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DIONYSUS

Integrating Danube Region into Smart & Sustainable Intermodal Transport Chains

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Scope of the document

The development of society and the economy is closely linked to transport, and the significant development of society and the economy in recent decades has also led to the development of transport. At the same time, the increase in the volume of transport has a repercussion on society and the economy, with significant socio-economic-environmental effects, among which both positive and negative effects can be identified. Transport is largely responsible for emissions, the exploitation of non-renewable energy sources, and noise pollution. As a result, in parallel with growth, the principle of sustainable development is becoming more and more important in addition to economic aspects. According to the OECD definition, sustainable transport is a process that does not endanger the health of the population and ecosystems and meets transport needs by using renewable resources at a slower pace than the time needed to regenerate them, and non-renewable resources it is used more slowly than the production rate of the renewable sources that replace them. The sustainable development of transport means at the same time ensuring economic growth, meeting the growing needs of society, and striving to reduce the burden on the environment.

Inland waterway transport can contribute to making transport more sustainable in many ways: in many cases, it is more economical, safer, and more environmentally friendly than road transport. The utilization of European and especially domestic waterways is currently low compared to their potential. There is significant potential in the transport of goods on the Danube, the size and share of inland freight transport could be significantly increased by improving the conditions of navigation.

Output T3.3 of the Dionysus project includes **Strategy & Recommendations for optimizing the waterborne transport of agricultural products in the Danube Region.**
To create recommendations for port transport improvement (which is an output of the activity), Case studies on waterborne transport of agricultural products models will be used.

1 Assessment of agricultural strategy and situation in the respective countries

2.1 Agricultural changes in Hungary

The coronavirus epidemic had no significant direct impact on agricultural emissions, but it was mainly affected by the drought at the beginning of the year, as well as frost damage and various animal diseases (avian influenza, swine fever). However, there were sales difficulties, mainly due to the decline in demand for animal products.

According to preliminary data, agriculture accounted for 4.1% of the gross value added of the national economy, 4.3% of investments, and 4.6% of employment in 2020. The investment volume was lower than in the previous year.

The production volume of the food industry as a whole exceeded the previous year, the restrictions introduced in the spring of 2020 only temporarily reduced production. In the food industry, 3.2% of employees worked in 2020, the proportion has not changed compared to the previous year. Investment in the food industry has increased compared to a year earlier.

According to the preliminary data of the 2020 Agricultural Census, the number of farms has decreased by a third since 2010, while the average size of the cultivated area has increased. The average age of managers has increased, but so has the proportion of people with an agricultural degree.

The combined foreign trade turnover of agriculture and the food industry increased in both directions in 2020 in almost both directions compared to a year earlier. In parallel with the growing turnover, the balance improved, the surplus amounted to HUF 991 billion.

The volume of agricultural output in the European Union in 2020 was lower than in the previous year. Hungary accounted for 2.1% of output, with maize having the highest share of agricultural products.

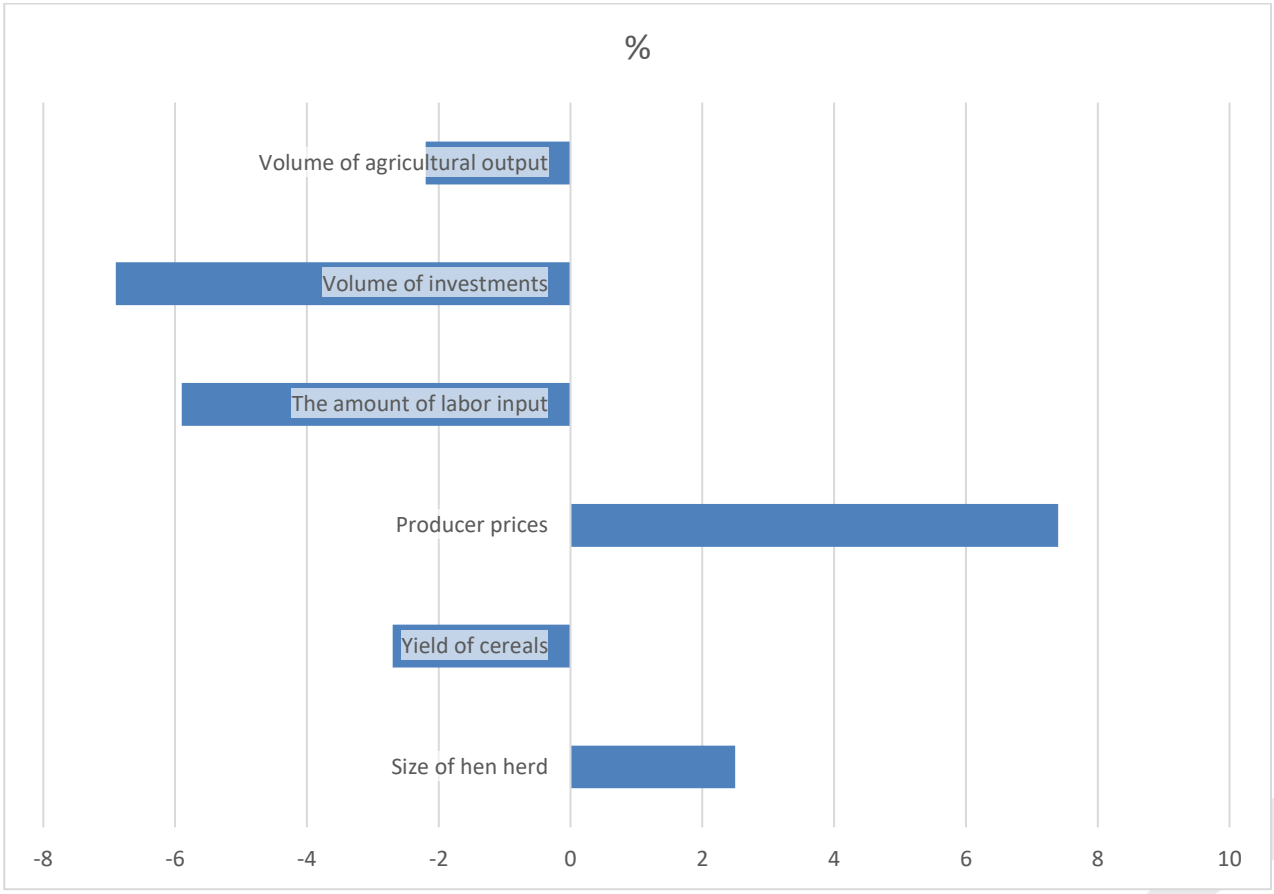
The amount of labor expenditure was 5.9% lower than in the previous year and corresponded to the full-time activity (1,800 hours per year) of 338 thousand people. With this, the declining trend of previous years continued.

Producer prices increased by 7.4% compared to the previous year. Plant products became more expensive by 11% and animal and animal products by 1.2%. The prices of sunflowers, cereals, and fruits have risen significantly.

More was harvested from corn, less from wheat, sunflower, and canola. The number of vegetables did not change overall, but significantly less fruit was grown.

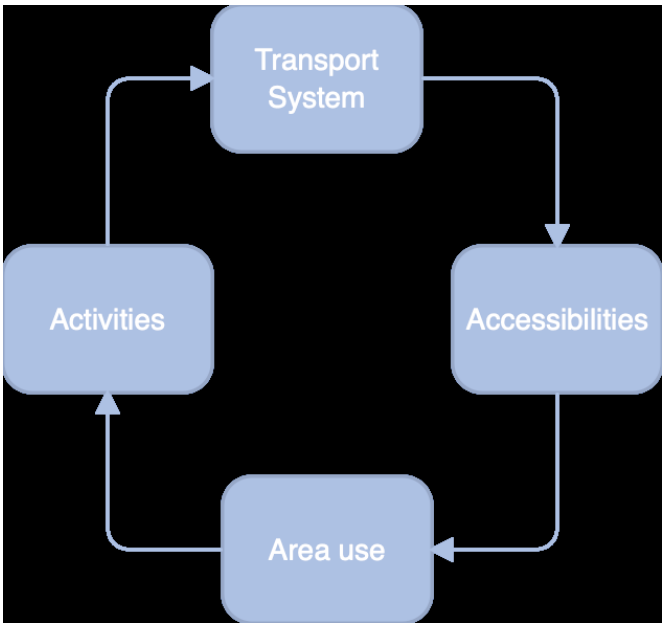
The stock of hens, pigs, and cattle on 1 December was higher than a year earlier.

In 2019, farmland prices continued to rise, but at a slower pace (5.4%). An average of HUF 1.6 million had to be paid for one hectare of arable land.



[1]

1.1.1 Components of transportation modelling examined



Starting at the bottom of the cycle (Area Use), the locations of population and employment determine the origins and destinations of the transportation process in travel models (Activities). Modeling the transportation system allows calculating accessibilities, which describe how well accessible an area or destination (including industrial and agricultural ports) is to all other areas. Accessibility shapes water use, as both industrial personas and agricultural investors search for locations that are – among other location factors – accessible.

1.2 Agricultural changes in Austria

The Austrian Rural Development Program was officially adopted by the EU on December 12, 2014. It outlines the country's priority spending on rural development during the next seven-year period. With the increasing number of contracts for organic farming and other sustainable farming techniques, the Rural Development Program aims to boost the implementation of climate-friendly farming practices and improve the management of natural resources. Further measures include the establishment of farm structures and rural infrastructure. The Common Agricultural Policy's 2nd Pillar aims to promote the development of farm infrastructures and rural areas. The new RD Regulation 2014-2020 sets out a series of goals and targets for the next five years. These include addressing the environment, social and economic priorities. *[1]*

Austria's agricultural land area is almost 80% rural. The country's population is almost 10% in rural areas. This programming period will focus on improving the profitability of farms located in mountain areas. Improvement of these farms' living conditions will be among the challenges that the government will face. In Austria, regions with high greenhouse gas emissions are becoming more problematic. Rural depopulation is also an increasing problem in the country. *[1]*

As part of the Austrian RDP, innovation is an integral part. Its cross-cutting objective enables the implementation of the environment and climate objectives and contributes to the creation of green jobs. In addition, there are measures to support organic farming in Austria. This is mainly due to the country's commitment to improving the management of soil and water quality and implementing more climate-friendly farming techniques. Transfer of knowledge between research and farming will be provided through the training of hundreds of thousands of participants. The links between the various sectors will be reinforced through 652 projects. *[1]*

[1] Source: https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/rural-development/country/austria_en

Target	Measure	Indicative public support		%
P1: Fostering knowledge transfer and innovation in agriculture, forestry and rural areas		**0.00**		
1A Innovation, cooperation, knowledge			**0.00**	
T1: percentage of expenditure under Articles 14, 15 and 35 of Regulation (EU) No 1305/2013 in relation to the total expenditure for the RDP (focus area 1A)	2.85	M01 Knowledge	0.00	
		M02 Advisory services	0.00	
		M16 Cooperation	0.00	
1B Research & innovation			**0.00**	
T2: Total number of cooperation operations supported under the cooperation measure (Article 35 of Regulation (EU) No 1305/2013) (groups, networks/clusters, pilot projects…) (focus area 1B)	645.00	M16 Cooperation	0.00	
1C Lifelong learning and vocational training			**0.00**	
T3: Total number of participants trained under Article 14 of Regulation (EU) No 1305/2013 (focus area 1C)	609,000.00	M01 Knowledge	0.00	
P2: Enhancing farm viability and competitiveness of all types of agriculture in all regions and promoting innovative farm technologies and the sustainable management of forests		**976,665,926.22**		**12.38%**

[2]Source: https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/rural-development/country/austria_en

2A Farm performance		**Total: 2A**	**827,270,777.70**	**10.49%**
T4: percentage of agricultural holdings with RDP support for investments in restructuring or modernisation (focus area 2A)	13.32	M01 Knowledge	30,983,957.00	0.39%
Total investment € (public + private)	3,220,000,000.00	M02 Advisory services	8,327,252.70	0.11%
Nr of holdings supported for investment in agricultural holdings (4.1)	21,500.00	M04 Physical Investment	781,956,895.00	9.91%
Nr of beneficiaries advised (2.1)	69,692.00	M16 Cooperation	6,002,673.00	0.08%
2B New farmers		**Total: 2B**	**149,395,148.52**	**1.89%**
T5: percentage of agricultural holdings with RDP supported business development plan/investments for young farmers (focus area 2B)	4.93	M01 Knowledge	8,986,770.00	0.11%
Nr of beneficiaries (holdings) receiving start up aid young farmers (6.1)	12,200.00	M02 Advisory services	713,764.52	0.01%
Nr of beneficiaries advised (2.1)	4,470.00	M06 Farm and business development	139,437,320.00	1.77%
		M16 Cooperation	257,294.00	0.00%
P3: Promoting food chain organisation, including processing and marketing of agricultural products, animal welfare and risk management in agriculture		**542,935,835.04**		**6.88%**

[2]Source: https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/rural-development/country/austria_en

3A Competitiveness of producers		**Total: 3A**	**540,893,720.53**	**6.86%**
T6: percentage of agricultural holdings receiving support for participating in quality schemes, local markets and short supply circuits, and producer groups/organisations (focus area 3A)	30.63	M01 Knowledge	21,417,030.00	0.27%
Total investment € (public + private)	860,000,000.00	M02 Advisory services	1,189,607.53	0.02%
Nr of operations supported for investment (e.g. in agricultural holdings, in processing and marketing of ag. products) (4.1 and 4.2)	350.00	M03 Quality schemes	133,000,000.00	1.69%
Nr of beneficiaries	38,000.00	M04 Physical Investment	144,248,580.00	1.83%
Nr of holdings supported (3.1)	35,000.00	M14 Animal welfare	228,500,000.00	2.90%
Nr of agricultural holdings participating in cooperation/local promotion among supply chain actors (16.4)	1,000.00	M16 Cooperation	12,538,503.00	0.16%
Nr of beneficiaries advised (2.1)	7,450.00			
3B Risk management		**Total: 3B**	**2,042,114.51**	**0.03%**
M01: Wissenstransfer und Informationsmaßnahmen (Artikel 14)	2,450.00	M01 Knowledge	1,546,899.00	0.02%
Nr of beneficiaries advised (2.1)	1,490.00	M02 Advisory services	237,921.51	0.00%
		M16 Cooperation	257,294.00	0.00%

[2]Source: https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/rural-development/country/austria_en

P4: Restoring, preserving and enhancing ecosystems related to agriculture and forestry		**5,025,235,531.76**		**63.70%**
4A Biodiversity, HNV and landscapes		**Total: P4**	**5,025,235,531.76**	**63.70%**
T8: percentage of forest/other wooded area under management contracts supporting biodiversity (focus area 4A)	0.05	M01 Knowledge	25,563,075.00	0.32%
T9: percentage of agricultural land under management contracts supporting biodiversity and/or landscapes (focus area 4A)	83.15	M02 Advisory services	4,758,430.11	0.06%
4B Water management		M04 Physical Investment	16,566,850.00	0.21%
T10: percentage of agricultural land under management contracts to improve water management (focus area 4B)	75.26	M07 Basic services	197,387,090.00	2.50%
4C Soil management		M08 Forest	105,203,304.00	1.33%
T12: percentage of agricultural land under management contracts to improve soil management and/or prevent soil erosion (focus area 4C)	78.50	M10 Agri-environment-climate	2,057,594,580.65	26.08%
T13: percentage of forestry land under management contracts to improve soil management and/or prevent soil erosion (focus area 4C)	2.91	M11 Organic Farming	784,000,000.00	9.94%
P4 All Focus Areas		M12 NAT 2000 & WFD	6,500,000.00	0.08%
Total investment € (public + private)	23,300,000.00	M13 Areas with natural constraints	1,810,100,000.00	22.95%

[2]Source: https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/rural-development/country/austria_en

Areas under forest environment contracts (15.1)	190.00	M15 Forest-environment	668,800.00	0.01%
Area (ha) under agri-environment-climate (10.1)	1,740,600.00	M16 Cooperation	16,893,402.00	0.21%
Area (ha) - maintainance of organic farming (11.2)	470,000.00			
Area (ha) - NATURA 2000 AG land (12.1)	2,500.00			
Nr of beneficiaries advised (2.1)	29,800.00			
P5: Promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy in agriculture, food and forestry sectors		**238,927,085.11**		**3.03%**
5A Water efficiency		**Total: 5A**	**21,534,720.51**	**0.27%**
T14: percentage of irrigated land switching to more efficient irrigation system (focus area 5A)	6.04	M01 Knowledge	616,915.00	0.01%
Total investment € (public + private)	39,500,000.00	M02 Advisory services	237,921.51	0.00%
Nr of beneficiaries advised (2.1)	1,490.00	M04 Physical Investment	20,122,200.00	0.26%
		M16 Cooperation	557,684.00	0.01%

[2]Source: https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/rural-development/country/austria_en

5B Energy efficiency		**Total: 5B**	**4,903,131.53**	**0.06%**
M01: Wissenstransfer und Informationsmaßnahmen (Artikel 14)	12,250.00	M01 Knowledge	3,155,840.00	0.04%
Nr of beneficiaries advised (2.1)	7,450.00	M02 Advisory services	1,189,607.53	0.02%
		M16 Cooperation	557,684.00	0.01%
5C Renewable energy		**Total: 5C**	**186,538,656.54**	**2.36%**
T16: Total investment in renewable energy production (€) (focus area 5C)	585,278,000.00	M01 Knowledge	8,111,458.00	0.10%
Total investment € (public + private)	515,200,000.00	M02 Advisory services	1,665,450.54	0.02%
Nr of beneficiaries (holdings) receiving start up aid/support for investment in non-agric activities in rural areas (6.2 and 6.4)	1,800.00	M04 Physical Investment	44,082,064.00	0.56%
Nr of beneficiaries advised (2.1)	10,430.00	M06 Farm and business development	21,061,200.00	0.27%
		M07 Basic services	105,700,000.00	1.34%
		M08 Forest	5,360,800.00	0.07%
		M16 Cooperation	557,684.00	0.01%
5D Reducing GHG and NH3		**Total: 5D**	**21,791,881.01**	**0.28%**
T18: percentage of agricultural land under management contracts targeting reduction of GHG and/or ammonia emissions (focus area 5D)	3.36	M01 Knowledge	658,354.00	0.01%

[2]Source: https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/rural-development/country/austria_en

