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Analysis of River – Sea Transport in the Direction of the Danube – Black Sea and the Danube Rhine River River Main

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ABSTRACT: Development of the river sea transport is directly related to the characteristics of waterway network which enables navigation between river basins and seas. Inland waterways in Serbia belong to the Danube navigational system. There are two navigational directions: Danube East and Danube West. River-sea transport can be directly established in these directions between the Serbian international ports on the Danube (Apatin, Novi Sad, Belgrade, Pančevo, Smederevo and Prahovo). Development of the Pan-European Corridor VII and the River Danube-Black Sea and Danube-Rhine-Main region would allow not only in Serbia but also in neighbouring states and all over Europe connection with the sea. In this paper the technical and exploitation characteristics of the river Danube will be analysed in terms of the navigation of various river and sea vessels with different exploitation characteristics.

1 INTRODUCTION

Advantages of river transport compared to other modes of transport as well as the growing need for the development of river transport and connection with the surrounding seas raise the question of the possibility of connecting the Danube River with the sea ports in the region. Characteristics of the navigation route of the Danube River, the distance of the harbours from other important ports in the region as well as the characteristics of the ports on the Danube River in Serbia are the basis for more complex implementation of river sea transport along the pan-European corridors. In order to get a complete picture of the river sea transport systems, which can be used in direction the Danube - Black Sea and the Danube - Rhine - Main and connection with other river systems, this paper also contains the characteristics of ports on the Danube River in the Republic of Serbia from the perspective of improved infrastructure and new modern systems for classification of the system of waterways. Furthermore are shown boats (river-sea) which are currently operating on the direction of the Danube - Black Sea. It is also given the review of the ship that could be used for navigation conditions on the Danube. Graphics of the amount of goods transported on the Danube are given in the direction of the Danube - Black Sea and the Danube - Rhine - Main.

2 WATERWAYS IN SERBIA WITH A FOCUS ON THE DANUBE

Two European transport corridors pass through Serbia – the overland Corridor X and the Corridor VII linking the 10 European countries which have exits to the navigable parts of the River Danube. From the Hungarian border to Belgrade, the Danube flows almost parallel to the highway and railway line route in Europe, which makes the area extremely valuable and important for economic and every other development. Danube ports in the Republic of Serbia belong to the middle course of the Danube, while ports in Prahovo belongs to the sector of the lower Danube. Engineering work on cutting sharp curves, the closure of side branches and the establishment of banks were carried out downstream by entering the Danube River in Serbia at the 1433rd km of its flow all the way to the mouth of the river Drava. Downstream from the mouth of the river Drava, river bed of the Danube is much broader with several sharp bends unsuitable for two-way navigation especially: from the 1375th to the 1372nd km, at the 1370th km, at the 1331st km, from the 1286th to the 1284th km and from the 1256th to the 1252nd km. Cutting the curve near the place Mohovo, river is prone to seasonal reductions in flow by about 8 km and it is characterized by the newly formed pan rocky bottom, high speed water and small width of the waterway.

For the ships that sail upstream and pass through the Mohovski channel prevail the water level in Novi Sad, so when the water level is 0 max Draft is 160cm, while for the ships that sail downstream, at water level 0 in Vukovar max Draft is 180cm.

Characteristic shoals of the river Danube between Serbian-Hungarian border and Belgrade or the confluence of the Sava and Danube TMC 1170 are: 1429-1425 km, 1401 km, 1397-1395 km, 1391-1389 km, 1382.5 to 1381 km, 1349 -1347 km, 1287-1283 km, 1276-1274 km, 12646-1264 km, 1248-1244 km, 1241-1238 km, 1230-1228 km and 1202-1197 km. Despite the large number of shallows in this sector in line with the recommendations of the Danube Commission, the sailing conditions at low levels are fulfilled:

- The minimum width of the waterway for straight sections is 180m and 200 m for curves.
- Minimum depth for the specified width is at least 2.5 m,
- Minimum radii of curvature are 1000 m.

Sector of the Danube from Belgrade to Sipa is under the impact of slow river flow due to the construction of hydropower and navigation system Đerdap I (The Iron Gate). The Iron Gate was built at the 943rd km of the river Danube. Two stage navigation locks were also secured, 310 m long and 34 m wide, with 5 m depth lock on the right side and 4.5 m on the left.

