift to another mode or to delocalize their activity.

The objective of the 2001 white paper "*European transport policy for 2010: time to decide*" was to shift the transport volumes from road haulage towards other, more sustainable modes such as inland navigation. A reactivation and strengthening of the small inland waterways can play a vital role in dealing with congestion, emission reduction and other external costs. This subject is a major issue for policy makers in the Netherlands, Belgium (Flanders) and France.

This paper analyzes three different policy scenarios to deal with these problems specified to a Flemish context. The first scenario, government does nothing in aiding the fleet or in improving the infrastructure. In the second scenario, the infrastructure becomes adjusted for larger ships with 1500 ton loading capacity. In a third scenario, the fleet on the small waterways becomes renewed with the introduction of new concepts. Also a newly developed small tug and barge concept for the small inland waterways is presented.

Keywords: sustainability, inland navigation, freight transport, policy, fleet, Naiades, mode shift, innovation

1. INTRODUCTION

Nowadays, there are a lot of different transportation modes, such as inland navigation, rail transportation, road haulage and even pipelines. In the past, however, inland navigation was the only economically feasible mode that could be used to transport cargo over longer distances. In the Netherlands, Belgium and France a lot of canals have been built, and small rivers are adjusted to accommodate ships connecting economic centres to larger waterways, i.e, rivers such as the Scheldt and the Rhine. A lot of companies, which are using inland navigation, are located at those waterways. In Figure 1, an overview of the different inland waterways (small and large) in the Netherlands, Belgium and northern France can be observed.

Figure 1- Inland waterways in North-West Europe*
Source: Bureau Voorlichting Binnenvaart
*All green waterways can be considered as small (CEMT II)

Waterways form a dense network that connects the two main ports in the Le Havre – Hamburg range (includes the port of Rotterdam and the port of Antwerp) with its hinterland. This hinterland consists of the Netherlands, Belgium, Germany, the northern part of France and Switzerland (via the Rhine). A large part of this network exists out of small waterways. Small inland waterways are here defined as waterways where ships with a loading capacity of 600 tonnes can sail on (CEMT = II, Length ship <=50 m; width ship <= 6.8 m).

Due to a lack of newly built small inland ships and newly starting small-ship enterprises, and due to the increasing age of the small inland fleet the small inland waterways risk to become

obsolete. This could lead to a mode shift from inland navigation towards road haulage or to a relocation of former waterbound companies. However, due to growing road congestion and an increasing awareness of environmental issues, the small inland waterways can play a vital role in providing sustainable solutions. These waterways, especially the small ones in the Netherlands Belgium and France, connect many regions to important hubs, such as the ports of Rotterdam and Antwerp, enabling transport of a major part of their hinterland cargo.

2. RESEARCH QUESTIONS AND METHODOLOGY

This paper analyzes the causes and effects of the decreasing number of small inland ships. Besides the analysis of the main problem different solutions are proposed and analysed. In this paper, the total analysis is built upon the following subthemes with each of them having their own research questions:

1. Diminishing of supply on the small inland waterway network: Why have there been so few new small ships being built in the last 40 years? What are the current and expected threats to the existing small inland fleet?
2. European policy: Which policy initiatives do the member states suggest to solve this problem?
3. Policy measures for the small inland waterway network in Flanders. Three different policy scenarios, which consist out of a base scenario and two different proposed solutions (adjusting the infrastructure or adjusting the small inland ships), are developed and analyzed.

3. DIMINISHING OF SUPPLY ON THE SMALL INLAND WATERWAY NETWORK

The problems, concerning the small inland ships, are split into three different subthemes. The first one is the lack of small newly built ships. The second subtheme is the reduction of the number of existing small inland ships. The third subtheme deals with the threats for the existing fleet of small inland ships.

3.1. Lack of new small ships

Figure 2 gives a schematic overview of the mechanism that will explain the expected lack of new small inland ships. This evolution is partly explained by the low financial possibilities in this subsector. The major reasons for the lack of cash and hence no new-building of small inland ships are:

Competition of the other modes and other inland ships
- Economies of scale of the inland fleet
- No new ship-owners of small inland ships

The market that is described in figure 2 is the freight market in which the small inland ships have to operate. In this market the small ships have to compete with their main competitors:

- Road transportation
- Train transportation
- Other inland ships
    - Large inland ships
    - Small inland ship

Due to this severe competition of road transportation and larger inland ships, small ships do not generate enough money while large ships can.

This also influences the second hand market. Due to the lack of cash not enough money is available to buy second hand ships and as a result the price of second hand vessels will be reduced. As a result the the sale& purchase market, will generate lesser financial investments for small inland shipping (SIS).

If the second hand prices drop and market conditions are bad no new ships will be ordered. Hence there will be no new-building market for the small inland ships.

The only investments into the SIS come from the scrap market or the rebuilding market. In the latter the ships can be transformed into a habitation ship for example. As a result the number of operational small inland ships will reduce. All these different reasons are further explained in this section.