Area (ha) (e.g. green cover, catch crop, reduced fertilisation, extensification…)	96,667.00	M02 Advisory services	475,843.01	0.01%
Nr of beneficiaries advised (2.1)	2,980.00	M10 Agri-environment-climate	20,100,000.00	0.25%
		M16 Cooperation	557,684.00	0.01%
5E Carbon conservation / sequestration		**Total: 5E**	**4,158,695.52**	**0.05%**
M02: Baratung-, Betriebsführungs-, und Vertretungsdienste (Artikel 15)	4,470.00	M01 Knowledge	2,887,247.00	0.04%
Nr of beneficiaries advised (2.1)	4,470.00	M02 Advisory services	713,764.52	0.01%
		M16 Cooperation	557,684.00	0.01%
P6: Promoting social inclusion, poverty reduction and economic development in rural areas		**873,155,721.52**		**11.07%**
6A Diversification, SMEs and job creation		**Total: 6A**	**136,275,083.52**	**1.73%**
T20: Jobs created in supported projects (focus area 6A)	310.00	M01 Knowledge	13,466,718.00	0.17%
Total investment € (public + private)	134,700,000.00	M02 Advisory services	6,001,966.52	0.08%
Nr of beneficiaries (holdings) receiving start up aid/support for investment in non-agric activities in rural areas (6.2 and 6.4)	1,249.00	M06 Farm and business development	45,937,501.00	0.58%
Nr of beneficiaries advised (2.1)	31,209.00	M16 Cooperation	70,868,898.00	0.90%

[2]Source: https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/rural-development/country/austria_en

6B Local development		**Total: 6B**	**682,556,380.00**	**8.65%**
T21: percentage of rural population covered by local development strategies (focus area 6B)	74.88	M07 Basic services	434,107,601.00	5.50%
T22: percentage of rural population benefiting from improved services/infrastructures (focus area 6B)	54.46	M16 Cooperation	257,294.00	0.00%
T23: Jobs created in supported projects (Leader) (focus area 6B)	490.00	M19 LEADER and CLLD	248,191,485.00	3.15%
Population benefiting from improved services/infrastructures (7.1; 7.2; 7.4; 7.5.;7.6; 7.7)	3,000,000.00			
Population covered by LAG	4,125,000.00			
Number of LAGs selected	75.00			
6C ICT		**Total: 6C**	**54,324,258.00**	**0.69%**
T24: percentage of rural population benefiting from new or improved services/infrastructures (ICT) (focus area 6C)	34.49	M01 Knowledge	1,124,258.00	0.01%
		M07 Basic services	53,200,000.00	0.67%
M20 TA		**231,393,366.38**		**2.93%**
			231,393,366.38	**2.93%**
Total public expenditure		**7,888,313,466.03**		**100.00%**

[2]Source: https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/rural-development/country/austria_en

[3]Source: https://www.awe.gov.au/sites/default/files/documents/ag-2030.pdf / ISBN 978-1-76003-414-6

[4]Source: https://www.awe.gov.au/sites/default/files/documents/ag-2030.pdf

1.3 Agricultural changes in Slovakia

The development of Slovak agriculture started in 1990, when it had to adapt to the conditions of the market economy. This process was carried out in order to adapt to the changes in the consumption habits of the population. The level of agricultural production has stabilized since the year 1995. In the years 2000 and 2003, due to the extremely dry weather, total production was affected by the economic situation and the natural disasters. In 2004, the unfavorable weather conditions were more favorable for farming. Due to the implementation of the EU's policies, we expect a profit in agriculture in 2004 of approximately SKK 2.9 billion. *[5]*

The increasing competitiveness of agriculture will contribute to the growth of the other sectors of the Slovak economy. The employment in the agriculture, forestry, fishing and hunting industry decreased sharply over the years 2000 and 2003, and it represented 4.7% of the economically active population in 2003. This decline in employment has led to the growth in the labor productivity. The arable land declined in recent years. It was possible to observe a change in the form of meadows and pastures. *[5]*

Arable land is used for cereals, industrial crops, and fodders. It accounts for 48% of the total production of cereals and 16% of the total production of industrial crops. The majority of land is used by these legal persons, while cooperatives cultivate it on a small percentage of it. The remaining land is used by independent farmers. The number of independent farmers has increased during the first years of the transition. However, the concentration of land used by these farms has remained the same. *[5]*

Many people who had their lands taken away from them used this opportunity to establish their own farms. In total, these lands have been returned to their owners. As for re-grads altitude, the territory of Slovakia has a total area of 49 036 km2. During the height of 800 meters, 14 % of the territory is at a height of 1,500 meters. For instance, the region of Hurbanovo in southern Slovakia has a long-term norm of 9.9 degrees Celsius with annual precipitation of 549 mm. In contrast, the region of the Orava in the north of the country has a long-term norm of 3.3 degrees Celsius with annual precipitation of 781 mm. *[5]*

The lowest lying area of the Slovak Republic is limited by the amount of energy input and the water regime conditions. Higher-lying areas are connected to less fertile soil. The Eastern Carpathian zone can be considered an area with a high potential for production of various crops. It has a total area of arable land of about 51 percent. The most common soil type is saturated Eutric Cambisols. Other soil types are Fluvisols, Brown Earths, Dystric Cambisols, and Molic Fluvisols. *[5]*

The variety of natural conditions that affect the production of potatoes and other crops in Slovakia is linked to the instability of harvesting seasons and the differences in the harvests between years and regions. The biggest difference between the last 20 years and the year-to-year change was 48 %. The decisive crop is winter wheat, which is grown on an area of 350 to

660 thousand ha. The second crop, spring barley, is produced on an area of 200 thousand ha. The third most important crop in terms of area is maize, which accounts for approximately 14% of the total crop area in Slovakia. The average size of this crop is about 780 ha. *[5]*

The main oil crop grown in Slovakia is oilseed rape, which is grown on an area of about 100 thousand ha. Other oil crops, such as soya, have developed and are mainly planted in Vchodoslovensk. In the case of sugar beet, the area has remained stable at 32 thousand ha over the last years. The area of potatoes has also decreased by a significant amount Peas are mainly represented by pods, while the bean type is also represented by beans. In terms of area, they are the main component of the crop. *[5]*

Aside from the larger rivers, montane and mountain pastures are also used for the pasturing of cattle. Fruit-growing and hop-growing are not included in the area's plant production. In total, the area of the permanent covers of this field includes about 30 thousand ha of land, which is about 12% of the area of agricultural land. Viticulture is the most important aspect of this field, with about 18 thousand ha of vineyards. The best-known regions in Slovakia are the Small-Carpathians and the Hont regions. Also, fruit-growing is very important for the country's economy. *[5]*

Animal breeding is an important aspect of the Slovak economy. It contributes to the country's gross agricultural production and is regarded as an important function of the Slovak culture. The history of beef cattle and sheep breeding in Slovakia dates back to the time when the country was a major player in the international market. The conditions for the production of these animals were mainly influenced by the biomass of grass. *[5]*

Beef cattle and pigs are now becoming more economical breeds. This is mainly due to the increasing number of dairy cows. Although many farms are dominated by a few individuals, the number of animals bred on large farms is still dominant. In contrast, in the case of beef cattle, the majority of the animals are kept on farms with a concentration of fewer than 50 heads. In contrast, in the case of pigs, about 35% of the animals are owned by individual farmers. *[5]*

The restructuring of animal production took place during the years 1993 to 2003. This restructuring has resulted in a decrease in the total number of units of farm animals. After the year 1993, the efficiency of farm animal types gradually increased. Milk cow breeding is one of the fastest-growing sectors, where the average year-to-year increase is about 200 kg. The evolution of the beef cattle breeding program has been influenced by the introduction of Holsteinisation. This has resulted in a shift in the utility type of the milk cow. Crossbreeds with pedigree Holstein cows and those with Slovak piebald breed and their crossbreeds form the majority of the milk cow population. *[5]*

Currently, we have 29 000 nursing cows in our system, which are mainly crossbreeds of domestic breeds with specialized meat cattle. The sheep population is undergoing a major change in its utility focus, which is mainly on milk or meat production. White high-grade and landrace are the decisive traits of maternal breeds. The crossbreeding of these two breeds leads to the development of effective hybridization. *[5]*

The development of organic agriculture in Slovakia began in 1991. The concept of ecological economy was also defined in this period. Over 30 farms have entered the system and are mainly agricultural cooperatives. After the conversion, 31 entities were permitted to label organic production as bio. This fundamental document established the basic direction of ecological farming in the Slovak Republic until the year 2010. It also adopted a set of measures aimed at its realization. *[5]*

In 1998, the State of Organic Agriculture was established. The area of cultivated land within this framework is about 65 388 ha. There are 131 organic farms, of which 65 are registered, and 59 are in conversion. The highest density of organic farms is in the mountain and sub-montane regions. *[5]*

Cereals, and other vegetables are grown the most. The cultivation of aromatic plants and medicinal plants is also successful. A large part of the plant production is exported to other countries. In animal production, there are various sectors that focus on the breeding of goats and sheep, as well as the production of cheese and other dairy products. This is carried out in compliance with the EC Regulation 2092. *[5]*

The Slovak food processing industry has always been dynamically developing. Its main objective was to improve its efficiency and competitiveness, while at the same time decreasing excess capacity. This industry is currently entirely in the private sphere. *[5]*

Currently, the food processing industry employs around 41.1 thousand people in the SR. This industry contributes to the industrial production of the country at a level of 13 %. In 2003, the most significant increase was recorded in the investments in starch, meat, sugar-making and winemaking. Investments in the environment by the food processing industry rose significantly in the past year. The most notable increase was in the dairy, meat, and poultry industries. In 2003, the investment in the food processing industry was mainly carried out by domestic and foreign funds. The majority of these funds came from the own funds and domestic bank credits. The other funds came from the support of the SR. *[5]*

This process involves assessing the safety and welfare of the various components of the food chain, from farm to fork. The Ministry of Agriculture carries out long-term monitoring of the food chain for the presence of harmful substances. This includes the retail chain and agricultural farms. It also performs other tasks related to the control of quality and health of the food. The control over the activities related to this field is organized by a control organization. The development of laboratory facilities of the resort secures the objectiveness and reliability of the results of the tests. The resort's goal is to safeguard the interests of consumers and prevent the harmful use of harmful foodstuffs. Food and fodder enterprises

are also responsible for the safety of their products. The operators of these establishments have been trained to follow proper hygiene procedures and traceability. *[5]*

Quality Policy is an indicator of the quality of the product and its origin. It is also an asset for producers and consumers. Since 2001, the Ministry of Agriculture has been informing the entrepreneurial public about the various options that are available to them. Rural communities may still be preserved, as producers will be able to live in their own regions. Products with protected indications of origin or a specific geographic indication are guaranteed to be of high quality and have special conditions. *[5]*

The Quality mark is a symbol that denotes the quality of a product that was produced according to the requirements of national and international regulations. The marking of agricultural products and foodstuffs is carried out according to the procedures laid out by foodstuff control bodies. In Slovakia, the rural region is defined as an administrative unit that is composed of several rural villages and towns with a population density of less than 110 inhabitants per km2. The criteria for classification of rural settlements and urban settlements are based on the population density per km2 and the boundary of 150 inhabitants. Significantly rural regions have a higher share of rural dwellers than urban dwellers. *[5]*

The basic objective of this document is to ensure that the rural population has a standard of living and adequate job opportunities. This can be achieved through the various economic activities that are aimed at developing a healthy environment and sustaining a productive and resilient rural population. The basis for the development of the strategy for rural development was the Agricultural and Rural Development Plan, which was presented in the Pre-Accession ProgramME. Improvement in the agricultural production sector, which includes the food-processing industry. Diversification of rural areas for investments that are not generating substantial revenue. Over-funded projects are referred to the SR through the National Development Plan, which was adopted in 2004. *[5]*

The global objective is to ensure that the Slovak Republic achieves a level of gross domestic product (GDP) growth that is at least 50% of the average level in the EU member states by the year 2006. The Slovak Republic's priority is the implementation of the Sectoral Operational Program for the Improvement of the Quality of Life of the Rural Population. The SOPA-RD is a programming document that draws funds from the EAGGF and FIFG guidance sections. It is aimed at supporting the development of rural areas in the whole Slovak Republic. Investments in agriculture and forestry support rural development. Improvement of processing and marketing of farm products is also promoted. Supporting the adaptation and growth of rural areas. *[5]*

The Slovak Republic's Rural Development Plan (RDP) was drafted in 2004-2006. It is a programming document that outlines the country's rural development goals and measures for implementation of these goals. The plan is carried out according with the geographical allocation and its main objective is to improve the efficiency of the rural population. The wood matter distribution in Slovak forests is closely linked to the territory's macro-relief. The eastern and western lowlands are wooded with broadleaved trees, while the central and

northern regions are dominated by coniferous trees. The requirements for a variety of forests and a steady supply of wood matter are promoted in order to maintain the ecological stability of the forests. Nine national parks have been established in Slovakia. These parks encompass the territory of the country: TANAP, Pieninsk NP, Nzke Tatry NP, Slovensk raj NP, NP Mal Fatra, and Slovensk kras. This process is promoted through the use of more natural methods, which include the use of mixed stands and selective economic methods. Protection of young forest stands, forest restoration, and the clearing of forests are some of the activities that are carried out during the cultivation of forests. *[5]*

The protection of young forest stands is an important aspect of cultivation activity. This area was protected in the year 2003 with measures designed to prevent weeds and protect the cultures. Monitoring of stand hygiene is a permanent preventive measure that can be carried out in juvenescent and mature stands. It includes the processing of dying and dead trees. The amount of timber logged in the forests of the SR has significantly fluctuated since 1980. In 1980, it reached a level of more than 5.8 mil m3. In the following years, the amount steadily increased. Cultivation of forests is managed by a number of state-owned companies and institutions, which are mainly responsible for the management of forests. There are also forests owned by individuals and cooperatives, which are managed by state-owned companies or institutions. There are more than 1778 hunting grounds in Slovakia. The hunting grounds are divided into 16 categories: independent game reserves, 14 peasantries, and 3 fallow deer. The spring stocks of these game species have increased in comparison with the previous years. The reintroduction of the bison to Slovakia is considered one of the most important achievements in the field of animal protection. In 1957, a breeding game preserve was established near Topoianky. This animal is currently protected by law. *[5]*

[5]Source: https://www.mpsr.sk/en/index.php?navID=30

1.4 Agricultural changes in Croatia

Croatia has about 1.3 million hectares of agricultural land. The country is self-sufficient in most of its agricultural products.

Although agriculture only contributes 4 percent to the country's gross domestic product, its importance is higher than its share indicates. In order to sustain its growth, Croatia's government should focus on restructuring policies. According to the Land Registry, only 63.1 percent of all farms in Croatia have fewer than three hectares of land. The average commercial farm size is about 8.5 hectares. The value of agricultural products imports from the US was just over $22 million in 2018. Most of these products are used for animal feed and various other purposes. *[6]*

The Croatian market for food products imported from European suppliers is dominated by European companies. The high-value food items segment is the largest contributor to the market. *[6] [7]*

	2016	**2017**	**2018**	**2019 (Estimated)**
Total Local Production	n/a	n/a	n/a	n/a
Total Exports	2,801,446	2,889,876	3,237,110	3,200,000
Total Imports	3,179,848	3,507,257	3,862,208	3,800,000
Imports from the US	20,119	19,123	22,078	20,000
Total Market Size	n/a	n/a	n/a	n/a
Exchange Rates	6.80	6.62	6.28	6.30

USD thousands (*total market size = (total local production + imports) - exports*)

Miscellaneous Consumer Foods

	2016	2017	2018	2019 (Estimated)
Local Production	800,000	800,000	800,000	800,000
Exports	898,063	975,875	1,121,733	1,000,000
Imports	1,903,959	2,136,504	2,360,562	2,300,000
Imports from the US	12,508	11,706	11,547	12,000
Total Market Size	1,805,896	1,960,629	2,038,829	2,100,000

USD thousands *(total market size = (total local production + imports) - exports)*

Local production is unofficial estimate.

Fish and Seafood

	2016	2017	2018 (Estimated)	2019 (Estimated)
Local Production	185,000	185,000	185,000	185,000
Exports	195,911	209,460	239,261	200,000
Imports	136,120	156,918	179,606	165,000
Imports from the US	1,672	435	27	100
Total Market Size	125,209	132,458	125,345	150,000

USD thousands *(total market size = (total local production + imports) - exports)*

Local production is unofficial estimate.

Soybeans and Soybean Meal

	2016	2017	2018	2019 (Estimated)
Local Production	**80,000**	**85,000**	**85,000**	**80,000**
Exports	**77,985**	**110,046**	**65,183**	**70,000**
Imports	**72,502**	**83,465**	**86,257**	**85,000**
Imports from the US	**0**	**0**	**0**	**0**
Total Market Size	**74,517**	**58,419**	**106,074**	**95,000**

USD thousands *(total market size = (total local production + imports) - exports)*

Local production is unofficial estimate.

[18]Source: Bachev, H. 2010. Governance of Agrarian Sustainability. Nova Science Publishers, ISBN: 1608768880, 9781608768882, 116 pp.

