Interreg

EUROPEAN UNION

Danube Transnational Programme

DIONYSUS

Integrating Danube Region into Smart & Sustainable Multi-modal & Intermodal Transport Chains

Output T3_4: Inter/multimodal logistics transport case for new waterborne logistics chains on Lower Danube

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[FINAL]

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1 Project context

As has been established in the AF of the DIONYSUS project, three case studies for inter/multi-modal logistics transport of agricultural products shall be carried out for new waterborne logistics chains shall be ensured by the following PPs: WCons, PGA and AAOPFR respectively. This shall result in the formation of good practice cases and execution of cooperation activities, being derived from the strategy.

2 Table of Romanian Agricultural Production Statistic Data

For the Lower Danube sector AAOPFR has made researches and collected data on the multi-modal logistics transport of agricultural products in order to find a new good waterborne logistic chain.

As agriculture plays an important role in the economic activity and in the export activity of Romania, we found out that in period 2020 - 2021, the following cereal productions were recorded:

Thousand tonnes	2020	2021	difference +/-
● CEREALS FOR GRAINS	18,153.7	27,791.3	+9,637.6
of which:			
- wheat	6,392.4	10,433.8	+4,041.4
- rye	28.5	35.1	+6.6
- barley and sorghum	1,141.0	1981.0	+840.0
- oats	196.7	209.8	+13.1
- grain corn	10,096.7	14,820.7	+4,724.0
- triticale	236.4	259.2	+22.8
● OILY PLANTS	3,228.8	4,574.0	+1,345.2
of which:			
- sunflower	2,122.9	2,843.5	+720.6
- soy beans	322.1	347.5	+25.4
- rapeseed	780.2	1,375.1	+59.0

In 2021:

- Romania produced 7.5% of the total wheat production of the European Union, ranking fourth in the hierarchy of Member States, after: France, Germany and Poland;

- Romania cultivated the largest area with grain corn in the European Union and obtained the largest production;

- Regarding sunflower production, Romania occupied the first place in the hierarchy of Member States, followed by Bulgaria, France, Hungary and Spain;

- Rapeseed production placed Romania in the first four Member States. In 2021, Italy obtained 34.1% of soybean production, followed by France (16.2%), Romania (12.8%), Austria (8.8%), Croatia (8.4%) and other Member States (19.7%);

In 2021, Romania delivered over 12.1 million tons of cereals (wheat, wheat flour, corn, barley, oats) across the borders of the EU, i.e. 27.4% of the total exports of the EU, which have risen so far to 44.1 million tons.

3 Table of Romanian Transport Tariffs Statistic Data

A large part of Romania's cereal export takes place with river ships on the Danube River, on route from land / Danube port / Danube - Black Sea Canal / Constanta Port / maritime ship.

The tariffs related to transport, including the river transport, on the above-mentioned route, for the years 2020 – 2022, are (average euro rates per tonne):

Transport OPERATION:		GIURGIU AREA	OLTENIA AREA
1. field truck to Danube port terminals	TTP	5 - 12	5 - 12
2. fobbing (downloading / storage / loading)			
Danube port terminals	FOBB1	3 - 6	3 – 6
3. transport from Danube port to Constanta port	RTC	12 - 15	16 – 20
4. Constanta port fobbing			
Indirect via silos	FOBB2	5 - 8	

4 Abbreviations

Abbreviation	Explanation
TTP	**T**ruck **T**ransport **P**rice;
FOBB1	**Fobb**ing in Danube Ports;
RTC	**R**iver **T**ransport to **C**onstanta;
FOBB2	**Fobb**ing in Constanta port;
TT	**T**ransport **t**ariff
DPD	**D**anube **P**orts **D**ues;
NAD	**N**aval **A**uthority taxes on **D**anube ports;
CC	**C**anal **C**osts;
CPD	**C**onstanta **P**ort **D**ues ;
NAC	**N**aval **A**uthority Costs in **C**onstanta & Cernavoda.

5 Transport costs

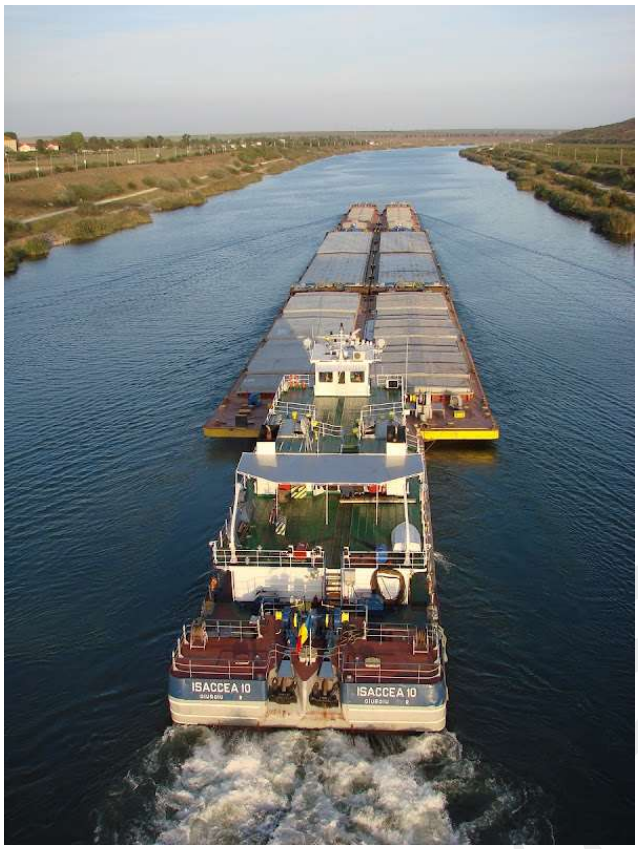
As we imagined, the full logistic link starting from the harvesting place in the field, loading the grains in the truck, transporting them to the port, downloading in the depots, loading in the fluvial barges, transporting all the way on the Danube and through the Danube – Black see canal, downloading on the depots and finally loading in the sea going vessel, we can put all the transport costs in a formula as follows:

Total Transport Costs = TTP x … to + FOBB1 x … to + RTC x … to + FOBB2 x … to

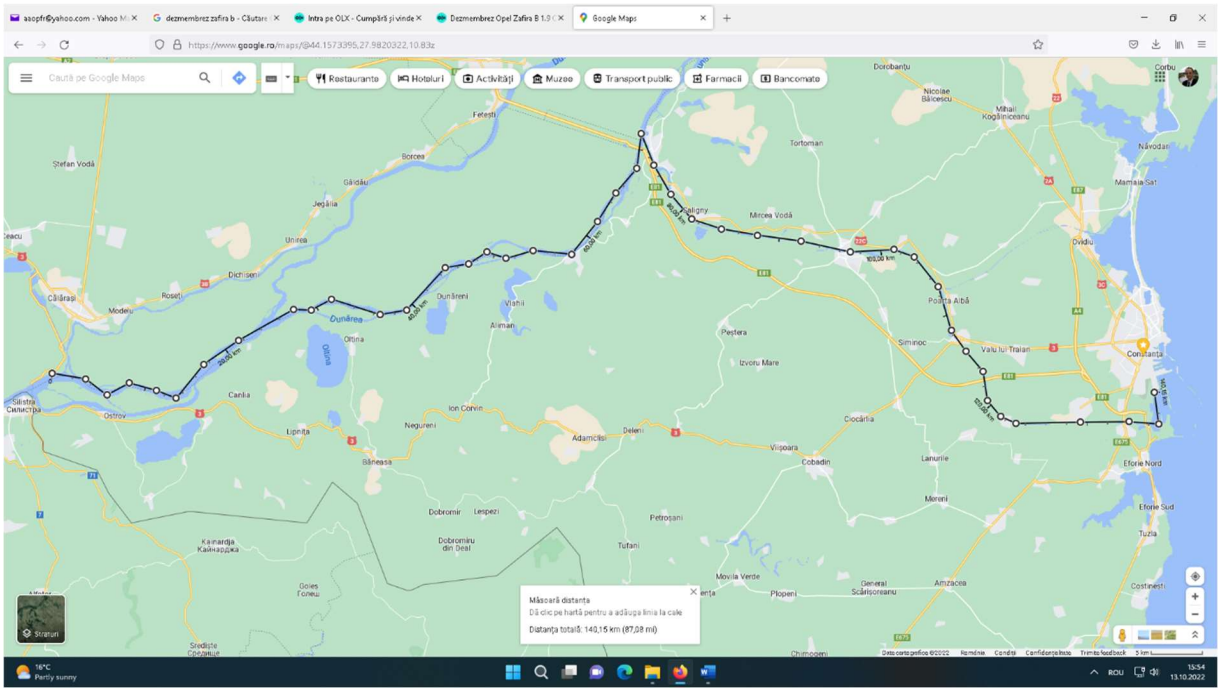
where the following abbreviations has been used:

TTP	- **T**ruck **T**ransport **P**rice;
FOBB1	- **Fobb**ing in Danube Ports;
RTC	- **R**iver **T**ransport to **C**onstanta;
FOBB2	- **Fobb**ing in Constanta port;

We exercised a new logistic link starting from Calarasi county and ending on board of a maritime ship in Constanta Port, that will transport 15,000.00 tonnes of wheat to Turkey. Due to the low level of the water on Danube, in the harvesting periods, the transport shall be done with convoys of maximum 6 barges of 1,500.00 tonnes capacity that will be loaded not more of 85% of the capacity of each barge (i.e. 7,500.00 tones per convoy). The river transport shall be done in two voyages so all the ports, canal and naval authorities dues will be doubled.



