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Socioeconomic Considerations with Respect to the Ten-T Development Plans for the Danube

Summary

September 2007

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with the contribution of WWF Danube-Carpathian Programme

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Executive Summary

This paper summarizes a comprehensive study on socio-economic considerations with respect to development plans for the Danube as part of the EU's Trans-European Networks for Transportation (TEN-T) that was undertaken by the Hungarian Environmental Economics Centre with support from the WWF Danube-Carpathian Programme. The study examines the problems of inland waterway transport on the river from a number of perspectives and proposes more sustainable solutions for development of the sector. The following conclusions can be summarized:

Main conclusions

1. On the EU agenda, there is a severe imbalance in proposed measures for achieving a modal shift: river regulation to increase waterway capacity is over-emphasised at the expense of policy regulation and market adaptation.
2. The imbalance of the three means can result in the inefficient use of public resources and cause social loss--due to the degradation of the ecological service potential along the Danube caused by river regulation. The highest inefficiency and social loss would result from interventions to the less modified Danube sections and their floodplains on the middle and lower flows of the river.
3. Among all the TEN-T development plans, bottleneck removal projects on the Danube have by far the highest spatial conflict with Natura 2000 sites: 67% of the total lengths of bottlenecks coincide with Natura 2000 sites.

Conclusions related to transport policy

1. Competition between transport modes forces Inland Waterway Transport (IWT) to increase its efficiency. But competition is taking place in market conditions where development of infrastructure and costs of negative effects are (mostly) not paid by market forces but are left to society. Without a strong basis for internalisation of external costs, IWT seeks efficiency improvements from better use of the load-space and operational time, pushing for constant modification of waterways to make them more suitable for these needs.
2. Rivers are dynamic systems and there will always be changing conditions in the waterways. However, the IWT sector wants stable and predictable conditions. Therefore without a strong stance on the protection of nature or some compensation method, the IWT sector will always push for the artificial reduction of the risks that the dynamic nature of the river presents. After removing one bottleneck, another one will always appear.
3. A modal shift towards IWT is beneficial when only external costs related to fuel combustion (like air pollution and greenhouse gas emissions) and congestion are considered. However, external costs arising from the development and maintenance of waterways are not included in these comparisons but they would modify results.

Conclusions related to market adaptation

1. From port to port, the main bottlenecks of full-load operation are related to constrained water depth, but in the door-to-door flow of goods there are other hindering blocks that deter demand for transport from IWT, such as lack of functioning intermodal connections, organisational inefficiencies, and lack of timely forecasts of water levels.
2. The demand for transport grows faster in other market segments than in the classic IWT markets (i.e. bulk goods). In order to service the potential market segments (e.g. manufactured goods), the actors must adapt. So far the IWT sector is falling behind in providing offers to the market (e.g. door-to-door service, clear terms for covering nautical risks), in large part due to organisational reasons.
3. IWT along the Danube can operate as part of a multimodal transport chain. It needs inter-modal agreements (legal and organisational background) and sound transhipment facilities.
4. Interests differ within the IWT market itself among vessel owners (depending on size and transport corridor), infrastructure owners, and crew. Interoperability of different river systems is more advantageous to the Rhine operators (mainly larger companies).

Efficiency loss from poor utilisation of vessel capacity

1. Bad waterway conditions are not the only reason behind poor utilisation of vessel capacity on the Danube. Organisational problems and the low quality of timely water-level forecasts also result in efficiency loss. It is reasonable to assume a 10 to 20% efficiency loss due to waterway conditions (i.e. a 4-7 dm unleaded draught because of safety reasons).
2. The extent of the loss that can be traced back specifically to waterway shortfalls does not justify intervention to the river.

Conclusions related to regional trends

1. Political changes rearranged the transport flows to and from the Central European (CE) economic centres. Recently the North Adriatic ports seem to take the role of the CE region’s continental gateways: traffic in these ports exceeds the traffic flow on the Danube.
2. The Danube has its primary role as a link among the Danubian centres, and as a seaport connection of the middle and lower flow countries through the Black Sea, but potential to serve a link to the ARA (Antwerp-Rotterdam-Amsterdam) seaport area is limited.
3. The current status of the Danube fleet, port infrastructure, and market organisation is an opportunity to re-plan the whole transport system from the beginning. There are insufficient local (Danube basin) reasons for the realisation of a single-standard pan-European corridor.

1 Introduction and main findings

This paper is a summary of a comprehensive study on socio-economic considerations with respect to the TEN-T development plans for the Danube, prepared by the Hungarian Environmental Economics Centre with the contribution of WWF Danube-Carpathian Programme Office. The aim of the study is to list considerations missing from the preparation of the TEN-T plans. The study examines the problems of the inland waterway transport (IWT) sector by adopting a multi-view approach. Besides reviewing the present problems of the IWT sector, the study considers the needs of society, such as preservation of nature and improvement of the environment, and proposes more sustainable solutions for development of the sector.

Although the problem of the growing transport volume in Europe, which exceeds the growth rate of the GDP, is beyond the scope of this study, we must underline that its negative effects (air pollution, noise, congestion, habitat fragmentation, etc.) reduce social well being. Therefore the growing intensity of transport can be considered as an undesirable side effect of commercial activity, and efforts to de-couple economic growth from transport growth should be strengthened.

The IWT sector is competing with other modes of transport in a market where the costs of creating infrastructure and the costs of the negative effects are (mostly) not paid by the market actors but by the whole society. In this situation, the IWT sector on its own will only strive to increase its efficiency by cost reduction and better utilisation of shipping capacity. This leads to smaller crews and bigger ships, which results in a demand for improved waterway conditions (bigger depth and straighter channels). But river construction works alter natural processes of the river and have negative impacts on its ecological services, generating additional costs for the society as a whole. Moreover, the waterway network will always remain smaller than the rail or road network, and in this sense IWT will always remain in a disadvantageous position.

