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Study on Navigation Conditions and Shipping Traffic on the Danube in the Period 2001-2020

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Abstract: The Danube, the second largest river in Europe after the Volga and the third largest in terms of economic importance after the Volga and Rhine, is 2 840 km long and crosses a total of 4 capitals and 10 countries. With a long history in commercial transport, the Danube is connected to the Black Sea by the Danube-Black Sea canal and to the North Sea by the Rhine-Main-Danube Canal. The economic importance of this river stems from its large shipping capacity at a much lower cost than other types of transport. At the same time, the Danube has a tourist importance due to the Danube Delta, one of the most beautiful regions in Romania due to the fauna and flora found in this area. In this paper, a statistical analysis was carried out on the naval traffic for the period 2001-2020 regarding the total number of incoming ships, outgoing ships and the total tons of cargo transported on the Sulina canal. The most important sectors and ports were identified, and a classification of the types of goods according to their contribution was made.

Keywords: navigation; economic importance; ship traffic; Danube

1. Introduction

The Danube is an international river of great importance, being the second longest river in Europe, and the transport of goods by this waterway has been used since ancient times for the transport of goods and people.

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The Danube springs from the Black Forest Mountains in Germany (Figure 1) in the form of two rivers called Brigach and Bregm and until it flows into the Black Sea, it crosses 10 countries and 4 capitals. This river is made up of over 100 important rivers, of which the longest is the Tisa, and the tributary with the highest flow is the Sava.

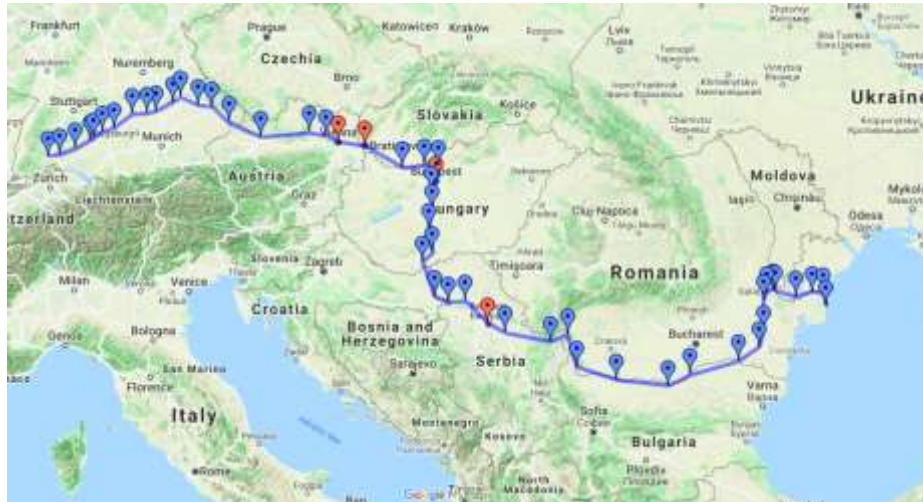


Figure 1. Map of the Danube

The economic importance (Dănilă, Chiroșcă & Rusu, pp. 123-130; Radmilovic & Masas, 2011, pp. 28-40) of this river increased considerably with the inauguration of the Black Sea Danube Canal in 1984, and also with the inauguration of the Rhine Main Danube Canal, completed in 1992, which currently allows the connection of the port of Constanta with the Port of Rotterdam, one of the largest ports in the world in terms of the amount of goods transported annually.

The main characteristics of the river are presented in Table 1. The advantages of this transport method are numerous, representing a much more preferred transport method than that of other types of transport, especially due to the costs.

Table 2. Main Particulars of the Danube

Location	Europe
Spring Area	Black Forest, Germany
Overflow Area	Black Sea, Romania
Basin size	817,000 km ²
Length	2,860 km
Average flow	6.500 m ³ /s
The main countries crossed	Romania, Bulgaria, Serbia, Croatia, Hungary, Slovakia, Austria, Germany

In this paper, a study was made on the navigation conditions and river traffic on the Danube. The main types of ships were identified, as well as the speeds required for each type. For the period 2001-2020, an analysis was performed on ships and cargo, both going in and going out.