The distance on the Danube and Danube – Black Sea Canal, on the short way (Old Danube) with low drafts that will permit only 85% capacity loading of the barges, between the Calarasi port and Constanta port is about 140 km.

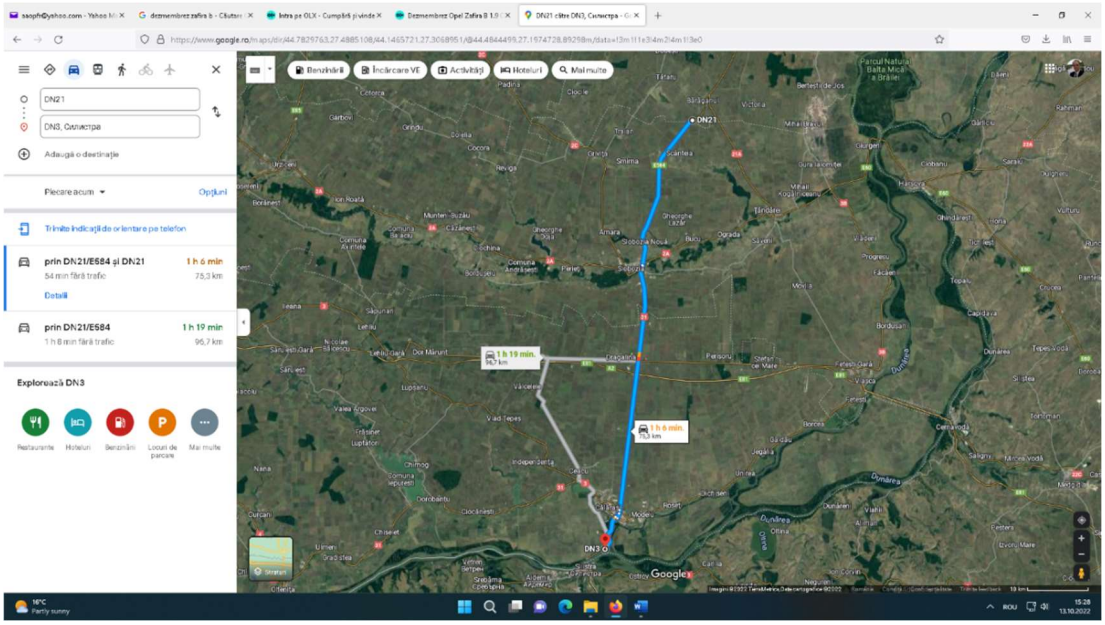


We used a medium rate of tariffs for RTC of 5.5 euro/tonne on this route (200 – 150 km), that includes all the Ports, Naval Authority, Danube - Black Sea Canal and Port of Constanta dues.

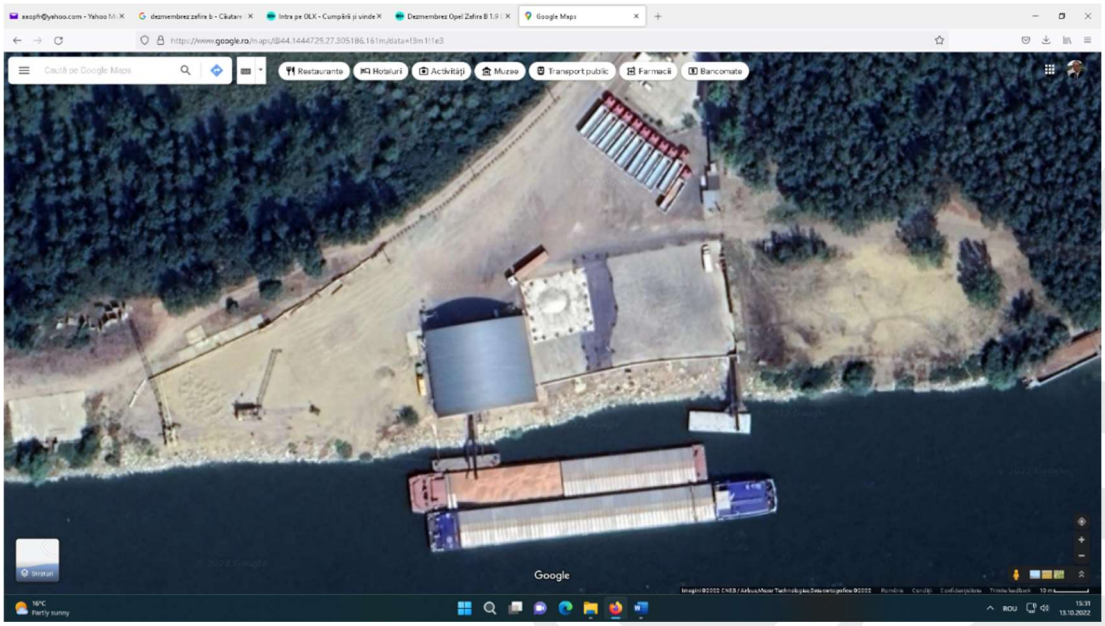
RTC = TT + DPD + NAD + CC + CPD + NAC Danube ports dues for barges operations, where the abbreviations meaning are:

TT	- **T**ransport **t**ariff
DPD	- **D**anube **P**orts **D**ues;
NAD	- **N**aval **A**uthority taxes on **D**anube ports;
CC	- **C**anal **C**osts;
CPD	- **C**onstanta **P**ort **D**ues;
NAC	- **N**aval **A**uthority Costs in **C**onstanta & Cernavoda.

The truck transport should be done by 25 tones capacity trucks from Baraganu area to Calarasi port (i.e. 75 km) and will be used 600 loaded voyages/trucks. Multiplying the number of km for one voyage with the number of voyages will result a total length of transport of 45,000.00 km.



The downloading / storage / loading in barges tariff is composed by specific tariff for each operation itself and is applied as a unique tariff for the full operation of discharging the truck, storing and loading the goods in the fluvial barges, per each tonne transferred from road to barge. Usually there are some exemptions for the storage tariff, if the goods will not stay longer than 30 days in the silos. As the loading of a 1,500.00 tonnes capacity barge will take not more than one day, in our example the storage tariff will not be applied. The Fobbing tariff used for the Danube port Calarasi, as a medium one for 2020, FOBB1 will be of 4,5 Euro/tonne of wheat that transited the silos.



The FOBBING tariffs in Constanta port are bigger so we will use a medium rate of FOBB2 = 6,5 Euro/tonne as the port dues are also bigger than in river ports.

As a result, the Total Transport Cost will be as follows:

TTP = 10.0 Euro/tonne ;

FOBB1 = 4.5 Euro/tonne ;

RTC = 5.5 Euro/tonne ;

FOBB2 = 6.5 Euro/tonne ;

TTC = 10 Euro/tonne x 15,000.00 tonnes + 4.5 Euro/tonne x 15,000.00 tonnes + 5.5 Euro/tonne x 15,000.00 tonnes + 6.5 Euro/tonne x 15,000.00 tonnes = 150,000.00 + 67,500.00 + 82,500.00 + 97,500.00 = **397,500.00 Euro,**

taking in consideration that the **tariffs for all costs were selected for the period June 2020.**

As from the statistics (https://agrointel.ro/148479/pret-grau-2020-cotatii-la-recoltare/) we found out that the FOB price of the wheat in harvesting period, 04 – 10. 06.2020 was 923 RON/tonne (186.84 euro/tonne) i.e. 2,802,600.00 Euro for 15,000.00 tonnes, it means that the transport costs represents 14.20 % of the wheat FOB price.

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1 Project context

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2 Abbreviations

Abbreviation	Explanation
CIF	Cost Insurance Freight
CIMNI	
CMR	Internationale Vereinbarung über Beförderungsverträge auf Straßen
LCI	
DS	

3 Multimodal and intermodal freight transport – overview, pro's and con's

Modal and intermodal logistics can mix and match all available modes of transportation, according to the market situation, customer benefits, available resources and environmental impact.[1]

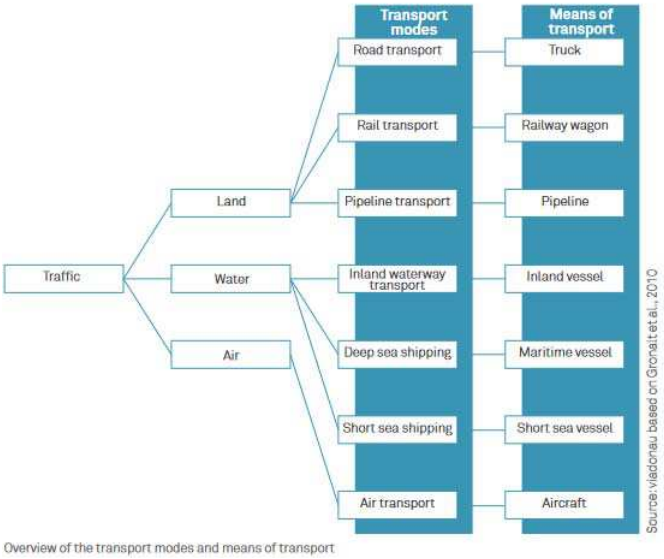


Figure 1: Overview of available transport modes and means of transport (Source: viadonau)

Multimodal transport is an umbrella concept, defining the general carriage of goods by at least two modes of transportation. Multimodal transport is a non-direct transport process, usually used for long-distance shipments.