Due to geographical endowments, IWT as an independent modal network can exist in the Amsterdam-Rotterdam-Antwerp seaport area and its hinterland. In the Danube Basin, IWT cannot provide door-to-door transport services without developing multimodal co-operation. Therefore the desirable increase of IWT in the European transport market and in the Southeast corridor (the Danube) cannot be achieved by single-sector development measures (removal of bottlenecks for large-scale navigation).

The shift in transport from road to rail or IWT results in decreasing environmental pressure in terms of emissions and energy consumption. However, comparisons of transport modes' environmental impacts usually do not include the external costs (ecological impact) of waterway development.

In order to prevent river ecosystem damage, the fewest possible river regulations should be combined with the most possible market regulations. Nevertheless, there is no clear legal framework regarding how the rights to the existence of river and floodplain quality are distributed. This is why the **public participation** in the planning process, required by the Water Framework Directive, and the accomplishment of **Danube basin-level Strategic Environmental Assessment of TEN-T interventions, is essential**.

2 What is TEN-T?

The first plan on the Trans-European Networks (TENs) for transport, energy, and telecommunications, was adopted by the European Commission in 1990. TENs were given a legal base in the Maastricht Treaty in 1993. Guidelines for the development of TENs for transport (TEN-T) were adopted by Decision No 1692/96/EC of the European Parliament and of the Council of 23 July, 1996, and amended by decision No 884/2004/EC of European Parliament and the Council of 29 April, 2004.

TEN-T comprises a network of roads, railways, inland waterways and ports, seaports, and airports throughout the EU and its accession countries, including missing connections and links. Projects for developing transport infrastructure and the services necessary for the operation of these networks are proposed by the Member States. Guidelines for developing the TEN-T identified projects of common interest. The concerns in the development of the TEN-T are completion of the connections, optimisation of efficiency, achievement of interoperability, and integration of the environmental dimension.

The TEN-T projects are organised along axes, which are referred to as corridors. This study deals with Axis no.18, or “Corridor VII,” the Rhine/Meuse-Main-Danube waterway. Capacity analyses identified several “bottlenecks” (Tables 1 and 2) on the Danube and the target of the TEN-T development plans is to eliminate them. The TEN-T guidelines do not specify how the elimination of bottlenecks should be done. However, the report of a high-level group on the TEN-T (so-called Van Miert report) suggested bottleneck removal by river regulation. Most of the targeted sections are the most valuable remaining riparian areas, which are listed as Natura 2000 sites.

Table 1: Bottlenecks in the Corridor VII

Germany	Low depth on the Danube and upgrading (Straubing-Vilshofen)
Austria	Low depth on the Danube (Wachau stretch)
	Upgrading the Danube (downstream Vienna)
Slovakia	Upgrading the Danube (fairway depth and bridge heights)
	Upgrading the Danube (into ECE class VII)
Hungary	Upgrading the Danube (fairway depth and bridge heights)
Serbia, Bulgaria, Romania	Upgrading the Danube (fairway depth on spots)

Source: Pine – Prospects for Inland Navigation in an Enlarged Europe – Full Final Report – Buck Consultants International, Progtrans, VBD, via Donau, 2004

Table 2: Cost of interventions

Route	Type of works	Distance	End of works	Total costs, million EUR	Remaining investments, million EUR
Vilshofen-Straubing	Improving navigability	70 km	2013	128	128
Rhine-Meuse	Improving navigability	140 km	2019	500	500
Lock of Lanaye	Construction of a lock	-	2010	75	75
Vienna-Bratislava	Improving navigability	47 km	2015	180	180
Palkovicovo-Mohács	Improving navigability	358 km	2014	250	250
Romania	Improving navigability	927 km	2011	640	500
Bulgaria (Bathin-Belene)	Improving navigability	26 km	2011	137	137
Total				***1910***	***1770***

Source: Van Miert Report 2003, Technical Annex, http://ec.europa.eu/ten/transport/revision/hlg_en.htm

It should be noted that a review of the TEN-T programme[1] mentioned the necessity of structural reforms and management of the demand side. However, it still focused on infrastructure development, which (as later will be demonstrated) still represents supply-side solutions.

[1] COM(2003) 564 final, http://eur-lex.europa.eu/LexUriServ/site/en/com/2003/com2003_0564en01.pdf

3 The Danube is different from the Rhine

TEN-T projects for bottleneck removal on the Danube aim to ensure access to deeper and larger ships, which would achieve a higher inter-operability of the Danube's and Rhine's waterway systems. In addition, when justifying these interventions into the Danube, many assumptions on possible future flows of IWT are based on current experiences from the Rhine. However, this chapter will show that the Danube has some inherent differences from the Rhine. Furthermore, due to these differences the higher interoperability of these two systems would be advantageous for the Rhine but would have many disadvantages for the Danube operators.

3.1 Geographical potential

Expert papers use the concept of corridors when studying traffic. In the European IWT, important corridors are the Rhine, the West (rivers and canals of the Netherlands, Belgium and northern France), the East (waterways of northern Germany, Check Republic and Poland), the North-South (waterways of France), and the South-East corridor (the Danube from Kelheim and its canals, like the Main-Danube canal).

Among the European waterway corridors, navigation is ideal in the Rhine system, thanks to its favourable geographical and historically determined economic characteristics. It connects huge economic centres along its path (in Germany and the Netherlands), has a sea connection in one of the busiest seaport areas of the world, a dense canal network at the river's lower flow, navigable tributaries, and several connection points to other IWT systems.

On the contrary, the **Danube waterway is not a system but a line** that serves as an axis among the Danube countries' economic centres (with far less intensive economic activity than the centres of the Rhine). The Danube waterway has limited domestic importance, since it lacks cross-links to other industrial zones and other transport networks. It has no canal system that connects to other IWT corridors apart from the Main canal, and it ends in a less developed seaport area.