2. Types of Vessels

The types of ships we meet on the Danube are divided into three main categories of ships, depending on how the goods are transported and depending on the ship's propulsion system. Therefore, inland navigation vessels are (Viadonau, 2019): self-propelled vessels, pushed convoys and tugs.

The first category, namely that of self-propelled ships, can be ships that transport dry goods, petroleum products, but also that transport goods in containers. These ships have their own engine and do not need a pusher to operate.

The second category, pushed convoys, are formations made up of several barges and a pusher. On the Danube, unlike the Rhine, this category is the most popular due to the large quantities it can carry, because it can form configurations of one to nine barges.

And the last category is represented by tugs, which are used to tow ships that do not have their own propulsion, but this category is rarely used due to higher costs than pushed convoys.

Another classification of ships sailing on the Danube can be made depending on the type of goods they carry. From this perspective, we encounter ships carrying dry goods such as cereals, ores, ships carrying liquid goods such as oil tankers, ships carrying goods in containers and RO-RO ships (Roll On - Roll Off) which are equipped with ramps and can transport cars, equipment or other types of goods that use their own means of operation.

A category of ships that have recently been of high interest are passenger vessels. More and more tourists prefer to spend their holidays on cruise ships, which have begun to become more and more luxurious and offer in addition to the possibility to visit several locations in one cruise, the same conditions as a luxury hotel.

Depending on the navigation conditions, the following speeds presented in Table 2 are imposed by the River Administration [4], for each type of ship and for the direction of travel.

Table 2. Speed Restrictions on Danube

Type of vessel	Speed Amonte	Aval
Small ships	8 Knots	9 Knots
Tugs or convoys	8 Knots	9 Knots
Passenger ships, rescue, fire and military ships	9 Knots	10 Knots
Ships up to 4,000 tdw	7 Knots	9 Knots
Ships between 4,000 tdw and 12,000 tdw	6 Knots	8 Knots
Ships between 12,000 tdw and 25,000 tdw	5 Knots	7 Knots

3. Navigation and Restrictions

Navigation on the Danube is carried out respecting a series of rules due to the particularities of this navigable axis. Limitations of the navigable waterway, environmental conditions, as well as the characteristics of the hydrological basin are factors that must be known before traversing this sector.

Another factor to consider when navigating the Danube is information about the depth of the ship, especially in critical areas of the sector. In order to avoid the problems related to the variation of the waterway depths, measurements are periodically made by the River Administration [4, 5], and the water levels [5] are publicly available, so that the navigators benefit from this information.

Figure 2 shows the navigable course of the Danube and the main Locks. Along the Danube are 190 bridges, 102 ports and 23 locks. When crossing an area with bridges, navigators must also take into account the height at which it is located.

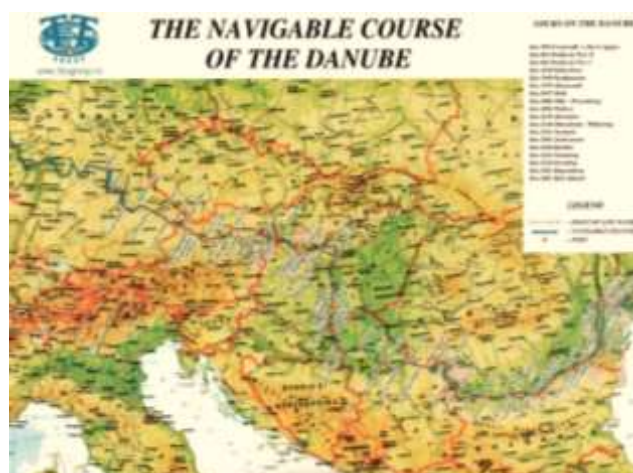


Figure 2. The Navigable Course of the Danube [1]

4. Naval Transport

Danube transport is influenced by two key factors that condition the volume of transport, namely the navigation conditions, depending on the environmental conditions, as well as the way in which the waterway is maintained. As a transport hub, this river connects the European supply, production and sales markets.

Based on data provided by the Lower Danube River Administration R.A. Galati [4], a study was carried out on the traffic of ships on the Danube.