"Multimodal transport is characterised by ***the transport of goods using two or more different transport modes*** *(e.g. change from waterway to rail). In order to change the means of transport, transhipment of the goods is required. In doing this, the strengths of the several individual transport modes can be used and the cheapest and most environmentally friendly combination can be chosen."*[2]

Figure 2: Steps in the multimodal transport by inland vessel (Source: viadonau)

Multimodal transportation offers following advantages:

[1] Manual on Danube Navigation, via donau, 4th edition 2019, P. 185 (https://www.viadonau.org/)

[2] Manual on Danube Navigation, via donau, 4th edition 2019, P. 186 (https://www.viadonau.org/)

- optimal use of all means of transportation, from both an efficiency and an environmental perspective,
- possibility to choose carriers and take advantage of the best rates,
- increased negotiation ability per stage or stretch of the route,
- reduce congestion in ports,
- reduce customs costs and better smuggling control.

The disadvantages usually lie in the legal and operational potential restrictions due to differences in international standards,

The intermodal transport is defined as a special form of multimodal transport, where *"[…] the goods are transported in **the same loading unit or with the same road vehicle on two or more modes of transport**. This means that, when changing transport means, only the loading units or the road vehicles are switched, while the goods remain in the same transport receptacles (such as containers or swap bodies)."*[3]

Figure 3: Steps in the intermodal transport by inland vessel (Source: viadonau)

Intermodal transportation offers many advantages in terms of time and costs[4]:

- increased efficiency by using unitised cargo (e.g. containers)
- better management of seasonal shipping peaks,
- low risk of damaging the goods,
- better monitoring of shipments from stage to stage,
- fewer inspections because containers are sealed,
- increased flexibility and handling of loading and unloading in ports,
- less time necessary to load/unload,
- cheaper insurance premiums.

Depending on the current market situation, intermodal transportation is competitive for average distances above 300km.

The disadvantages which may emerge are related to:

- potentially increased transport time due to delays in handling,
- difficulties emerging from the transferring between modes at the points of interchange,
- terminal costs,
- high investment costs for the transporters.

[3] Manual on Danube Navigation, via donau, 4th edition 2019, P. 187 (https://www.viadonau.org/)

[4] Here and in following: https://www.unescap.org/sites/default/d8files/event-documents/03MultimodalTransportationConceptAndFramework.pdf and Manual on Danube Navigation, via donau, 4th edition 2019 (https://www.viadonau.org/) and "Possibilities for intermodal grain transports in the Mälardalen region – environmental and economical aspects", M. Kuhlström, 2003

The main challenge emerges from the higher degree of required coordination between the different actors in the transport chain. Also the partially inefficient transport management systems (TMS), can be unsuitable for intermodal alternatives.[5]

On a European level, the new political and organisational thinking reflected by the Green Deal open up new potentials for the multimodal and intermodal transportation.

[5] Manual on Danube Navigation, via donau, 4th edition 2019, P (https://www.viadonau.org/)

4 A comparison of IWT, truck and rail transportation

The differences among the IWT, truck and rail freight transportation can be best explained by comparing the energy efficiency, the generated external costs, the bulk freight capacity and the infrastructure costs.[6]

In a nutshell:

- IWT is the most energy efficient and thus environmentally friendly mode of transportation (almost 4-time more efficient than road transportation),
- IWT generates the lowest external costs related to climate gases, air pollutants, accidents and noise,
- IWT (in our specific case the Danube transportation) has a significantly higher transport capacity per transport unit,
- the costs for building and maintaining IWT routes can be up to 4-times lower than the infrastructure costs for rail & road (example Germany).

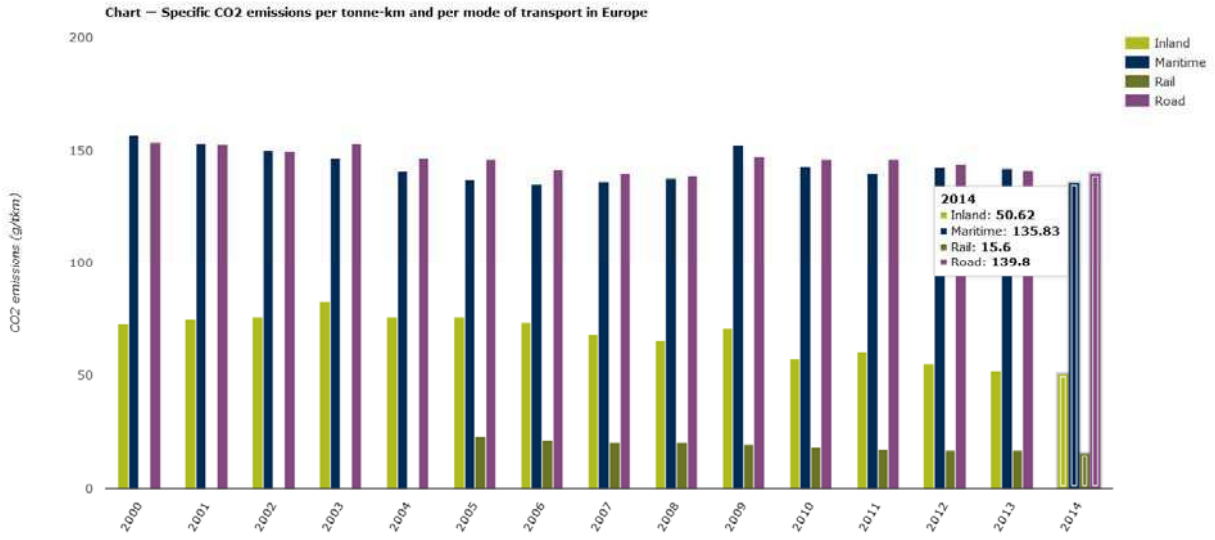


Figure 4: Specific CO^2 emissions per tonne-km and per mode of transport in Europe

IWT on second place after rail transportation[7]

[6] Manual on Danube Navigation, via donau, 4th edition 2019, P. 20 (https://www.viadonau.org/)

[7] https://www.eea.europa.eu/data-and-maps/daviz/specific-co2-emissions-per-tonne-2/#tab-chart_1

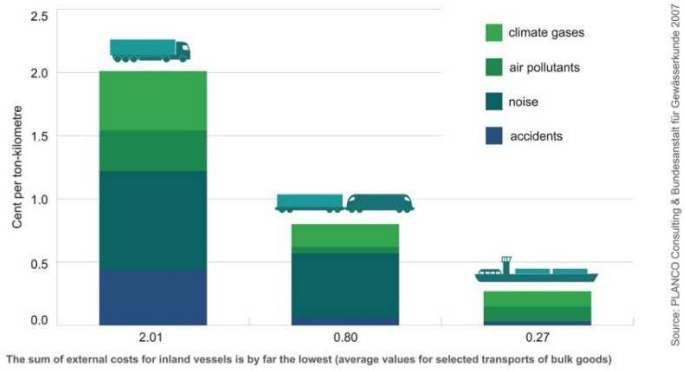


Figure 5: Comparison of external costs through negative effects per mode of transportation[8]

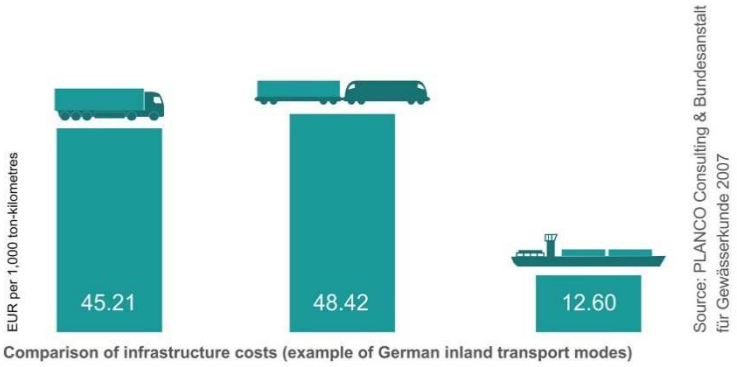


Figure 6: Comparison of infrastructure costs among the different modes of transportation (in Germany)[9]