The role and share of the IWT sector in overall transport is primarily determined by the geographical locations of the industry, which are very different in the southeast corridor compared to the others. In the Danube countries 46% of the transporters are more than 50 km away from the nearest inland port, whilst in other corridors only 28% are 50+km from inland ports. The average density of ports with international importance along the southeast corridor is 90 km (recalculated only for the Danube line the figure would be 60-70 km), while along the Rhine it is 30 km[2]. In addition, due to historical reasons most of the **big industrial sites in the Danube countries have direct access to rail**.

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[2] Source: Shifting Cargo to inland navigation; Transport Research 4th Framework Programme, Waterborne Transport, DG VII-93, 1998

These geographical differences explain why **IWT** in the lower Danube countries serves inter-regional trade and has a very **limited role in domestic transport**. The distance analysis of transport flows in the corridors confirmed that more than 40% of the goods on the Danube were shipped for over 700 km, the mean distance being 492 km, whilst e.g. on the Rhine over 50% of all cargo is transported less than 70 km, the mean distance being 169 km[3].

The Rhine corridor leads the whole IWT market as the core of the waterway network, while the Danube is in the waterway network's and market's periphery. **Increasing interoperability and unification of the waterway systems will favour the Rhine system, while it will be a drawback to some of the peripheral regions (i.e.: regional service providers, small shippers).** The overall growth of the volume and share of the IWT sector does not necessarily mean that all the stakeholder groups benefit from it, since economies and market actors in the periphery have different interests from those in the core.

3.2 Navigation sector potential

Share of the sector

The share of inland waterway transport in the total transport performance[4] in Europe is greater than 10%, but it is concentrated around the Amsterdam-Rotterdam-Antwerp (ARA) seaport area and its connecting network. In the Netherlands IWT has a 43% share of transport, and in Belgium and Germany 12% and 14%, respectively, while in the Danube countries this value is below 10%. In Hungary, the IWT performance in 2000 was almost 1 billion tkm, that is, a 3.1% share of total transport.[5]

Instead of the national/international division of transport, however, it is more precise to focus on economic regions and transport among them. Getting further from the ARA core area, the traffic share of IWT drops significantly. The comparison of the traffic in Emmerich, a large industrial region on the Dutch-German border (57% of the goods carried on waterway), with Passau on the German-Austrian border (6.2% of the goods carried by IWT) illustrates this difference.

Networks

The waterway network is concentrated in a limited area of the continent, the Rhine and the West corridors. Network density is very uneven: the highest is in the Netherlands (123 km/100 km2) and Belgium (47 km/100 km2); while in the southeast corridor the density varies between 4-15 km/100 km2. The **railway** network is much more evenly developed throughout Europe therefore its **potential should be realised further**.

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[3] Source: Shifting Cargo to inland navigation; Transport Research 4th Framework Programme, Waterborne Transport, DG VII-93, 1998

[4] Transport performance (in tkm) is the transported volume (in tonnes) multiplied by the transported distance (in km)

[5] Pine – Prospects for Inland Navigation in an Enlarged Europe – Full Final Report – Buck Consultants International, Progtrans, VBD, via Donau, 2004

Fleet

Each corridor has its own typical ship types and fleet characteristics as a result of the adaptation to the natural and economic conditions. This demonstrates that the **fleet is an adaptable asset**, although its adaptation requires investments.

In 2000 there were 2,650 dry cargo and 300 tanker barges registered in the Danube. In the Rhine corridor the respective figures are 6,600 and 1,000[6]. The typical Rhine ship (80 to 85% of all cargo ships) is self-propelled; pushed barges are frequent only on the lower flows and are designed with a 3,000 tonne capacity and at least 2.8-metre draught. On the contrary, on the Danube pushed-barges form the vast majority, although their share is decreasing, and there are only 200 self-propelled vessels with an average 900-tonne capacity and a 2.3-2.8 m draught.

At present, **there are 1,619 ships on the Rhine that have equipment to navigate on the Danube as well**, while **on the Danube there are only 59 vessels that can operate in both corridors**.

As a result of the economic transformation and the current insecure market/regulatory environment in the Central-European region, investments in fleet modernisation have been lacking, and the **Danube fleet** became **outdated**.

The out-of-date waterway infrastructure and fleet of the Danube can be advantageous, since it gives stakeholders the possibility of **new fleet investments that adjust to the river conditions**.

Ports

The Pine Study revealed several aspects of the present port infrastructure along the Danube that hinder further expansion of IWT traffic. The main problems are:

1. Shortage of special storage capacity (e.g. for high-value goods, grain, liquids, and perishable goods),
2. Worn-out equipment,
3. Difficulties expanding facilities in urban environments,
4. Inflexible management, and
5. Weak infrastructure links to major rail and road routes.

Efficient port functioning is a prerequisite for the expansion of IWT; therefore these problems must be addressed before irreversible interventions to the river occur.

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6 Pine – Prospects for Inland Navigation in an Enlarged Europe – Full Final Report – Buck Consultants International, Progtrans, VBD, via Donau, 2004

Interoperability of the Rhine and Danube systems

The Danube navigation market became more or less one market only 15 years ago, and it is still in evolution, therefore identification of trends and prediction of effects of changes are more difficult than in stable, mature markets (e.g. the Rhine and West corridors). In spite of that, a tendency in the overall IWT market toward market concentration seems to be clear: the **number of companies and the number of ships are declining**, parallel to a growth in the average vessel size. The biggest transport performance increase (30-40%) is projected for the largest ship segment, with a capacity above 1,500 tonnes.

Bottleneck elimination favours the owners of ships with a bigger draught. Larger companies are more likely to have these types of vessels, and also to equip them according to several standards. Therefore they can take more advantage of the increased level of interoperability of different river systems. Consequently, bottleneck elimination encourages actors towards investments that give less consideration to environmental constraints.