Figure 3 shows the river traffic for the period 2005 - 2020 depending on the capacity of the ships that crossed this sector. It can be seen that the ships carried a much smaller amount of cargo than they could carry in total. The ratio between the transported goods and the maximum transport capacity was registered in 2014, but unfortunately it represents only 17% of the total quantity that could have been transported.

In total, only 10% of the total capacity that could have been transported was transported during the whole period. The most predominant are the ships that have a deadweight tonnage between 3000 tdw and 6000 tdw, representing a percentage of 50% of the total registered ships.

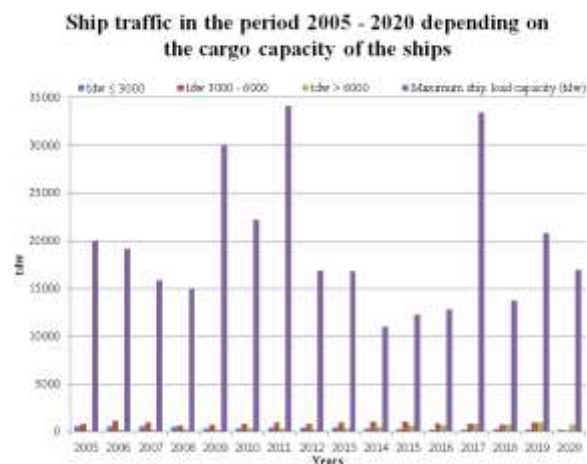


Figure 3. Ship Traffic on the Danube by Type of Cargo Capacity of the Ships

The total number of ships depending on their direction, incoming or outgoing is shown in Figure 4. We can see that the proportion of incoming ships is similar to the proportion of outgoing ships, and the number of ships is kept relatively constant from

year to year, with small differences. For example, in 2020 there will be a decrease of approximately 23% compared to 2019, due to the pandemic situation.

Figure 5 shows the goods traffic for the same period, 2001-2020. If the number of ships entering and leaving is relatively proportional to the number of ships, the quantity entered is much smaller than the quantity of goods leaving, the percentage being about 20% for the goods going in and 80% for the goods going out.



Figure 4. Traffic of Incoming/Outgoing Ships on the Danube for the Period 2001-2020

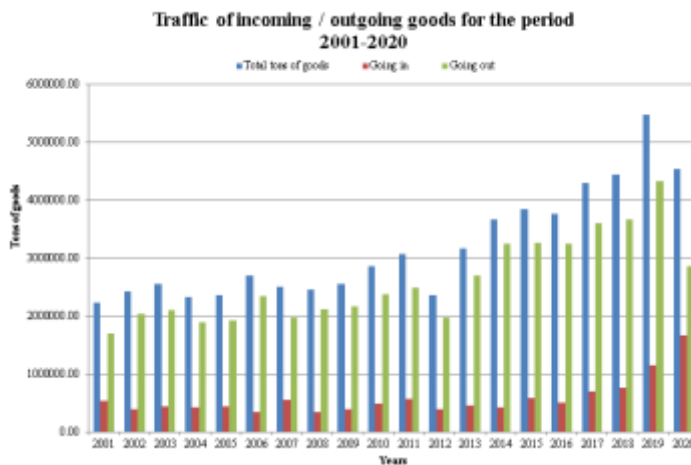


Figure 5. On the Danube for the Period 2001-2020

5. Conclusions

In this paper, a study on navigation conditions and naval traffic on the Danube in the period 2001-2020 was conducted. The traffic on the Danube was analysed regarding the types of ships and the quantity of goods and according to their direction (going in / going out).

As a transport axis, the Danube River connects the key European markets for supply, production and sales, and through the Rhine Main Danube Canal connects the Port of Constanta and the Port of Rotterdam.

The Danube is of great economic importance, both as a mode of transport, especially for the industrial areas located along the Danube corridor, but also from a tourist point of view, the cruise ships being more and more numerous in this sector.

However, navigation on the Danube has some limitations, both in terms of the conditions of its infrastructure and the environmental conditions, which may prevent some sectors from being crossed.

Therefore, the Danube must be seen as a priority. If there were no variations in the height of the water level, which is the biggest problem at certain times of the year, the Danube River could be the most important transport axis in Europe.

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