Given that the lower Danube is typically low character, with plenty of layers which form shoals and sandbanks, navigation is regulated by several measuring points. The most suitable water meter is in place Djurdje I at 0 cm, the greatest draft permitted is 200 cm.

As we mentioned above, the most appropriate places with water meter station for analysis of the possible draft ships are in Vukovar, for the middle Danube, and Djurdje, for the lower Danube. Using the comparative analysis we will get the approximate number of sailing hours per day for river-sea vessels throughout the year. In accordance with the characteristics of the Danube, we observe periods with no restrictions to navigation and with limitations period primarily due to water levels. The first period is in the range of 1st January till 30th June when navigation is possible without restrictions and the second period July-December when it is possible to limit the draft ships. It is found in the lower Danube for water meter station in Djurdje that there are no shipping restrictions for 294 days a year. The same analysis for water meter station in Vukovar was found that there are no shipping restrictions for 237 days a year.

2.1 *The basic characteristics of the river-sea vessels*

The river-sea vessels are provided for both inland and coastal waterways conditions. In order to successfully respond to the navigation requirements, these ships must have high manoeuvrability characteristics (for mastering shallows, going through the locks etc.) and the limited amount of upgrades due to the passages through bridges in case of high water levels.

There are types of river-sea vessels:

- For waves up to 3.5 m height and the distance from the coast to 50 nautical miles,
- For waves up to 6 m height and distance from the coast to 50 nautical miles for open seas, or 100 nautical miles for closed seas.

In this paper we are going to discuss about the possibility of the use of the vessels whose basic structural and operational characteristics are shown in Table 1

Table 1. General vessel characteristics

General characteristics	1557[2]	1557[3]	1553[4]
Length (m)	114,20	132,60	119,90
Largest between lpp (m)	110,50	128,60	115,20
Maximum Draft (m)	3,50	3,65	3,50
Length (m)	13,22	16,90	13,40
Maximum Computational length (m)	13,00	16,50	13,00
Height of the hull (m)	5,50	5,50	5,80
Maximum height of the vessel (m)	15,70	15,90	13,00
Registered Capacity (t)	2700	4875	2700
Boat Speed in deep water (kn)	10,60	11,00	10,90
Storage capacity (m^3)	4300	6740	3556-fuel 1895-dry cargo
Navigation autonomy (day)	10	7	10

The analysis of the navigation conditions on the Danube near the place Djurdje showed the following facts:

- limited draft period is expected to begin on 18th September
- limited draft period is expected to end on 16th November
- limited draft period is expected to last for 67 days,
- medium possible size of vessels is TSR=529.09cm, with a standard deviation that is equal to s = 181.73 cm which gives the interval of possible drafts for river-sea vessels Tmin=347.36cm and Tmax=710.82cm,
- the expected number of days per year for sailing without draft restrictions is 365-67 = 298 days

[2] projected ship model
[3] model of tanker ship
[4] model of combo ship

The analysis of the navigation conditions on the Danube near the middle sector of Vukovar established the following facts:

- limited draft period is expected to begin on 14th January and 14th September
- limited draft period is expected to end on 5th March and 12th December
- limited draft period is expected to last for 130 days,
- medium possible size vessels is TSR = 425.56 cm, with a standard deviation that is equal to s=150.54 cm which gives the interval of possible drafts for river-sea vessels Tmin=272.02 cm and Tmax=576.10 cm,
- the expected number of days in the year for sailing without draft restrictions is 365-130 = 235 days

(Source: The seminar held at the Traffic Engineering, University of Belgrade, 2002.)

2.2 *The Danube River*

The Danube river is an important part of the pan-European Corridor VII and strategic relationship with Europe and Eurasia, which should stimulate the development of trade, tourism and services in Serbia. Out of the total navigable length of the Danube (the total of 2580 km), 22.8% lies in the territory of Serbia. After the NATO bombing in 1999, when the bridges in Novi Sad were bombed and demolished, the navigability of this River was very limited. Apart from this, there are still some destroyed and sunk ships and unexploded landmines from the World War II in the river bed.

Sunken obstacles and bottlenecks are the real difficulties for navigation on the Danube. Bottlenecks on the Danube usually appear on the 1430th km and 1250th km. There are 18 identified bottlenecks on that section (180 km long), mostly sharp bends and narrow cross section. The most difficult bottlenecks are Apatin - where a large section is narrow, Vermelj - with sharp bend near Vermelj, Petreša and near Staklari where the radius of curvature is smaller than the absolute minimum (750m).