In 2008, Croatia's total imports of Consumer Food were valued at over $2 billion. The steady growth in the number of supermarkets and the increasing demand for food in urban areas have helped boost the country's consumer food industry. The value of US' fruits and vegetables exports to Croatia in 2018 was only valued at $0.7 million due to lower prices offered by other suppliers. These products are not registered as imports in the US. Due to its lack of self-sufficient fruit production, Croatia is prone to importing exotic fruits. In 2018, its pork imports reached $258 million. *[6] [7] [8]*

Although the ban on hormone-treated beef has been in place since 2008, imports from the US have still grown significantly. This is expected to change as the country adopts EU standards in 2019. Although the country does not have a domestic pet food industry, it imports a large portion of its consumption. This is an indicator of potential sales opportunities for US-made products in Croatia. Premium pet food is a good opportunity for US exporters. In 2018, over $35 million worth of wine was imported from Croatia. Wine regions in Zagreb offer great opportunities for US winemakers. *[9]*

Croatia imported tree nuts worth $35 million, which included $6 million from the US. Its demand for these products is still strong due to its domestic production. Croatia's annual fish and seafood imports are valued at over $155 million. The country mainly imports fish and seafood from Spain and Italy. The price and credit availability are the key factors that determine the sourcing of soybeans. Currently, only GMO-free beans are acceptable for human consumption in Croatia. *[9]*

The demand for food products such as vegetables and fish will continue to rise in Croatia. Its standard of living is also improving, and it is becoming a more tourist destination. This will help boost the country's fish breeding industry. *[10]*

[6]Source: https://hr.usembassy.gov/embassy/zagreb/sections-offices/
[7]Source: https://www.privacyshield.gov/article?id=Croatia-Agricultural-Sector
[8]Source: https://www.mps.hr
[9]Source: http://www.zdravlje.hr
[10]Source: http://www.zv.hr/en

1.5 Agricultural changes in Serbia

Over the past decade, various policy frameworks and implementation mechanisms were changed. Despite this, the agricultural policy of Serbia has made significant progress. *[11]*

The most important step in the implementation of the policy reforms was the start of the negotiations on Serbia's EU accession. This process accelerated the institutional and policy reforms. The agricultural policy is also regulated through the various documents that have been adopted and established since 2013. The strategic framework for agriculture and rural development was adopted in 2014. This framework provides a more stable and transparent framework for implementing policies. The biggest threat to the implementation of the strategy is the absence of a medium-term programming document and unstable system of financing. *[11]*

This paper aims to analyze the various documents related to the agricultural policy framework in the country and to determine the measures that will be implemented in the future. It also reviews the various budgetary transfers and funds in the recent years and highlights the changes in the eligibility criteria for various commodities. The main objective of this study was to analyze the various legislative acts and the various policies and programs that were implemented in Serbia in 2005. The data on the measures and the policy pillars were collected through the Agriculture Policy Module (APM) classification scheme. *[12]*

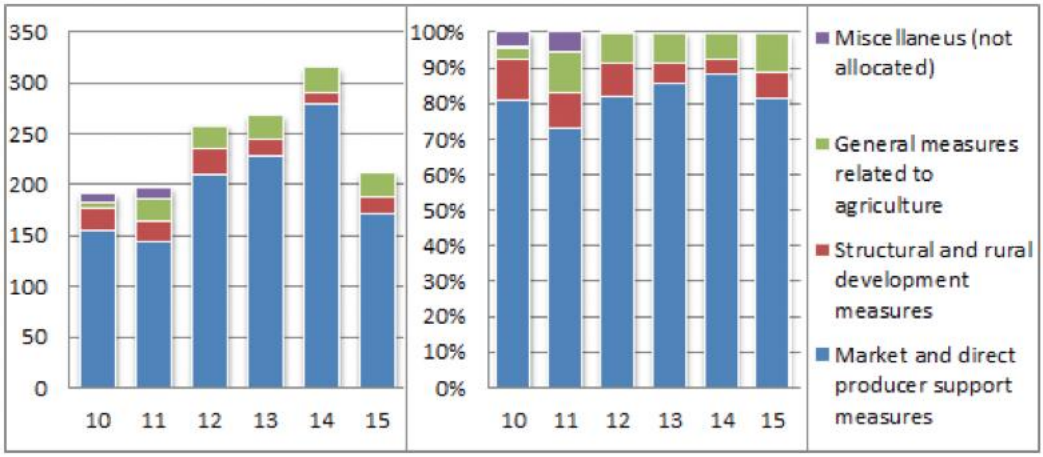
The rapid pace of EU integration has produced numerous policy and institutional changes in Serbia. This process has contributed to the improvement of Serbian agriculture's performance. The Serbian government has updated the agricultural policy framework and introduced a new model of implementing it. This document is based on the two main legislative acts that were adopted in 2010. The Law on Agriculture and Rural Development was adopted in 2014. It regulates the various aspects of implementing the policy framework but does not deal with the establishment and adoption of the policy frame. *[12]*

The 2014 strategy for agriculture and rural Development was adopted. However, the program for rural development has not been implemented. The Law on rural development and agriculture was replaced with a new legislation that aims to promote rural development and farming. Instead of a multi-year program, the implementation of agricultural policies is carried out on the basis of annual regulations and support measures are also implemented on the basis of rules and regulations. The number of incentives that can be allocated for the production of milk depends on the quality of the milk and the quantity of milk that is produced per cow during the lactation period. *[13]*

The absence of a comprehensive evaluation and monitoring system on agricultural policies can prevent the effectiveness of government programs. This is one of the weakest links that

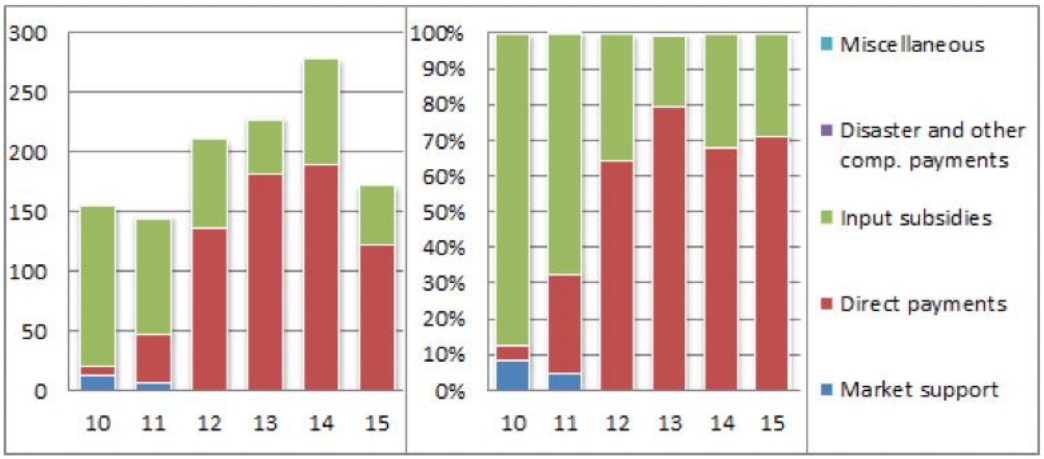
impedes the implementation of agricultural policies. The budget expenditures to support agriculture in 2010 to 2015 varied from 2010 to 2014. The share of agriculture in the total budget remained below 5%. Throughout the 2010-2015 period, the share of agriculture in the overall budget was lower than the GVA's contribution. This shows that the country is on average among developing nations. *[14]*

The total budget transfers to agriculture in 2015 decreased by 33% compared to the previous year, with most of the cuts being made for direct producer support measures. The increase in funding for rural development support was mainly caused by the increase in the number of on-farm investments in competitiveness. *[15]*



[18]Source: Bachev, H. 2010. Governance of Agrarian Sustainability. Nova Science Publishers, ISBN: 1608768880, 9781608768882, 116 pp.

Most of the first pillar funds go towards direct producer support measures. In 2015, the funds allocated for these measures decreased compared to 2014. *[15] [16]*



The reduction in the budget for rural development and agriculture is the result of the decline in the area covered by the direct payment. The direct payments per animal head are implemented in 2010 and 2011. They are also applicable to the following types of animals: breeding animals (sheep and goats, pigs and cows), fattening animals (cattle and pigs), and various types of parental poultry. The main trend in the amount of input subsidies was the concentration of support on mineral fertilizers and diesel fuel. In 2015, the maximum amount of support per hectare was lowered. *[16]*

Direct support between the producer and the government for variable inputs has been reduced to a maximum of 100 EUR/ha for areas up to 20 ha. This level was reduced to 50 EUR/ha in 2015 for areas over 20 ha. Aside from the fuel and mineral fertilizers, various insurance subsidies were also implemented during the period. In 2015, the Law on incentives did not apply. The implementation of agricultural policies has been more consistent in the past due to the establishment of a legal framework. However, the implementation of various measures has been slow and lacks transparency. Some of the measures that were envisaged by the Law on Incentives in Agriculture and Rural Development have not been funded. *[16] [17]*

The main flaw of Serbia's agricultural policy is the unstable and unpredictable budget framework. This policy mechanism distributes the funds allocated for various support measures based on the needs of the whole economy instead of on a predetermined formula. This method leads to a lower percentage of realized funds on an annual basis. The analysis of direct support payments confirmed the existence of policy deficits due to the lack of a monitoring system and benchmarks. The existing system is sufficient to ensure the continuity of support envisaged in the Law on incentives. *[16] [17]*

Non-compliance of various regulatory and agricultural policies can result in the government resorting to other instruments beyond the provisions of the Law. In response to the failure of the market, the government resorted to various measures beyond the law. Serbia has made some progress in optimizing its programs and administrative structures, but there is still a need for more effective implementation of these policies. *[16] [17]*

The annual budget and the multi-annual program are not defined. The policy-making process remains unclear and lacks a standardized evaluation system. The budget and the annual regulations are not defined, and the financial envelopes are not. Various legal instruments and solutions were also used to overcome these limitations. The reforms of the agricultural policy and institutional structures are on the agenda of the Serbian Ministry of agriculture for years. Despite the commitment to these changes, the accreditation of the Paying Agency for the IPARD funds is not yet completed, which means that the funds will not be distributed within the stipulated time frame. *[16] [17]*

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[11] Source: APM Database - Serbia (2016). Agricultural Policy Measures Database compiled for Serbia under the SWG Projects (unpublished data).

[12] Source: Bogdanov, N. and Papić, R. (2016). Agricultural statistics database compiled for Serbia under the SWG Projects. Available at: http://app.seerural.org/agricultural-statistics/.

[13] Source: Bogdanov, N. (2016). Serbia: Agricultural Policy Brief in: Tina Volk et al. (ed.), Analysis of the agricultural and rural development policies of the Western Balkan countries. JRC Technical Report EUR 27898, Joint Research Centre, European Commission, Pp: 108-127.

[14] Source: Bogdanov, N. and Rodić, V. (2014). Agriculture and agricultural policy in Serbia, in Volk et al. (ed.) (2014), Agricultural Policy and European Integration in Southeastern Europe, FAO, Budapest, Pp 153–166

[15] Source: Bogdanov, N. and Božić, D. (2010). Review of agriculture and agricultural policy in Serbia, in Volk T. (ed.) (2010), Agriculture in the Western Balkan Countries, IAMO, Studies on the agricultural and food sector in Central and Eastern Europe, Halle, Pp 189–217

[16] Source: Bogdanov, N., Stevović, M. and R. Papić (2016). Agricultural policy of Serbia – challenges and current solution, in Stojanovic, Bogdanov, Sevarlic (ed.) (2016) Status and perspectives of agribusiness and rural areas in Serbia, NDES, Faculty of Economy University of Belgrade, Pp 114-136

[17] Source: Rednak et al. (2013). A tool for uniform classification and analysis of budgetary support to agriculture for the EU accession countries. Agricultural Economic Review, Vol. 14, Pp 76–96

1.6 Agricultural changes in Bulgaria

Despite the large academic and practical importance of the topic, empirical studies on the role of governing structures in agriculture have been scarce in East Europe. This chapter presents an interdisciplinary framework for studying the impact of various forms of governance on the sustainability of agriculture. The main factors that affect the profitability and social, ecological, and managerial aspects of Bulgarian farms are analyzed. The study aims to identify the dominant modes governing various types of farms in the country. *[18] [19] [20] [21]*

Different kinds of agricultural producers have different characteristics and different modes of governance. They operate in different ways and different markets. Some of these include private, collective, and hybrid modes. Research on the relations between the governing structures and agrarian sustainability is ongoing. This field of study aims to analyze the various governing modes that are used by farms in different types of operation. *[18] [19] [20] [21]*

The goals of sustainable development are often achieved by the different systems of governance in different countries. For instance, the development of the agrarian sector is considered one of the most important factors in Bulgaria's overall development. Although there are few empirical studies on the impact of dominant governing structures in agriculture on the sustainability of the food supply in Bulgaria, this paper argues that the various modes of governance in the country have an impact on the sustainability of the agricultural sector. *[18] [19] [20] [21]*

The main findings of this study reveal the various governing modes of Bulgarian farms and their impacts on the environment and agrarian sustainability. The goal of this study was to identify the various links between the various governing forms utilized by Bulgarian farms and the country's level of agrarian sustainability. *[22] [23]*

This study focused on the various aspects of the operations of different kinds of agricultural producers in different locations and sizes. It found that the varying characteristics of these producers affected the level of their agrarian sustainability. The study also revealed that the various factors that contribute to the improvement of agrarian governance can be categorized as individual factors and modes. Various factors such as soil conditions, climate, and institutional environment can affect the behavior and sustainability of agents. This is therefore important to analyze and develop strategies that can help minimize these impacts. The complexity of the system of governance and its effects on the various aspects of agrarian sustainability are some of the factors that are studied in order to develop effective assessments and studies on these issues. *[24] [25] [26] [27]*

This paper aims to provide a comprehensive analysis of the various facets of the agrarian governance system and its relation to the sustainable development. It also reviews the various modes of governance at higher levels and their impacts on the system's overall sustainability. The goal is to improve the precision of estimates and the consistency of data collected by farm managers regarding the activities of non-farming agents. This can be done through the participation of various interested parties, including the farm managers, academicians, and local and central authorities. *[24] [25] [26] [27]*

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[18]Source: Bachev, H. 2010. Governance of Agrarian Sustainability. Nova Science Publishers, ISBN: 1608768880, 9781608768882, 116 pp.

[19]Source: Bachev, H. 2010. Management of Farm Contracts and Competitiveness. VDM Verlag Dr. Muller. ISBN-10: 3639301552, 176 pp.

[20]Source: Bachev, H. 2016. Defining and Assessing the Governance of Agrarian Sustainability. Journal of Advanced Research in Law and Economics, Volume VII, 4(18): 797-816. DOI: 10.14505/jarle.v7.4(18).12

[21]Source: Bachev, H., Ivanov, B., Toteva, D., Sokolova, E. 2016. Agrarian Sustainability and its Governance – Understanding, Evaluation, Improvement. Journal of Environmental Management and Tourism, Volume VII, 4(16): 639-663. DOI: https://doi.org/10.14505//jemt.v7.4(16).11

[22]Source: Furuboth, E.G., and Richter, R. 1998. Institutions and Economic Theory: The Contribution of the New
[6] Georgiev, M. 2010. "Rent Seeking" in Agricultural Contracts in the Country. Trakia Journal of Sciences. 8(3): 230-233.

[23]Source: North, D.C. 1990. Institutions, Institutional Change and Economic Performance. Cambridge University Press, ISBN: 0521397340, 9780521397346, 152 pp.

[24]Source: Raman, S. 2006. Agricultural Sustainability. Principles, Processes and Prospect. The Haworth Press Inc. New York, ISBN-13: 978-1-56022-310-8, 475 pp.

[25]Source: Sauvenier, X., Valekx, J., Van Cauwenbergh, N., Bachev, H. et al. 2005. Framework for Assessing Sustainability Levels in Belgium Agricultural Systems – SAFE. Belgium Science Policy, Brussels, 23 pp., Available at: https://www.belspo.be/belspo/organisation/Publ/pub_ostc/CPgen/rappCP28leaflet_en.pdf

[26]Source: Terziev, D., Radeva, D. 2016. Studying the New Agriculture. 2nd International Conference on Development and Economics (I.CO.D. ECON). Thessaloniki, Greece,

[27]Source: Williamson, O.E. 1996. The Mechanisms of Governance. Oxford University Press. ISBN: 0199879567, 9780199879564, 448 pp.

Institutions	Private modes	Market Modes	Public modes
Post-communist transition(1989-2000г.)			
Not well defined eco-rights and rights on resource rights, bad enforcement; Lack of concept for sustainability	Provisional lease in contracts for farmland and material assets; Unregistered farms; Firms; Cooperative farms; Consumers cooperatives; Interlinked and barter trade; Credit cooperatives	Spotlight trade with free-market prices; Direct marketing; Trade on wholesale and terminal markets; Commodity exchange trade; Trade with informal brands, origins, and ecosystem services; Free (monopoly) agricultural water pricing; Clientalisation	State and cooperative farms; Organization under privatization, liquidation and reorganization; State regulation of wholesale and retail prices; Export licenses and quotas; Import tariffs and duties; State crediting of working capital for grain producers; System of agro-market information; Outdated system of social, economic, and eco-regulations, monitoring and information; Foreign and international programs and assistance projects; State reserve
Pre-accession to EU(2001-2006г.)			
Better defined and badly enforced rights on agrarian and eco-resources, and contracts; Harmonization with EU legislation and standards	Unregistered farms; Firms; Cooperative farms; Specialized and multipurpose cooperatives; Long-term contracts for marketing against innovation, credit, inputs etc. supply; Water User Associations; Vertically integrated modes; Professional associations; Water Users Associations; Credit Cooperatives	Direct marketing; Wholesale, terminal and exchange markets trades; Trade with formal brands, origins, organic products, and ecosystem services; Free (monopoly) agricultural water pricing	Product subsidies; Preferential credit for investment projects; Preferential short-term crediting; Special Accession Program for Agrarian and Rural Development; Regional programs for agrarian development; Cross-compliance requirement; Quality and eco-regulations, standards, and control agencies; Regulations for organic farming; Agricultural Advisory Service; Harmonization of standards for quality, safety, ecology etc. with EU; Foreign and international programs and assistance projects; State reserve

EU membership (Since January 1, 2007)			
Well-defined rights, and	Unregistered farms; Firms; Cooperative	Direct marketing; Wholesale,	Implementation of EU regulations and standards;

better enforcement; EU Community Acquis; Collective institutions; Monitoring and sanctions from EU	farms; Specialized and multipurpose cooperatives; Long-term inputs supply and marketing contracts; NGOs; of behavior; Diversification into processing, services and marketing; Credit cooperatives; Water User Associations; Professional producers organizations; Vertically integrated modes; Eco-associations, Eco and other labels; Protected origins and brands	terminal and exchange markets trades; Trade with formal brands, origins, organic products, and ecosystem services; E-commerce with agrarian products; Free (monopoly) agricultural water pricing; Insurance against natural disasters	EU Operational Programs; National programs for eco-management (lands, waters, waste, emissions, etc.); NPARD; Direct EU payments; National tops-ups; Export subsidies; Milk quotas; Advisory Service; Regional programs for agrarian development; System of social, economic and eco-monitoring, analysis and control; Protected zones (NATURA); Compensations for natural disasters; Mandatory training for farmers; Income and garbage taxation; Support to trans-border initiatives; Social security and assistance system; State companies for research, maintenance of eco-systems, etc.