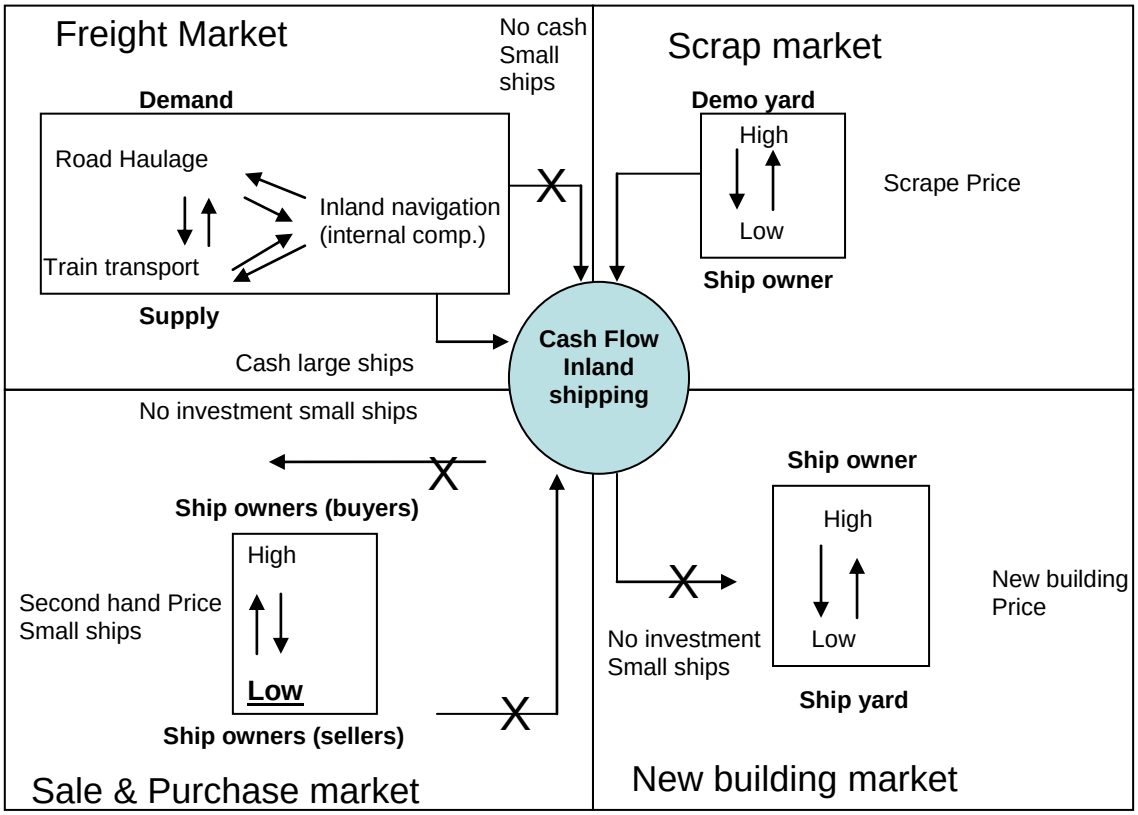

Figure 2 - Overview of the cash flow mechanism form inland navigation
Source: own composition based on: original figure adapted from Maritime economics 2nd edition 1997 Stopford

3.1.1 Competitiveness small inland ships

Looking closer to the freight market, it becomes clear that, next to the competition between the normal inland ships, there is also a mode competition, Road haulage is often the dominant competitor. We distinguish three different types of competition for the small inland ships. First, there is competition with road haulage. Companies on small waterways are also accessible for road transport. Especially at relatively small distances and for small volumes, trucks will be the main competitors for the small waterway fleet.

The second type of competition is that between large (>1500 tonnes) and small ships on the large waterways. Due to economies of scale, larger barges transport goods cheaper then smaller ones. Therefore, small ships experience difficulties to compete with larger ships on large waterways. Small inland ships will mostly sail to destinations or origins at small waterways, and thus their biggest competitors are, as mentioned before, road haulage. However, trucks can offer a complete door-to-door service to customers.

The third type of competition is between the small inland ships themselves. Almost all small ships operate on a stand alone basis and have little to no market power. Table 1 shows that 87% of the Dutch ships and 93% of the Belgium ships are operating as stand-alone entrepreneurs.

	Enterprises Netherlands		Belgium	
	Actual	**Percentage**	**Actual**	**Percentage**
1 vessel	2930	87%	1058	93%
2 vessels	230	7%	51	5%
3 vessels	73	2%	11	1%
4-5 vessels	56	2%	7	1%
6-10 vessels	39	1%	5	0%
10-20 vessels	28	1%	1	0%
20+ vessels	9	0%	0	0%
Total	3365	100%	1133	100%

Table 1: overview of inland shipping companies in the Netherlands and Belgium in 2002
Source: the power of inland navigation 2009 (Netherlands) ,FOD economie 2008 (Belgium)

The severe internal competition creates difficulties to enter the market with a second-hand small ship. When a commencing captain wants to operate a small ship as an independent entrepreneur, he needs to take the costs of repair, maintenance, loan, fuel and his salary completely into account. Older owners, who have already paid off the investment and are expecting to cease business in the near future (within 2 to 5 years), will rather sail occasionally, only charging the operating costs of the vessel (fuel and crew costs).

3.1.2 Economies of scale

In order to reduce costs, to increase turnover and to improve the mode competiveness towards road haulage and railways, bigger ships are being built. These bigger ships can transport goods at lower unit cost (and thus price) than smaller ships (= economies of scale).

As a result, the number of medium-sized ships (<1.500 tonnes) and especially the small ships (<600 tonne) are hardly being built (BCI,2008).

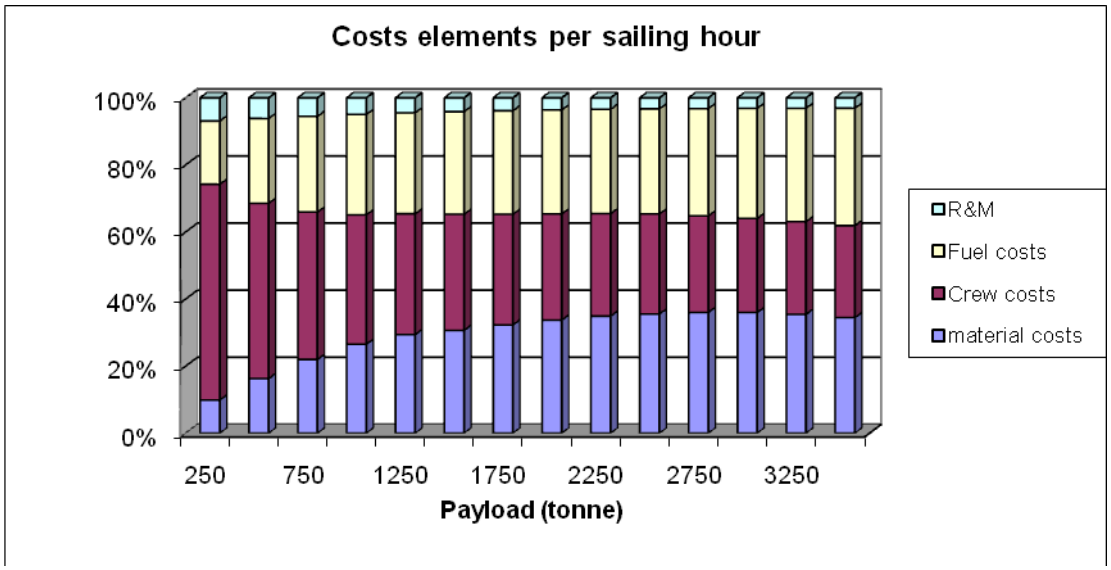

Figure 3 - Cost structure inland ships
Source: NEA 2003

Figure 3 shows the costs structure of the inland ships. Looking at the cost structure of the small inland ships it becomes clear that the majority of the costs (more then 50%) are made up by crew costs. Together with fuel costs they represent more than 75% (600 tonne ships) of the total costs. These variable costs are thus much larger then the fixed costs. When the ship is increasing in size the ratio between the variable and the fixed costs is changed. The variable costs are substituted for fixed costs. If one takes the (west European) wages of the crew members into account it becomes interesting to invest in a bigger vessel. The effect of an increase in scale on the inland fleet can be seen in figure 4.