Table 2. Total length of navigable waterways Serbia (km) at medium water level for vessels with a total capacity (source: Transport by inland waterways, Traffic Engineering, Zoran Radmilović)

WATER WAY	Total length of Waterways (km)	Total length of the waterway (km) for vessels with following load				
		150 t	400 t	650 t	1000 t	over 1500 t
DANUBE	588	588	588	588	588	588
HS DTD	600	342	321	321	-	-
TOTAL	1188	930	909	909	588	588

On the part of the waterway of the Danube River, which passes through Serbia dimensions of the waterway are determined in relation to authoritative levels (high and low levels of the river navigation)

- width of the waterway towards B = 180 m
- width of the waterway in a curve B = 120 m
- The depth below the low-level navigation (EN or NPN[5]) h = 2.5 m
- The minimum radius of curvature R = 1000 m (Exceptionally is allowed radius of at least 750 m)
- The lowest point in the navigation under the bridge:
  - High above the navigation level H = 9.0 m[6]
  - In the secondary part of the course H = 10.0 m
- width of the navigation bridge openings at low level
  - The part of the confluence of the river Drava, at least L = 80.0 m
  - Downstream from the confluence of the Drava river, at least L = 150.0 m
- The height of the power line voltage of 110 kV
  - High above the level of the vessel B = 19 m (For every kV further than 110 kV height is increased by 1 cm)
- For phone and power low voltage lines above the high-level waterway H=16.5m
- Dimensions of the lock chamber
  - Usable length Commerce L = 150.0 m
  - Usable width of Commerce L_k = 310,0 m
  - Minimum depth at the threshold B_F = 34,0 m

The height of the waterway of the Danube, which is under the impact of the Hydroelectric Power Station "Đerdap" (aka the Iron Gate) was determined in relation to the slow water level:

- Depth below the lowest slow water level h = 3.5 m
- Height of buildings, above the waterway, was determined in relation to the most slow-water elevations.

2.3 *Danube–Tisa–Danube Canal (DTD)*

Hydro system Danube-Tisa-Danube canal is a unique network that connects the Danube and the Tisa in Vojvodina. It represents a hydro system for internal water drainage, irrigation, flood control, water supply, disposal of waters, sailing, tourism, fishing and the cultivation of forests. The DTD hydro system with natural and partially reconstructed streams is 960 km long of which 600 km are navigable. Its network connects 80 villages in Vojvodina. There are 23 gates in the system, five safety constitution, followed by 15 locks and five more that are no longer in operative, the five major pumping stations and 86 bridges (64 road bridges, 21 rail bridges and a pedestrian bridge).

[5] EN-international sign for low level sailing adopted by the Danube Commission in Budapest, or an abbreviation of the French word étiage navigable (source: Transport by inland waterways, Traffic Engineering, Zoran Radmilović)

[6] Before the destruction of bridges in Novi Sad, 1999. year (source: Transport by inland waterways, Traffic Engineering, Zoran Radmilović)

Table 3. The Navigable canal Danube-Tisa-Danube Canal (source: Transport by inland waterways, Traffic Engineering, Zoran Radmilović)

The Danube Tisa-Danube - canal	The total channel length (km) for vessels with following load			Navigable depth (m)	Total length (m)	Width at bottom (m)
	1000 t	500 t	200 t			
TOTAL	337,60	215,30	45,80	1,5-2,15	598,70	7-42-

Table 4. Ports Characteristic on the river Danube in the territory of the Republic of Serbia (source: www.dunavskastrategija.rs)

PORT	km	Coast	total area (m²)	Number of pools	water depth (m)	Number of anchoring	Winter shelter
Apatin	1.401	left	46.830	2		10	yes
Bogojevo	1.367	left	-	-	-	-	-
Bačka Palanka	1.295	left	1.168.000	1	3	1	yes
Beočin	1.269	right	-	-	-	-	-
Novi Sad	1.254	left	350.000	6	4	36	yes
Belgrade	1.168	right	1.000.000	1	(min) 4	NA	yes
Pančevo	1.153	left	2.400.000	1	5	9	yes
Smederevo (old port)	1.116	right	-	1	-	2	-
Smederevo (new port)	1.111	right	31.000	1	8	2	yes
Kladovo	933	right	-	-	-	-	-
Prahovo	861	right	70.473	1	4-5	7	yes