[28]

[28] Source: https://ec.europa.eu/info/sites/default/files/food-farming-fisheries/key_policies/documents/rdp-factsheet-romania_en.pd

This paragraph aims to analyze the various forms of governance that are integral to the management of agrarian sustainability. It is done for the study of the system and its various aspects. The analysis involves the study of economic, social, and ecological factors. These are governance frameworks that are focused on addressing the various aspects of ecological and economic sustainability. They are characterized by several key components, such as the management of water, air, soil, and climate. [28]

A particular mode or process should only be assessed if it has significant impact on various aspects of sustainable development. In case of multiple forms of governance, it should be evaluated as a package. The concept of agrarian governance is analyzed across various levels. The various forms of this system of governance are to be studied and refined. Some dominant forms may not be applicable to farms of a particular type. At certain levels of farm and region, there may be no formal structure or system of governance for agrarian sustainability. This is because farm organizations and the general management system of a sector or country may be affected by these levels. [28]

The concept of collective actions is considered when it comes to the management of agricultural farms. It is also applicable to other industries and subjects. This process aims to evaluate the relative and absolute potential of different types of farms for achieving sustainable agriculture and environmental protection. This analysis is usually focused on farms with complex internal structures (e.g., multi-member cooperatives, public farms, etc.). It involves analyzing the various aspects of farm management, including but not limited to management structure, profitability, environmental protection, and employee welfare. [28]

1.6.1 Indicators for Assessing Agrarian Sustainability at Sectoral Level in Bulgaria

Economic Sustainability	Social Sustainability	Ecological sustainability
Farm income of household/family working units; Gross margins in subsector/average for agriculture; Net income/profit; Gross revenues/production costs comparing to average for agriculture; Productivity of farmland and livestock; Marketed output/own consumption; Share of value added in subsector in total agriculture	Annual working hours of farm labor Average age of employed; Equality in the status of man and women; Remuneration of man and women comparing to other sectors; Average remuneration of hired labor comparing to minimum in the country; Number of employed labor comparing to all in agriculture; Vacant positions comparing to all in agriculture	Share of investment for environmental protection; CO_2 emissions; Share of lands with erosion risk; Share of follow up and permanent grasslands in utilized farmland; Risk of pollution of ground waters; Varieties of crops and livestock; Variation in yields and output comparing to agriculture

[28]

1.6.2 Indicators for Assessing Potential Efficiency of Governance Forms of Agrarian Sustainability

The evolution of agrarian governance depends on various factors such as political, institutional, and economic. Some of these include the personal characteristics of the participants. Science and technological advancement are also important factors that contribute to the sustainable development of our society. The choice of form of governance depends on the social and economic conditions that are necessary for sustainable exploitation of agricultural and natural resources. Other factors that affect the system of governance include the public policies and international agreements. For instance, some Bulgarian farms adapt their production methods and technologies to the new instruments introduced after 2007. This process is carried out in order to maintain the integrity of the production system and its environment. [28]

The various factors that are related to the governance of agrarian sustainability were analyzed in order to identify their importance and compatibility with the modern stage of agriculture's development. The former is caused by the delay between the actions that were initiated and the positive effects of these actions. It is also caused by the changes in agents' behavior and the state of agrarian sustainability. Lack of knowledge about the various processes and

changes in the agrarian sector and rural areas, as well as the nature and extent of their impact on the environment and communities are some of the factors that have affected the development of agrarian sustainability. [28]

Each governing form is evaluated by analyzing how its various components affect the behavior of agents and how these influences the overall performance of the sector. This step is also taken into account to see how the changes in the socioeconomic status of the country and the regions affected the farm sector. The level of agrarian sustainability is affected by various factors such as the environment, competition, financial crisis, and natural evolution. This issue can be linked to the various levels of government and the level of involvement of the farming community in addressing these issues. The potential of farms and the sectors for adaptation to changes in the environment and market are some of the main factors that are considered when assessing the sustainability of agrarian operations. The efficiency of various modes is different since they have distinct capabilities and responsibilities. Some of these include providing adequate information, mitigating risk, and improving the effectiveness of the management system. [28]

An efficient and well-trained eco-system would induce voluntary actions, while most commercial enterprises require outside incentives to encourage their employees to perform actions. Water supply and usage would also be affected by actions that are not voluntary, such as price hikes and punishments. [28]

Free market has many advantages and disadvantages, and it can be divided into three categories: 1) protection rights and investment, 2) coordination and incentive, and 3) freedom. [28]

Market management is associated with various risks and uncertainties. It could be risky and costly due to the lack of information and the instability of prices. Private ordering is a better method for market coordination and monitoring. [28]

Extension of internal mode beyond the small-partnership boundaries may require significant costs for development and operation. It can also lead to the establishment of economies of scope and scale, which can be explored in various ways. Ownership of a business can provide numerous opportunities for improvement in productivity and management efficiency. It could be connected to the complexity of dealing with large amounts of information and the need for effective management of information asymmetry. Non-profit and cooperative businesses also suffer from a low capability for long-term investment due to their non-profit goals and non-traded character. [28]

Large collective organizations usually require extensive maintenance and evolution to keep up with their increasing complexity. These costs can include the management of conflicts, restructuring, and termination of members. Unlike in the private sector, public organizations do not have an automatic mechanism for selection of ineffective forms. This makes public decision making more time-consuming and costly. In order to overcome some of the

disadvantages of public modes, implementing market-like mechanisms in the public sector is a way to go. [28]

The efficiency of the management of agrarian sustainability is related to the extent to which the various components of the system can be rationalized and maximized in terms of their social, economic, and ecological impacts. It is also related to the management of costs. The former describes the potential of a system or individual mode to achieve agrarian sustainability. The latter shows the ultimate result or effect of the system or method on the farm. A high or increasing level of agrarian sustainability refers to a high efficiency of the governance system. This concept is usually evaluated by assessing the various aspects of the governance. [28]

Economic Sustainability	Social Sustainability	Ecological sustainability
Share of marketed output; Innovation activity; Extent of implementation of required agro-technique operations; Share of private investment; Participation in public support programs; Amount of public subsidies; Amount of direct foreign investment; Implementation of systems for quality control; Long-term inputs supply contract; Long-term contract for marketing of output; Membership in farm organization; Training of personnel; Number of protected origins, brand names etc.	Social initiatives of farms and agrarian organizations; Extent of implementation of working condition standards; Extent of diversification of activity; Share of women managers of farms; Number of hired labor; Number of collective initiatives; Membership in community and interests groups organizations; Dynamics of labor remuneration; Extent of social assurance; Amount of costs for social development	Implementation of efficient crop rotation; Implementation of Good Agricultural Practices; Introduction of professional codes of eco-behavior and eco-standards; Transition to eco or organic production; Introduced eco-products and services; Amount of costs for environmental protection; Amount and coverage of signed public eco-contracts; Membership in eco-cooperatives and associations; Number and coverage of agro-ecological payments; Amount and share of uncultivated farmland; Number of type of animals per unit farmland; Amount of chemicals for crop protection total and per unit of utilized farmland

[28] Source: https://ec.europa.eu/info/sites/default/files/food-farming-fisheries/key_policies/documents/rdp-factsheet-romania_en.pdf

The efficiency and system-level analysis of agrarian sustainability are very important considerations for policymakers and practitioners. However, in many countries, such assessments are far behind the modern developments in theory and practice. This study aims to identify and analyze the various mechanisms and modes of governance related to agrarian sustainability in different regions and sectors of a country. It also collects microeconomic data to analyze the various activities and behavior of farming organizations. [28]

1.7 Agricultural changes in Romania

The European Commission adopted the Romania's RDP 2015-2020 program on May 26, 2015, which outlines the country's goals for using almost 9.5 billion of public money available for the next seven years. The program focuses on three priority areas: promoting competitive advantage in the country's agricultural sector, improving the environment, and stimulating economic development. [28]

The RDP will help support the development of over 3 400 small farms and help more than nine 400 young farmers start up. It will also restore and preserve ecosystems related to farming and forestry. Over 7 million ha will be allocated for the prevention of soil erosion and land abandonment. The training of more than 184 000 people will be reinforced in the agricultural sector. Almost 27% of Romania's rural population should benefit by investing in infrastructure projects to improve living conditions. The Rural Development Program is a vital component of the country's infrastructure development. [28]

One of the great advantages of the Rural Development concept is that it allows Member States to design their own programmes which fit their needs. For instance, in Romania, the focus of the RDP is on improving the profitability of the farm and restructuring the agricultural sector. The Support for Rural Development is the second pillar of the Common Agricultural Policy, which provides Member States with an envelope of European Union funding to manage national or regional programmes. For the 2014-2020 period, 118 multi-year programmes are foreseen in all Member States. The objective of the Commission's work is to promote networking activities at national and EU level. It also aims to coordinate actions and maximize synergies among the ESICs. [28]

The Rural Development Program for Romania was adopted by the European Commission in 2015 and outlines the country's priority areas for using the almost 9.5 billion of public money available for 2014. The program aims to stimulate economic development, improve living conditions in rural areas, and promote environmental protection. The RDP will support the modernization of over 3 400 farms and the development of over 30 000 small farms. It will also help restore and preserve ecosystems related to agriculture. In order to prevent soil erosion and land abandonment, the government will provide almost 7 million ha of support. The training of unskilled workers in the agricultural sector will also be strengthened. [28]

Almost 27% of the rural population would benefit from investments in rural infrastructure. This is the reason why the Common Agricultural Policy supports national and regional initiatives that aim to improve the infrastructure of rural areas. The new RD Regulation 2014-2020 sets out clear targets for achieving six economic, social, and environmental priority areas. It also encourages coordinated actions and better coordination with the other European funds. This document provides an overview of the challenges and opportunities that Romania is facing as a result of the RD Regulation. The table shows the priority areas and their allocated budget. Romania's unemployment rate is 7%.[28]

Romania has a population of almost 20 million and around 45% of its residents live in rural areas. The country's agricultural economy contributes 6.6% of the country's gross domestic product. The restructuring of the farming sector is a key challenge to increasing competitiveness. It is mainly concentrated in the large and medium sized farms, which account for around 7% of the total holdings. The average size of a farm in Romania is considerably smaller than that of the EU average. Its productivity is still low, at 30% of the EU average. Access to credit and farm insurance are among the challenges faced by small farmers in Romania. Despite this, the sector still provides 30% of total employment in the EU. There is a need for training in agriculture and rural areas to improve the skills of the workers, while at the same time promoting economic development in rural areas. [28]

Many large agricultural areas in Romania are prone to soil degradation due to climate change. This environmental phenomenon is expected to intensify as a result of the increasing number of natural disasters. While the rural areas have the potential to increase their agricultural production, they are mainly affected by the lack of irrigation systems and are in need of intensive land management. [28]

The Rural Development Programme will help Romania address these challenges through six priority areas: improving the competitiveness of the agricultural sector, sustainable forestry, social inclusion, and local development. The Rural Development Program (RDP) aims to improve the skills of farmers and other rural dwellers in order to stimulate economic development in agriculture, forestry, and rural areas. It also supports the development of small processing units (SPU) and farms. Over 14 400 small and micro enterprises in rural areas will benefit from the advisory services of the RDP. The program also supports the establishment of over 200 co-operation projects. [28]

The goal of the program is to improve the competitiveness of small farms through the promotion of association. In forestry sector, the investment will be made to expand the network of forest roads. Over 120 farms affected by COVID will receive temporary support. Over 5 000 farmers will benefit from the insurance premium. The program also includes investments in disaster risk reduction and agricultural potential restoration. Around 600 pig and poultry properties will receive payments for their animal welfare commitments. [28]

More than 1.1 million hectares of farmland and more than 950 000 ha of forests will benefit from climate and environmental payments. In 2015, the total area of land with natural constraints was reduced by almost 50% in Romania. This reduction, which was achieved

through the introduction of a new delimitation process, will cover almost 50% of the country's agricultural land. The objective of the program is to prevent land abandonment and erosion in areas affected by natural constraints. [28]

The Rural Development Program (RDP) has support for 363 projects aimed at improving the efficiency of irrigation infrastructure in order to decrease water consumption. This will be done through training and advisory actions. There will be over 430 investments in the areas of carbon sequestration and greenhouse gas reduction. These will be focused on reducing deforestation and land use. Supporting afforestation will also help in reducing greenhouse gas emissions. [28]

Over 3 000 projects will be supported to set up/develop non-agricultural businesses within rural areas, and almost 27 000 jobs will been created through the LEADER programme. Almost 800 projects will be financed under the RDP to improve rural infrastructure, and it will help improve the living conditions of some 27% of the rural inhabitants. The infrastructure projects include roads, wastewater supply facilities, afterschool, and agricultural high schools. The government supports the establishment of new orchards, the reconversion of old ones, and the setting up of producer groups within the fruit processing industry. [28]

Target	Measure	€ Total public	%
Priority1: Knowledge transfer and innovation in agriculture, forestry and rural areas[2]			
1A: Fostering innovation, cooperation, knowledge base **0.44%** of RDP expenditure	01 knowledge		
	02 advisory		
	16 cooperation		
1B: Strengthening links (with research etc.) **211** cooperation projects	16 cooperation		
1C: Training **19 960** participants trained	01 knowledge		

Priority 2: Farm viability, competitiveness and sustainable forest management		**2 195 447 379**	**23.25**
2A: Economic performance, restructuring & modernisation **0.09%** of holdings with RDP support[3] **4.10%** of small holdings with RDP support[4] **2.66%** of medium-sized holdings with RDP support[5]	01 knowledge	3 044 926	0.03
	04 investments	1 178 132 786	12.48
	06 farm / business development	251 477 271	2.66
	21 COVID - 19 crisis	182 500 000	1.93
2B: Generational renewal **0.31%** of holdings with RDP supported business development plan/investments for young farmers	01 knowledge	2 375 166	0.03
	02 advisory	192 000	0.00
22.61% of holdings between EUR 12 000-50 000 Standard Output with RDP support for business development for young farmers[6]	06 farm / business development	476 754 112	5.05
2C+: Improving the economic performance of forests **909** km of forest roads built under supported projects	04 investments	100 971 119	1.07
Priority 3: Food chain organisation, including processing and marketing of agricultural products, animal welfare and risk management		**1 117 514 138**	**11.83**
3A: Improving competitiveness of primary producers **0.04%** of agricultural holdings receiving support for	01 knowledge	60 000	0.00
	02 advisory	3 478 000	0.04
participating in quality schemes, local markets and short supply circuits, and producer groups/organisations	03 quality schemes	6 081 232	0. 06
	04 investments	211 809 293	2.24
	09 producer groups	20 037 124	0.21
	14 animal welfare[7]	792 480 077	8.39
	16 cooperation	31 356 903	0.33
3B: Farm risk prevention and management **0.14%** of farms participating in risk management schemes	01 knowledge	60 000	0.00
	05 restoring potential	28 452 434	0.30
	17 risk management	23 699 076	0.25

Priority 4: Restoring, preserving and enhancing ecosystems in agriculture and forestry[8]		**2 677 228 128**	**28.35**
4A Biodiversity **14.67%** of forest/other wooded area under contracts **9.11%** of agricultural land under contracts 4B Water management **10.73%** of agricultural land under contracts 4C Soil erosion and management **3.42%** of agricultural land under contracts **0.66%** of forestry land under contracts	01 knowledge	550 000	0.01
	10 AEC	816 774 641	8.65
	11 organic farming	247 038 159	2.62
	13 ANC	1 522 717 575	16.12
	15 forest env-climate	90 147 754	0.95
Priority 5: Resource efficiency and shift to low carbon and climate resilience economy in agriculture, food and forestry sectors		**724 889 603**	**7.68**
5A Water efficiency **294.28%** of irrigated land switching to more efficient irrigation systems[9] **63.35%** of land with viable irrigation infrastructure switching to more efficient irrigation systems[10]	04 investments	440 978 719	4.67
	10 AEC	18 542 621	0.20
5C Renewable energy **EUR 1.95 million** total investment in renewable energy production	06 farm / business development	2 165 018	0.02
5D Reducing GHG and NH3 **1.63%** of LU (Live-stock Unit) concerned by investments in live-stock management in view of reducing GHG (Green House Gas) and/or ammonia emissions	01 knowledge	180 000	0.00
8.94% of agricultural land under management contracts targeting reduction of GHG and/or ammonia emissions	04 investments	216 236 592	2.29
5E Carbon conservation and sequestration **1.09%** of agricultural and forest land under management contracts contributing to carbon sequestration or conservation	08 forests	46 786 653	0.50

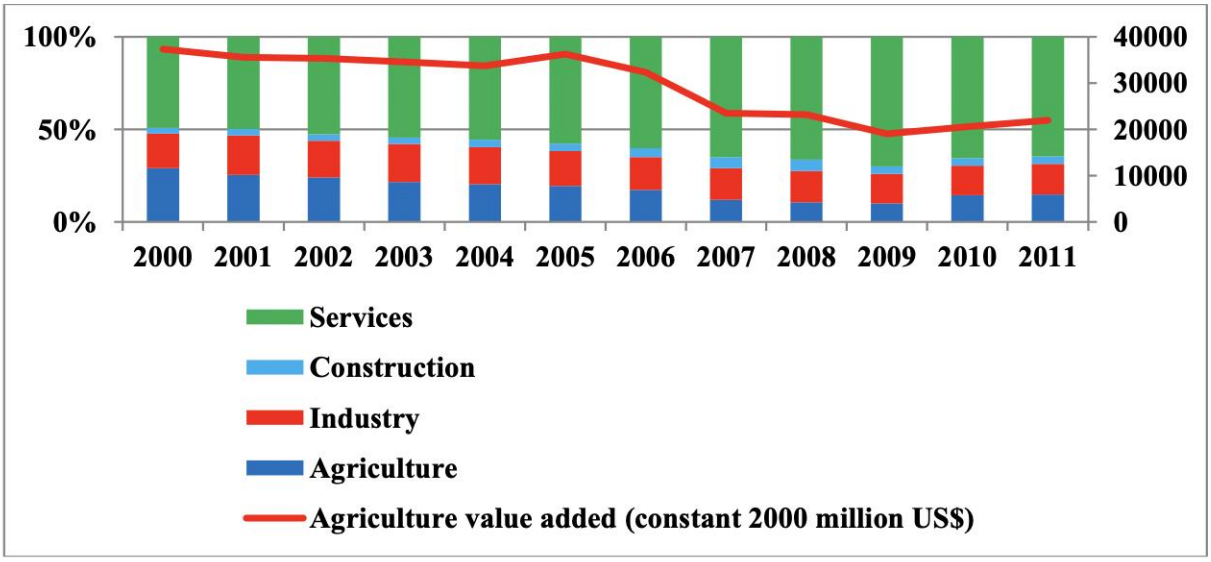
Priority 6: Social inclusion, poverty reduction and economic development in rural areas		**2 546 942 780**	**26.97**
6A Diversification, creation of small enterprises and jobs **24 474** jobs created in supported projects	04 investments	326 391 774	3.46
	06 farm / business development	276 960 987	2.93
6B Fostering local development **100%** rural population under local development strategies **26.63 %** rural population with improved services/infrastructure **2 055** jobs created (via LEADER)	07 basic services	1 305 958 145	13.83
	19 LEADER and CLLD	637 631 874	6.75
Technical Assistance		181 352 030	1.92
Total public expenditure €		**9 443 374 059**	**100**

[28]

[28] Source: https://ec.europa.eu/info/sites/default/files/food-farming-fisheries/key_policies/documents/rdp-factsheet-romania_en.pdf

1.8 Agricultural changes in Moldova

Despite the decline in the agricultural sector, it still accounts for 12% of the country's gross domestic product (GDP) in 2011. The services sector has become more significant over the years, as it now accounts for almost two thirds of the total industry. *[29]*



[29]

[29] Source: http://extwprlegs1.fao.org/docs/pdf/mol159051.pdf - NATIONAL STRATEGY ON AGRICULTURE AND RURAL DEVELOPMENT FOR THE PERIOD 2014-2020

The Moldovan macroeconomic environment is quite different from that of other Eastern European countries. In 2010, the value added by agriculture to the gross domestic product (GDP) of the region was 10%. However, the contribution of agriculture to the region's economy has decreased by an average of 10% over the past decade. Since 2000, agriculture has been experiencing slow and volatile growth due to various factors, such as external weather conditions. This is one of the main reasons why the economy has been showing unstable growth patterns. Crop production is vulnerable to climate distress due to its high volatility. In Moldova, the years of severe droughts have resulted in a disastrous crop production. This is a reflection of the lack of adequate weather-related risk mitigation measures. *[29]*

The crisis has caused the prices of various inputs to go up, which in turn has slowed down agricultural production. This is a contributing factor to the decline in agricultural employment in Moldova. Despite the importance of agriculture in terms of employment, the number of people working in the sector has significantly declined over the years. This decline was mainly due to the many workers who exited the pool and migrated to the service sector. Although the employment rate in Eastern Europe remained high in 2011, it declined in some countries. For instance, in Moldova, it almost halved in a decade. *[29]*