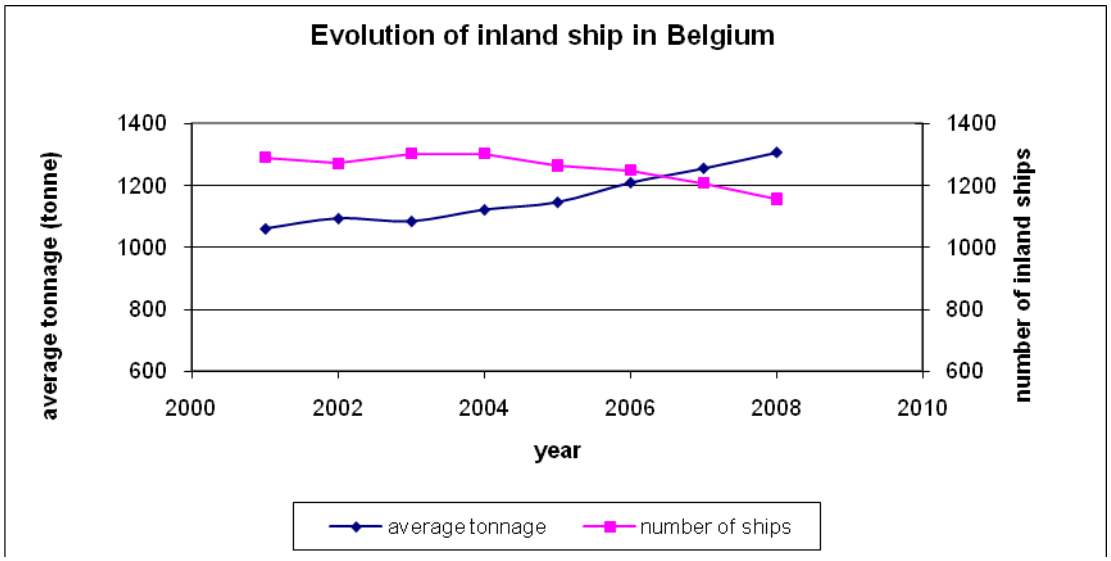

Figure 4 - Evolution of dry cargo inland ship in Flanders
Source: Federale Overheidsdienst Mobiliteit en Vervoer Vervoer te Land Binnenvaart 2009

There is an increase in the average tonnages of the inland ships, while the number of ships sailing on the inland waterways is going down. This implies an increase in scale for the inland fleet and a reduction of the number of small ships.

The same trend can be found for the Dutch inland fleet (BCI, 2008). Figure 5 shows the evolution of the number of small and large ships. In this figure, the trend up to 2003 is extrapolated to the year 2015 (linear extrapolation).

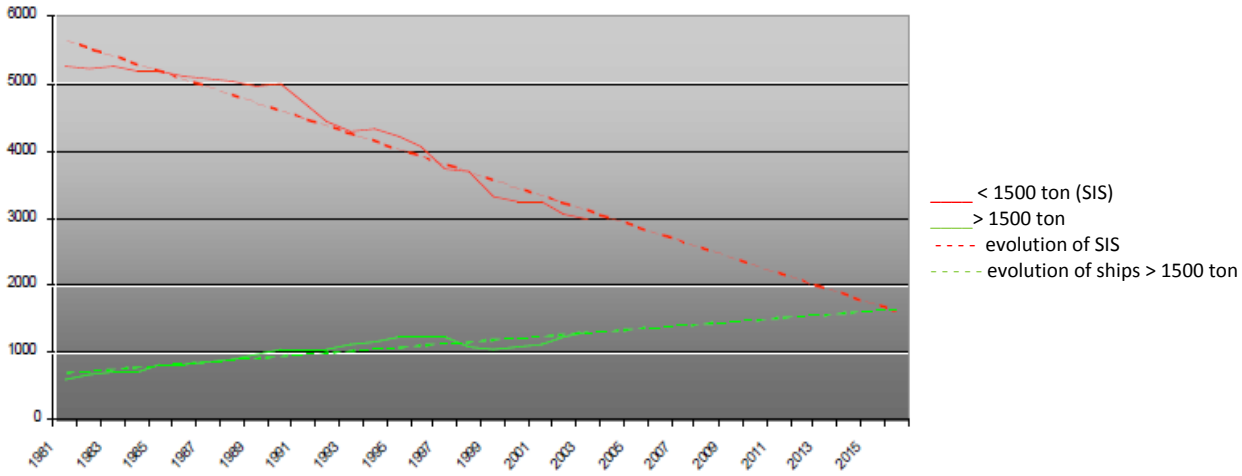

Figure 5 - Trend lines of small (in this graph defined < 1.500 tonnes) and large ships
Source: Buck Consultants Int. (2008), CBS, BCI

3.1.3 Ship Owners

As a result of the economies of scale, the ship owner can make potentially more money with a large ship then with a smaller one. Normally, a young captain commences with an old small ship and sails a few years with that ship. After a few years, the ship gets sold to a new starter and the former captain of the small ship buys a larger one. This “slow growth” mechanism has almost come to a complete stop, because it is easier to make a suitable business case with a large ship than with a small one. The new ship owner will therefore opt for a large, newly built ship instead of a (new or old) small one.

Next to economic reasons, there are also social reasons that contribute to the reduction of the amount of people willing to work on a small ship. There are not a lot of people willing to live on a small inland ship due to the small living areas. The larger ships have a much larger living area than the small inland ships. Combined with the increase in comfort on newer ships, new captains, with their family, will opt for a new larger ship instead of a small one (BCI, 2008).

Another social reason is that there are not a lot of families left willing to live together on a small inland ship nowadays. Therefore, the captain of a small inland ship must take a mate on board and pay him the wages agreed in the common labour agreement. This will lead to an increase in personnel cost because, if the partner also lives on the ship (mostly the wife of

the captain), she counts as the mate of the captain and she is most of the time not fully charged in the crew costs (BCI,2008).

3.1.4 Banks

Banks will not invest easily in new small inland ship due to the fact that these ships cannot be exploited at an high economic level: the risk is too high. When the prices in the market are not high enough compared to the costs of operating a small ship on an economic basis, ship owners will not make any profit. Therefore, they will not have enough money to make replacement investments in new ships or to repay the loan for the investment. Also, the image of the small inland ships is often not well known (BCI, 2008).

3.1.5 Entry and exit barriers

The competition between road haulage and inland navigation was already been considered one of the reasons for the diminishing of the small inland fleet. Another aspect of the competition between road transport and (small) inland ships is that, when the market is bad, trucking companies can adjust their supply easier then small inland ships. A truck can be sold and the truck driver can start in another profession. The owner of a small inland ship does not only build an enterprise but also builds a home. This social fact is also a reason why the owner will not easily abandon his ship/house due to comparable bad market conditions as in the example of the truck driver. The exit barrier of inland (small) ships is much larger then the exit barrier of trucking companies.

Also the entry barrier for inland ships is much higher than in road haulage. In order to sail with a ship the captain must have all its certificates and he must have at least a minimum three years of sailing experience (FOMV 2010).

3.2. Diminishing of the small inland fleet

In the previous part, it was explained that hardly any new small inland ships are being built. In this part of the chapter, it is explained why the existing small inland fleet is diminishing. First, the reasons are given for a reduction of the small ships. The second part will deal with potential threats to the still existing fleet.