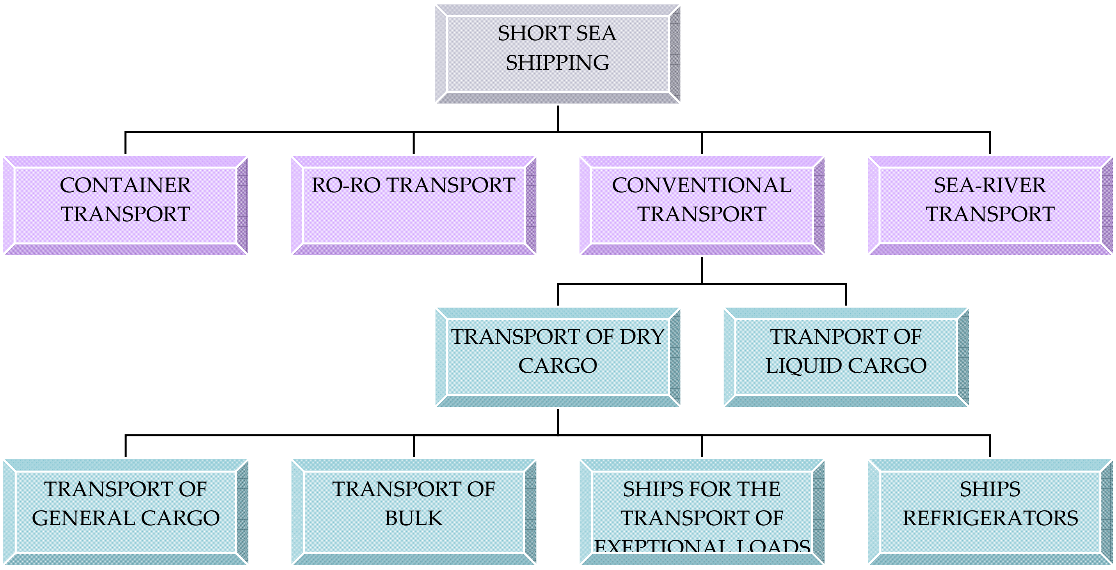


Diagram 1. Types of short sea transport (source: http://www.shortsea.nl/main/attachements/VENICE100608INTEGRATED.pdf)

Most of the locks are operational, but revitalisation is more than needed. Although daily maintenance of almost every part of the DTD canal is performed and it seems that it's taken care of the locks, it is clear that a larger revitalisation is not done in recent years to the 5 locks (bottleneck Kučura Lock, Lock Vrbas, Serbian Miletić Lock, Botoš lock and Kajtašovo Lock). The General Master Plan for Inland Water Transport shows that the current situation in the Serbian water transport system requires urgent actions with a view to a faster recovery of transport, which will result in safe navigation, rehabilitation of the network of inland waterways and port development. (General Master Plan for Transport in Serbia, EAR, Belgrade, 2009)

3 PORTS ON THE DANUBE IN SERBIA

According to data from the Danube Commission on the Danube River and its tributaries there are 91 ports for commercial purposes of which 11 are in Serbia. There are eight ports of international importance on the Danube in Serbia: Apatin, Bogojevo, Bačka Palanka, Novi Sad, Belgrade[7], Pančevo, Smederevo and Prahovo.

River ports have adequate capacity for current needs, but the equipment is old and inefficient. Only Port "Belgrade" has conditions for container transport, but neither of these ports is equipped with RO-RO terminals. Port capacities, due to lack of transhipment of goods, are used on average about 30%. Only ports in Pančevo and Belgrade have container terminals. The basic information on the features of ports in the Republic of Serbia on the Danube River is presented in Table 4.

[7] maritime (river-sea port)

4 "SHORT SEA SHIPPING"

A short coastal transport, "short sea shipping" means the movement of cargo and passengers by sea between ports situated in Europe in a geographical sense, or between those ports and ports situated in countries outside of Europe having a coastline on the enclosed sea borders bordering Europe.

The goal and intention of the EU is to stop the anticipated 50% increase in traffic of heavy goods vehicles, to divert part of the vehicle and marine waterways and thus to balance the division of traffic on all forms of transport.

Short coastal transport is divided into:
- container transport,
- RO-RO transport,
- sea - river transport and
- conventional transport.

4.1 *Short sea model*

Short coastal transport allows the use of different levels of transport. The largest used transportation is a combination of ship and truck. In Figure 2 is presented intermodal transport between two ports with a combination of ship-to-truck, inland-time supply and vice versa.