The rapid changes in the economy have driven many people out of rural areas and into urban areas. This migration has started in search of better income. Over the last 6 years, the number of people moving out of rural areas has significantly increased. The main reason for this is the closure of many rural schools and the lack of skilled workers. *[29]*

It is clear that agriculture remains one of the largest employers in the country. The number of people employed in the sector has maintained its stable rate of around 320-330 thousand since 2009. During the economic crisis, the agriculture sector provided the social buffer that many people needed as they migrated back to agriculture. The decline in agricultural employment has led to higher labor productivity, which is still well below the region's average. *[29]*

From 2000 to 2010, labor productivity in Moldova doubled, but it remained well below the Eastern-European average. The value added per worker in 2010 was 15,000 US dollars, which suggests that the labor productivity gap in the new member states was significant. Due to the rapid increase in personal income, and the large influx of remittances, the domestic demand for agri-food products has increased. This is mainly because of the increasing complexity of the consumers and the need for higher value-added products. *[29]*

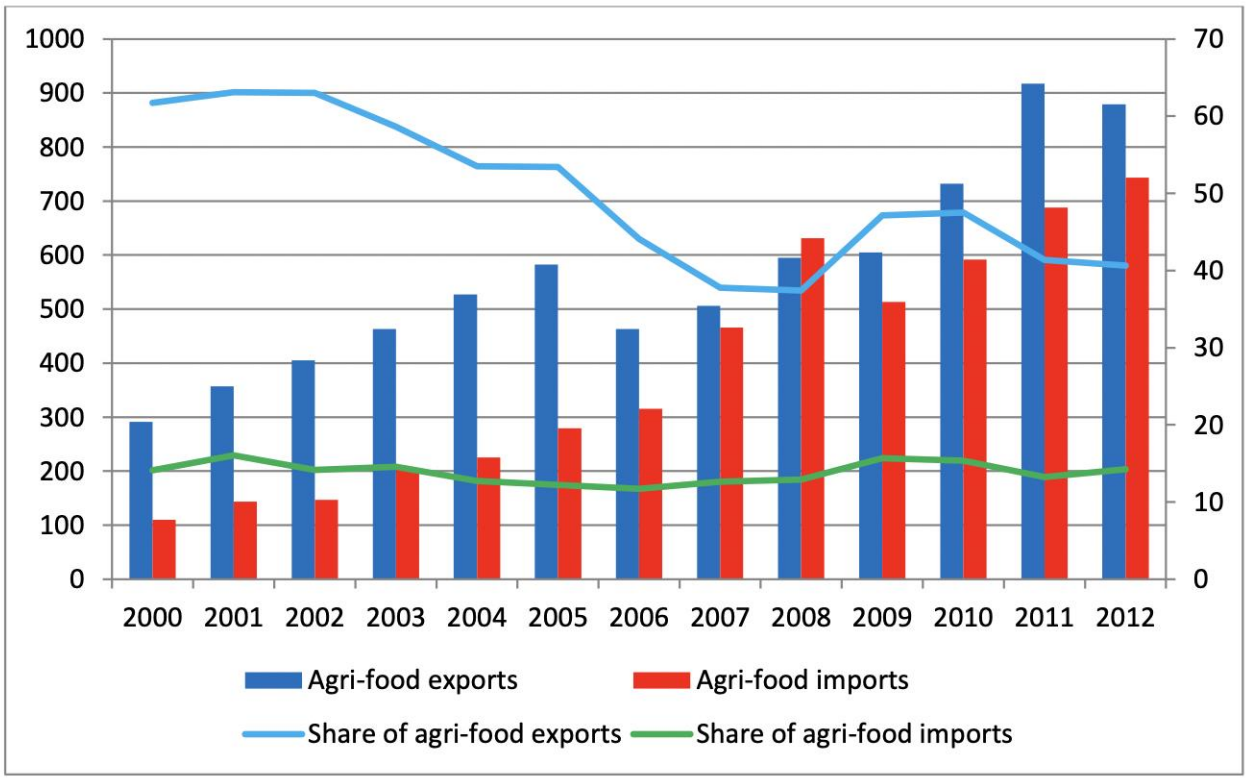
The main trading partners of Moldova in agri-food are the EU and the CIS countries. As a result, 60% of the country's total agri-food exports were sent to the EU in 2011. The share of CIS countries in Moldova's agri-food exports decreased by 30% in 2000-2011. On the other hand, the share of CIS countries in total agri-food imports increased by 25%.*[29]*

Over the past decade, Moldova has managed to maintain a balanced trade balance. However, its overall trade deficit has grown significantly beyond expectations due to the increasing

consumption of processed food products. This has caused a deterioration of the balance of agriculture's trade. Since Moldova joined the World Trade Organization in 2001, its trade liberalization has lowered barriers to agri-food import. The country has also lowered its customs duties. Since March 2008, Moldova has been enjoying the benefits of the European Union's (EU) preferential trade terms (ATP+). This includes the removal of customs duties on many products from Moldova. *[29]*

Moldova is also a member of various regional and international economic organizations. Its agricultural exports have been affected by the changes in the trade regime with its key trade partners. Since its agricultural products are mainly exported to the EU and CIS, Moldova's agri-food market has been dominated by two main destinations: EU and CIS. However, since Russia joined the WTO in 2012, its market has changed significantly. *[29]*

Due to Moldova's dependence on Russia for energy supplies, its trade situation with the country is complex. The emergence of a post-Soviet trade block between Russia, Belarus, and Kazakhstan has raised concerns for the country. The development of trade relations between the West and Russia is taking place in the context of the negotiations for a Free Trade Agreement between the EU and the DDCFTA. *[29]*



[29] Source: http://extwprlegs1.fao.org/docs/pdf/mol159051.pdf - NATIONAL STRATEGY ON AGRICULTURE AND RURAL DEVELOPMENT FOR THE PERIOD 2014-2020

In the long run, the DCFTA is expected to boost Moldova's GDP by around 5.4 percent. As for exports, this increase is larger than the 8 percent expected increase in imports. The trade deficit is also expected to remain relatively stable. Over the long run, wages in Moldova are expected to increase by 4.8 percent. The country's consumer price index is also expected to decrease by 1.3 percent annually. In Russia and Ukraine, the benefits of the EU-Moldova DCFTA will outweigh the risks. For both countries, this agreement will increase their national income by over 120 million a year. *[29]*

The most significant change would be in the sugar industry, which would affect the country's agricultural and processed food export sectors. These sectors are mainly dominated by five groups: oilseeds and Oleaginous fruits, beverages and spirits, cereals, and fruits and nuts. In three out of the five product groups, the share of Moldovan cereals in the EU is higher than that of the world's total export. This suggests that the country's producers may be able to overcome the market barriers related to the phytosanitary regime. A more nuanced picture may be revealed by the number of products that are separated by their respective HS 6-digit levels. The main product in this sector is walnuts. In 2011, Moldovan fresh apples were mainly exported to non-EU markets, while the majority of fresh fruits went to the EU. These products make up a small portion of total Moldovan exports. *[29]*

The main factor that has restricted the growth of Moldovan apples in the EU is the complexity of the fruit market. This is especially true in the case of alcoholic drink. Moldovan wines are more valuable to the CIS markets than to the EU. SPS does not seem to be a barrier to entry for Moldovans into the EU market. *[29]*

In 2006, after a one-off jump, they steadily recovered and reached a volume of around USD 20 million. In 2010, after exceeding the quota for the previous year, they started using it in full. In 2011, the volume of Moldovan exports increased significantly due to the new regulation. Wines exported to EU markets are typically higher quality than those targeting CIS markets. Until 2006, the Moldovan wine industry relied on exporting cheap and semi-sweet wine to Russia. The ban on Russian import had a negative effect on the domestic market. *[29]*

Moldovan wines are not being promoted in the most advantageous markets due to the country's low market shares and the competition from other regions. As a result, the prices for Moldovan wines are significantly higher than those of wines from other countries. The DCFTA has abolished all tariff barriers for wine in the EU. This is good news for consumers and producers alike. *[29]*

1.8.1 Analysis of Rural Development issues

Rural areas make up 58% of Moldova's population. In 2011, over 2 million people lived in rural areas. The country's population decline started after around 660 thousand people left in 1997. Moldova has the highest percentage of rural population in the Eastern-Europe. By comparison, the share of rural population in Belarus is the lowest in the region. In 2012, the

average rural population in the region was 35%. Despite the fact that half of Moldovans live in rural areas, the country's rural employment rate is only 36%. This figure shows that the labor opportunities in these regions have significantly decreased over the years. *[29]*

The share of the economically active population in Moldova is the lowest in the Eastern European region. This is mainly due to the massive migration of the active labor force in the country. The share of active agriculture in Moldova's population has remained high in 1992, while the rate of employment among young people has declined in the past couple of decades. Those with only a primary education were the most likely to find jobs in rural areas. Rural employment rate declined from 30% to 5.2% during the 2000 to 2011. *[29]*

The low wages in agriculture are highly determined by the type of job that they require. In 2011, people working in the services sector earned three times more than those in agriculture. Although the gap has shrunk, the situation remains high. Due to the decreasing possibilities in rural areas, many people are leaving Moldova for work abroad. The number of individuals who are looking for work has increased by over a thousand in the last decade. Among the age groups, the most significant increase is among young adults. *[29]*

Every fifth Moldovan citizen is working abroad. Almost half of the country's population is working in rural areas. Young agricultural entrepreneurs are most likely to be the ones who can introduce new technologies and methods to boost the rural economy. In 2011, around 200 thousand people from rural areas were working abroad. This figure is believed to be under-reported, while the real migration numbers are much greater. It is clear that most of the people who come from rural areas of the country are from the remittances route. The share of household income that was sent home from abroad remained relatively stable during 2006 to 2012, but it has started to increase since then. This suggests that rural households started becoming increasingly dependent on the money that they send back home. *[29]*

Aside from remittances, the income of rural residents depends on both their self-employed status and on the pension system. In 2011, the majority of income was generated by foreign funds, while the others came from agriculture and self-employment. The majority of rural residents' income was not derived from formal employment. The other major source of income was from farming. The increasing number of students in secondary and primary education has limited the potential for higher income generation. It has been estimated that the number of children attending school has decreased over the years. This could be the result of the lack of financial resources to support education and the need to employ children. *[29]*

The condition of rural infrastructure is a major factor that limits development possibilities in Moldova's rural areas. In 2011, the lack of electricity in rural areas was the third most common issue affecting the development. The quality of water and wastewater services in Moldova are generally in poor condition. In most cases, they do not meet the hygiene requirements. Also, the lack of dwelling facilities makes rural households less equipped for living. Road networks are considered the most impoverished infrastructure in the country. In 2006, only 7% of the road network was considered good or satisfactory. The rest 93% was in a bad or unfavorable technical state. Many villages in Moldova have bad roads that affect the transportation of

goods and the quality of their produce. This is a negative factor for the supply chain and increases the prices of the goods. Fortunately, there are solutions that can be implemented through rural job creation. The development of the agro tourist sector in Moldova is still ongoing and needs more support. This industry's share of overnight stays in tourist establishments increased by 3% in 2004 to 2012. *[29]*

[29] Source: http://extwprlegs1.fao.org/docs/pdf/mol159051.pdf - NATIONAL STRATEGY ON AGRICULTURE AND RURAL DEVELOPMENT FOR THE PERIOD 2014-2020

1.9 Agricultural changes in Ukraine

Over the past three decades, the producer support index has been volatile due to fluctuations in the market price support (MPS). Since 1992, it has been negativing in most years. Various food products and sugar have been protected by import tariffs, which have led to higher prices

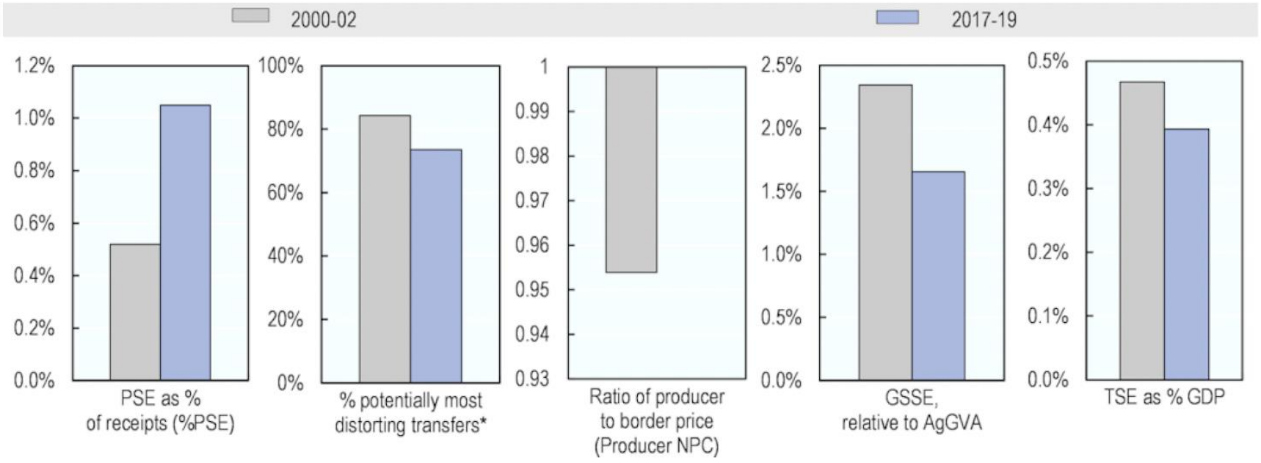
for some. The impact on the prices of state-owned funds and commodities is likely to be limited. The total MPS for the sector has also been positive. The GSSE spent 1.6% of its agricultural value-added in 2017, which is well below the levels seen during the mid-1990s. *[30]*

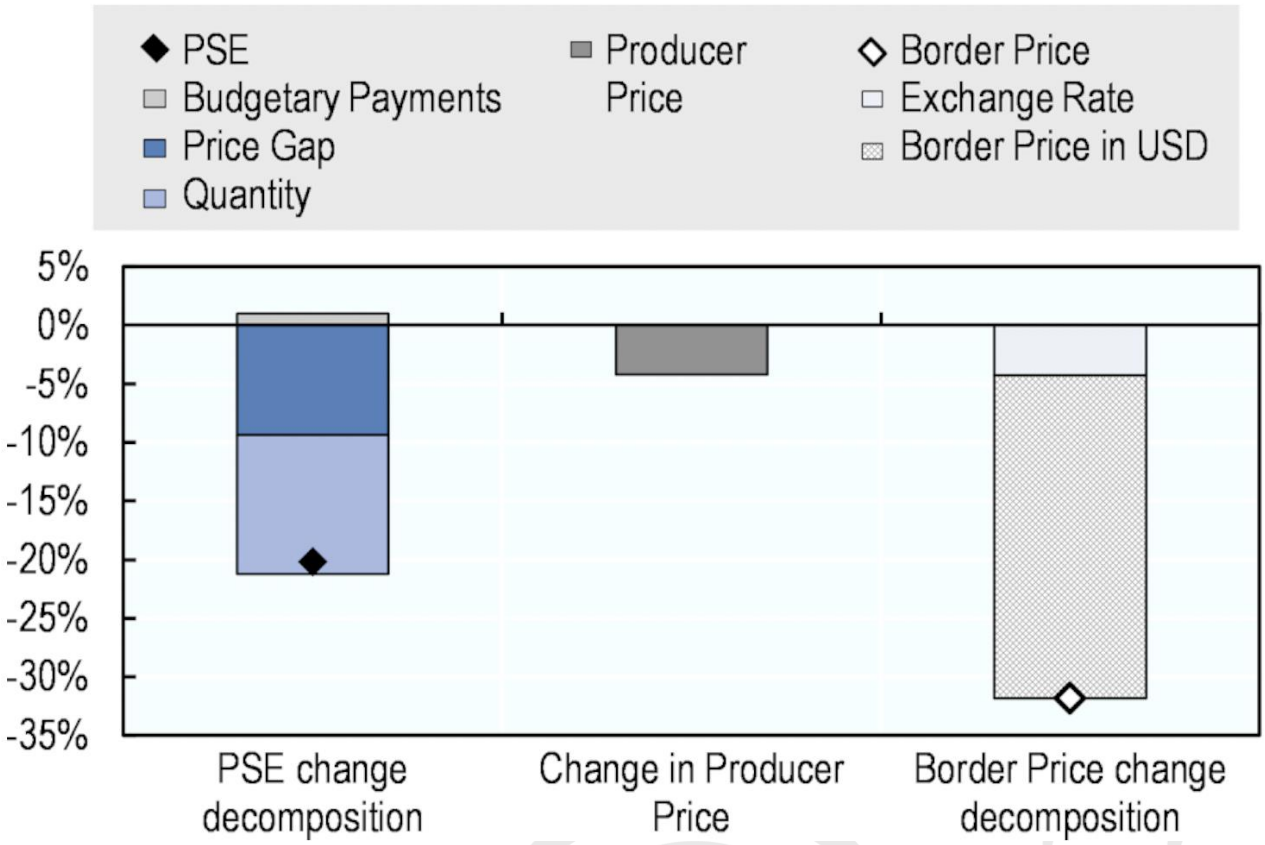
The Agrarian Policy and Food Ministry was integrated with the Ministry of Economic Development and Trade, which aims to accelerate the reforms in the agricultural sector. This includes the development of policies related to land use, market deregulation, and digitalization. New farms are required to use the land for farming purposes within the first three years. In addition, they are compensated up to 30% for the construction or renovation of grain storage and processing capacities. Several export-oriented sectors, such as for sunflower seed and milk, have remained below world prices. The lack of export infrastructure and the activities of state-owned enterprises may also contribute to this negative support. *[30]*

To take advantage of Ukraine's agricultural competitiveness, it should improve its infrastructure and export processes. It should also implement the elimination of special VAT regimes. Improvement of the functioning of the input markets is a key component to ensuring that farmers have access to the inputs they need. This is evidenced by the end of the moratorium on the land sales. The reforms needed to make the sale and purchase of agricultural land in Ukraine legal will only boost the efficiency of the industry once this is done. *[30]*

This proposal is linked to the modernization of Ukraine's regulatory framework and its infrastructure for the export-oriented sectors. The Action Plan should help in monitoring and reporting greenhouse gas emissions by various sectors. It should also help in identifying and implementing specific reduction targets and policies. In late March 2020, the Ukrainian Ministry for Economic Development and Trade and Agriculture and grain traders signed an agreement which limits Ukraine’s wheat export for the 2019/20 season. The document aims to ensure stability in the domestic market and to prevent prices from rising. *[30]*

Despite the government's insistence that it would not impose further restrictions on wheat sales, it noted that the sales should reach the limits agreed with the traders. This temporary measure was implemented to protect the domestic market. On March 27, 2019, the Agrarian Fund and DPZKU, a grain firm, announced that they would sell over 128 000 tons of wheat to prevent a price rise. This order was implemented to safeguard the interests of the public. The Cabinet of Ministers is currently working on a list of products that should be renewed for state regulation. *[30]*