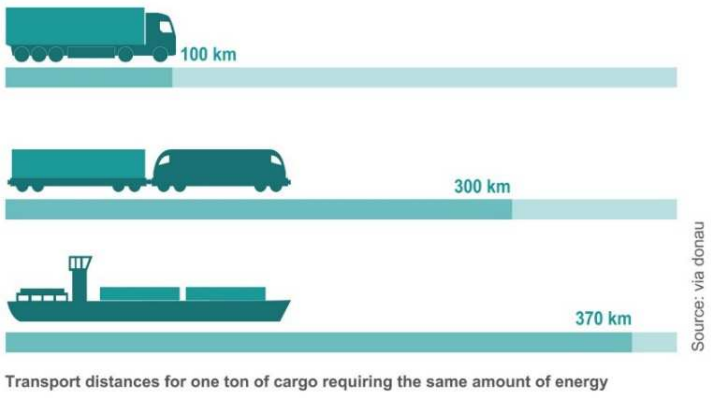


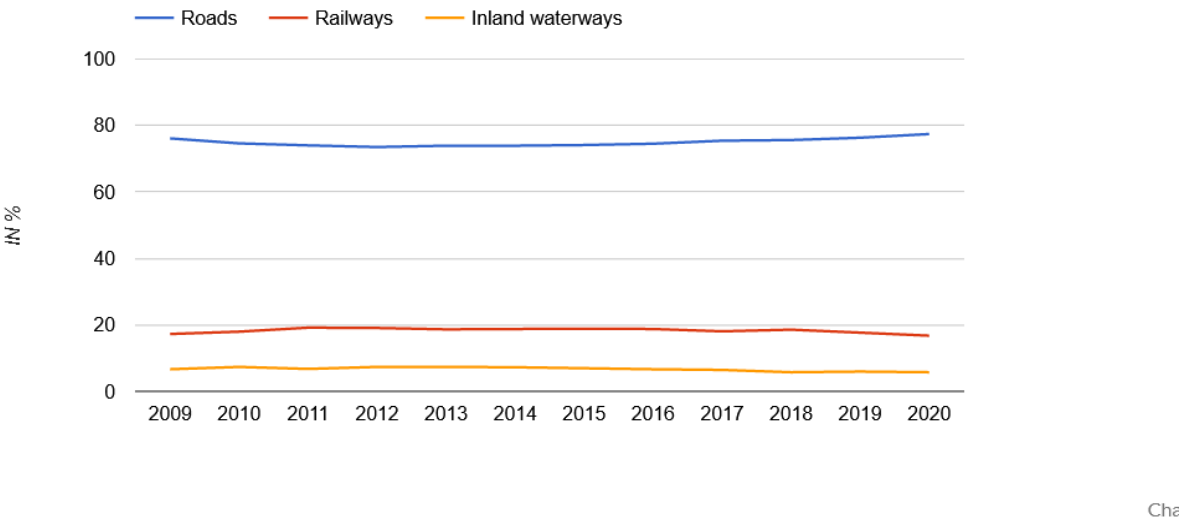
Figure 7: Comparison of energy efficiency for different types of transportation[10]

[8] https://www.viadonau.org/en/economy/danube-logistics

[9] https://www.viadonau.org/en/economy/danube-logistics

[10] https://www.viadonau.org/en/economy/danube-logistics

FIGURE 16: MODAL SPLIT SHARE OF INLAND TRANSPORT MODES IN THE EU-27 (IN %) 2009-2020



Source : Eurostat [tran_hv_frmod]

Figure 8: Development of the modal split share of inland transport modes in the EU-27 2009 – 2020 (Source: Eurostat)[11]

The modal split in the EU didn't change dramatically over the past years, showing no breakthrough in reducing the road transportation and increasing rail & inland waterways share.

According to Statistik Austria, in 2018 the shares of the transport volume concerning the freight transport by road, rail and Danube waterway freight transport in Austria were as follows:

- 83,6% was carried out by road freight transport with a total of 574,0 million t;
- The share of rail transport was 15,3% (105,3 million t);
- On the Danube waterway was transported only 1% of the freight (7,2 million t).

The overall development of the modal split since 1982 is presented in the figure below:

[11] https://inland-navigation-market.org/chapitre/2-freight-transport-on-inland-waterways-2/?lang=en

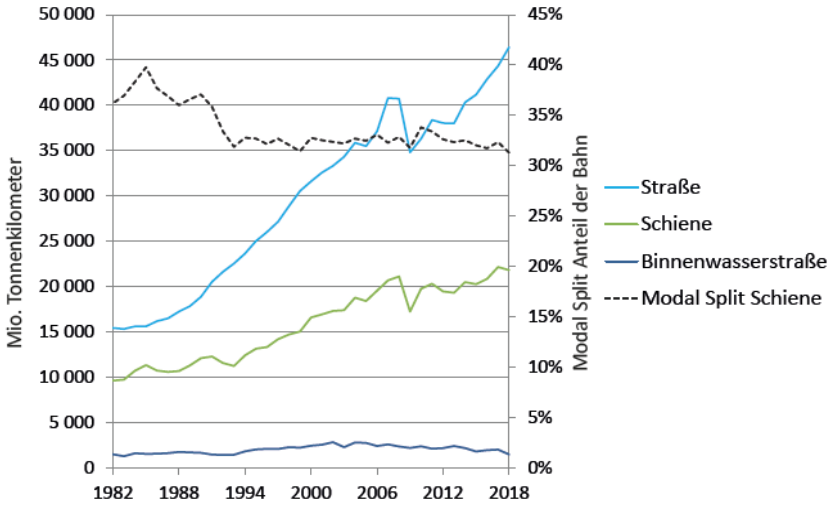


Figure 9: Freight traffic performance development 1982 – 2018 in Austria[12] on rail, road and inland waterways in million tonne-kilometres

light blue line = street; green line = railway; dark blue line = inland waterway; dotted line = modal split railway

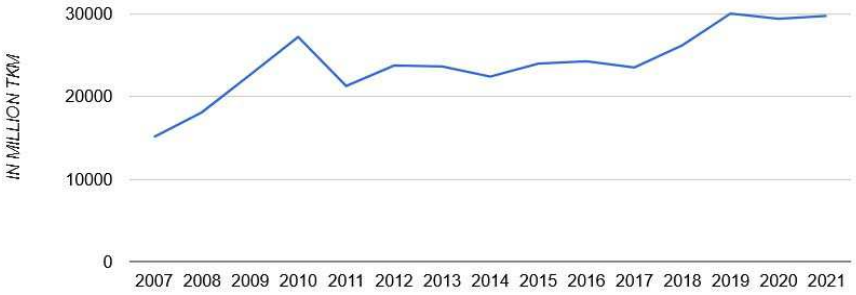
[12] Fact Sheet Strasse – GSV die Plattform für Mobilität https://www.google.at/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwikjtmS66LuAhXpoosKHWrJBVgQFjACegQIBBAC&url=http%3A%2F%2Fwww.gsv.co.at%2Fwp-content%2Fuploads%2FFACT%2520SHEET%2520STRASSE%2520WEB%252005%25202020.pdf&usg=AOvVaw0q_vSoLNvidlwafuMk_oJU

5 Agricultural freight transport overview in the Danube basin

Cargo transport on the entire navigable Danube between Kelheim (Germany) and the Black Sea lies in the range between 36 and 40 million t per year. Transport performance on the Danube (EU Danube countries plus Serbia) reached 29.8 billion TKM in 2021.[13]

Figure 10: Source: CCNR analysis based on Destatis, VNF, Eurostat [IWW_GO_ATYGO], UK Department of

FIGURE 13: TRANSPORT PERFORMANCE IN FREIGHT TRANSPORT ON THE DANUBE *



Sources: Eurostat [IWW_GO_ATYGO] and [IWW_GO_QNAVE] (Serbia)

Transport ** Transport performance in IWT in all EU Danube countries plus Serbia. Data for Serbia available since 2018*

Figure 11: Transport performance in freight transport on the Danube 2007 - 2021[14]

Regarding the type of cargo, **agricultural products rank second** after the iron ore. Transport of agricultural products in the Danube basin is mainly impacted by variations in harvest volumes and

[13] https://inland-navigation-market.org/chapitre/2-freight-transport-on-inland-waterways-2/?lang=en

[14] https://inland-navigation-market.org/chapitre/2-freight-transport-on-inland-waterways-2/?lang=en

by the competition between different harvesting regions (Middle Danube region vs. Black Sea region). In the third quarter of 2021, the Black Sea region gained market shares in the export of grain to North Africa and other parts of the world, to the detriment of the Middle Danube region. This led to a lower transport volume of grain on the Danube, between the Middle Danube region and the seaport of Constanţa.

On the Upper and Middle Danube, grain, food products and foodstuff are entirely transported downstream (export of agricultural products from Hungary and Serbia to the seaports, mainly to Constanţa).

The two Danube countries with the highest container transport are currently Hungary and Austria.[15]

According to the Market Observation for Danube Navigation released by the Danube Commission for year 2021, the total volume of cargo transported on the Upper Danube through the Jochenstein lock (DE/AT) in 2021 was 2,221 thousand tons, by 4.7% less than in 2020. Compared to 2020, there was an increase in the downstream transportation by 10.9% and a decrease upstream by 12.7%.

The total volume of cargo transported through the Gabcikovo lock (HU/SK) in 2021 was 4,944 thousand tons, by 1.3% less than in 2020. Upstream transit was around 2,915 thousand tons, or 58.9% of the total volume – 65.8%.