Namely, if there are two cities in which certain goods must be carried out and if the distance between these cities is 50, 100 and 200 km, 5 trucks should be hired for each distance nowadays and for each transport should be engaged manpower, time and money. It takes some time to carry the goods and return. Nowadays, goods are mostly transported in this way.

Trucks for transport to a nearby airport can be used to save time and reduce costs and then all of the goods in several tours can be transported to certain destinations where they will wait for other trucks.

Apart from the given model and its specifications, it is also presented how the model could be expanded from small (short haul) to long-distance port (long haul). Figure is related to the cities New Bradford, Bayonne and Jacksonville.

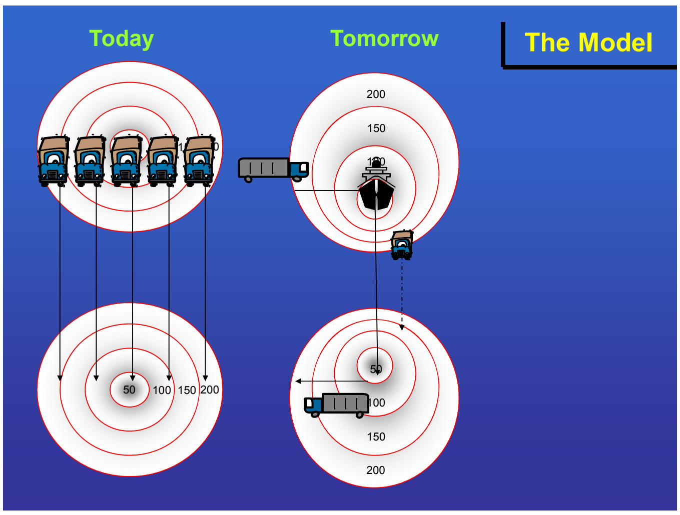


Figure 2a. Short Sea shipping (a- model), source: www.mass.gov/Agov3/docs/Short%20Sea%20Shipping.ppt

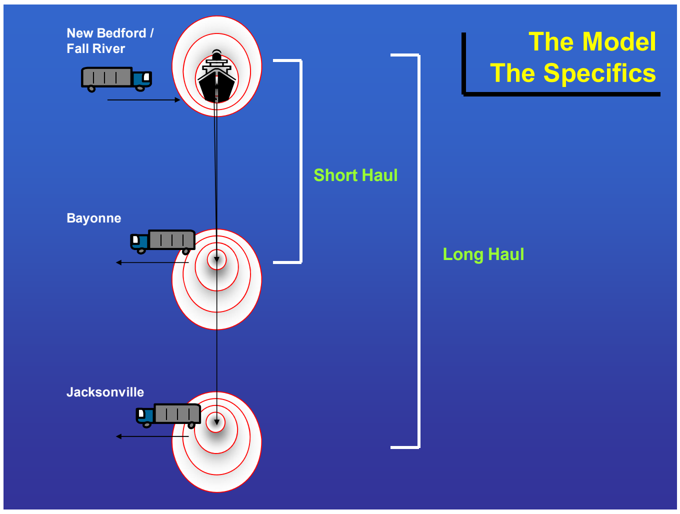


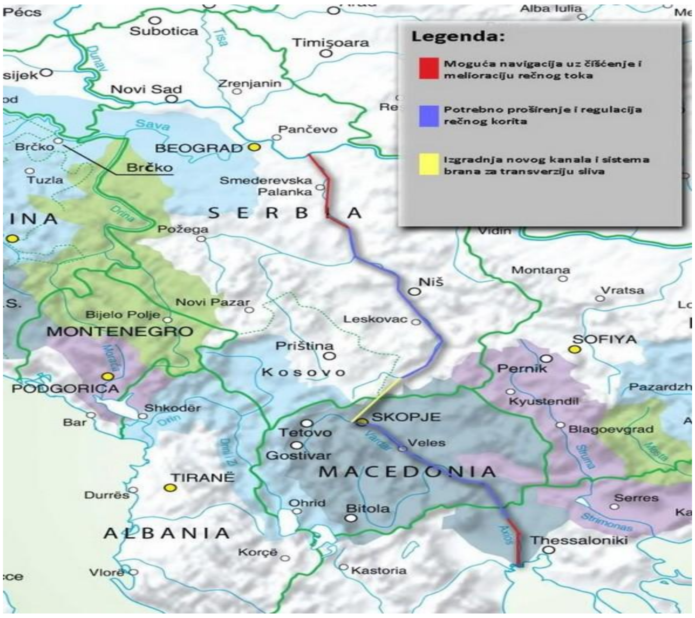
Figure 2b. Short Sea Shipping (b - of implementation of the model in the case of intermodal transport, ship-to-truck between the port), a source: www.mass.gov/Agov3/docs/Short%20Sea%20Shipping.ppt