3.2.1 Reduction of the small inland fleet

Small ships, sold to low wage countries*:* Old and depreciated small inland ships, which cannot be further exploited in Western Europe, can be sold to new EU-members states, where they can be exploited on an economic level. That is because of the fact that the largest part of the costs of the small ships is determined by the crew costs. Those costs are reduced due to the low wages in those countries. As a result, the number of available small inland ships in Western Europe becomes further reduced.

Regulation/policy: Changes in inland shipping policy had a large impact on the small inland fleet. Due to market liberalization (abandonment of the "tour-de-role-system [1]" system) and demolition rules (old for new regulations[2] 1989 and the scrapping rules) a lot of small inland ships have been withdrawn from the inland fleet (*Dullaert et.al. 1998*). The abandonment of the "tour-de-role-system" system led to more competition and therefore stimulated the increase in ships' size.

Due to the demolition rules, where old ships could be demolished at a fixed price per tonne in order to reduce the overcapacity in the inland fleet, a lot of old, small ships have been demolished, turning the diminishing small fleet further adrift (Konings 2004).

The small ships must also comply with the rules for inland ships concerning new structural and emissions regulations. The investments to update the small ships to these new standards can be higher than the market price of the small ships. Hence, such an investment is not economically feasible. As a result these new rules threaten to force remaining small ships to cease their business.

3.2.2 Threats to the small inland fleet

Increase in fleet age: The first threat is that due to no new building of small inland ships, the age of the fleet is increasing. In figure 6 the average loading capacity of the newly built inland ships per building year is given.

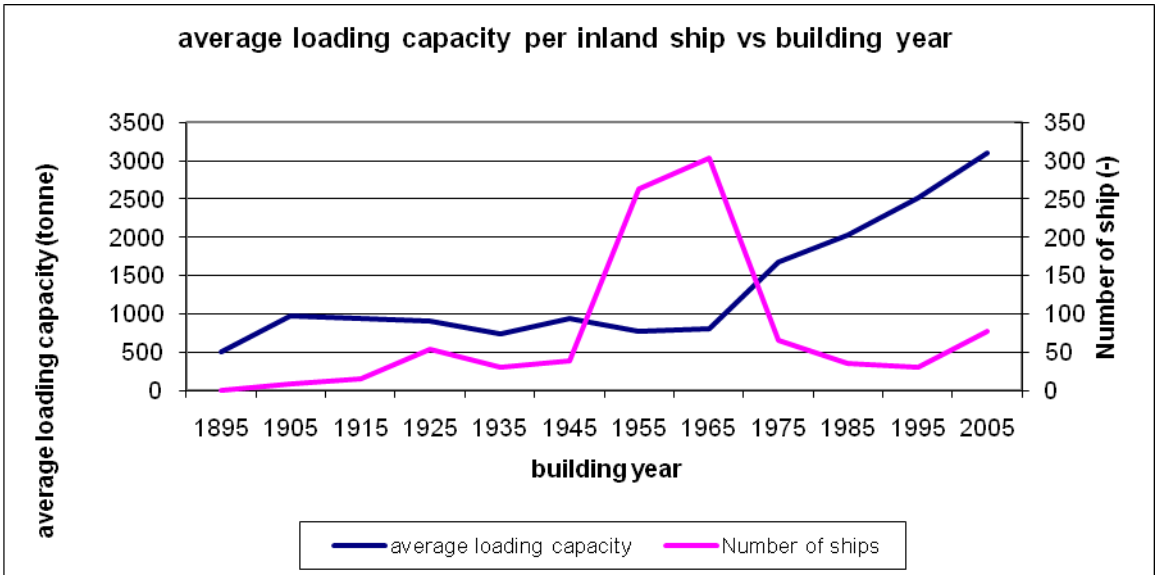

Figure 6 - schematic overview of diminishing supply of small inland ships
Source: ITB, 2009

From figure 6 can be concluded that from the sixties the number of new built ships is small but that the average size of the vessels increased tremendously from 900 tonnes to 3000 tonnes. This is an indication that little to no small ships have been built after the 1960th. The

[1] Principle where the cargo was offered at a fixed price and conditions are offered to the first ship available after unloading
[2] Policy to reduce the overcapacity in the inland fleet. In order to build a new ship with the same tonnage of the old ship, the latter has to be demolished first

average age of the small inland fleet is thus over 60 years. These ships are now not only at the end of their economic life span but also at the end of their technical life. If the structural integrity of the ships is diminishing due to an increasing age, the ship has to be demolished.

Increase in captains' age: There are hardly new captains starting up a business with a small ship so that the average age of the captains of the small ships is increasing. Most of the sailing captains are reaching the end of their professional working life. This evolution leads to a lack of skilled captains to replace the existing ships. Because of a reduction in the number of captains, it can be expected that the remaining part of the captains with a small inland ship will have enough market potential to survive. But companies want to have a reliable transportation mode that will operate for years to come. If the remaining captains can not provide that service for a longer period, because they are also quitting in the near future, then the companies located at the small waterways will have to transport their cargo with other modes such as road transportation, which can provide continuity. A mode shift occurs towards less sustainable solutions and the existing waterway infrastructure for the SIS becomes for recreational purposes only.

Due to the fact that the problems concerning the small inland ships are not only related to the technical condition of the ships but also to the lack of new captains for the small inland ships, the diminishing supply on the small inland waterways will not be linear as in figure 5 but it will decrease faster due to a lack of available captains. In figure 6 this is sketch graphically.