The fleet on the Rhine that can operate in both waterway systems is 25 times bigger than that of the Danube. Ships on the Danube are smaller and thus have higher tonne-specific costs compared to large vessels from the Rhine. In addition, the Danube vessels use propulsion technology, which is adapted to the river's nautical conditions but results in more expensive operation compared to technology used in the Rhine ships. Due to these differences even the Danube vessels that are licensed for both systems cannot enter the Rhine market due to the cost level.

If higher interoperability is achieved by making the Danube accessible to deeper ships, even more of the existing Rhine fleet will be able to enter and compete in the Danube market. However, current Danube fleet will lose its advantage, as its adaptation to less favourable nautical conditions will no longer be an advantage. Finally, the knowledge of special natural characteristics of the Danube, which is needed for efficient navigation there, will also no longer be necessary. Danube operators and fleet are likely to lose their competitive advantage in their home river.

Thus protection of the natural river conditions protects the local economy through several complex processes. The skills of the local personnel are upgraded through the knowledge of special natural characteristics on the Danube, which also protects their jobs.

4 IWT trends on the Danube and global trends

Overall transport volumes in Europe, and road transport in particular, are growing at an unforeseen pace due to three main reasons:

1. The growing trend towards globalisation;
2. Deregulation, privatisation and the liberalisation of the market; and
3. Trade towards Eastern Europe.

Current forecasts anticipate 2-4.7% annual growth rates of the IWT market on the Danube during the period of 2015-2020, which does not mean large transport volumes in absolute terms. **Not even the most optimistic forecasts predict the Danube to have more than 10% of the transport volume of the Rhine.**

Most growth prediction scenarios are based on an assumption that demand for IWT will increasingly consist of new goods types (chemicals, machinery, and manufactured goods). However, currently the port and transhipment infrastructure is not suited for these types of goods. The growth scenarios assume a smooth transformation of transport suppliers to service this future demand but give no explanation on why the IWT sector is unable to service this market segment now.

Finally, growth scenarios do not take into account possible changes of transport routes. Due to the growing volume of trade, bottlenecks re-emerge on existing transport routes. This forces global trade to open up new routes for goods flow. This has occurred in the Southeast of Europe: after the removal of administrative (political) barriers, **the ports of the Northern Adriatic** (Rijeka, Koper and Tireste) **have the greatest potential to serve as a connection to the sea for the Central European region**. They are significantly closer to the East Asian economic centres than the Northwest European ports. Whereas **the Danube's sea connection (Constanta) is in a disadvantageous position** when compared to the North Adriatic due to the bottleneck at the Bosporus and the low economic activity of the Black Sea region. The traffic in the North Adriatic ports is continuously growing, and in 2005 Rijeka and Koper had the aggregate volume of 25 million tonnes (equal to the entire Danube goods transport).

The Danube, in this context, can serve as a seaport connection for the middle and lower flow countries through the Black Sea connection, and as an alternative route to the Central European region.

5 Ecological impacts of waterway development and floodplain ecosystem services

In this chapter we present an overview of the ecological services of the floodplains, and impacts of TEN-T navigation infrastructure on these services.

5.1 Ecosystem services in general

Functions related to hydrological processes

Naturally vegetated floodplains reduce the force, height, and volume of floods and help to maintain base flow and seasonal flows in rivers and streams. Floodplain soils and vegetation also help to improve water quality and to purify water as it filters down to an aquifer. Wetlands serve as a permanent and temporary storage for sediments, and play and important role in the processes of soil formation. They are also a source of water for vegetation, as well as for domestic, agricultural (irrigation, livestock), and industrial use.

Functions related to biochemical processes

Rivers and the adjacent wetlands play an essential role in maintaining nutrient cycles (e.g. nitrogen, phosphorus, iron, calcium, and magnesium). Mineralisation of organic matter and regeneration of inorganic nitrogen are the two most important processes. Vegetation on floodplains filters and keeps nutrients and sediments mobilised during floods, and it recycles them to production by stabilising sediments and using nutrients for growth.

Marine species of economic importance depend heavily on the nutrient inputs from river flows, since temporal and spatial variations of nutrients control numerous essential functions in coastal marine habitats. These essential elements fuel primary production and marine food chains.

Functions related to habitat

In rivers, the mixing of water provides dissolved oxygen and organic matter for organisms including microbes, invertebrates, and fish embryos. Fish also use wetlands as important spawning sites. Two thirds of the fish humans consume depend on wetlands at some stage in their life cycle.

Rivers serve as important corridors between habitat islands, and therefore facilitate regional biodiversity. In Europe, 30% of threatened bird species depend on inland wetlands, and 69% of the important breeding areas for birds contain wetland habitats. Overall, 28% of all fauna species are endangered, but among the species that depend on wetlands the proportion of endangered species is much higher – 47%.

Wetlands serve as a buffer zone between aquatic and terrestrial habitats. In general, more species of plants and animals occur in floodplains than in any other landscape. Floodplain forests provide timber, fuel wood, and other tree products such as medicines.

5.2 Ecosystem services in the Danube river basin

Natural flood control

Over four fifths of the length of the Danube is regulated. In the 19th and 20th centuries, altogether 15-20,000 km^2 of the Danube floodplains were cut off from the river by engineering works, and most of the side-arms have been disconnected. This has led to a clear amplification of flood peaks, which now arrive faster and higher than before floodplain modification.

Sedimentation control

The Upper Danube dams that interrupt the natural water flow trap sediments and block continuous sediment supply. Downstream of Bratislava 80% of the waters are diverted into the sealed side-channel of the Gabcikovo hydro dam system. Only the remaining 20% is lead into the former riverbed and its extended side-arm system. The lack of former hydro-dynamics such as regular inundation and dry periods, created a new progressive degradation of the floodplain ecosystem in Hungary. The impounded section is silting up; while downstream of the dam the erosion has resulted in a two meter deepening of the riverbed.