[30] Source: https://www.oecd-ilibrary.org/sites/4d38c439-en/index.html?itemId=/content/component/4d38c439-en

1.9.1 Ukraine: Estimates of support to agriculture

Both agricultural and total factor productivity grew significantly above global averages in the decade ending 2016. The acceleration in productivity was largely due to the increasing use of intermediate inputs and the shrinking capital stock. Several laws and decisions on agricultural policy have been adopted in Ukraine. The country's agricultural policy is based on the following principles: priority is given to the development of rural areas, and priority is allocated for the promotion of agriculture. The scope of Ukraine's agricultural policies is influenced by the country's association with the European Union. As a result, the financial scope of these policies has increased significantly in 2019. *[31]*

Million USD					
	2000-02	2017-19	2017	2018	2019p
Total value of production (at farm gate)	**9 619**	**31 213**	**28 510**	**31 469**	**33 659**
***of which:** share of MPS commodities (%)*	86.8	82.9	81.8	82.7	84.2
Total value of consumption (at farm gate)	**8 841**	**21 537**	**20 238**	**21 066**	**23 308**
Producer Support Estimate (PSE)	**53**	**330**	**-238**	**668**	**561**
Support based on commodity output	-415	-2	-591	357	226
Market Price Support[1]	-531	-2	-591	357	226
Positive Market Price Support	388	339	169	437	411
Negative Market Price Support	-919	-342	-760	-80	-185
Payments based on output	116	0	0	0	0
Payments based on input use	203	144	191	120	120
Based on variable input use	169	65	161	10	23
with input constraints	0	0	0	0	0
Based on fixed capital formation	31	79	30	109	97
with input constraints	0	0	0	0	0
Based on on-farm services	2	0	0	0	0
with input constraints	0	0	0	0	0
Payments based on current A/An/R/I, production required	265	189	162	191	214

Based on Receipts / Income	265	162	162	158	166
Based on Area planted / Animal numbers	0	27	0	33	48
with input constraints	0	0	0	0	0
Payments based on non-current A/An/R/I, production required	0	0	0	0	0
Payments based on non-current A/An/R/I, production not required	0	0	0	0	0
With variable payment rates	0	0	0	0	0
with commodity exceptions	0	0	0	0	0
With fixed payment rates	0	0	0	0	0
with commodity exceptions	0	0	0	0	0
Payments based on non-commodity criteria	0	0	0	0	0
Based on long-term resource retirement	0	0	0	0	0
Based on a specific non-commodity output	0	0	0	0	0
Based on other non-commodity criteria	0	0	0	0	0
Miscellaneous payments	0	0	0	0	0
Percentage PSE (%)	**0.5**	**1.0**	**-0.8**	**2.1**	**1.6**
Producer NPC (coeff.)	**0.95**	**1.00**	**0.98**	**1.01**	**1.01**
Producer NAC (coeff.)	**1.01**	**1.01**	**0.99**	**1.02**	**1.02**
General Services Support Estimate (GSSE)	**121**	**197**	**139**	**221**	**230**
Agricultural knowledge and innovation system	51	68	68	68	68
Inspection and control	26	108	55	130	141

Development and maintenance of infrastructure	36	10	5	14	11
Marketing and promotion	1	0	1	0	0
Cost of public stockholding	1	3	3	3	4
Miscellaneous	7	7	8	6	7
Percentage GSSE (% of TSE)	**69.5**	**37.3**	**..**	**24.9**	**29.1**
Consumer Support Estimate (CSE)	**384**	**34**	**566**	**-270**	**-195**
Transfers to producers from consumers	478	58	580	-240	-168
Other transfers from consumers	-38	-20	-13	-24	-22
Transfers to consumers from taxpayers	0	0	0	0	0
Excess feed cost	-55	-4	-1	-6	-5
Percentage CSE (%)	**4.3**	**0.2**	**2.8**	**-1.3**	**-0.8**
Consumer NPC (coeff.)	**0.95**	**1.00**	**0.97**	**1.01**	**1.01**
Consumer NAC (coeff.)	**0.96**	**1.00**	**0.97**	**1.01**	**1.01**
Total Support Estimate (TSE)	**174**	**527**	**-99**	**889**	**791**
Transfers from consumers	-440	-38	-568	264	189
Transfers from taxpayers	651	585	481	649	623
Budget revenues	-38	-20	-13	-24	-22
Percentage TSE (% of GDP)	**0.5**	**0.4**	**-0.1**	**0.7**	**0.5**
Total Budgetary Support Estimate (TBSE)	**705**	**529**	**492**	**532**	**564**
Percentage TBSE (% of GDP)	**1.9**	**0.4**	**0.4**	**0.4**	**0.4**
GDP deflator (2000-02=100)	**100**	**1 225**	**1 137**	**1 313**	**..**
Exchange rate (national currency per USD)	**5.38**	**26.55**	**26.60**	**27.20**	**25.85**

[30] Source: https://www.oecd-ilibrary.org/sites/4d38c439-en/index.html?itemId=/content/component/4d38c439-en

Between 2013 and 2015, real GDP fell 16%, while inflation rates rose to almost 50% due to political factors. Since then, the economy has grown at a steady rate of 2.4% to 3%. Despite this, unemployment remained high at almost 9% in 2014. *[31]*

[30]

Various forms of domestic price intervention are also carried out by the Agrarian Fund. These include the implementation of various domestic price measures, such as tariff protection. The Fund can also intervene in other activities such as procurement of food and agricultural commodities. The law "On State Support for Agriculture in Ukraine" sets out the minimum and maximum prices that the Agrarian Fund may buy from the state. These prices are not applied to the maximum prices. Minimum prices are not bound by guaranteed prices and are subject to various conditions. They are typically referred to as floor prices by private market operators. Since 2016, the Agrarian Fund has been buying and selling limited amounts of grains under the mechanism. *[31]*

The Single Tax was introduced in 1998 to replace several taxes that were previously levied on agricultural enterprises. Since then, the scope of this tax has been narrowed. The Single Tax regime generates significant tax benefits for agricultural producers. In 2018, it was estimated that the value of these benefits amounted to around 4.3 billion Ukrainian Hrs. As a result of the Ukraine's Law on Agricultural Land Turnover, which was not extended into 2020, the sale and purchase of agricultural land in Ukraine is now illegal. *[31]*

The European Union's liberalization of trade with Ukraine took effect on September 1, 2017. The opening of the market for Ukraine's principal agricultural products, which includes grain, meat, and milk products, is expected to be completed within a transition period of about seven to ten years. *[31]*

Some goods, such as dairy and eggs, were lowered to zero import duties. However, some duties will be eliminated during this transition period. 10% of the tariff lines will be preserved for certain products. Since January 2016, Ukraine has zero in-quota tariff rates for imports of certain food products from the European Union. The agreement is part of the DCFTA. The DCFTA aims to overcome Ukraine's difficulties in complying with the requirements of the European Union for food safety, veterinary and Phyto-sanitary regulations. *[31]*

In 2016, the comprehensive strategy on implementing legislation on sanitary and phytosanitary measures was approved. This procedure allows Ukraine to submit a proposal for harmonization of its SPS legislation with the EU's requirements. In 2016, Ukraine committed to not exceeding 60% of its 1990 emissions across various sectors. *[31]*

The strategy for low carbon development of Ukraine up to 2050 was approved in 2018. The goal of the plan is to create a level playing field for all sectors of the economy and to separate economic growth and environmental development. The implementation of the Concept on Climate Change and the Environment was approved by the Central Committee of the Ministry of Agrarian Reform in 2018. The Ministry of Economic Development, in collaboration with other agencies, is developing measures to improve the environmental practices of agriculture and forestry. *[31]*

Various measures supporting agriculture have also been implemented. These include the establishment of a single tax regime, which will provide annual tax benefits of more than 4 billion US dollars. They also support various programs and projects designed to improve the profitability of the farming industry. Support for the crop side included various types of compensations, loans, and grants. On the other hand, the value-added tax system was discontinued in 2017. This system provided various benefits to producers, but only for a year. *[31]*

On August 29, 2019, the Agriculture and Agrarian Policy and Food Ministry was integrated with the Economic Development and Trade Ministry. The new agency will be responsible for the development of Ukraine's agricultural and industrial sectors. The State Agency for the Forestry and Fisheries of Ukraine has been transferred to the Environment and Energy Ministry. The merger of these two agencies into the Ministry of Trade and Economic Development aims to accelerate the reforms in the agricultural sector. In 2019, the total expenses of the Ministry of Agraria and Food of Ukraine amounted to over USD 168 million. The Ministry of Economic Development and Trade and Agriculture have also put in place various regulations and strategies aimed at attracting private investment in the agricultural sector. *[31]*

The Action Plan updates the country's strategy for achieving Ukraine's Association Agreement compliance. It takes into account the various regulatory acts and initiatives adopted by the Ukrainian authorities in the past years. In October 2019, the government also approved a procedure for establishing special conditions on the import of food and animal feeds. The goal of this procedure is to improve the control over the imports of animal feed products and food. It aims to remove the burden from the importers by simplifying the procedures and reducing the threat of dangerous products entering the market. The Law "On production, circulation, labeling, and presentation of feedstuff" was adopted by the Parliament in 2017. This legislation establishes the legal and organizational basis for providing consumers with information about food. *[31]*

Among others, the law sets out the duties of the operators of the food market in relation to the various issues related to the placement and labeling of food products. The Law provides for the establishment of organic market operators and public authorities responsible for the promotion and regulation of organic products. It also sets out further public policies aimed at developing organic markets. This procedure is in line with the requirements of the EU Regulation 889/2008. The provisions of this Order will come into force in June 2020. *[31]*

The document sets out requirements for the characteristics of honey, its terminology, and labeling. The strategy aims to improve the management and operation of irrigation and drainage systems in the country. It includes various working directions such as the reform of the public administration for irrigation and drainage. New measures were introduced in 2018 to support small and medium sized producers. These include general area payments and farm membership fees. *[31]*

It is obligatory for producers to use the land for farming purposes. In 2019, partial reimbursement of the construction or modernization of grain storage and processing facilities could be granted. The use of such facilities could also be refunded. Despite the lack of a law on agricultural land turnover, the sale and purchase of land in Ukraine remains illegal. Ukraine is a member of the World Trade Organization since 2008. The country charges high import tariffs on most agricultural products. Despite this, its agricultural products are still cheaper than non-agricultural products. *[31]*

Export duties are also applicable to some oilseeds, raw hides, and live animals. For soybeans and rapeseed, the latter was suspended from September 2018. In addition, negotiations on a DCFTA with Turkey are ongoing. In 2019, the European Union and Ukraine agreed to increase the duty-free quotas for Ukrainian processed poultry and beef. By 2021, the two TRQs are expected to reach a combined volume of over 90 000 tones. In December 2019, Ukraine banned the import of various goods from Russia. Some of these include meat and dairy products, alcoholic drinks, infant food, and various other processing products. The list was further extended until the end of 2020. *[31]*

In July 2019, Ukraine banned the import of mineral fertilizers, animal feeds, and veterinary products from Russia. In addition, anti-dumping duties on chocolate and other cocoa-based products from the Russian Federation remained in place. The Memorandum aims to promote

the interaction between different grain market participants and the exchange of information on expected grain export volumes. It also includes measures to monitor the grain market's functioning. Instead of holding meetings on a regular basis, grain market participants have decided to exchange information on a monthly basis. *[31]*

The goal of the strategy is to improve the competitiveness of Ukrainian agricultural products and to stimulate the export of food and processed goods. It is also aimed at developing the Ukrainian food brand and increasing the country's market diversification. The system was modernized, with many regional customs offices reduced. The Export Promotion Office was also established to help Ukrainian exporters expand their markets. The Export Credit Agency provides various support services to Ukraine's export industry. It is aimed at facilitating the country's transition from its raw material export to a supplier of added value. *[31]*

[30] Source: https://www.oecd-ilibrary.org/sites/4d38c439-en/index.html?itemId=/content/component/4d38c439-en

[31]Source: https://latifundist.com/en/novosti/49385-minekonomiki-i-uchastniki-zernovogo-rynka-podpisali-dokument-ob-ogranichenii-eksporta-pshenitsy; USDA (2020): Cap on Ukrainian Wheat Exports, GAIN Report Number UP-2020-0019, 6 April 2020, https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Cap%20on%20Ukrainian%20Wheat%20Exports_Kyiv_Ukraine_04-05-2020.

2 Overview of the steps involved in transportation planning

2.1 Analysis of Operational model for planning the harvest and distribution of perishable agricultural products

The next chapter presents fresh products that provide recommendations for developing a strategy.

The paper presents a conceptual framework that enables producers to generate short term planning decisions related to the production and distribution of fresh produce. This model can help producers maximize their revenues by making informed decisions during the harvesting season. Some of the factors that affect profitability include the cost of labor, the preservation of crops, and the use of transportation modes. The proposed planning model can help minimize the trade-off of the freshness while achieving significant savings. It can also be used to reduce the transportation cost and labor expenses of the grower. *[32]*

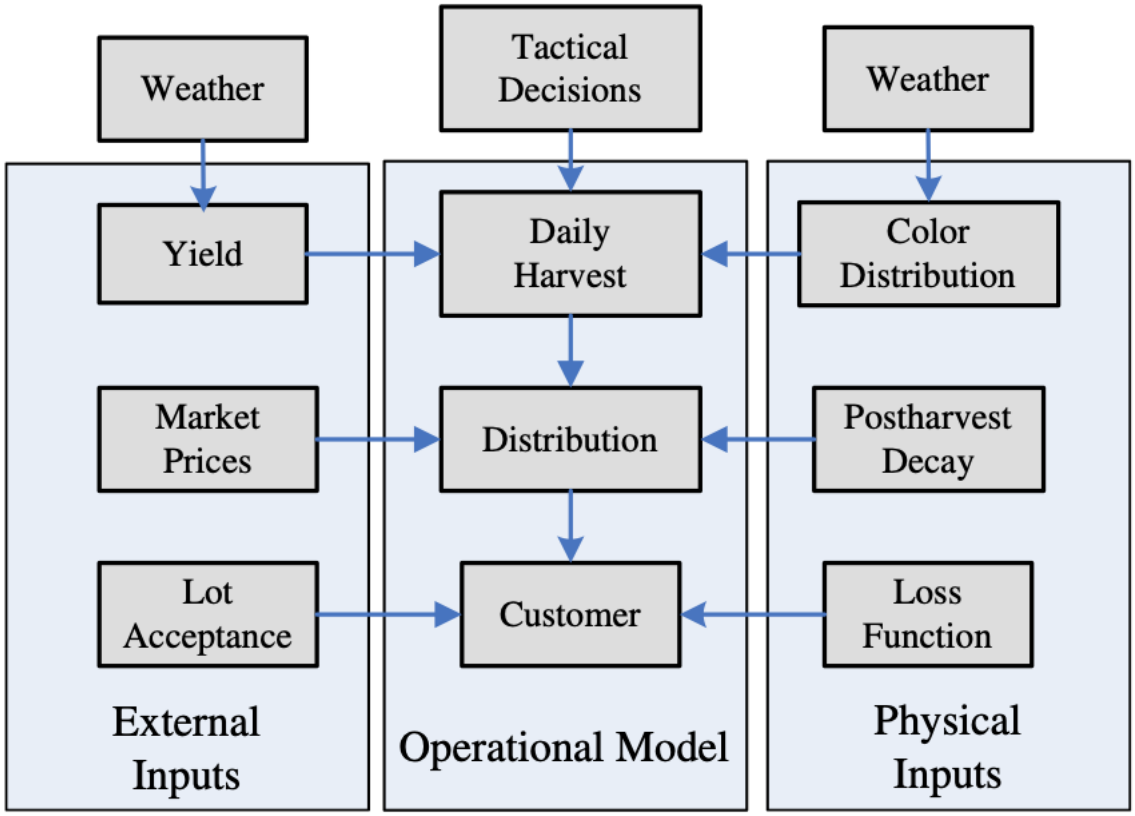
Fresh fruits and vegetables producers often face various planning problems such as deciding how much technology to use, how much space to use, and when to plant and harvest. This process can be very challenging if the objectives of the crop are conflicting. From a planning perspective, the various decisions a grower makes can be considered strategic or tactical level. Some of these decisions, such as the timing of plant and equipment purchases, can be considered tactical level planning problems. This paper aims to assist a farmer in developing an operational planning model that will take into account the various aspects of a crop's cultivation, harvest, and distribution. *[32]*

The concept of an operational model aims to help producers make informed decisions while harvesting fresh crops, which can result in maximized revenue. This model would help minimize the risk of making poor decisions and maximize the profitability of the crop. One of the most critical factors that a short-term harvesting operation has to consider is the management of labor costs. It also involves ensuring that the quality of products is at the time of sale. *[33]*

The paper aims to develop a planning model that balances the loss of production due to the perceptivity of the crops with the costs that are incurred to prevent that loss. The paper was focused on the modeling complexity and economic importance of certain fresh crops such as tomatoes. They were also selected due to their versatility. The main issues presented in this section are those related to the operation of horticultural crops. Section 4 presents an operational model for planning the various activities related to their growing and distribution. *[33]*

One of the main differences between the tactical and operational planning for the harvesting and marketing of perishable crops is that the latter's goals are usually better informed than

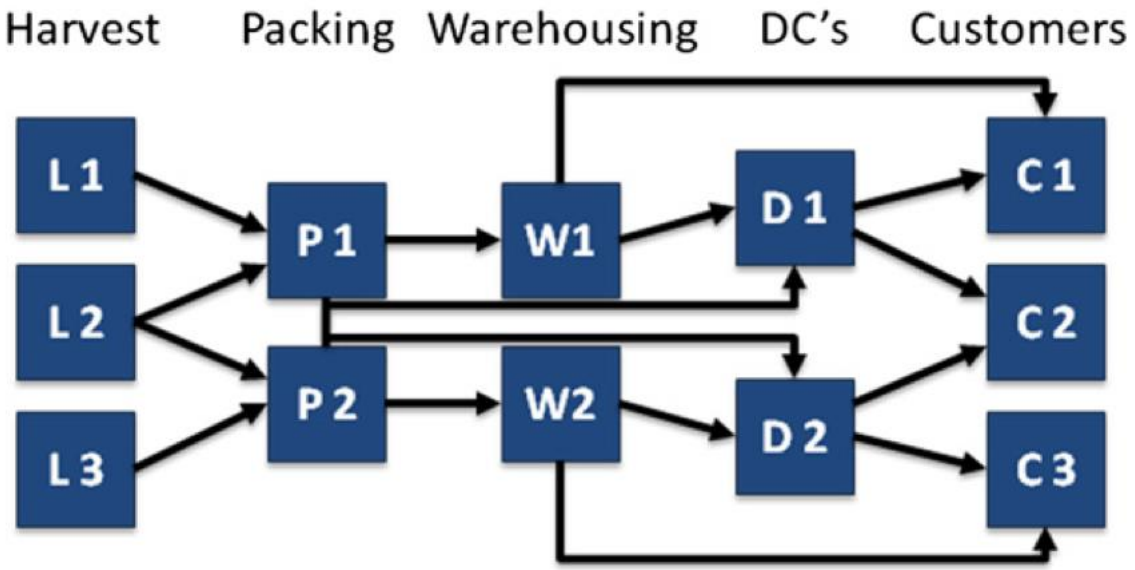
those of the former. However, these plans are still subject to various factors that can affect the decisions that are made. A planning model should include all the factors that affect short-term planning issues, such as the post-harvest behavior of crops, transportation time, and labor costs. It should also consider the transportation mode and the harvest policy to enable the crops to reach their intended customers. *[34]*



[32] Source: Ahumada, Omar, 2008. Models for Planning the Supply Chain of Agricultural Perishable Products, Ph.D. Dissertation, Arizona State University.