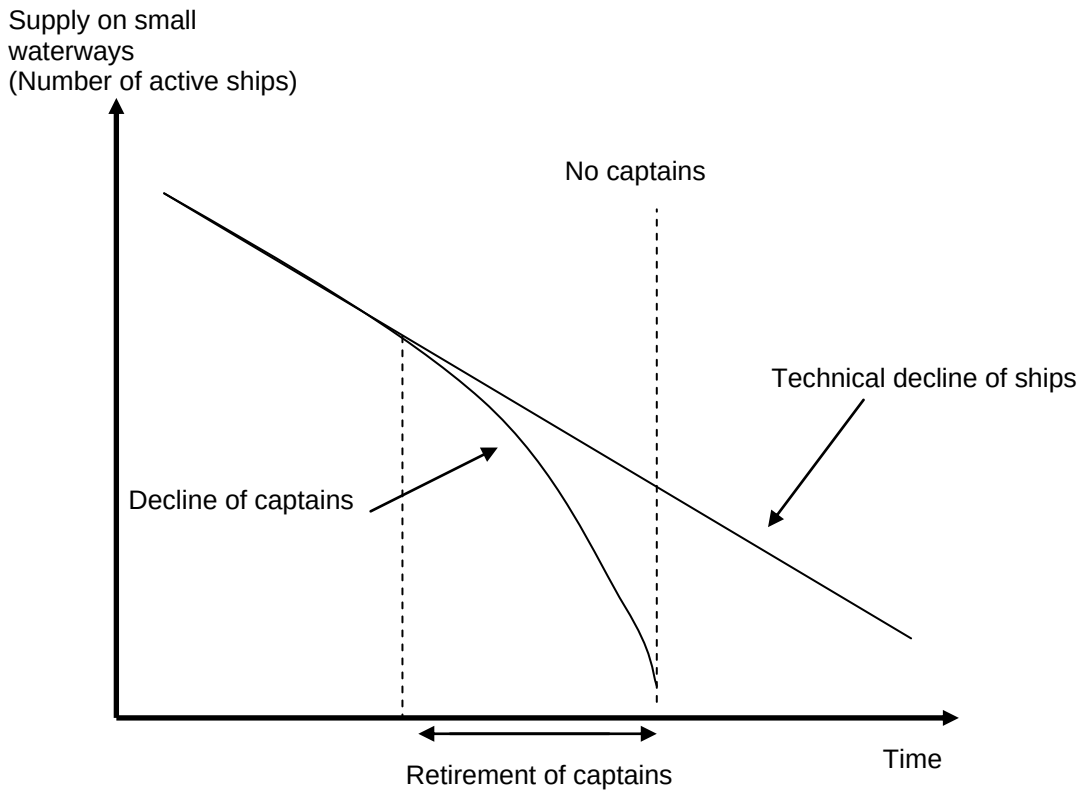

Figure 7 - schematic overview of diminishing supply of small inland ships
Source: own composition

4. EUROPEAN POLICY

According to the Naiades communication[3] small vessels do have a future in serving customers along small waterways (CEMT I-III) and in providing feeder services from and to hubs. Nevertheless, Naiades also mentions that the share of labour costs in the total costs can be as high as 57% especially for smaller ships and that therefore the continuing trend towards larger vessels can be explained as a way to raise labour productivity on board (Naiades, 2006: 12-17). Naiades suggests several instruments to facilitate innovative vessel concepts and technologies necessary for the renewal of the small fleet and asked member states to develop new policy initiatives to maintain and stimulate the small waterways. The European Commission has published guidelines for state aid, possible de minimis rules[4] and a handbook for IWT funding. Other initiatives are mostly found at the level of the member states. The following table presents a short overview of all suggested policy initiatives in the Naiades framework to stimulate the inland navigation on the small waterways.

Table 2 - Aid schemes towards small inland navigation
Source: Platina – platform, http://www.naiades.info/funding/

Aid scheme	Eligible Actions	Rate of co-financing and conditions	Eligible beneficiaries	Time frame	Total budget
Belgium (Flemish region)[5]	Investments in modernisation of small inland vessels (<class IV, <20 yr, <80m, ≤9,5m)	Vessel length of up to 66 metres: Max. 30% of investment costs. 80 metres: Max. 20% of investment costs. Max. EUR 40,000 for each ship / year	Vessel operators with their place of business in Flanders	01/01/2009-31/12/2009	400,000 EUR
Belgium (Walloon region)[6]	Investments in modernization, transhipment facilities, regular container services	Max. 30% of investment costs (modernization). Max. 20% (30% for SMEs) of investment costs (transhipment). For each transported container: 12 EUR (20 ft.), 18 EUR (30 ft.), 24 EUR (40 ft.), 27 EUR (45 ft.); max. 20% (30% for SME) of operating costs of regular container service	Physical persons and legal persons with their place of business in Wallonia	01/01/2008 – 31/12/2013	21,000,000 EUR
Germany	Shipbuilding, acquisition of vessels, modernisation of vessels (e.g. double hull), innovative techniques	6% of taken out loan. Max. 100.000 EUR per application	Inland navigation vessel operators with their place of business in Germany and with vessels listed in a German inland ship register; only SME	01/09/2009 – 31/12/2011	2,000,000 EUR p.a.
France[7]	Reduction of consumption and emissions (e.g. hull, propulsion), environmental evaluation, technical improvement of vessels, on-board transhipment cranes, on-board information and	Max. 30%, max. 60,000 EUR (based on additional costs only, compared to standard equipment). Max. 50% of additional costs, max. 3,000 EUR. Max. 30%, max. 60,000 EUR (150,000 EUR for hold	EU inland waterway transport operators with an office established in France	01/01/2008 – 31/12/2012	16,500,000 EUR

[3] For more information, visit http://www.naiades.info/funding/index.php
[4] De Minimis-support as agreed upon in regulation 2000/1998/EC of 15/12/2006. The EC allows support for enterprises as long the given grants do not exceed €200,000 in a period of three years. This support is allowed for inland navigation starting from 1/01/2007 to 31/12/2013 according to the conditions as mentioned in the regulation.
[5] For more information, visit http://www.binnenvaart.be/nl/steunprogrammas/steunprogrammas.asp
[6] The Walloon aid scheme aims at the entire inland navigation in the region, but according to fleet data of the Walloon Ministry, more than 53% of all descending and ascending ships on the most important Walloon waterways are smaller than 1000 tonnes. Around 37% is even smaller than 650 tonnes. Therefore it is assumable that most of the aid will go to small ships. Own calculations based upon collected data for the Albert Canal, Meuse, Sambre, Canal Charleroi-Brussels, Canal du Centre, Canal Nimy-Blaton-Peronne and the Upper Scheldt (waterways chosen according to total number of ships upstream and downstream in 2007 [19249, 125278]. For more information, visit http://voies-hydrauliques.wallonie.be/opencms/export/sites/met.dg2/doc/fr/nav/statistiquesnavigation2007complet.pdf
[7] In France the national fleet (1372 vessels) consists of 78 % of ships below a capacity of 1000 ton and 33% of all ships less than 400 ton. This part of the fleet (<1000 ton) has a capacity of 47% of the total fleet capacity. The number of ships below 400 ton has a total of 18% of all capacity. The evolution in scale of the fleet shows the trend to bigger ships where as in 1985 more than half the fleet had a capacity below 400 ton. For more information, visit http://www.vnf.fr/vnf/img/cms/Tourisme_et_domainehidden/trafic_deux_mille_huit_200906041643.pdf

	communication technologies (incl. RIS), measures to develop new regular river transport services and improve security (studies and prototypes), upgrading of vessels for call at maritime quays, life-long training for IWT personnel, purchase of used vessels by young IWT entrepreneurs	volume increase); for evaluation: max 50-70% depending on company size, max. 700 EUR. Max. 25%, max. 50,000 EUR (excluding vessel modification). Max. 50% of additional costs, max. 5,000 EUR. Max. 50%, max 100,000 EUR for studies; max.20%, max. 200,000 EUR for hull (based on additional costs only, compared to standard equipment). Max. 50%, max 100,000 EUR for studies; max.20%, max. 200,000 EUR for hull. Max. 50%, 1,000 EUR per person. 80 EUR/TDW, max 20%, max. 60,000 EUR			
Netherlands [8]	Industrial research and experimental development projects (including feasibility projects) which will contribute to innovations in inland navigation in the following areas: Logistics and new markets, transshipment, reduction of air emissions and fuel consumption, ship technology, information and communications technology, education, security	Max. 50% (65% for SMEs) of eligible costs for industrial research projects; max. 65% (75% for SMEs) for feasibility projects. Max. 40% (55% for SMEs) of eligible costs for experimental development projects; max. 50% (60% for SMEs) for feasibility projects. Max. 45% of eligible costs for projects consisting of both industrial research and experimental development	Companies active in inland waterway transport or providing services in the logistics process in which IWT plays a predominant role	30/06/2008 – 01/07/2012	2,000,000 EUR p.a.