Table 2.5

Cargo volumes in upstream HU/SK cross-border transport (by groups of goods)

Year, thousand tons / Commodity group	2014	2015	2016	2017	2018	2019	2020	2021
Food products and animal feed	1,440 35%	1,283 42%	1,316 37.8%	1,389 38.7%	1,022 35.1%	1,774 48%[3]	1,321	879
Iron ore raw materials	1,080 26%	749 24.6%	862 24.8%	803 22.3%	669 23%	841 22%	948	969
Grain	206 5%	200 6.5%	298 8.6%	308 8.5%	252 8.6%	271 7.3%	352	394
Metal products	376 9%	358 11.7%	417 12%	473 13.1%	418 14.3%	340 9.2%	117	71
Petroleum products	406 10%	84 2.7%	233 6.7%	286 7.9%	317 10.9%	241 6.5%	212	86.7
Organic and synthetic fertilizers	238 5.8%	171 5.6%	167 4.8%	165 4.6%	86.2 3%	91.5 2.5%	75.2	132.8

Table 2.6

Cargo volumes in downstream HU/SK cross-border transport (by groups of goods)

Year, thousand tons / Commodity group	2014	2015	2016	2017	2018	2019	2020	2021
Organic and synthetic fertilizers	434 33%	414 26.8%	563 30.5%	513 26.6%	317 20.1%	535 25%	505	464,5
Petroleum products	323 24%	480 31%	530 28.7%	631 32.7%	585 37.1%	671.3 31.4%	578	870
Metal products	290 22%	399 25.8%	493 26.7%	432 22.4%	435 27.6%	380.4 17.8%	96.5	140

Figure 12: Development of cargo volumes upstream/downstream Upper Danube[16]

Agricultural products are mainly imported to Austria (43%) or are in transit (50%). The modal split of agricultural goods in Austria 2019 was: ca. 79,03% on road, 16,37% on railway and approx. 4,06% on Danube waterway (+63,1% to 2018). In 2020, the road haulage segment grew by 16,3% (foreign

[15] https://inland-navigation-market.org/chapitre/2-freight-transport-on-inland-waterways-2/?lang=en

[16] https://inland-navigation-market.org/chapitre/2-freight-transport-on-inland-waterways-2/?lang=en

trucks) and by 7,8% (Austrian trucks), the railway segment grew also by 4,8% while the Danube segment grew by 0,3%.[17]

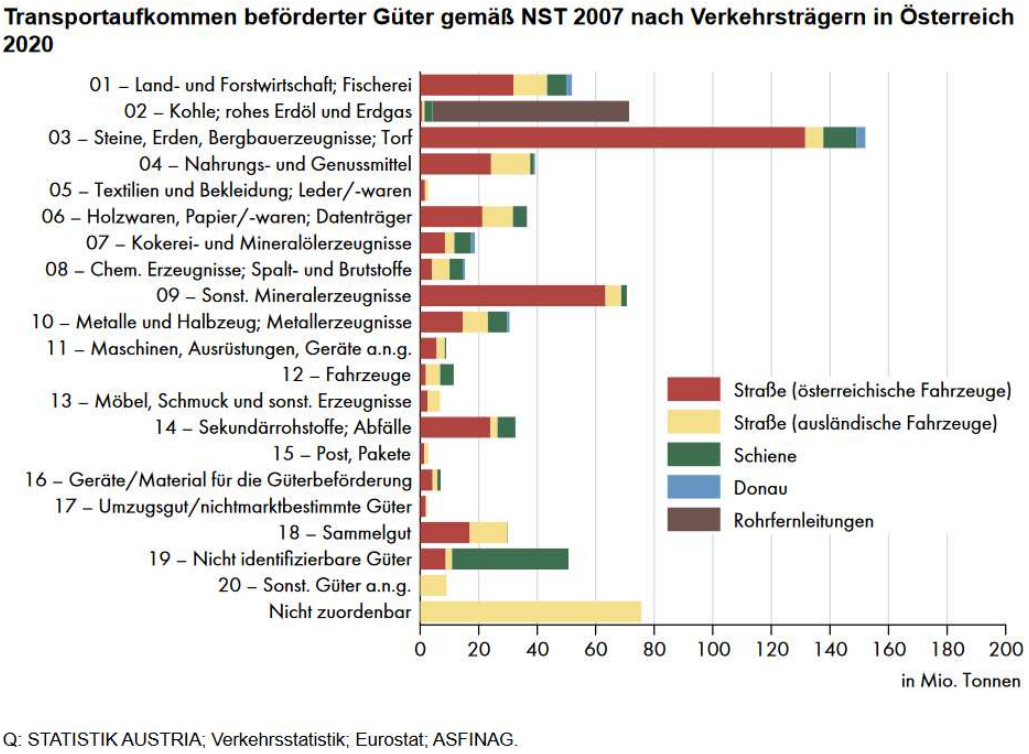


Figure 13: Transport volume in Mio. tons by transport mode in Austria 2020[18]

01 – Agricultural, forestry and fishery products;
red = road, Austrian vehicles; yellow = street, foreign vehicles; green = railway; blue = Danube

In year 2021, Austria imported approx. 2,256 million tons of cereals and exported approx. 1,41 million tons. Most trade partners are EU-countries.[19]

Austria exported 742.700 tons of wheat, as follows: 68,1% to Italy, 17,7% to Germany and 7,9% to Switzerland. Austria imported 1,19 million tons of wheat, as follows: 42,2% from Hungary, 35,5% from the Czech Republic, 13,1% from Slovakia and 3,9% from Germany. Austria exported approx. 515.100 tons and imported 1,09 million tons of corn maize. 73,5% of the exported corn maize went to Italy and approx. 15,4% to Germany. 43,2% of the imported maize came from Hungary, 20,3% from the Czech Republic and 11,8% from Slovakia.

[17] https://www.statistik.at/fileadmin/publications/Verkehrsstatistik-2021.pdf

[18] https://www.statistik.at/fileadmin/publications/verkehrsstatistik_2020_-_barr.pdf

[19] Here and in following: Grüner Bericht 2022, Federal Ministry of Agriculture, Regions and Tourism, p. 35ff

6 Grain logistics

Grains and oilseeds can be mainly transported as dry bulk cargo or containerised[20].

For the transhipment at ports/terminals, the equipment consists of gantry cranes and other multipurpose cranes which can use hooks and grabbers. With the help of the cranes, loading hoppers tranship the dry bulk cargo from inland vessels to trucks or wagons/rail. Loading hoppers can also be used for the temporary storage of grains. Further equipment used are reach stackers as well as full and empty container forklifts. Grains are fertilisers are moisture sensitive. Overhead gantries are used for covered transhipment. Soya meal, grains and fertilizers are however most frequently transhipped by means of pneumatic or mechanical equipment (high-pressure suction or pumping devices, conveyor belts, elevators or screw conveyors).

Agricultural bulk goods are then stored in silo installations. They can be stored over a longer period without any quality loss. Goods in silos can be used continuously or transhipped onwards to other modes of transport.

Major factors impacting domestic and international grain logistics are related to supply, placement and transit. Supply is affected by environmental factors such as weather – timing of harvest, disease, pests – influencing quality and yield, by the seasonality of production and marketing strategies. Scheduling, demands of other system users, issues with the equipment, weather, and the time required to load and unload, port and terminal capacities impact placement and transit times.[21]

[20] here and following: Manual on Danube Navigation, via donau, 4th edition 2019, (https://www.viadonau.org/)

[21] Logistics and Supply Chain Strategies in Grain Exporting, Wilson/Carlson/Dahl, Agribusiness & Applied Economics Report No. 457, August 2001

7 First-DDSG Logistics Holding - CNE (Central Northern European O.I. GmbH: Case study for the inter/multi-modal transport of corn from Serbia to Austria

Subject, covered destinations, conditions and the purpose of the logistic chain:

From Subotica to Pernhofen, 1000t of corn, 24hrs sailing

Figure 14: First-DDSG Logistics Holding barges for cargo transportation

1. Geographical coverage and transit time

The land of origin is Serbia and the land of destination is Austria with the following points of transhipment: field/silo; silo/port; port/barge; barge/port; port/customer,

which in turn has the following distances between nodes:

- field/silo 60km truck;
- silo/port 55km truck;
- port/barge;
- Danube 855km barge;
- barge/port;
- port/customer 100km truck.

and its own timeline of logistics execution just as it is written below:

- field/silo 60km truck; 3h
- Silo storage: 1 week – 6 months
- Silo/port 55km truck; 2h
- port/barge 1,5 days (working days)
- Danube 855km barge; 6 days (working days)
- barge/port 1,5 days (working days)
- port/customer 100km truck 3h.

2. Cargo properties:

Type of cargo is corn with specifics 1,45 m3/to (weight, volume, density, etc.).

3. The transport means that are involved in this supply chain are trucks and barges in bulk.

4. There are the following requirements of the cargo:

- for transport it must be clean, dry and covered,
- the storage has the same requirements: clean, dry and covered
- transshipment conditions are again the same, it must be clean and dry.

5. This supply chain involves following parties from origin to destination:

- farmer harvesting,
- trucking company in harvesting area,
- silo operator,
- port operator,
- barge operator,
- port operator port of destination,
- trucking company to final destination.

6. Logistics chain requirements from the parties involved:

- farmer – certificate of origin, goods analysis;
- trucking company – CMR between field and silo storage;
- silo operator – storage documentation, goods analysis;
- port operator – transshipment protocol, facility cleaning documentation;
- surveyor – LCI, DS, Quality, goods analysis S
- shipper/Carrier – BL, cargo invoice, custom documents;
- port operator – transshipment protocol;
- trucking company – CMR.

7. Average costs broken down to main supply chain legs as of Dec. 2022, average prices per ton are:

- Field-silo € 5
- Storage costs €3
- Silo-port €5
- Port-transsshipment €5
- Barge-transport €15
- Port-transshipment €5
- Port-final destination €10

8. Required contractual arrangements for decision making on transport modes:

- CIF (trading)
- Bratislava Agreement and/or CIMNI (transport by barges)
- CMR (transport by trucks)

9. Shortcomings:

- infrastructure - poor road conditions in the harvesting area;
- administrative barriers - too much bureaucracy and too many custom formalities.