Since the construction of the Iron Gate dams I and II, there has been a significant decrease in the sediment transport to the lower stretches, which has caused lateral bank erosion that can be observed for more than 1,000 km downstream. The lack of natural sediment transport contributes to the degradation of the Danube Delta.

Another problem in the Delta is the creation of artificial channels for transport purposes by dredging. The total length of artificial watercourses equals the length of the natural water network, which changes the natural runoff of the water and the process of sedimentation.

Water supply and water purification

Groundwater resources in the floodplains play a major role in drinking water supply in the Danube Basin, in some countries considerable part of drinking water is abstracted from the bank filtrate. In spite of the river pollution by untreated or partly treated waste water from cities such as Budapest and Belgrade in most of the cases groundwater can be fed into the public water supply network after a simple one-stage treatment or even without any treatment. However, due to previous dam constructions on the Danube, its floodplains already show a reduced self-purification capacity. **Thereby expensive water cleaning treatments are increasingly required**.

Fisheries

The remnants of side branches and oxbows[7] all along the middle and lower flow sections provide excellent conditions for fisheries. The remaining floodplain areas, like the Kopacki Rit area in Croatia and the section between Calarasi and Braila in Romania, are the most important fish-spawning areas.

Since the early 1900s, Danube sturgeon fishery has almost disappeared, and current fisheries are maintained through aquaculture. The major causes of decline in fisheries are dams, creation of channels, loss of floodplain areas, sand and gravel extraction and non-native species introductions[8].

Fuel and timber

Whereas many western European countries have little or no remaining floodplain forests, Eastern and Central Europe has retained many impressive tracts, notably on the Danube and its tributaries. Reed and timber from floodplains are used for heating households, construction and traditional manufacturing, especially in the Danube Delta. The deepening of the riverbed and the sinking of water-table level results the degradation of the floodplain forests.

Wildlife

The habitats created by the Danube and its tributaries house a mix of wildlife, with about 2,000 vascular plants and more than 5,000 animal species. More than a hundred globally protected species find their home in the nature reserves along the Danube.

5.3 Valuation studies on ecosystem services in the Danube river basin

Inland Waterway Transport is considered as an environmentally beneficial transport mode, in terms of its external costs related to fuel combustion, such as air pollution and climate change effects, as well as noise, traffic safety, and congestion. Several studies[9] dealt with this topic and found that these external costs of road transport are 3 to 5 times higher compared to IWT or rail. However, these **evaluations do not consider the negative effects of creating and maintaining waterways**.

Several valuation studies on the services of the Danube wetlands and floodplains were carried out. The following table summarises the results of the studies.

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[7] An oxbow is an entirely cut-off small lake that formerly was part of the river-channel.

[8] Hughes, R. M. and R. F. Noss. 1992. "Biological Diversity and Biological Integrity: Current Concerns for Lakes and Streams." Fisheries, May-June 1992

[9] External Costs: Extern-E Research results on socio-environmental damages due to electricity and transport Eur 20193, 2003, www.externe.info;
Marco Polo Programme, http://europa.eu.int/comm/transport/marcopolo/index_en.htm;
Pine Study 2004;
Real Cost Reduction of Door-to-Door Intermodal Transport, Final Report, 2003, EC;
UIC Study (International Union of Railways), IWW/Infras, Paris, 1999;
Unification of accounts and marginal costs for Transport Efficiency, Final Report for Publication, 2003, EC

Table 3: Valuation studies done on floodplain services in Danube River Basin

Study	Study Region	Method Used	Factors assessed	Results
Kosz, 1996	Danube floodplains, Vienna	Contingent Valuation Avoided treatment costs	Value of Wetlands for groundwater	EUR 44-105 million
Kosz et al. 1991	Vienna, Austria	Market pricesContingent Valuation	Wetland services: forest production, grassland, fish, recreation	USD >522/ha
Gren 1994	Danube (flood-plains)	Market pricesContingent Valuation	Fish, water supply, wetland services: N sink, forest production. Hunting, grassland, recreation	USD 458/ha
Schönback (1997)	Danube Floodplains, National park	Travel Costs, Contingent Valuation	Value of National Park	EUR 8,3 billion (11,500ha)

Source: Barbier E.B, Acreman M., Knowler D., 1997 Economic Valuation of Wetlands, Ramsar Convention Bureau Gland, Switzerland & http://www.environment.nsw.gov.au/envalue

Kosz analysed the avoided costs in case of founding a national park downstream of Vienna, instead of using the river for hydropower generation. The impounded reservoir would pose pollution to the groundwater that would have to be cleaned thereafter. He found that a national park with floodplain protection was the “most efficient way to protect groundwater quality and quantity.”

In order to determine the potential benefits from improving water quality and overall management of the Danube, Gren conducted a total valuation study of the floodplains, which found that the economic value of the most important services is US$ 458 per ha per year (1994 prices), and that the most important services are nitrogen sink/denitrification (56% of this value) and recreation possibilities (29%).

5.4 TEN-T plans’ impact on ecosystem services

The biodiversity of large European rivers is mainly affected by (1) pollution and (2) hydro-morphological degradation. As a consequence, floodplains are among the most endangered landscapes worldwide. While the negative effects of pollution are decreasing because of improved wastewater treatment, hydro-morphological degradation of the Danube will worsen if the planned navigation improvement measures are implemented. We must highlight that 65.2% of the stretches targeted by the TEN-T projects are part of the Natura 2000 network.

The proposed bottleneck removal projects on the Danube include dredging, closing lateral channels, bank reinforcement, improving riverbeds, and construction of groynes, dikes and weirs.

Dredging

Several studies analysed the effect of dredging on habitats, plants, and animals, and they found that it already has severe consequences within several years after dredging[10]. Invertebrates inhabiting the river bottom, fish eggs, and plants are directly affected or destroyed. Riverbed erosion and significant changes in water table levels were also reported. Falling water tables have a negative influence on the overall soil fertility of a region.