4.2 *Sea and river transport*

Sea and river transport are observed and studied as a huge transportation technology system that represents the organizational and material factors focused on quality cargo transportation of certain technical means at specific cost of capital and labour.

Today, there is an increasing need for inland waterways connected with the so-called "sea highways" ("Motorway of the sea") in order to save time and achieve higher profits. Given that transport is the cheapest and that waterways volume of transport is increased in the past few years, so it is assumed that in the future this type of transport will be developed rapidly.

Main advantages of river transport on the Danube River would be the following:
- economy, which is reflected in the amount of transported cargo ship and lifetime of external and infrastructure costs.
- minimum drive energy consumption, which is reflected in the balance of power savings in ship-transported cargo units;
- minimum amount of material for the construction of vehicles per ton of transported cargo, which is reflected in the materials for the construction of ships;
- safety of navigation, which is reflected in lower traffic density in comparison to other forms of ground transportation;
- ecologically most appropriate mode of transportation of cargo, which is reflected in the slight percentage of water pollution and air pollution in relation to other forms of land transport in Serbia. With the fact that the ships can transport the large amount of cargo, emission of goods transported per unit weight is reduced.
- minimum requirements for the land is reflected in projects that would allow the occupation of the land for inland waterways.



(red)	possible navigation by cleaning and reclamation of river flow
(yellow)	construction of a new system of canals and dams for transversion of basin
(blue)	needed expansion and regulation of the riverbed

Figure 3. Overview of the possible directions of river transport Danube-Morava-Vardar-Thessalonica (Source: *Open questions and perspektive cooperation with countries in Danube region*, dr. Edita Stojić-Karanovic)

The new government in Serbia has revived the idea of Charlemagne, 13 centuries old, for Europe to overcome the connectivity of rivers from northwest to southeast. Digging a canal to connect the Danube, Morava and Vardar waterway from the Mediterranean to northern Europe should be reduced by 1,200 km compared to the current route through the Black Sea. $ 17 billion is needed for this venture that the optimistic forecasts could be completed within eight years. The idea of building the channel is not new. In the second half of the 19th century a company for waterways construction was operating in the USA. One of the directors of the company was a Serb Igor Eugen Lazarević Hrebeljanović. This company has commissioned a project in Belgrade Danube - Morava - Vardar - Aegean Sea.

The first project of this channel-to-order of the company previously mentioned, was made by Nikola Stamenković, a professor at the University of Belgrade. This project determined, in a professional and creative way, the main route of canal which has survived to this day. The project has been in the Serbian language and it was made public in 1900. and a design solution is published in English 1932.

The main disadvantages that characterize the use of river transport are as follows:

- unfavourable meteorological and hydrological conditions (ice, wind, fog, low and high water) and the overlap of these phenomena related to seasonality (the appearance of high and low water levels, ice stagnation and strong winds) and permanent faults (changes in the sector of navigation);
- limited geographic spread, which is related to the natural spatial distribution and trends of inland waterways;
- level of quality of transport services, which is reflected in the confidence of transportation, speed, ability to transport "door to door", security, flexibility, durability and energy efficiency;

River and sea transport can be divided in several ways:

- the mode of transportation,
- the type of load,
- the amount of cargo and more.

The most important is the way of transportation. River and sea transport can be divided in:

- river-sea transportation of cargo handling from the sea in boats and vice versa, in special places or ports at the mouth and
- river-marine system without handling of cargo at the mouths of the rivers into the sea or ocean.

4.3 *River-sea transportation of cargo handling*

River-sea transportation of cargo handling at the confluence of three main technologies include following elements:

- Sea transport ship
- River transport ship
- Harbourmaster funds along with reloading equipment and fleet moorings

Comparative analysis of navigational characteristics of the Danube and structural characteristics of the river of sea vessels it was determined that only the depth of its sectors and in certain parts of the year, appears as a limiting factor. It can also be found that part of the Danube River downstream of Mohovski channel has significantly better navigational capabilities in regards to the part of the river upstream of Mohovski channel. One concludes that sea vessels can sail loaded in the ports on the Danube in the Republic of Serbia (Prahovo, Smederevo, Belgrade Pančevo and Novi Sad) wit maximum draft and the biggest registered payload for nearly 300 days a year.