10. Recommendations:

- infrastructure and equipment requirements – improvement of road conditions, silo modernisation, Danube fleet and port modernization;
- administrative/authority procedures - digitalization, simplification of procedures, maintenance of the river way, 24/7 operations on key points like customs in the ports;
- further measures to improve the efficiency of operations in the entire logistics chain - simplify procedures to operate 24/7.

Interreg

EUROPEAN UNION

Danube Transnational Programme

DIONYSUS

Integrating Danube Region into Smart & Sustainable Multi-modal & Intermodal Transport Chains

Inter/multimodal logistics transport cases for new waterborne logistics chains

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3 Abbreviations

Abbreviation	Explanation
PPs	Dionysus project partners
WCons	Wieser Consult
PGA	Port Governance Agency
AAOPFR	Romanian River Ship Owners and Port Operators Association
GDP	Gross Domestic Product
IWT	Inland Waterway Transport

4 Scope of the report

In the Application Form of the DIONYSUS project, three case studies for inter/multi-modal logistics transport of agricultural products were foreseen to be carried out by the following PPs: WCons, PGA and AAOPFR respectively. Formation of good practice cases and execution of cooperation activities, being derived from the strategy, should result with new waterborne logistics chains.

5 Agricultural production statistics in the Republic of Serbia

Serbia produces various agricultural products, mostly grains, fruits and vegetables which constitute a significant part of its GDP and exports. Agriculture in Serbia is an important sector of the Economy of Serbia comprising 6.0% of GDP and is valued at 2.416 billion euros (as of 2017).

Agricultural land occupies some 65% of the total area of Serbia, equivalent to approximately 5.7 million hectares. Of this, arable land totals 3.3 million hectares (65% of agricultural land), orchards cover an area of 2.4 million hectares (5% of agricultural land), vegetable production covers 295,000 hectares and vineyards 70,000 hectares (1% of agricultural land). Permanent grasslands cover 1.4 million hectares, equivalent to 28% of agricultural land. [1]

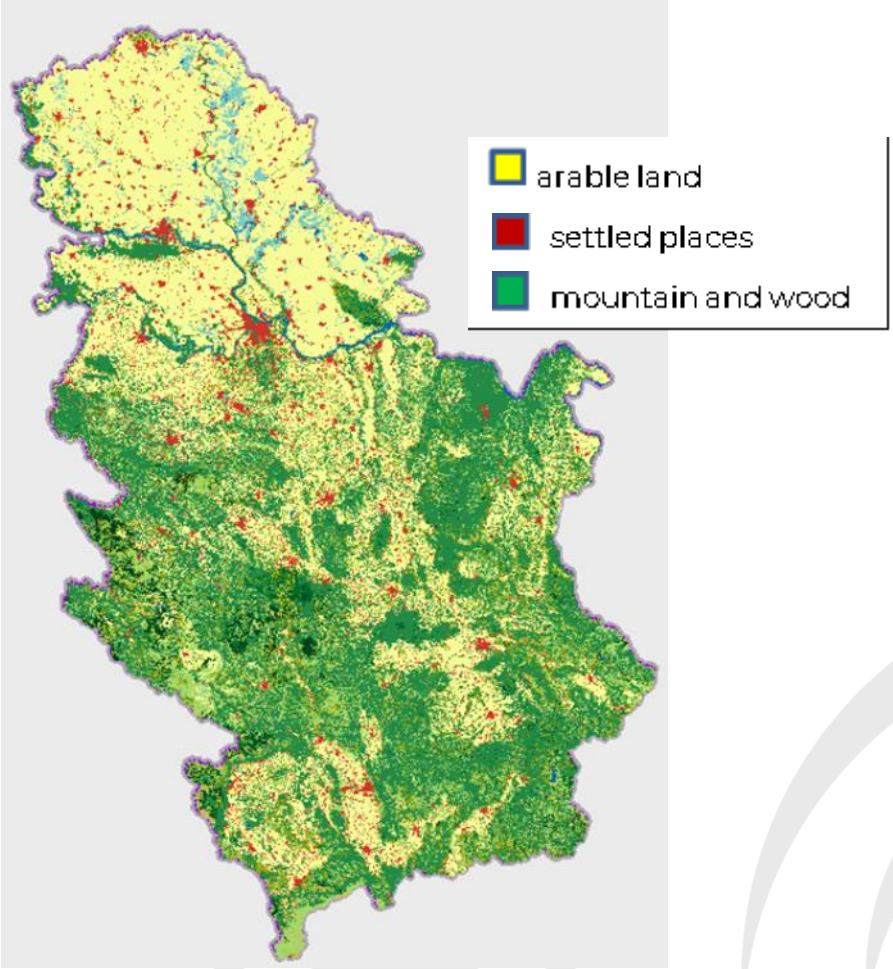

Figure 1. Land cover map

1 https://www.sepa.gov.rs/download/ae_programme_for_serbia.pdf

Agricultural production is mostly present in the northern province of Vojvodina on the fertile Pannonian Plain (45% of all used arable land), and the southern lowlands adjacent to the Sava, Danube and Great Morava rivers.

Crop production is growing considerably. Cereals dominate crop production, accounting for 45% of arable land, or 60% of the total cultivable land. The most important cereals are wheat and maize, whereas only 10% of the area under cereals is used for the production of rye, barley and oats.

Fruit and vegetables occupy about 12% of the total agricultural land area and are predominantly cultivated on private holdings in central Serbia on small, family-owned farms. Serbia has ideal climatic conditions for growing many varieties of fruit, rendering it well suited for the production of organic fruit.

Compared to other sectors of the Serbian economy, the agro-food sector plays a very prominent role in overall trade, accounting for some 20% of total exports. Serbia's main export commodities are cereals (maize, wheat), raw and processed fruit (frozen raspberries, prunes), refined sugar and some livestock and meat products.

Serbia is among the top five producers in the world of raspberries (127,011 tons as of 2018) and plums (430,199 tons as of 2018). It is also a significant producer of maize (6,158,120 tons, ranked 32nd in the world) and wheat (2,095,400 tons, ranked 35th in the world). The production of sugar beet (2,299,770 tons) and sunflower seeds (454,282 tons) meets domestic demand for sugar and vegetable oil and permits the export of some 180,000 tons of sugar to the European Union.

Export trade structure according to the destination of trade: European Union 47,6%, CEFTA 43,6%, and 8,8% other countries. The top 10 agricultural products in export are: corn, white sugar, raspberry, wheat, sunflower oil, edible and raw, beer made from malt, fresh apples, soft drinks, griz raspberry and soybean oil[2].

For agricultural and food products, for which the transport requires specific temperature regulations, the current trade has been done by road transport.

Cereals and oilseeds are transported by inland waterways in Serbia.

According to the annual report of the Association of Grains of Serbia, the total export of all cereals and oilseeds during 2019 amounts to 4.3 million tons.

When it comes to the most represented world crop culture, the record export of corn in 2019 in the amount of 3,117,958 tons, is a consequence of the good yield of corn for two years in a row, 2018 and 2019, but also uniform exports throughout 2019. Of the 3,117,958 tons exported, 2,216,245 tons were shipped by the Danube, which is 71.08% of total exports (58.33% last year). Most of the corn was exported to Romania, Italy and Austria.

2 Ministry of Agriculture, Forestry and Water management / www.minpolj.gov.rs

5.1 Cereals

In 2019, cereals production for Serbia was 10.5 million tonnes. Though Serbia cereals production fluctuated substantially in recent years, it tended to increase through 2010 - 2019 period, ending at 10.5 million tonnes in 2019.

Grain farms cover around 1,702,829 hectares of arable land in Serbia (as of 2018), making 66.22% of total used arable land.

Grain	Hectares (as of 2019)
Maize	962,083
Wheat	577,499
Rye	5,046
Barley	100,118
Oat	22,669

Table 1: Planted areas of cereals

5.1.1 Maize

In 2017, maize production for Serbia was 4 million tonnes. Though Serbia maize production fluctuated substantially in recent years, it tended to increase through 2006 - 2020 period ending at 8 million tonnes in 2020. In 2020 planted area for corn was approximately 970,000 ha, an increase of 10 percent compared to last year and 20 percent compared to the past ten-year average.

Serbia's 2019/20 total consumption requirement is estimated at approximately 4.3 million tonnes annually, with most being used for animal feed. Serbia is one of the largest corn exporters in Europe and, in record good years, among the top ten countries in the world.

The record export of maize in 2019 in the amount of 3,117,958 tonnes is a consequence of the good yield of corn for two years in a row, 2018 and 2019, but also uniform exports throughout 2019. Of the 3.1 million tonnes exported, 2.2 million tonnes were shipped by the Danube, which is 71.08% of total exports (58.33% last year).

Table 2 shows harvested area, drastically growth total production from 4 million tonnes in 2017 to 7.87 million tonnes in 2020. Also yield increase by 100 percent, from 4 ha/t in 2017 to 7.9 t/ha in 2020.