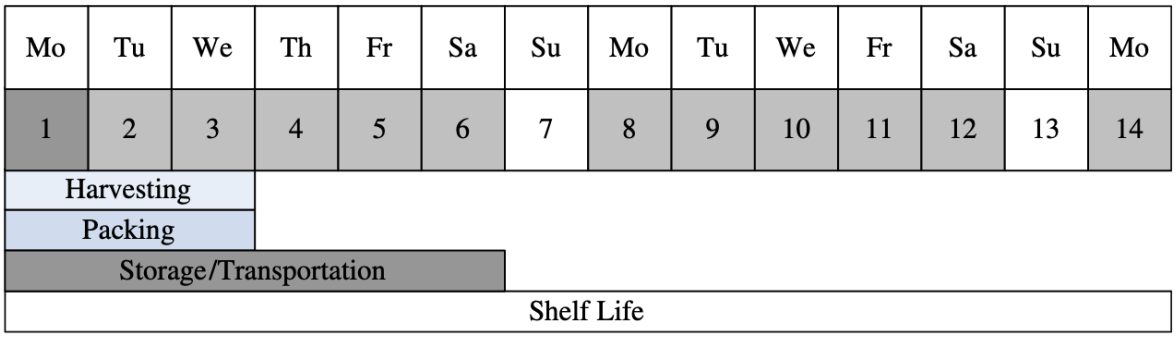
The main factors that affect the distribution of fresh produce vary depending on the country and industry. In the case of the horticultural supply chain, contracts can be sold or picked up in the open market. These contracts typically involve different arrangements for storage and transportation. Different markets exist for different kinds of tomatoes such as the mature green and the vine ripe varieties. For instance, the mature green tomatoes are usually harvested before they reach their maturity stage. *[35]*

Most fresh produce growers have to consider the various factors that affect their cost and operational limits when planning their operations models. These include the demands of the market, environmental factors, and their ability to meet these constraints. The development of an operational model is done so that the various decisions related to the production and marketing of crops have already been made. It implies that the individual who made the decisions has complete knowledge about the varieties and the routes used for transporting them. *[35]*



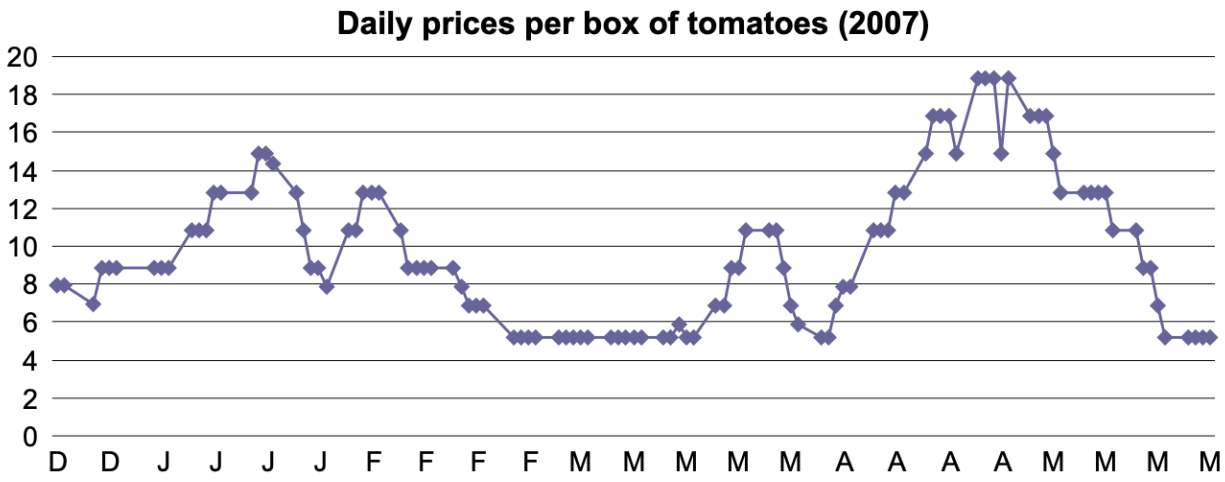
[32] Source: Ahumada, Omar, 2008. Models for Planning the Supply Chain of Agricultural Perishable Products, Ph.D. Dissertation, Arizona State University.

It is also assumed that, since the demand for crops is not expected to increase at the operational planning level, there is not a need to increase the production of crops. It is also assumed that there are historical data on the quality and yield distributions of the crops planted. For planning horizon, we propose a 4-week look-ahead horizon for harvesting and transportation decisions. A planning horizon is a conceptual framework that shows the phases of a farm's harvesting, storage, and transportation. It can be observed from Fig. 3 and is usually applied at least once per week. *[35]*



[32] Source: Ahumada, Omar, 2008. Models for Planning the Supply Chain of Agricultural Perishable Products, Ph.D. Dissertation, Arizona State University.

The limited shelf life of various crops prevents them from being stored for long enough to create a demand-supply imbalance. This causes the industry to under-produce and over-produce. This behavior can be seen in the case of fresh tomatoes, where prices go up when the supply is low and down when the demand is abundant. Tomatoes can also be highly variable during the harvesting season. The daily prices of Tomatoes in the US are shown in Fig. 4. These prices are computed from the data collected by the US Department of Agriculture during the 2007 growing season. The changes in these prices have significant effects on the profitability of the crop. *[35]*



[32] Source: Ahumada, Omar, 2008. Models for Planning the Supply Chain of Agricultural Perishable Products, Ph.D. Dissertation, Arizona State University.

2.1.1 Logistics chain of perishable crops

The primary role of the operational model is to take into account the various aspects of the produce supply chain, such as the distribution of goods and services. This process involves making various decisions related to the procurement, storage, and transportation of goods and services. Customers also have various requirements when it comes to the distribution of their products. This is evidenced by the various types of resources that are required to support this process. *[35]*

The operational model assumes that the transportation modes can handle the varying requirements of the products. However, these modes are not always able to handle the capacity of the final customers. The basic unit of transport is given in containers. It is assumed that all transportation modes are identical and that the same containers are used in all modes. *[35]*

[32] Source: Ahumada, Omar, 2008. Models for Planning the Supply Chain of Agricultural Perishable Products, Ph.D. Dissertation, Arizona State University.

[33]Source: Ahumada, Omar, Villalobos, J.Rene, 2009. Application of planning models in the agri-food supply chain: a review. European Journal of Operational Research 195, 1–20.

[34]Source: Ahumada, Omar, Villalobos, J. Rene, in press. Planning the production and distribution of fresh produce. Annals of Operations Research. doi:10.1007/ s10479-009-0614-4.

[35]Source: Allen, Stuart J., Schuster, Edmund W., 2004. Controlling the risk for an agricultural harvest. Manufacturing and Service Operations Management 6 (3), 225–236. Calvin, Linda, Cook, Roberta, 2001. US Fresh Fruit and Vegetable Marketing:
Emerging Trade Practices, Trends, and Issues. Agricultural Economic Report 795. United States Department of Agriculture.

2.2 Agriculture, transportation, and the COVID-19 crisis

Food supply chains are often interconnected globally. Many of these supply chains have been disrupted due to the COVID-19 pandemic, which could threaten their stability. The brief analysis aims to identify the various modes of transportation that COVID-19 will affect. It includes rail, ocean freight, containerized, and home delivery. In this paper, I discuss the various implications of the COVID-19 pandemic on the supply chain, including the need for continued monitoring and industry engagement, as well as the development of strategies to address the various threats to the supply chain. *[36]*

Due to the rise of consumer pickup and delivery services, the transportation of food has become an integral part of the distribution chain. Many of these services have been affected by the outbreak of the COVID-19 pandemic. Due to the drastic decline in the demand for ocean freight, many companies have stopped transporting COVID-19. This has created an abundance of capacity. This past year, various factors, including a delayed harvest, an early start to winter, and a labor strike, put a significant delay on grain export rail movement. It resulted in long lines at Vancouver's port. Fortunately, grain export rates have started to recover during March. Although not directly impacted by the social distancing rules, this industry could be vulnerable if a large portion of its workforce fell ill. Fortunately, the reduction in non-agriculture rail freight traffic has created a pool of capable workers that can handle the demand for grain and agricultural commodities. *[38]*

Due to the closure of China's COVID-19 production, a shortage of empty containers has developed in Asia. These containers are usually filled with specialty crops that are transported back to Asia. The introduction of COVID-19 regulations will increase the time it takes for containers to enter port and worsen the situation. The demand for specialty crops in international markets will also affect the profitability of ocean transport. Many companies have adopted social distancing protocols to prevent employees from getting injured or killed while delivering goods. Modern transportation systems have separated the labor deployment from the human contact required to operate safely. *[38]*

The most vulnerable groups are those who deliver goods to establishments or grocery outlets that have personal contact with the customers. In March, many long-distance truck drivers reported that they did not have enough time to use the restrooms at rest stops and weigh stations due to the closures of roadside restaurants. To address this issue, governments of various provinces have placed portable toilets at these facilities. *[39]*

In an effort to minimize the impact of COVID-19, various provincial governments increased the hours of service for truck drivers. The availability of tractor units and drivers for transporting agricultural goods is a strong indication of the robust nature of the transportation industry. The drop in diesel prices, which has significantly reduced the cost of trucking, has also helped minimize the impact of the COVID-19 outbreak on the transportation industry. Many of the unanticipated delays that will occur due to the effects of absenteeism

will be caused by factors that will not be immediately fixed, such as temporary plant closures and transportation changes. In order to prevent these issues, governments must step up their efforts to monitor and plan for the recruitment and retention of workers for critical parts of supply chains. Due to the emergence of COVID-19, many households are taking a strict social distancing approach, with the exception of shopping for groceries. This is evidenced by the updated advice for wearing masks. If the SARS-CoV-2 virus can be spread by aerosol or surface contact, then pharmacies and grocery stores are considered very dangerous places. This is because they are the only sources of the virus that can isolate people. *[40] [41] [42]*

An incentivized move away from in-store shopping to availing a service such as grocery pickup or delivery could help minimize COVID-19 externality. There are many people who could be trained to safely pack grocery bags. They could be re-purposed to provide these jobs, especially since there are many UBER drivers and taxi drivers who could also be trained to deliver groceries. It would be simple to expand this program to include all food and drug retailers to hire additional workers to expand their pickup and delivery capacity. This measure would also support the social distancing of consumers and small businesses. *[40] [41] [42]*

The in-store shopping externality of COVID-19 households could make it possible for more people to avoid social distancing and reduce public resources. This measure will allow more consumers to save money and reduce wait times. However, it will also cause some delays in the supply of non-refrigerated shipping containers. The temporary closure of processing plants due to COVID-19 will create temporary demand for transport services. The additional food supply chains created by the social distancing requirement will also require additional public support. *[40] [41] [42]*

Many transportation services are operated by small teams of drivers, which make them more resilient to COVID--19 absenteeism. Also, lower demand for these services will help minimize transportation costs. Even in the event of a severe pandemic, transportation services will still be able to meet the demands of most food supply chains. *[40] [41] [42]*

[36] Source: McKeen, A., & McGran, K. (2020). Missing home, with few places for rest, Canada's truckers embrace their "essential" work amid the pandemic. The Star. Retrieved from https://www.thestar.com/news/canada/2020/04/04/missing-home-with-few-places-for-rest-canadas-truckers-embrace-their-essential-work-amid-the-pandemic.html

[37]Source: Quorum Corporation. (2020). Weekly performance update for grain week 34 (2019-20 CY). Grain Monitoring Program. Retrieved from http://grainmonitor.ca/current_report.html

[38]Source: Shih, W. (2020). COVID-19 and global supply chains: Watch out for bullwhip effects. Forbes. Retrieved from https://www.forbes.com/sites/willyshih/2020/02/21/covid-19-and-global-supply-chains-watch-out-for-bullwhip-effects/#6928db537195

[39]Source: Smieszek, T., Lazzari, G., & Salathé, M. (2019). Assessing the dynamics and control of droplet- and aerosol-transmitted influenza using an indoor positioning system. Scientific Reports, 9(1). https://doi.org/10.1038/s41598-019-38825-y

[40]Source: Tabak, N. (2020). Canada issues hours-of-service exemption for COVID-19 relief. Freight Waves. Retrieved from https://www.freightwaves.com/news/canada-issues-hours-of-service-exemption-for-covid-19-relief

[41]Source: Tellier, R., Li, Y., Cowling, B. J., & Tang, J. W.-T. (2019). Recognition of aerosol transmission of infectious agents: A commentary. BMC Infectious Disease, 19(1), 101.

[42]Source: van Doremalen, N., Bushmaker, T., Morris, D. H., Holbrook, M. G., Gamble, A., Williamson, B. N., … Lloyd-Smith, J. O. (2020). Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. New England Journal of Medicine, 382, 1564– 1567

2.3 European Inland Waterway Transport Platform analysis 2020

The IWT Platform Annual Report 2019 made it clear that it was still juggling multiple tasks in 2020 despite the significant progress that was made in building the organization's structure. However, the pandemic had also affected the platform in various ways. In order to improve processes and increase efficiency, more work was needed to be done in 2020 to streamline them. This was because the set-up budgets were too strict. In 2020, it was decided to bring some flexibility in the workplan. This year, the mid-year review was held, and it was the right time to renegotiate some parts of the budget. *[43]*

In 2020, the IWT Platform recalibration was held in person. The objective was to get a handle on the various aspects of the recalibration, as well as how it would be carried out. The key decisions were then made regarding the hiring of a permanent team member and the study on the Modal Shift. The first phase of the project, which was called "Communication Strategy", was completed in 2019. *[43]*

Work on the European Technology Platforms continues. These platforms play a vital role in the delivery of the R&I Agendas of the European Commission. The European Union's various projects help create strong links between the various sectors and their stakeholders. In 2020, for instance, the CEF was able to attract more interest from the industry. *[43]*

The European matchmaking platform ENTRANCE is a follow-up of the EIBIP project, which was focused on improving the mobility tools and services in Europe. As for PLATINA3, it's a dedicated project that aims to boost the innovation in the inland navigation industry by bringing all IWT partners together. On December 9, 2020, the European Commission launched the follow-up to the EU Green Deal 2020. The document aims to provide a comprehensive overview of the transition to a more sustainable and smart mobility. In order to achieve this, the inland marine transport industry will grow by 25% by 2030. *[43]*

Also, it produces low levels of CO2 emissions, as compared to road transport. This is a plus for the industry as it allows for better transportation options. The uncertainty of 2021 is already affecting everyone involved in the industry and its stakeholders. No one can predict how or when the fight against Covid-19 virus will end, and what the overall damage will be. *[43]*

The impact of the Covid-19 pandemic has been severe and wide-scale. It has affected the profitability of the transport sector and its long-term growth. This is mainly due to the drastic reduction in freight transport and passenger transport during the first half of the year. At the same time, the passenger shipping industry was collapsing at the start of this pandemic, while other segments were also heavily affected. It is the fundamental requirement of the IWT sector to ensure that free movement of crew members and goods in Europe is ensured. During the past year, the sector has continuously called for the introduction of adequate measures to prevent Covid-19 from affecting the industry. *[43] [44]*

The sector also thanked the European Commission for its support in the Recovery & Resiliency Facility and urged the Member States to allocate the necessary funds for the IWT and the energy transition. *[43] [44]*

The IWT sector also welcomed the efforts of the Danube Commission in addressing the Covid-19 crisis. The CCNR took various measures in April 2020 to support the industry in overcoming the crisis. The EU also issued regulations related to the outbreak of Covid-19. The recovery of the IWT sector is not only about making it stronger from the Covid-19 crisis, but also about pushing it forward to become more sustainable and digitalized. This is the reason why the sector has to be at the forefront of the Green Deal. *[43] [44]*

2.3.1 What are the future perspectives for sustainable and innovative inland navigation?

2020 was the first year that the I&G Committee fully functioned. The committee's focus was on the Greening part of the digital economy. The topics covered by the DTLF remained top of mind for the IWT sector. In order to address these issues, a mini-DTLF was set up One of the

objectives of this project is to make sure that the eFTI fits well with what is already in place in the IWT. Another is to make sure that C.I.S. is a part of the overall transport system that is integrated seamlessly. *[43] [44]*

The RIS COMEX project is a multi-purpose project that aims at establishing a framework for the operation and management of Corridor RIS Services. It is not yet far away from the C.I.S. The IWT Platform members are being actively involved in the discussions related to the RIS and the use of digital documents in the supply chain. The main topic of discussion was Europe's strategy on data. Although the various workshops mentioned above were very useful, they are still far away from the daily requirements of the operators and barge-owners. Transition was the key word in Greening in 2019. Both the European Union's latest Green Deal and the end of the Horizon 2020 program highlighted the importance of shifting towards a low-carbon economy. *[43] [44]*

The industry needs a push towards greening, but the timeline for this is still not yet clear. This is the reason why the concept of a green transition is becoming an absolute necessity for the industry. In 2020, the CCNR and some of its Member States launched a study on the financing for the IWT's energy transition. The objective of this project was to establish a strategy for the transition and to provide a comprehensive analysis of the various aspects of the IWT's operation. *[43] [44]*

As a result of the various developments that happened in 2020, a transition period for the Non-Road Mobile Machinery emissions was also being looked at. As a result, the transition period for ships that are going to install transition engines has been extended. This means that those who want to replace their old engines with a new CCR2 can do so for one year longer than previously stated. The secretaries of the I&G Committee take the time to listen to their partners and to develop effective solutions. Not only do they listen to their partners, but they also create opportunities for cross-party collaboration. *[43] [44]*

The key question remains: how can the goals be achieved in a sustainable and economical way? As the industry and regulators work together, how can we make the transition happen in a way that is both economical and sustainable? *[43] [44]*

2.3.2 What is the focus on waste and safety regulations in International inland navigation?

The Committee has been involved in the various phases of the Convention on the collection, reception, and disposal of waste generated by ships and cargo on inland waterways. *[43] [44]*

The cost of disposing of solid waste in the various CDNI Contracting States exceeds the fees that are being collected. This issue could have led to a feared deficit in the financing system. It is also important to analyze the system in order to identify potential future adjustments. This can be done by studying how it operates and what kinds of changes it needs to make. *[43] [44]*