Most of the suggested policy gives direct aid through subsidies and other grants to stimulate the inland waterways. But also several projects are being investigated at the moment by the different governments together with universities and private firms. Projects such as SSST (Small ships on small trajects)[9], Mercurius[10] and Barge-Truck[11] are for example being set up in the policy framework of the Dutch Government. The Flemish regional government in Belgium also finances several initiatives in inland navigation on the small waterways. In other European countries, there are no significant funding policies concerning the small waterways. EU Member states such as the UK do not possess an inland waterway network as in the Netherlands, France or Flanders. Most of the UK fleet are small ships and there is no clear trend towards bigger ships because of the limited infrastructure and the very small mode share. Other countries, such as Hungary and the Czech Republic, focus on general infrastructure improvements supported by the EU's Cohesion Fund and the European Regional Development Fund. The fleets of the Danube countries face different problems. Because of historical reasons most vessels were state-owned companies. As a result, in the Danube corridor, a shortage of self-propelled vessels and an overcapacity of push barges can be observed (BCI et.al., 2004).

[8] The total Dutch direct grant is focussed upon the entire sector, but according to the Dutch policy paper, “shipping for a vital economy” of the “Ministerie van Verkeer en Waterstaat” special attention is given to the small waterways. For more information, visit: http://www.verkeerenwaterstaat.nl/kennisplein/3/6/361585/Visie_binnenvaart.pdf, pp.25
[9] http://www.senternovem.nl/sbir/projecten/small_ships_on_small_trajects_ssst.asp
[10] http://www.senternovem.nl/sbir/projecten/de_kleine_binnenvaart.asp
[11] http://www.senternovem.nl/sbir/projecten/bargetruck.asp

5. POLICY SCEANRIOS FOR THE SMALL INLAND WATERWAY NETWORK IN FLANDERS

In order to analyse the possible effects of different policy measures on inland navigation on the small inland waterways in Flanders, several policy scenarios are developed. The first scenario is the base scenario where no policy measures are implemented. The other scenarios consist of two different proposed solutions to deal with the previously mentioned problems.

- **Scenario 1: No government interference**. In this scenario, government does nothing in aiding the fleet or improving the infrastructure
- **Scenario 2: Enlarging the infrastructure**. By enlarging the infrastructure for larger ships up to 1500 tonne capacity (CEMT IV), the traffic on the former small waterways could increase, but small ships could further decrease in number.
- **Scenario 3: Fleet renewal.** In this scenario the government could grant subsidies for the development of new inland navigation for the small inland waterways. Two existing and a new concept are presented.

5.1. No government interference

Scenario one includes a more liberal approach which suggests a scenario without policy intervention. Subsidies can disturb the market and lead to a welfare loss. The trend towards bigger ships can be explained because of the advantages in scale. Because of this reason, scenario one would reduce the fleet of small ships even further, risking to leave the small waterways unused. It is obvious that government policy aims at supporting the traffic on the small waterways and therefore chooses a more active approach. This scenario contains too many risks in order to add to the performance or sustainability on the small waterways. The external costs of small ships will disappear, but these costs will be shifted towards other, less sustainable modes. Nevertheless, the criticism on government involvement and the possibly caused dysfunctions upon normal market mechanisms should be properly dealt with.

In order to determine the impact of losing the usage of the small inland waterways, a calculation is made in a scenario where all goods that are now transported with inland navigation would be shifted towards road haulage. Rail transportation is neglected in this consideration because the chosen companies involved in the calculation are not (or not directly) connected to the railway network. This means that the amount of vehicle kilometres will increase due to the fact that trucks can not transport as much cargo as inland ships. This increase in vehicle kilometres will have an impact on the external costs, and more in particular emissions and congestion. Figure 8 shows the considered small inland waterways where in table 3 the amount of cargo transported per year with an origin or destination of the considered waterways are given.

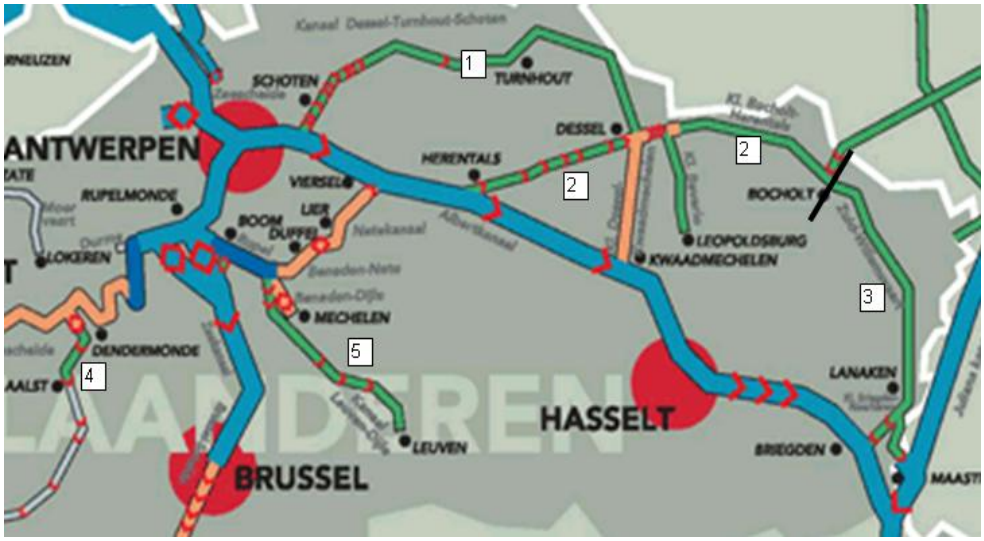

Figure 8 - small waterways in Flanders
Source: PBV

Table 3 - Cargo flows on small inland waterways
Source: WenZ and Scheepvaart NV cargo flow data

	Waterways	**2008**
		[tons]
(1)	Dessel-Turnhout-Schoten	811.295
(2)	Bocholt-Herentals	1.940.455
(3)	Zuid Willemsvaart	632.633
(4)	Dender	474.752
(5)	Leuven-Dijle	195.539
	Total	4.054.674

Because the origins or destinations of these cargo flows are not known, an average performed distance of 66.89 km per trip of inland navigation on the Belgian infrastructure (FOD Economie, 2009) is used to determine the amount of performed tonne*km.
The external costs of the two considered modes can be seen in table 4. The external costs are built up out of air quality (emissions), climate costs (CO_2), accident, noise, congestion and infrastructure costs.