Maize			
Years	Area harvested, ha	Production, t	Yield ha/t
2017	1,002,319	4,018,370	4.0
2018	901,753	6,964,770	7.7
2019	962,083	7,344,542	7.6

2020	996,527	7,872,607	7.9

Table 2: Maize: Area harvested, production and yield per year[3]

Maize is mostly exported to Romania (61%), Italy (21%) and Austria (9%). However, Romania usually is not the final destination, and this means that export is done through the Port of Constanza.

5.1.2 Wheat

In 2019, wheat production for Serbia was 2,5 million tonnes. Out of 318,868 tonnes of exported wheat during 2019, 70,600 tonnes were prepared by the Danube, which is only 22.14% of total exports, last year 600,000 tonnes, or 50% of total exports. Total domestic consumption of wheat in Serbia for 2019/20 is estimated to be approximately 1,8 million tonnes annually.

In 2020, wheat production for Serbia was 2,8 million tonnes. Though Serbia wheat production fluctuated substantially in recent years, it tended to increase through 2006 - 2020 period ending at 2,8 million tonnes in 2020.

Table 3 shows harvested area, total production and yield per hectares of wheat. Yield per hectares increased from 4.1 ha/t in 2017 to 4.9 ha/t in 2020.

Wheat			
Years	Area harvested, ha	Production, t	Yield ha/t
2017	556,115	2,275,623	4.1
2018	643,083	2,941,601	4.6
2019	577,499	2,534,643	4.4
2020	581,128	2,873,503	4.9

Table 3: Wheat: Area harvested, production and yield per year[3]

Wheat is mostly exported to North Macedonia (34%), Bosnia and Herzegovina - BiH (21%) and Albania (17%).

5.1.3 Rye

In 2020, rye production for Serbia was 4,725 tonnes. Table no 4 shows harvested area, total production and yield per hectares rye. Yield per hectares increased from 2.4 ha/t in 2017 to 3.2 ha/t in 2020. Total production increase from 11,248 tonnes in 2017 to 15,240 tonnes in 2020.

Rye

[3] Statistical Office of the Republic of Serbia, www.stat.gov.rs

Years	Area harvested, ha	Production, t	Yield ha/t
2017	4,673	11,248	2.4
2018	4,736	13,418	2.8
2019	5,046	12,963	2.6
2020	4,725	15,240	3.2

Table 4: Rye: Area harvested, production and yield per year[3]

5.1.4 Barley

Barley is a secondary grain crop in Serbia. Total barley consumption for the past five years has ranged between 300,000-400,000 tones, of which around half is for animal feed and half for the brewery industry. Consumption of brewery barley has been increasing due to constant demand from breweries. Barley planted for brewery use continues to expand every year.

Table 5 shows harvested area, total production and yield per hectares of barley. Barley production for Serbia increase from 305,493 tonnes in 2017 to 490,115 tonnes in 2020. Yield per hectares increased from 3.3 ha/t in 2017 to 4.6 ha/t in 2020.

Barley			
Years	Area harvested, ha	Production, t	Yield ha/t
2017	84,687	305,493	3.3
2018	105,740	410,138	3.9
2019	100,118	373,340	3.7
2020	106,318	490,115	4.6

Table 5: Barley: Area harvested, production and yield per year[3]

Barley is not a significant commodity in Serbia's overall grain trade. With increased planted area, exports of barley have increased, while imports declined. In 2018/19 Serbia exported a record high quantity of 67,744 tones. Exports are mostly to EU countries, Bosnia and Herzegovina and Montenegro.

5.1.5 Oats

Table 6 shows harvested area, total production and yield per hectares oats. Oats production for Serbia decrease from 69,538 tonnes in 2017 to 52,135 tonnes in 2020. Harvested area is reduced from 28 thousand hectares in 2017 to 17 thousand hectares in 2020.

Oats

Years	Area harvested, ha	Production, t	Yield ha/t
2017	28,537	69,538	2.4
2018	26,111	74,707	2.9
2019	22,669	56,242	2.5
2020	17,116	52,135	3.0

Table 6: Oats: Area harvested, production and yield per year[3]

5.2 Protein corps

5.2.1 Peas

Table 7 shows harvested area, total production and yield per hectares peas. The area planted with peas in Serbia has decreased last few years, from 8,097 hectares in 2017 to 6,038 tonnes in 2020.

Peas			
Years	Area harvested, ha	Production, t	Yield ha/t
2017	8,097	37,854	4.7
2018	6,736	29,261	4.3
2019	6,282	25,612	4.1
2020	6,038	27,612	4.6

Table 7:Peas: Area harvested, production and yield per year[3]

5.2.2 Beans

Table 8 shows harvested area, total production and yield per hectares of beans. The area planted with beans in Serbia has decreased last few years, from 13,181 hectares in 2017 to 8,512 thousand in 2020. Yield per hectares beans is constantly about 1 ha/t.

Beans			
Years	Area harvested, ha	Production, t	Yield ha/t
2017	13,181	13,034	1,0
2018	9,112	11,140	1,2
2019	9,091	9,027	1,0
2020	8,512	9,253	1,1

Table 8: Beans: Area harvested, production and yield per year[3]

5.2.3 Lucerne

Table 9 shows harvested area, total production and yield per hectares of Lucerne. The production of Lucerne in Serbia has growth last few years, from 475,580 tones in 2017 to 650,360 tones in 2020. Yield per hectares drastically increased from 4.2 ha/t in 2017 to 6.2 ha/t in 2020.

Lucerne			
Years	Area harvested, ha	Production, t	Yield ha/t
2017	112,218	475,580	4.2
2018	103,366	513,316	5.0
2019	106,095	594,981	5.6
2020	104,191	650,360	6.2

Table 9: Lucerne: Area harvested, production and yield per year[3]

5.3 Oilseeds

5.3.1 Soybean

The area planted with soybeans in Serbia has increased drastically over the last fifteen years, from 131 thousand hectares in 2005 to 230 thousand in 2019. There is a tendency of more and more land area being dedicated to soybean cultivation which is driven by various factors, but the main reasons are increased market demand and good prices. Although yields are still much dependent on weather conditions, improving farmers' knowledge about farm management and introducing digitalization as well as the use of precision agriculture on a larger scale, can further contribute to higher production yields.

Table 10 shows harvested area, total production and yield per hectares of soybean.

Soybean			
Years	Area harvested, ha	Production, t	Yield ha/t
2017	201,712	461,272	2.3
2018	196,472	645,607	3.3
2019	229,372	700,502	3.1
2020	236,758	751,578	3.2

Table 10: Soybean: Area harvested, production and yield per year[3]

Due to excellent weather conditions in 2018, Serbia had a record high soybean production season. According to the official data from Statistical Office of Serbia, in 2018 Serbia had an average yield of 3.3 metric tonnes per hectare (For comparison, the usual mean is 2.6 t/ha). The total production of soybeans in 2018 reached the capacity of

approximately 760,000 tonnes a figure 50% higher than the 2017 number, when production was significantly damaged due to the extreme drought. According to official statistics, the 2019 season was also good with a total production of 710,000 tonnes. Other information sources, like the Commodity Exchange from Novi Sad and Donau Soja Organization in Serbia, have published data which even exceed official statistics on production.

The main export markets of Serbian soybean are the EU countries and the Russian Federation.

5.3.2 Rapeseed

Table 11 shows harvested area, total production and yield per hectares of rapeseed.

Rapeseed			
Years	Area harvested, ha	Production, t	Yield ha/t
2017	19,376	48,740	2.5
2018	45,628	135,422	3.0
2019	30,804	84,311	2.7
2020	24,638	73,668	3.0

Table 11: Rape seed: Area harvested, production and yield per year

5.3.3 Sunflower

Table 12 shows harvested area, total production and yield per hectares of sunflower.

Sunflower			
Years	Area harvested, ha	Production, t	Yield ha/t
2017	219,338	540,590	2.5
2018	239,148	733,706	3.1
2019	219,404	729,079	3.3
2020	221,149	636,688	2.9

Table 12: Sunflower: Area harvested, production and yield per year

5.4 Sugar beet

Table 13 shows decrease of harvested area and total production but increase of yield per hectares of sugar beet. Yield per hectares growth from 46.7 ha/t in 2017 to 53 ha/t in 2020, while harvested area decrease from 53,857 ha in 2017 to 37,418 ha in 2020.

Sugar beet

Years	Area harvested, ha	Production, t	Yield ha/t
2017	53,857	2,513,495	46.7
2018	48,125	2,325,303	48.3
2019	42,539	2,305,316	54.2
2020	37,418	2,018,215	53.9

Table 13: Sugar beet: Area harvested, production and yield per year

5.5 Feed

Table 14 shows decrease of harvested area and total production but increase of yield per hectares feed of maize for fodder.

Maize for fodder			
Years	Area harvested, ha	Production, t	Yield ha/t
2017	33,244	534,521	16.1
2018	29,831	588,178	19.7
2019	37,401	763,354	20.4
2020	35,663	746,926	20.9

Table 14: Maize for fodder: Area harvested, production and yield per year

5.6 Other

5.6.1 Fruit

Fruit production is one of the key sub-sectors of Serbia`s economic development. In 2019 export of Serbian fruits amounted to 568.2 million euros. Measured by the value of apples, in 2019 Serbia was the first exporter from Europe to Russian Federation. Massive apple orchards are expanding all across Serbia, especially in Vojvodina with premium melioration systems, trendy varieties and expensive anti-hail nets.