Modern ships for basic technology transport can be divided into:

- ship to transport pallets (pallet carrier);
- ship to transport containers (container ship);
- ship for horizontal transhipment Ro-Ro (Roll-on/Roll-of ship);
- multi-purpose vessel (Lo-Lo/multi purpose Lo-Lo ship) and Ro-Lo
- tank barges ship (barge carriers)

5 RIVER-SEA TRANSPORT SYSTEM

5.1 *River transport ship*

Connecting maritime capacity of the river resources in a single integrated transport system is achieved with transport barges technology of larger overseas ships.

Technology of transport barges for inland water transport, with sea transport services, has led to the merger with overseas shipments with inland waterway transport in a single integrated intercontinental scale. Technical basis of river-sea intermodal transportation consists of three elements:

- cargo barges as a unit;
- mother ship (carrier barges) and
- reloading equipment and accessories.

Table 5. Cost of external costs for the above-mentioned distance

GENT-BUDIMPEŠTA			GENT - BELGRADE			GENT – KONSTANCA			
ROAD	RAIL	IWW	ROAD	RAIL	IWW	ROAD	RAIL	IWW	SSS
10.370€	10.566€	4319€	13017€	12366€	5001€	17970€	17848€	7700€	10.000€

Table 6. Total costs for the above-mentioned distance (source: *www.ildeproject.com*)

GENT-BUDIMPEŠTA			GENT – BELGRADE			GENT – KONSTANCA			
ROAD	RAIL	IWW	ROAD	RAIL	IWW	ROAD	RAIL	IWW	SSS
26370€	12166€	5319€	29217€	13966€	6101€	34970€	19448€	9200€	13000€

6 CASE STUDY OF MERCHANTABILITY RIVER-MARITIME TRASPORT

6.1 *The "Ilde"*

Ilde project (Improvement of intermodal links to the Danube Estuary) is a contemporary project that aims to promote, develop cooperation and increase prosperity countries in the Danube basin (Bulgaria, Romania, Hungary and Serbia).

The project is designed to provide safe navigation and a larger vision of connecting cities in the Danube basin.

According to research navigable vehicles cause the lowest external costs of only 0,28 € per t-km and the largest external costs of up to 2,00 € per t-km which is primarily due to the large number of traffic accidents, noise and high concentration of CO_2 :

In addition to the above costs in analyzing intermodal routes the cost of infrastructure (construction and maintenance) are used.

Already known values are taken for analysis and when these distances are included the following values are obtained. Values are calculated for the transport of goods of 300t. The values are obtained when the cost of the graph is multiplied by 3 (100t * 3 * distance).

Table 5 provides the exact look on a savings of goods transport by inland waterways to other modes of transport. However, if the distance is increased, cost of transport inland waterways will also be increased which is not in order.

Internal costs for transportation of goods by truck is reflected in the following parameters:

- Fuel (40L - 100km highway, 1litre is 1 €)
- salary workers (250 € for each)
- fee (about € 100 per country)
- 5t truck transports,
- the train carrying 20 tons and
- boat carrying 300t

For the transport of goods of 300t the following costs are:

For our country, river traffic on the Danube river is interesting, in the shorter distance with the transhipment port in terminals. For such short distances calculations are as follows.

For a distance of 1100 km the time of loading and unloading (with 2 container cranes) is estimated:

Table 7. Calculation of time for loading and unloading at terminals, (takes a day to carry 300 TEU) (source: www.ildeproject.com)

LOADING AND UNLOADING	TIME
the unloading	9 hours
the loading	9 hours
total time	18 hours

The result for a week carriage of goods by inland is as follows:

Table 8. Calculation of transport and time costs

TOTAL AMOUNT OF TRANSPORT	2100 TEU
TRANSPORTATION COSTS	250 € per one TEU
TIME	108 hours
TRANSFER TIME IN PORTS	18 hours

Generally, container volumes in Serbia are very small. There are only few Serbian exports and the degree of containerization in Serbia is generally very low.