Table 4 - External costs
Sources: Standaardmethodiek MKBA (MOW, 2006), p. 152, values 2020 projection,
*Acradis et.al 2009, p.119 (2005 values)

	Air quality	Climate	accidents	noise	Congestion*	Infrastructure*
	[EUR/tonne *km]	**[EUR/vehicle *km]**	[EUR/tonne *km]	[EUR/tonne *km]	**[EUR/vehicle *km]**	**[EUR/vehicle *km]**
Inland ships	0.0004	0.23	0.0001	-	-	-
Road Haulage	0.0015	0.015	0.0032	0.0006	0.4233	0.0015

Table 5 shows the result of the calculation. The number of vehicle movements increases significantly, resulting in a higher number of vehicle kilometres. As a result, the external costs increase from € 240,000 to € 6,400,000.

Table 5 - Results of external cost calculations per year

	number of vehicle movements	t*km	veh*km	**ext. Costs**
inland shipping	6,758	271,217,144	452,029	**€ 239,575**
Road haulage	168,945	271,217,144	11,300,714	**€ 6,407,505**

Next to an increase in external costs, the large network of small inland waterways will not be used. This infrastructure ceases then to play a vital role in providing an alternative to the already heavily congested road network.

5.2. Adjustment of the inland waterway infrastructure

The second scenario involves higher public budgets and deals with more resistance. Enlarging the infrastructure allows bigger ships to reach new destinations. The suggested solution is to upgrade the existing small inland waterway network from CEMT II to CEMT IV. The locks on the waterways have to be enlarged and the waterway width and depth has to be increased. Next to those adjustments, a new bottom and side plating have to be installed. In figure 9 presents a schematic overview of the different necessary adjustments to upgrade an existing waterway. The unit costs of performing the required works mentioned in table 6 are taken from Technum NV 2008.

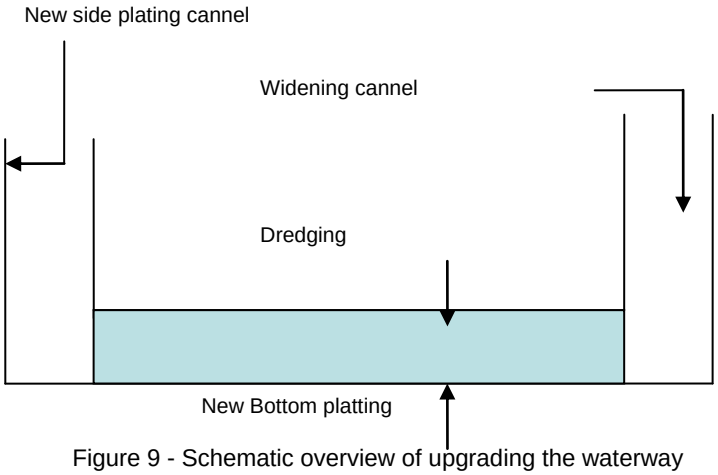

Figure 9 - Schematic overview of upgrading the waterway

The required depth of a class IV waterway is 4.5 meters, while the required width is equal to 14 meters. When the existing dimensions of the waterways are known, the costs can be calculated for upgrading those waterways from a class II to a class IV. The result of that cost calculation can be seen in table 6. The calculations shows that the total costs of upgrading the small waterways in Flanders will cost approximately 1.7 billion Euros.

Table 6 - overview of the investment costs

Route [-]	**Replacing locks** [EUR]	**dredging** [EUR]	**investment bottom plating** [EUR]	**investment widening** [EUR]	**investment canal sides** [EUR]
1	€ 270,000,000	€ 38,340,000	€ 82,700,100	€ 13,608,000	€ 104,206,500
2	€ 90,000,000	€ 35,784,000	€ 88,213,440	€ 14,515,200	€ 111,153,600
3	€ 30,000,000	€ 25,560,000	€ 73,511,200	€ 12,096,000	€ 92,628,000
4	€ 90,000,000	€ 32,802,000	€ 64,322,300	€ 10,584,000	€ 81,049,500
5	€ 150,000,000	€ 14,910,000	€ 64,322,300	€ 10,584,000	€ 81,049,500
					€ 1,681,939,640

5.3. Adjustment of the inland ships

Another approach towards the problems concerning the small inland waterways is not to adjust the infrastructure but to adjust the inland ship (or even the logistics). First two existing solutions are presented. Also a newly developed inland navigation concept for small inland waterways is presented.

5.3.1 Existing solutions

Neo-Kemp (small inland container ship)
The NEO-kemp vessel is a small inland container ship (63 m length, 7 m wide, maximum 32 TEU loading capacity) introduced in 2000 by the Dutch company Neo Logistics Services. The wheelhouse is located at the bow of the vessel hence a good visibility is obtained without the need to lift the wheelhouse. There are nine of these ships built and deployed on waterways where the larger vessel could not sail. The investments are relatively high and these ships can only be used with crew members who are employed by a shipping company instead of a small independent entrepreneur (BCI 2008 and Konigs 2004).

Due to the dimensions of this vessel it can not serve the small inland waterways of CEMT class II. The length and the width are too large. The NEO-kemp ships have been sold in 2003 to Mercurius Shipping Company.

Waterslag project (push barge coupled with a small ship)
In this project a small push barge- which can pass independently a lock- is coupled to a “classic” small inland ship. The loading capacity of the ship is doubled hence a more competitive price can be offered. This could lead to a positive contribution towards mobility, economy and environment. The pushed barge will be specially designed for the usage on the small waterways in Flanders and the south of the Netherlands (Waterslag 2006-2008).

The project has successfully introduced in 2008 but the concept is now taken out of use due to the crisis. The down side of using this concept is that still a small inland ship needs to be used. The main problems concerning the reduction of the captains and the changed social conditions of not willing to live on board of the vessel are not tackled with this concept. Also the small inland ship has to push the barge on large waterways which will reduce the total speed of the convoy and thus increase the crew costs (increase in travel time). The total convoy will sail at its “normal” speed but then need more power which would increase the fuel costs.

5.3.2 New inland shipping concept

A new inland shipping concept for the small inland waterways needs to be developed that could solve the mentioned existing problems of the small inland ships. This concept needs to take following criteria in account:

- The concept must suitable for the small waterways (<600 tonnes)
- The concept must be able to carry containers as well as bulk cargo

- It must be able to compete with road transportation
- The concept should be a profitable business
- No more living on board of the ships
- Provide a sustainable transportation solution to deal with the increasing emission problems

In order to fulfil these criteria a concept has been developed that can best be described as a two stage tug and barge concept (van Hassel 2009). In the first stage, the tug and barge concept sails in its usual configuration with several barges pushed by a single tug and travelling through large inland waterways from seaports to the entrance of the small inland waterway. In the second stage, at the entrance of a small inland waterway, the convoy is uncoupled and the several small barges will sail separately to their different destinations on this waterway.