In 2019 export of frozen raspberries, blackberries, mulberries, etc. represents 31.7% of world exports placing Serbia No.1 exporter of this group of products in the world. Serbia is in the top 3 largest providers of frozen fruit to Austria, the Russian Federation and Germany.

Around 90-95% of raspberry production is intended for export, mainly frozen in bulk. This constitutes a huge potential for investors who are considering Serbia as a production facility for their final products with all kinds of different berries such as:

spreads, jams, toppings, ingredients for the ice-cream industry, fruit cubes for yoghurt production, etc.

Fruit Production, 2019	Quantity (Tones)
Plum	358,930
Apple	499,578
Grape	163,516
Raspberry	120,058
Sour cherry	96,965
Pear	54,859
Peach	48,204
Strawberry	19,608

Table 15: 2019 Fruit production in the Republic of Serbia

5.6.2 Vegetable

Ideal climate for vegetable production makes Serbia the main vegetable exporter and supplier of Southeastern Europe. The most popular vegetables produced in Serbia are paprika (pepper), tomato and cabbage, potato.

Vegetable Production, 2019	Quantity (Tones)
Potato	702,086
Cabbage	178,308
Melon and Watermelon	163,483
Paprika	118,256
Tomato	111,639
Cucumber	29,711
Onion	29,588
Peas	25,612

Table 16: 2019 Vegetable production in the Republic of Serbia

6 New logistics chain example – transport of agricultural products in containers

Majority of the Serbian export of cereals and oilseeds are being transported in bulk by inland waterways. This is the case since lower transportation costs have important role in trading with larger quantity of goods.

However, for trading with smaller quantities of goods or shipping of agricultural products with higher value, containerisation can play important role.

Having that in mind, as well as ongoing works on the extension of capacities in the Port of Novi Sad which include setting up of the container terminal, Port Operator DP World Novi Sad has been involved in the logistics operation, transportation of 72 40ft HC containers loaded with lucerne in bales from Serbia to UAE. This case could be considered as a pilot case for the known client, but also as valuable experience for the future set up of the new container liner service on the Danube river.

Figure 2 - Motor vessel Vigilia loaded with containers in the Port of Novi Sad

Agricultural company has the production site in Padinska skela, near Belgrade. Fields are within the 30km range and after the harvest lucerne is brought in the warehouse in bulk. Next step is packing the goods in bales and drying, since it is necessary to reach certain level of humidity for the transportation. Trucks brought containers on the production site where the goods were loaded in containers by the Agricultural company. In the Port of Novi Sad, containers were loaded on the self-propelled vessel and continued voyage to the Port of Constanza, and further to Abu Dhabi within the maritime leg.

It is important to note that transportation was arranged in March 2022, before the War in Ukraine has affected enormous raise of freight rates and fuel prices.

6.1 Geographical coverage and transit time

The land of origin is Serbia and the land of destination is UAE.

The following are points of transshipment with distances between nodes and transport means used:

- field/warehouse - 30km - truck;
- container loading;
- warehouse/port (Novi Sad) - 80km - truck;
- inland waterway vessel loading;
- IWT - port (Novi Sad)/sea port (Constanta) – 1013km – motor vessel;
- inland waterway vessel discharge;
- ocean going vessel loading;
- maritime transport – 4.000 nautical miles – ocean going vessel;
- ocean going vessel discharge;
- port/customer - 100km - truck.

Timeline of logistics operations:

- field/warehouse – 1h;
- warehousing – 1 – 6 months;
- container loading – 3 days;
- warehouse/port (Novi Sad) – 2h;
- inland waterway vessel loading – 1 day;
- IWT - port (Novi Sad)/port (Constanta) – 4 days;
- inland waterway vessel discharge – 4h;
- ocean going vessel loading – 1 day;
- maritime transport – 10 days;
- ocean going vessel discharge – 1 day;
- port/customer – 4h.

6.2 Cargo properties

The cargo is lucerne in bales with average specifics 0,58 to/m3 (wilted).

The cargo is loaded in 40ft HC containers, approximately 23 tons per container.

Figure 3 - Lucerne bales in warehouse

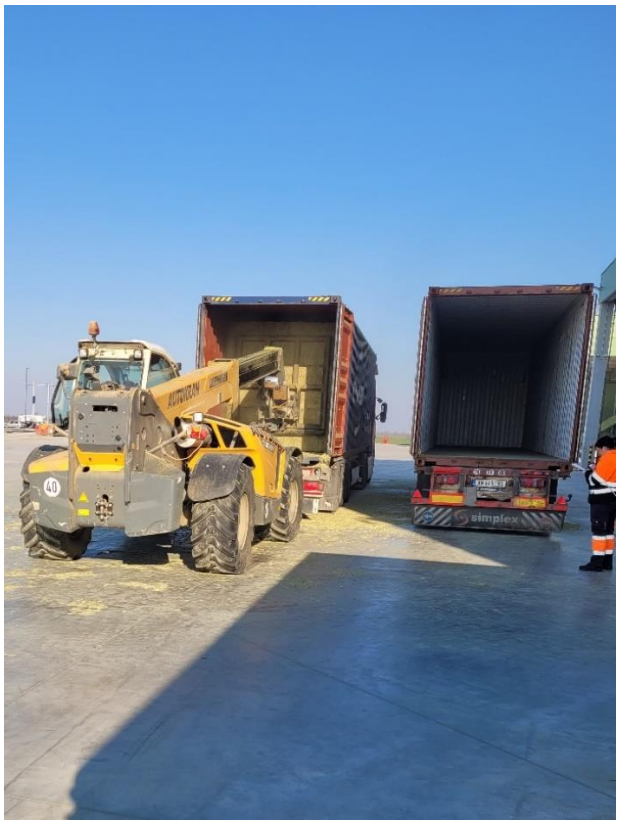

Figure 4 - Lucerne bales loaded in container

6.3 Transport means involved, transport equipment and transshipment equipment used

Transport modes: road transport, inland waterway transport, maritime transport

Transport means involved: trucks, self-propelled vessel, ocean-going vessel

Transport equipment: 40ft HC container

Transshipment equipment: forklifts, reachstackers, portal cranes

On the photo below, Nederland flagged motor vessel Vigilia (LoA 135m; B 11,4m; DWT 3600t) in the Port of Novi Sad. This vessel was used for the inland waterway transport node.

Figure 5 - Motor vessel Vigilia

6.4 Requirements of the cargo for transport, storage, and transshipment

Since the cargo has been loaded in containers, there were no special conditions for transport other then ones at the place of loading/unloading cargo in containers. These warehouses have to be clean, dry and covered.

Transport containers also have to be clean and dry.

6.5 Actors involved in the logistics chain from origin to destination

The following actors and roles were recognized in the logistics chain:

- agricultural production company – harvesting, storing, packing, and loading goods in containers,
- trucking company in the country of origin – road transportation,
- port operator in the country of origin - transshipment,
- inland waterway vessel operator - IWT,
- port operator in the seaport - transshipment,
- sea-going ship operator – maritime transport,
- port operator in the destination seaport – transshipment,
- trucking company at final destination – road transport,
- consumer – receive goods in own warehouse,
- customs agents – custom clearance in the country of origin, transit and country of destination,
- shipping agents – in all ports.

6.6 Information flow along the logistics chain: description of administrative processes and documents handled

Since the overall transport arrangement was coordinated by the external logistics company, most of the work orders and engagement of local agents/operators were handled at the same level.

However, each actor was in charge for own procedures and appropriate documentation, as follows:

- agricultural production company – certificate of origin, goods analysis, cargo invoice,
- trucking company – CMR,
- port operator – transshipment protocols,
- shipper/Carrier/shipping agent – Bill of Lading,
- customs agent – custom documents.

6.7 Costs of logistics chain execution: average costs broken down to main logistics chain legs

Average costs broken down to main logistic chain legs as of March 2022 are:

- Road transport from production site to inland port – €250 per container
- Inland port vessel loading - €45 per 40ft full container
- Inland waterway transport - freight rate €17 per ton
- Seaport 1 vessel loading/unloading – data not available
- Maritime transport – data not available
- Seaport 2 vessel unloading – data not available

- Road transport from seaport 2 to receiver – data not available

6.8 Contractual arrangements relevant for decision on transport mode

Bratislava Agreement and/or CMNI for transport on inland waterways

CMR for road transport

6.9 Shortcomings: infrastructure, superstructure, equipment shortcomings experienced, administrative barriers identified

Infrastructure and superstructure: Unstable navigability of the Danube river due to the low water level, poor condition of the infrastructure in inland port.
Equipment: portal crane in inland port unable to reach 4th row when loading full containers.
Administrative barriers: low level of digitalization.

6.10 Recommendations and lessons learned: infrastructure and equipment need, administrative/authority procedures, measures to improve the efficiency of operations in the entire logistics chain

Infrastructure and equipment requirements: ongoing works in the Port of Novi Sad will improve berthing conditions and container handling. It is expected that noted crane limitation in terms of container handling will be solved soon, otherwise use of the car crane will continue to slow down waterside container handling.

Administrative/authority procedures – digitalization is necessary, especially in cross border procedures in ports.

Use of self-propelled vessel is rapidly shortening transit time. In this case, with the 24h navigation motor vessel Vigilia reached Constanza in downstream sail in less then 4 days.