Groynes and dams

Groynes have a major impact on the morphology of the river. They increase the velocity of a river, which deepens the navigation channel, and retain sediments on the sides. Dams that disrupt the longitudinal connectivity of rivers prevent or reduce the natural migration of certain species. Due to decreased velocity in the impounded stretches, sediments retained cover natural habitats of the bottom-dwelling organisms. Reduced flow also leads to diminished oxygen diffusion to the bottom. Furthermore, due to sediment trapping before dams, less sediment is supplied downstream, resulting in riverbed erosion, which in its turn leads to lowering of groundwater tables.

Closing lateral channels

Meander cut-offs, carried out to improve the navigation route, result in siltation of side arms and oxbows, and a slow drying of floodplains. It reduces water storage capacity of the system, causes loss of habitats, disrupts migration corridors and leads to exacerbated flooding in downstream areas. Changes in the nutrient exchange, lowering of the water tables in adjacent aquifers, and a reduced water purifying capacity of wetlands are also frequent consequences of canalisation projects.

Dikes/Levees

Former floodplains were drastically reduced by construction of dikes along the Danube. In the section between Romania and Bulgaria, dikes are usually only 200 to 300 m away from the main stream. Outside the dikes former wetland habitats were changed by human activity and through natural succession processes after the disconnection from the river. As a consequence of the river being squeezed into a narrow corridor, accelerated flooding with higher peaks occurs.

Conclusion

The alteration of rivers through channel modification or deepening, dikes, closures of side arms, and similar projects has severe direct and indirect impacts on the entire river and floodplain ecosystem. It destroys the sustainable (long-term) living conditions of ecosystems.

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[10] Essery, C. J. and Wilcock, D. N. 1991. Environmental Impacts of Channelization on the River Main, Country Antrim, Northern Ireland. Journal of Environmental Management 32;
Haynes, J. M. and Makarewi, J. C. 1982. Comparison of benthic communities in dredged and undredged areas of the St. Lawrence River, Cape Vincent, New York. Ohio Journal of Science 82;
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Traditional flood mitigation should be supplemented with flood management strategies that recognise the need for the **extension of flood retention areas** by habitat restoration.

The high level of overlap of the waterway development locations with the Natura 2000 sites (65.2%) cannot be neglected.

6 How should navigation be developed?

6.1 Recent obstacles to IWT growth

The Shifting Cargo to Inland Navigation Research Programme synthesised several interviews with the different stakeholders in transport, and found that on the southeast corridor the main obstacles for increased exploitation of IWT were:

<u>Infrastructure:</u>

- Low reliability of stable waterway conditions
- Long-lasting periods of low water, especially on the Upper Danube in Germany
- Waiting times in front of locks
- Frequent technical problems on the locks
- Locking priority given to passenger vessels against cargo ships
- Long distances between transporters and the nearest ports
- Lack of container transhipment facilities in ports

<u>Information deficits about the actual waterway conditions:</u>

- Insufficient information on the nautical situation
- Absence of reliable medium- and long-term water level forecasts
- Actual water-level gauge readings very often given with 24 hours' delay
- Inadequate information flow with regard to possible lock closures

<u>Fleet structure:</u>

- Lack of long-range shallow draught push-boats (new concepts of construction)

<u>Service offers:</u>

- Lack of regular scheduled services
- Lack of complete services
- Minimal fuel and water supply along un-serviced sections

<u>Information deficit for the transporters:</u>

- Long periods of waiting for information from operator

<u>Railway price policy:</u>

- Railway freight rates below the reasonable cost level

This list shows that many obstacles are organisational and lie within the competence of the navigation sector actors, while the last obstacle should be tackled by the state or European transport policy.

The Shifting Cargo study also revealed that a significant increase of the market share of IWT could be achieved without waterway development, but rather through the application of measures that approach the cost structure. We discuss factors that influence performance of the IWT sector in order to clarify which methods are most suitable for achieving a higher market share.

6.2 All transport modes must contribute more to the real cost of use

Current infrastructure networks have been developed over the past decades, or even centuries, without having in mind the concept of external effects caused by economic activities. In the actual regulation framework, users of a given infrastructure do not pay the real costs of use, and what they do pay is not in the same ratio in each transport mode. Furthermore, there is no regulation providing a framework for internalising external costs that a specific transport mode imposes on society and the environment. Without such regulation, road transport, having the most advanced network, is in a more favourable position than any other transport mode.

A shift from road to rail and IWT, as well as the promotion of multimodal transport solutions are in the interest of both the IWT sector and environmental protection. An interest in having a less standardised river is partly shared with people working in the sector: **the need for the knowledge of a less standardised river raises the demand for a local workforce**, and the development of related services generates employment in the area. Additionally, local people have a common interest in their health and living environment, while deepening the river is rather in the interest of the big transport firms.

The real costs of transport (including external costs), however, must be paid by those who benefit from it. The **"Polluter pays" principle** is the basis of this approach. It requires a better understanding of the impacts and a legal framework for feedback. **Internalisation of external costs** into costs paid by users is necessary.

Nature's interest is a free-flowing river, while society's interest is provision of ecosystem services (biodiversity, climate change mitigation, water supply, local access to the river, fisheries, etc.). A balanced river system requires dynamic water-level changes with periodic inundation of floodplain and water retention there. **The public interest is that the users, not the public, pay the costs of elimination of harmful effects of waterway development and maintenance, and costs of nature rehabilitation.**

The IWT sector's interest is the increase of transport volumes, and therefore they are interested in capacity increases: enlargement of networks and provision of more stable and deeper navigability conditions. The biggest and most organised actors even push for common navigation standards including all waterways. Transport companies' interest is that the cost of navigation conditions' improvements is financed by the state or the EU.

6.3 Inland navigation must fit into the transport chain

The trends discussed earlier make it clear that inland navigation needs to be fitted into a transport chain. The prerequisite for multimodal transport solutions is the operation of quick and cheap transhipment ports and the use of interoperable load units. Apart from the low port density and the poor quality of existing port infrastructure, the new logistic centres in the new member and accession countries are also part of the problem, since they have been developed for servicing the road transport or road, rail, and air connections, but provide no possibility for later connections to the IWT network.