Push-barge convoys are already been used for a long time on the large waterways in Europe (Rhine trade) and the United States (Mississippi trade). In those push barge convoys the barges are left behind at the begin point and end point of the trip. These barges can thus be handled without the presence of a push ship. Thus the most expensive part of the ship (the engine and crewmembers) can be better deployed. At the places where the barges are left behind a port tug is used to relocate the barges from a clustering point to the terminal. These push barges convoys consist out of large push barges.

In the developed concept the barge size will be decreased in order to analyse the possibility to deploy a tug and barge system for the small inland waterways. The main focus of the concept is to combine economies of scale on large rivers (i.e. tugs and barges together) while the individual barges are small and economically feasible enough to sail on small waterways. In this way the total convoy could compete the with road transportation. Figure 10 gives an overview of the developed concept where two barges are left behind at the entrance of a small waterway which can now sail independently to their final destination on the small waterway.

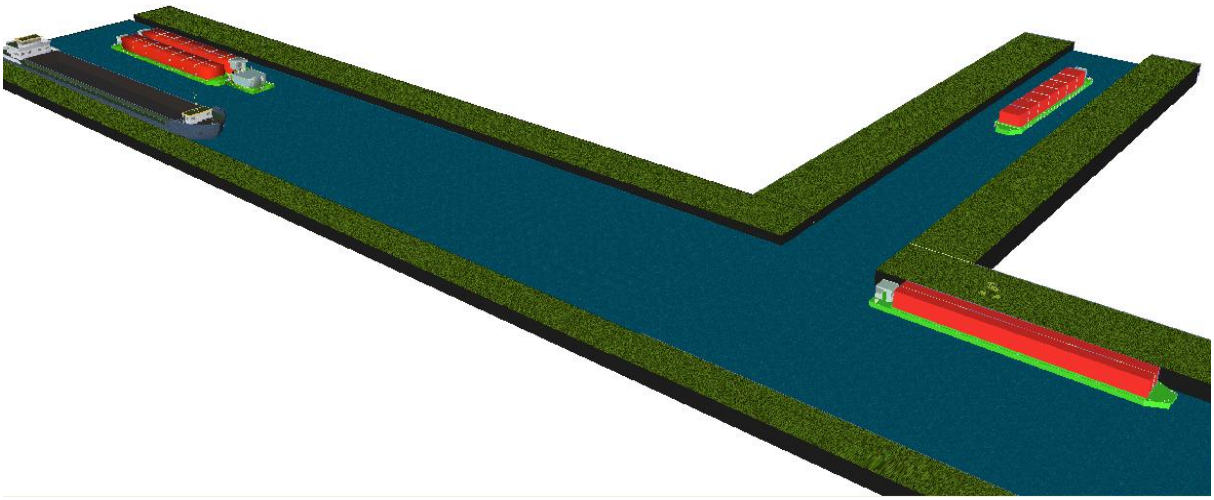

Figure 10 – Schematic overview of the concept
Source: own composition

The concept will have different crews who will operate the tug and the barges. One crew will be operating the tug when the barges are pushed to and from the entrance of the small inland waterways and the seaport. This crew will also deal with the coupling and uncoupling of the barges. The crew members will work in a week on/ week off regime on the tug so that they do not have to live on board of the tug. The replacement crew will be located in the seaport where they will move the barges to and from the terminals in the port. The last crew is a flexible one who will sail the barges on the small inland waterways. This new captain gets on board and sails the barge to the final destination on the waterway. When the barge is moored the captains will be brought back to the starting point. These captains will go home when the work is done. It is also possible that people can rotate for instance from seaport duty to small river duty or from small river duty to push ship duty. This could make the work more diverse.

The barges are “exchanged” at the seaport and at the entrance of the small waterway. It is not necessary that the small barge captain starts his sailing activity right at the moment that the tug and barge convoy reaches the entrance of the small waterway. The barges will be left behind at the exchange point and the next day, the barge captain can start his work. It is only necessary that the barges that have to be sailed back to the seaport are present at the moment that the tug and barge convoy reaches the exchange point.

For propulsion, the barges use electric engines either powered by a generator set located in the aft of the barge or by batteries located in the double bottom of the barge. Several systems could be used to charge the batteries. A power connection on the quay can be used during loading and unloading, favourably using electricity from a grid based on “green” energy such as wind or solar power. If recharging through the grid is not possible due to too high costs or insufficient equipment present at the quays at the small waterways, the batteries will be recharged by the main engines of the tug while sailing in the tug and barge configuration.

An additional advantage is that the loading and unloading of the barges is separated from the sailing part. One of the problems for inland ships is that they experience a very long waiting time in the ports, on average 10 to 16 hours. The costs - and thus the charter price - for inland ships are increased due do these waiting times. Thus, in the proposed concept, the most expensive part of the inland ship, the main engines and the crew, will be sailing as much as possible because the tug doesn’t have to wait in the port to load and unload the barges. It only has to spend time in the port to couple and uncouple the barges. Another potential advantage is that the barges can be handled by the port terminals at off-peak hours. The handling costs of a container in the sea port (unloading and loading) make up the majority of the total costs, so that a reduction in the handling costs will have a large impact on the total costs.

The barges that need to be handled in the seaport are stored at a collection point in that port. That collection point can be one point in the port from where the barges are sailed to the appropriate terminals, or more points near large terminals could be formed. From those

collection points, the barges are sailed to the deep sea terminals by a captain who will work only in the seaport.

6. CONCLUSION

The supply on the small inland waterway network is diminishing due to three major reasons:

- Technical decline and withdrawing of the existing small inland fleet
- No new small inland ships being built
- Reduction of the available captains

As a result of the diminishing small inland fleet the 4.000.000 tonnes of cargo transported by the small inland ships risk to be shifted to the road. Those tonnages are added to the already heavily congested roads. These extra tonnages and the further increase in cargo flows will lead to more investments in expending the road capacity while the available infrastructure of the small waterways will not be used at all. This capacity is very much needed to deal with a large part of the total tonnages that have to be transported.

Due to a growing awareness of environmental care and carbon footprint it is the aim of the EU member states to stimulate the usage of more sustainable modes that produce the least amount of emissions for each preformed tonne*km. In that respect the reactivation of the small inland waterway network could prevent a negative mode shift.

Another consequence of the diminishing of the small inland fleet is that the diversity in the total inland fleet will disappear. The new ships that are being built are increasing in size and therefore the available sailing area of these ships is reduced because the large ships can only sail on a limited number of inland waterways.

If one takes the two different proposed solutions into account then it can be concluded that by adjusting the infrastructure a very large investment is needed (in Flanders 1.8 billon EUR) while adjusting the shipping concept is less costly. Also the new inland shipping concepts could be implemented by a private company meaning that they will bear the risk of the enterprise. The government could stimulate to develop new concepts. This research invites a complete social costs benefits analysis (SCBA) of the different scenarios to point out which scenario prevails.

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