Since 2001, exports have been growing strongly. Despite this growth, trade between Flanders and Serbia remains modestly. The industrial sectors with good development potential for Flemish-Serbian trade are:

- Agribusiness
- Manufactured goods
- Automotive equipment and components (Cars, tractors, tires) and
- Wood products

Due to the lack of interviews in Serbia, it is difficult to draw a potential map for Flemish-Serbian trade. But it seems that, similar to the results gained by interviewed companies in Hungary, the most valuable connections between Flanders and Serbia seem to be container transport by SSS between Flanders and the Adriatic ports, as well as Bulk and Container transport by SSS between Flanders and the Adriatic ports.

The Croatian and Slovenian ports (Koper, Rijeka) would capture the most part of the business if Short Sea Shipping connections would be improved between. Currently sea connections exist between Antwerp and Bar (Montenegro) once a week and are ensured by Maersk and Hapag Lloyd. Regarding rail and IWT connections, it is expected that container terminals in Hungary (Budapest, Szeged, Port of Baja) and Croatia (Zagreb) would profit from a growth in Flemish-Serbian trade because of the limited amount of the Serbian terminal infrastructure.

It appears that shippers prefer the ports of Koper, Rijeka, and Thessalonica rather than port of Bar. For

Rijeka, they seem to use mainly trucks, whereas Koper and Bar have good connection with Belgrade by rail that can be improved and increased in the future. However, interesting information and cost indications could be gained regarding an inland navigation shuttle service on the Danube between Constanta and Belgrade. This service is operated by the ILDE project partner from Serbia, Yugoagent.

Yugoagent operates two barges between Constanta and Belgrade. Three more barges can be deployed if extra capacity is needed. Normally one sailing per week in both directions is organised. The barges are classic bulk barges (not cellular) with a capacity from 1300 up to 2000 tons or 80 TEU. Flat-rack containers for heavy and bulky semi-finished goods and out of gauge cargo are used to transport building materials.

Each year an average of 2.000 full TEUs and 1.000 empty TEUs are transported by barge. Imports (Constanta – Belgrade) accounts for 60% and Exports (Belgrade – Constanta) accounts for the remaining 40% of the average total freight. In general the shuttle runs only between Belgrade and Constanta. However, upon request, the ports of Pancevo, Novi-Sad in Serbia and the ports of Ruse and Turnu Severin in Bulgaria can be served as well.

Table 9. Barge Service Constanta – Belgrade (Source: Yugoagent, 2007)

Constanta/Belgrade	20´container	40´container
THC	€ 75.00	€ 130.00
Customs Transit	€ 50.00	€ 50.00
Full container	€ 300.00	€ 430.00
Empty return	€ 50.00	€ 100.00
Documents on border	€ 20.00	€ 20.00
THC Belgrade	€ 65.00	€ 85.00
Total	€ 560.00	€ 815.00

7 CONCLUSION

According the statistics water transport in Serbia is only 4.7% of the total traffic which shows that we are much behind the EU countries, where the percentage of river transport in relation to the total traffic is 15%. Table 10 presents a comparative review of transport in the period from 2000 to 2006. year.

Table 10. Comparative review of transport (source: Economic Bulletin)

COMPARATIVE REVIEW OF TRANSPORT			
YEAR	RIVER (000 t)	ROAD (000 t)	RAILWAY in stations (000 t)
2000.	3 729	3 900	14 146
2001.	3 609	3 300	11 839
2002.	3 796	3 200	11 947
2003.	2 664	2 400	12 879
2004.	3 295	1 800	14 513
2005.	6 360	3 100	14 219
I-VI 2006.	2 085	1 519	6 680

In any case, there are many combined river transportation options, especially when it comes to the application of modern technology of combined transport, as well as current information-management technologies that are already in use worldwide.

Today only few shipping company operates on the inland waterways. The possibility of introducing river-sea transport of goods and combined transport system increase the possibility of introduction of new ships that would sail on the inland waterways.

River and sea transport on the Danube, in accordance with the guidelines of the development of river-sea transport, tend to further develop and improve services. Unfortunately, the expected volume of use of this form of transport is difficult to predict given the economic development of the country. After the renovation of ports and port harbor it can be expected an increase in transport on the Danube river. In consideration of the port on the Danube in the Republic of Serbia (Prahovo, Smederevo, Belgrade, Pančevo and Novi Sad) fluvial marine ships can sail almost 300 days a year loaded with a maximum registrated load capacity.

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