Another fundamental obstacle to the interoperability of transport modes is that at present, many types of containers exist, and that generally shipping and trailing containers are mostly mutually incompatible. Shifting cargo to IWT requires **standardisation of transport units**.

6.4 IWT must increase its flexibility

Demand for transport has been changing over the last few decades. As a consequence of increased value per tonne of products, the share of transportation in the total costs is declining. Due to the growing competition on the liberalised market, transport prices are also decreasing in absolute terms.

The segments in which European transport is growing the fastest are metal products, chemicals, and manufactured goods. Petrol, foodstuffs and building materials show a medium growth, while the classic IWT segment, that is, bulk goods, show slower or no growth potential.

As the fastest-growing segment consists of higher-value goods, this trend makes shippers less sensitive to transport price changes. Instead they are looking for reliable transport services: growing speed and **punctuality together with flexibility and availability** are the new market requirements, to which the supply side of the IWT market has to adapt. The demand side is less willing to make steps, since a wide range of other transport modes is available.

6.4.1 Fleets must adapt to the market and the river

Fleets were once adapted to demand both in the Rhine and the Danube corridor. Along the Rhine immense economic activity created demand for the regular transportation of big volumes of goods between the seaports and industrial centres. The adaptation to this stable demand made vessel size grow until the limits set by the waterway characteristics were met.

Along the Danube the current fleet was formed under the centrally planned economic regimes. Big state-owned navigation companies served the needs of heavy industry, transporting large volumes of bulk goods without the pressure of time or market competition. The answer to these market conditions and the waterway characteristics was the use of separable convoys of barges. By the collapse of the socialist trade system, the fleets became outdated lacking the funds for their replacement. The restructuring of the economy - after the collapse - fundamentally changed the demand for IWT.

New trends in demand do not allow the previous level of utilisation of these big transport units. From the economic point of view, it is irrational to use, in new condition, a transport infrastructure that was adapted to different needs. In this sense, until the end of the amortisation cycle of the current equipment (the scheduled time of its replacement, and possible adaptation period) the owners will suffer from efficiency loss, due to the gap between supply and demand. Therefore **it is more advantageous to finance adaptation of the fleet to the market and river conditions or temporarily compensate for the loss than transform the rivers**.

Technical solutions that enable the division of the shipload capacity (like containers), and marketing measures such as turning to new market segments can all contribute to the renewal of the IWT. As the modal shift to IWT has a beneficial external effect, the adaptation of the sector is worth supporting from public resources.

In order to demonstrate the problem from the financial point of view, the Hungarian Environmental Economics Centre made calculations of loss to IWT companies arising from a partial (not full) utilisation of vessel capacity, using data from the Upper Danube on transport volumes and utilisation rates. They identified a 25% efficiency loss due to waterway-related components, which should be considered as an upper limit because of the calculation method used.

The estimated efficiency loss in relation to waterway conditions is equal to a four decimetre draught difference. It corresponds to losses from EUR 9-13 million annually. That is what could be gained by the operators if one of the alternatives for the Straubing–Vilshofen section (the main bottleneck between Rotterdam and Passau) were realised. The cost of the project alternatives ranges from EUR 126 million to 513 million. Differences between gains and costs is within an order of magnitude, which shows that the **time interval of the return on the investment for waterway deepening is similar to, or beyond, the lifecycle of the vessels**. In this sense, the currently **outdated Danube fleet should face development** towards the adaptation to waterway conditions **rather than modifying the river**.

6.4.2 Complete and continuous service supply

Many studies prove that the potential market for IWT is higher than the volume actually serviced by the sector. The problem is the lack of effective market-based solutions to gain a higher IWT share. Many shippers do not even examine alternatives to road transport due to lack of time or information.

The Shifting Cargo study examined the shippers' requirements and found that the most important criteria of choice were cost, punctuality, transport time, and safety. Regarding the barriers of using IWT, they claimed that the most important ones were prolonged transport times, low availability, lack of solutions for lower volumes, and risk of transhipment. Service flexibility and missing information were also mentioned. Regarding what they expect from the transport operator, complete and continuous service offered by a single firm, shipment tracing systems, liner service and precise offers were ranked as the most important.

This research reveals that the shippers want to minimise the time spent dealing with the problem of transport: they need full service and clear parameters for making a decision, as this would allow operators to optimise transport according to the most advantageous combination of modes available.

The problem of too low transport volumes is an organisational question that transport firms should address. **Containerisation** is a good example of how organising, with technical innovation, can open up new markets and clear away former bottlenecks, although, at the same time, it can create new ones. It enables division of capacity and **requires less water depth, but the problem of insufficient height arises at some bridges**. Support in information technology (IT) to optimise the container flow is essential.

Time has become a crucial factor. However, better management can improve the current situation in this respect by developing transhipment procedures, and by addressing shippers' willingness to tolerate uncertainties in transport, by offering lower prices or other incentives. According to the Shifting Cargo study, **43% of shippers are prepared to accept longer transport times** and are flexible in accepting different service levels **at lower prices if conditions are clear**.

6.5 Relationships between vessel draught and transport cost

The Pine Study reveals four factors that have an effect on the overall costs of IWT: registration effect, size effect, differences of labour costs by region, and capacity utilisation. It concludes that the registration effect and the capacity utilisation effect are the dominant issues, and for the latter it blames water depth shortages. This result is based on calculations of per tonne costs at different utilisation levels of the most common ship types. Since the reason behind this capacity loss is draught possibility, we recalculated original data to estimate costs per tonne at different draughts.

Table 4: Cost per tonne on a standard model route, in EUR/tonne

Ship types	Cost calculations of the Pine Study – costs at different capacity rates				Cost calculations at different levels of used draught							
	100%	90%	70%	50%	25 dm	24 dm	23 dm	22 dm	21 dm	20 dm	19 dm	18 dm
Europe A	3.99	4.44	5.71	7.99	3.99	4.19	4.41	4.65	4.92	5.22	5.66	6.17
Europe B	4.63	5.15	6.62	9.27	4.63	4.86	5.11	5.39	5.70	6.05	6.56	7.16
Labe	3.55	3.94	5.07	7.09	3.55	3.73	3.94	4.18	4.44	4.74	5.13	5.60
Eur Danube	3.47	3.86	4.96	6.95	3.47	3.65	3.83	4.04	4.28	4.54	4.92	5.37
GMS A	3.53	3.93	5.05	7.07	5.60	6.00	6.46	7.00	7.63	8.39	9.33	10.49
GMS B	3.81	4.23	5.44	7.62	6.03	6.46	6.96	7.54	8.23	9.05	10.06	11.31
Pushed	1.34	1.48	1.91	2.67	1.34	1.41	1.50	1.59	1.70	1.82	-	-

Base data: Pine – Prospects for Inland Navigation in an Enlarged Europe – Full Final Report – Buck Consultants International, Progtrans, VBD, via Donau, 2004

The table displays that typical Danube ships reach a 70-50% utilisation ratio at low draught (18 dm) (green cells) and 100% at 25 dm (yellow cells), while the GMS type (Rhine) ships are not competitive at the standard 25 dm draught on the Danube because they can operate at only a 60% utilisation rate (blue cells).

The overall profitability of ships depends on the frequency of each water depth (fluctuation in time). When bigger ships can reach high utilisation rates, they can achieve a high profit margin, but the profitable operation period is short. **Smaller ships have a smaller profit margin but their overall utilisation rates are better, and their profitable operation period is longer**. We can conclude that the **loss due to natural circumstances is usually overestimated**.

6.6 Addressing water-level fluctuations

Bottlenecks in the system emerge not only in the form of water-depth shortages: water-level fluctuation has its own constraining effects as well. However, as these natural constraints are consequences of the living nature of the river, before their modification, it must be examined how much of the experienced utilisation loss can be traced back to the waterway shortfalls, and to what extent it is due to other factors in the transport chain.

Delays can be compensated by incentive pricing, and companies usually have a portfolio of different ships and operate on more than one route. This decreases the effect of water-depth constraints, and enables operators at a certain organisational and technical level to adapt in order to minimise the utilisation loss.

Waterway standards specify the duration of a specific water depth for a certain number of days per year. Meanwhile, the fluctuation of water levels affects the exploitation of the potential draught of vessels, since high fluctuation or the lack of reliable forecasts force the operators to use bigger safety margins (unloaded draught, which allows a ship to navigate if water-depth conditions worsen along the route). The problem is that water-level forecasts for the Danube are often published only three days ahead, and the loading in ports such as Rotterdam takes place farther in advance for long transports to the Danube. This results in the application of extra safety margin[11], which makes the vessel-specific costs increase.

Here it should be highlighted as well that there is a clear connection between the capacity utilisation level of a ship and its draught, and also between the density of the cargo and the loaded draught. Lower-density goods such as agricultural and petrol products face fewer constraints. Moreover, the problem of accurate prediction exacerbates with distance.

Finally, the magnitude of the fluctuation of water level on the river is the result of the water-retention ability of the whole river basin. Therefore, an improved water retention capacity by extending floodplain ecosystems can reduce the water level fluctuation, and a better understanding of the water circulation in the catchment area can result in more precise forecasts, which both have direct positive economic effects.

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[11] Safety distance is the name given to the unloaded draught, which allows the ship to navigate if the water-depth conditions worsen along the route.

6.7 Conclusions on navigation development

The obstacles that hamper better utilisation of IWT on the Danube can be lifted through:

1. Policy regulation,
2. Non-river infrastructural developments,
3. Focus on demand,
4. Fleet adaptation to rivers and markets,
5. Floodplain restoration
6. River regulation (elimination of bottlenecks).

The supply side of the IWT market currently lacks answers to the new trends in demand. The reasons for this phenomenon can be grouped to:

1. Technical obstacles (e.g. incompatibility of different container types),
2. Market-type obstacles (like service time, the cost of using transhipment facilities, and the lack of offers that cover the whole transport procedure including the risks), and
3. Extra-market conditions (such as ownership structure, unpredictability of nautical conditions and the disadvantageous regulation framework).

The adaptation process of the IWT market needs harmonised measures to be taken by all participants in the market, including policy makers. **It is not proven that policy regulation and market measures cannot bring effects without elimination of bottlenecks, whereas, even with improved waterway conditions (regulated river), the above discussed obstacles would leave the IWT sector disadvantaged.**

On the Danube, IWT can efficiently operate as one element in the transport chain. The creation of co-operation, and the maintenance of logistical chains both need operational flexibility and the distribution of risks among the participants. The ownership structure on the Danube (bigger firms) is favourable for these processes but the distribution of the involved costs and gains among the stakeholders is again a regulatory decision.

The effect of river deepening in itself is questionable, since:

- The real bottleneck effect is low, and can be reduced by flexible use of the ships.
- The adaptation possibilities of the market are unexploited. Single-transport-mode view and the lack of incentive pricing divert demand for transport from IWT.

- The port infrastructure, information technology and forecast services lag behind.
- The size of the waterway network will never compare to other modes of transport. Without a general regulation framework for the whole transport market (including pricing of infrastructure and natural uncertainties) the disadvantageous position of IWT will re-emerge.
- Market research on the demand side shows that the deepening of the river is not necessary.
- If the Danube countries copy the Rhine system, it will result in inefficient and expensive infrastructure, which requires a growing involvement of public resources, because the river systems are fundamentally different. Moreover, the opening-up of new routes such as the North Adriatic ports changes the direction of the transport flow.

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