The Round Table meeting was supposed to discuss the various working methods and financing mechanisms utilized for the operation of the CDNI system. A survey has been developed to gather opinions about the existing service level and the industry's wish for the future. This survey is intended to be carried out in 2021. As the proposal is being forwarded for approval in Switzerland, France, Belgium, and Switzerland, the industry has already reacted positively to the proposal. *[43] [44]*

The 37th annual meeting of the UNECE's Dangerous Goods Committee was postponed to 2021. It was replaced by a meeting in 2021. As a result, the annual meetings of the ADN Safety Committee were also postponed to 2021. One of the most important topics of the meeting were the transition from the EBIS system to SIRE, which took place on January 1, 2021. The shipping industry was very satisfied with the system in the past, and it is now worried about the changes in the future. The new degassing regulations will only be effective after the last Contracting State has ratified and deposited its document of ratification. In Belgium and Switzerland, however, the process is not yet complete, and it is not expected to happen in 2021. This means that the regulations will most likely not be introduced in 2021. *[43] [44]*

In addition, the provisions of the ADN are often not followed by both tanker and dry cargo ships. For instance, if a ship is carrying substances that are not required for explosion protection, but which require the carrying of documents, this does not apply to the tanker. The issue of opening of cargo tanks and sampling will be discussed in Geneva in 2021. The Dangerous Goods Committee will then take over the task. The provisions of the ADN do not meet the requirements of the current practice. The IWT Platform experts were also invited to contribute to the Working Group. *[43] [44]*

The participants discussed various topics related to the operation of cargo tanks. Some of these included the following: empty cargo tank check, cleanliness check, and gas free measuring. The ADN Expert Training Working Group met in 2020 to update and improve the questions for the basic examination. In December 2020, the group also discussed and updated the provisions of the ADN 2021. The Dangerous Goods Committee will focus on the safe transportation of dangerous goods in 2021. The Committee sends its members to the ADN Safety Committee in August 2021. *[43] [44]*

2.3.3 What is the focus on waste and safety regulations in International inland navigation?

The Committee has been involved in the discussions on the legal framework of the Convention on the collection, reception and disposal of waste generated by ships and cargo on the Rhine and other inland waters. *[43] [44]*

The actual costs of waste collection in the participating countries of the CDNI are exceeding the fees that they are required to pay. This issue could have caused a deficit in their financing system in 2021. It is high time to analyze the existing system and its various components in order to identify future adjustments. Following the Covid-19 severe repercussions, the

meeting was postponed to 2021. It was then decided that the Committee would draft a common stand that would represent the position of the inland navigating industry. *[43] [44]*

This survey is intended to gather opinions on the current system and its implementation. The results will be used in the first semester of 2021. The meeting of the UNECE's ADN Safety Committee, which was supposed to take place in January 2021, was postponed to January 2021. These meetings are attended by various representatives of the various parties involved in the Dangerous Goods Committee. Some of these include the ministries of the concerned countries, safety experts, and various industry associations. Aside from the ADN Safety Committee meetings, other important topics were also being discussed by the inland navigation industry. One of these is the transition from Ebis to SIRE on January 1, 2021. *[43] [44]*

The shipping industry has been very satisfied with EBIS since it was introduced. However, with the transition to SIRE, many uncertainties still remain. The IWT Platform has issued a letter of guidance to all parties regarding the transition from EBU to SIRE. The Dangerous Goods Committee is still monitoring the implementation of the new regulations on degassing. In Germany, the Netherlands, Luxembourg, and the UK, the document has already been deposited. Unfortunately, the new degassing regulations will not come into force in 2021. This is because the process for ratifying the regulations is dragging on too long. *[43] [44]*

Due to the complexity of the regulations, it is often difficult to implement the provisions of the ADN. The ADN requires the carrying of documents on board, but this is rarely necessary when a tanker is carrying substances that do not require explosion protection. Dry cargo vessels, on the other hand, are not clear on this issue. The issue of opening of cargo openings will be discussed in August 2021 at a meeting of the Dangerous Goods Committee in Geneva. *[43] [44]*

The provisions of ADN do not meet the requirements of today s practice and are not always clear. This issue was raised by the experts of the IWT Platform. The committee members identified three main topics that need to be addressed in order to improve the safety and efficiency of the cargo handling process. These topics are empty cargo tank check, cleanliness check, and gas free measuring and tank washing. The ADN Expert Training Working group was the only group that managed to meet in 2020 and discuss the various questions that were included in the catalogue. *[43] [44]*

The Committee members worked on improving the wording of the questions in order to make the examination easier. However, they did not discuss the duration of the examination and the various answer options. The Dangerous Goods Committee will continue its work on the topic of safe transport of dangerous goods in 2021. In 2021, it will also use the Platform to discuss topics related to inland waterways. *[43] [44]*

2.3.4 What is the focus on education and social regulations in International inland navigation?

The Committee's activities are related to the crew's work on board ships and the training and education in inland navigation. The Committee meetings were held in 2020 with the participation of representatives of the EBU and the ESO. A brainstorming session was also organized for member companies. In 2020, a new Sub-Working Group was established to discuss the working time of social partners. The deadline for the implementation of the Professional Qualifications Directive is approaching quickly. *[43] [44]*

Most of the standards that are required to implement the Professional Qualifications Directive have been adopted. Important ones include the basic safety training and the practical examination of OL. In January 2020, the Committee had a brainstorming session with various industry representatives to discuss the suggestions made by the TASC report. The Committee members agreed that the regulations should be flexible and modern to respond to changes in the market. Using CESNI standards can help make legislation more responsive and predictable. It can also help avoid confusion and make the rules more voluntary. *[43] [44]* Aside from the elements mentioned in TASCS, other components such as the RPN and other crew regulations will also be taken into account. This includes the modes of operation and tables. The new manning regulation is not a final draft, and many questions still need to be answered in detail. The roadmap does not provide a definite draft, but it is a good basis for its elaboration. It is important to distinguish the manning regulation from the working time regulations. In most cases, the former is more advantageous since it allows employees to work more efficiently, and it enables employers to control their working hours. *[43] [44]*

Since 2018, the Social Partners Working Group has been dealing with the various social security issues that arise when workers are onboard a ship. Since the main focus of the Working Group was the river cruise industry employees, the representatives of this sector were also included in the group. *[43] [44]*

During the course of the course of the pandemic, river cruise companies provided valuable insight regarding their contractual details. As a result, the Working Group was organized again in 2020 to gather more social partners. The Committee took stock of the discussions on the various issues that affected the Fit Check program and its future work. Among the changes was the shifting of the issue due to the Covid- 19 pandemic. The goal of the Fitness Check is to ensure that all regulations related to the operation of carriers of goods by waterway are completed by the end of 2020. There are two groups of regulations related to social regulations that the check should address. *[43] [44]*

Although the directive is very important, it is handled differently in different Member States. The Committee wants to improve it and make it more useful for European SMEs. Among the regulations that are being discussed is the posting of workers. This directive will affect the navigation of inland vessels. As a result, various points have already been identified for the upcoming fitness check. The Committee is looking forward to working on the roadmap of the

new European Manning Regulation and to start preparing the draft of the new social security system. This will be the last task that the committee tackles in 2021. *[43] [44]*

2.3.5 What is the focus on technical regulations in International inland navigation?

The committee's main objective in 2020 was to develop and implement regulations that will improve the safety and efficiency of inland vessels. The committee also pays attention to the various police regulations that apply to the IWT sector. The work plan for 2020 was largely based on a work plan of the European Working group on technical regulations (CESNI/PT). The European inland navigation organizations told the CESNI Committee that the operators should not suffer due to the implementation of Covid-19, as it would affect their certification. The organizations requested to carry out a review of the work program's priority areas. *[43] [44]*

The NTC has provided its contribution to the mid-term review of the work programme of the CESNI/PT. The working group discussed the various input received from various participants and concluded that the current work program should be evaluated periodically. The ES-TRIN is regularly updated to reflect the latest technological developments and to ensure the highest level of safety on inland waterways. In 2021, the Committee has adopted a new edition of the standard. The European Union and the CCNR may apply ES-TRIN 2021, which is not binding, in their respective legal framework. This Standard will be enforced from January 2022, in a coordinated way. *[43] [44]*

Freeboard and draught marks reduction. Sound level thresholds for both underway and stationary vessels. Portable fire extinguishers. Door locks in passenger vessels. At the end of 2019, CESNI held a workshop on collisions between bridges and inland vessels. The human factor was also highlighted as one of the main factors that led to the accidents. The Committee decided to carry out further studies on this issue in order to identify possible solutions. The Dutch Ministry of Water Management has initiated a study on human factors that contribute to inland navigation accidents. The study is funded by the IWT Platform and the IVR. *[43] [44]*

The findings were focused on five main factors that affected the operations of the vessel: human factors, processes, equipment, and organizational culture. The factors were analyzed using a variety of tools and methods. The report "Human factors that cause inland navigation accidents" was published in 2015. It pointed out that the lack of human-machine interfaces in the wheelhouse has led to the emergence of bad human-machine interfaces. The Committee has already formulated various research questions related to the layout of wheelhouses and human-machine interfaces. Some of these are: what is the ideal wheelhouse design for minimizing human error? *[43] [44]*

The following year, the Platform received an offer for a study on human factors that cause accidents in inland navigation. The objective of the study is to find out how these factors can be linked to the human-machine interface (HMI). *[43] [44]*

A roadmap for the inland shipping industry was established by the CESNI Committee in 2006. This document sets out two action points related to the reduction of vibrations and noise in inland vessels. There are also various measures that inland navigation operators can take to reduce the noise pollution in their vessels. In addition, the effects of different measures vary depending on the ship's design and the environment. In most cases, the most economical and least expensive solutions are chosen first. *[43] [44]*

The Working Group CESNI/PT is developing a safe use of winches guideline for inland vessels. This platform was established to enhance the safety of inland vessels by pooling the knowledge of various parties involved in the marine industry. There were many incidents in 2018 and 2020 when the cords of lifejackets got tangled in the anchor winch. The Working Group CESNI/PPT has been discussing the non- conformity of the regulations for lifejackets in 2016/425. This Committee has also proposed a way to improve the communication between the manufacturers and the users. *[43] [44]*

2.3.6 What is the focus on inland waterways and how to maintain / improve this infrastructure?

In 2020, the Committee was following the work of various parties involved in the field of infrastructure, such as the European Commission and the Trans-European Transport Network. It also participated in the discussions concerning the protection of the Danube and the Rhine. Despite the importance of infrastructure to the mobility of the European Union, its underinvestment remains significant. According to the European Commission, the total amount of infrastructure investment declined from 2009 to 2017, and the investment in inland ports is expected to reach around EUR 47 billion by 2030. *[43] [44]*

The European Union's transport infrastructure policy aims to promote connectivity across Europe and reduce regional, social, and economic disparities. This policy is based on Regulation 1315/2013. The Committee has been involved in the revision of the IWT-2020 agenda. Its main objective is to get more EU funding for the infrastructure related to IWT. To achieve this, the Committee has identified a wider waterways network as one of the goals. *[43] [44]*

The goal is to double the share of inland waterway transport within the next 30 years. This requires the establishment of new inland waterway ports and other infrastructure. Currently, only the biggest waterways are eligible for CEF funding. The Committee has proposed to lower

that threshold to allow for waterways with class III and higher to be considered for funding. *[43] [44]*

The future TEN-T policy will require the proper and regular maintenance of inland waterways. Also, the implementation of climate-resistant infrastructure. The Committee participated in the various phases of the TEN-T corridor fora. As part of its work, the Committee also coordinated with the experts on the various aspects of the waterways. *[43] [44]*

The IWT is also involved in the FAIRway Danube project, which is a flagship project of INEA. It aims to improve the safety, environmental friendliness, and efficiency of inland navigation along the Danube. Climate change has led to an increase in the frequency of low water periods on rivers across Europe. The Danube and the Rhine have experienced these periods more than once. The effects of the low water on the river systems were significant. The disruptions in the supply chain caused by the lack of water affected the entire value chain. Climate change is already threatening the stability of inland navigation transport. This is why it is necessary to adapt our infrastructure to this phenomenon. *[43] [44]*

Sector representatives have requested the authorities to limit the number of blockades and the availability of mooring places for vessels. This has led to a multi-year work on the FAIRway2 Danube, which is also ongoing. The project involved the establishment of a series of national action plans for waterway management. The Danube Master Plan is a tool that can be used to coordinate the management of the river's navigation. Its results were presented in 2020 and were well-received by the public. *[43] [44]*

The IWT sector asked the French Ministry of Transport to carry out a full operation of the locks in Gabcikovo. Due to the closures, one of the lock chambers was opened a month earlier than expected. Works related to the restoration of the locks of Gerstheim, Fessenheim, Volgelgrn, and Strasbourg have been carried out in 2020 under a special support program. A study on the possible locations of additional mooring places for hotel ships along the French bank of The Upper Rhine has been concluded. The study on the cargo vessels' needs will be carried out shortly. *[43] [44]*

A study on the Rhine's cargo berths is planned for 2021. A steering committee has been established for the cooperation between the VNF and the EDF. This step involves carrying out a survey to identify potential areas of improvement for public mooring facilities in the project countries. *[43] [44]*

[43] Source: Guideline: Safe use of Winches in the Inland Barging Industry; Guideline: Veilig gebruik van lieren in de Binnenvaart ; Leitfaden: Sicherer Einsatz von Winden in der Binnenschifffahrt

[44]Source: European Inland Waterway Transport Platform -https://www.inlandwaterwaytransport.eu/wp-content/uploads/IWT-Platform-2020-Annual-Report.pdf

3 Defining transportation modelling

4.1 Hydrological transport model

Whilst many definitions exist defining transportation modeling it is primarily a mathematical tool using computer software to represent an actual transport system (the real world) to forecast travel patterns and flows between origins and destinations in geographic space by different modes „ (Victoria Transport Policy Institute). *[45]*

A hydrological transport model is a type of mathematical model that is used to simulate the flow of water and to determine the quality of its water. It was mostly used during the 1960s and 1970s due to the environmental legislation. Much of the original work on the models originated in the US and the UK. Today, they are used globally. The goal is to determine if the model is distributed or lumped. For instance, if the model is simple, then only one pollutant may be addressed from a point discharge. In complex models, different sources of pollutants may be treated in a dynamic environment. *[45]*

A model is often based on a physical model. If its parameters can be observed in the field, it is referred to as physically based. Generally, a model has several modules that deal with various aspects of land use. A hydrological model is often used to describe a river's course and its effects on a given environment. It can also be used to evaluate the effects of different types of pollutants on a given environment. *[45]*

A comprehensive model is a representation of a process or set of processes that are observable in the real world. It can be used to describe processes such as surface runoff and subsurface flow. The Stanford Watershed Model was the first model to integrate the various sub models for basin-wide chemical hydrology. The modern versions of this model are the SWMM, the HSPF, and the SWMM. The transport and flow processes are represented by partial differential equations or empirical models. Some of the main sub models are involved in the following areas: Evapotranspiration, Channel Flow, and Sediment Transport. *[45]*

Although some models have a chemistry component, most of them are designed to handle the latest data sources. Black box systems are used to model processes using data. They are typically linked to a certain input (rainfall) and output (runoff). The surface runoff element is a key component of a hydrologic transport model and plays a crucial role in the assessment of chemical contaminants. The unit hydrograph theory has been used to integrate water chemistry into model protocols. *[45]*

The Clean Water Act prompted the US Environmental Protection Agency to develop water quality models. One of these was a surface runoff model that was first tried at the Southeast Water Laboratory. The focus on surface contaminant models has not been matched by the emphasis on pure water chemistry models. In the US, the EPA has a hard time interpreting different proprietary contaminant models. The model was applied to four different countries to estimate the transport of nitrogen, phosphorus, and suspended sediment. The results

indicated that the model is more accurate than a statistical method in estimating the nutrient transport. *[45]*

The concept of a transport model for suspended sediment was developed and tested in tropical and semi-arid regions. It was able to simulate the riverine total nitrogen content and the transport loads of suspended sediment. The main conclusion of this study was that the model could be used to predict the transport of materials in a drainage basin during stationary periods but cannot be generalized to areas not specifically affected by the model. The US EPA's DSSAM Model was used to analyze the impacts of various water quality decisions in the Truckee River basin. It predicted the presence of dissolved oxygen, nitrogen, and sediment in the river. The DSSAM Model is based on the Total Daily Load metric known as TDML. It allows the EPA to manage many river systems in the U.S. through a dynamic approach., which is similar to the concept of the Total Daily Load. *[45]*

3.1.1 Hydrological Transport Model – Literature review

The physical model can be used for simulation of hydrological transport system while the statistical method is used for determining the flow dynamics. The velocity of an open channel can be determined by dividing it into steady and unsteady flow. The flow can also be divided into smooth and unsteady flow. These equations are commonly used to simulate the link between hydraulic parameters and a certain position. They can be utilized for steady flow calculation. However, for unsteady flow, the empirical equations are limited. *[45]*

The mass balance and the Navier-Stokes momentum equations are the essential components of flow simulation. They are partial differential equations that are used to describe the spacial and temporal dynamics. The dimension and the equation form are computed as the relative scale of the research objects and the requirements of accuracy are specified.

$$\frac{\partial Q}{\partial t} + gA\frac{\partial y}{\partial x} + \frac{\partial Q^2}{A\partial x} = gA(S_0 - S_f)$$

$$\frac{\partial A}{\partial t} + \frac{\partial Q}{\partial x} = q$$

where Q = discharge; t = time; x = distance along the channel; g = gravity acceleration; S0 = bottom slope of the channel; Sf = momentum slope in the channel; q = lateral inflow per unit length along the channel. *[45]*

3.1.2 Hydraulic Information Collection

This discipline includes the geometric elements and the various hydrological variables required in a hydrological model. The data collected during field survey and observation should be used to collect the necessary information for a successful hydrological transport model. *[45]*

3.1.3 Model Calibration and Validation

The calibration of hydrological models is a process that involves various limitations. Some of these are nolinearity, scale, equifinality, uncertainty, and uniqueness. The generalized likelihood uncertainty estimation (GLUE) is a direct optimal approach that is commonly used in hydrologic modeling. The objective of this research is to compare the 3 optimization algorithms that were used in the study of the HYDRU-1D model with the observed data. The procedure for validating the results is known as validation. The proposed method is based on the calibrated FEQ model for simulation of unsteady flow in 3 flooded periods. *[45]*

This project aims to retrieve hydrological data from DEM and integrate them with other data in the FEQ model for open- channel un- steady flow simulations. *[45]*

3.1.3.1 Research Questions

1. How to retrieve hydrological information from DEM?
2. How to design the GUI to link the Hydro Preprocessing with FEQ? 3. How to integrate the information into FEQ model?
4. How to calibrate the FEQ model by observed data?

From the research questions described in previous subsection, 4 specific objectives are divided from the main objective.

1. To retrieve information for DEM by Hydro Preprocessing.
2. To develop an interface for linking Hydro Preprocessing with FEQ model.
3. To integrate required information into FEQ model for unsteady flow simulation.
4. To calibrate the FEQ model and validate the result.

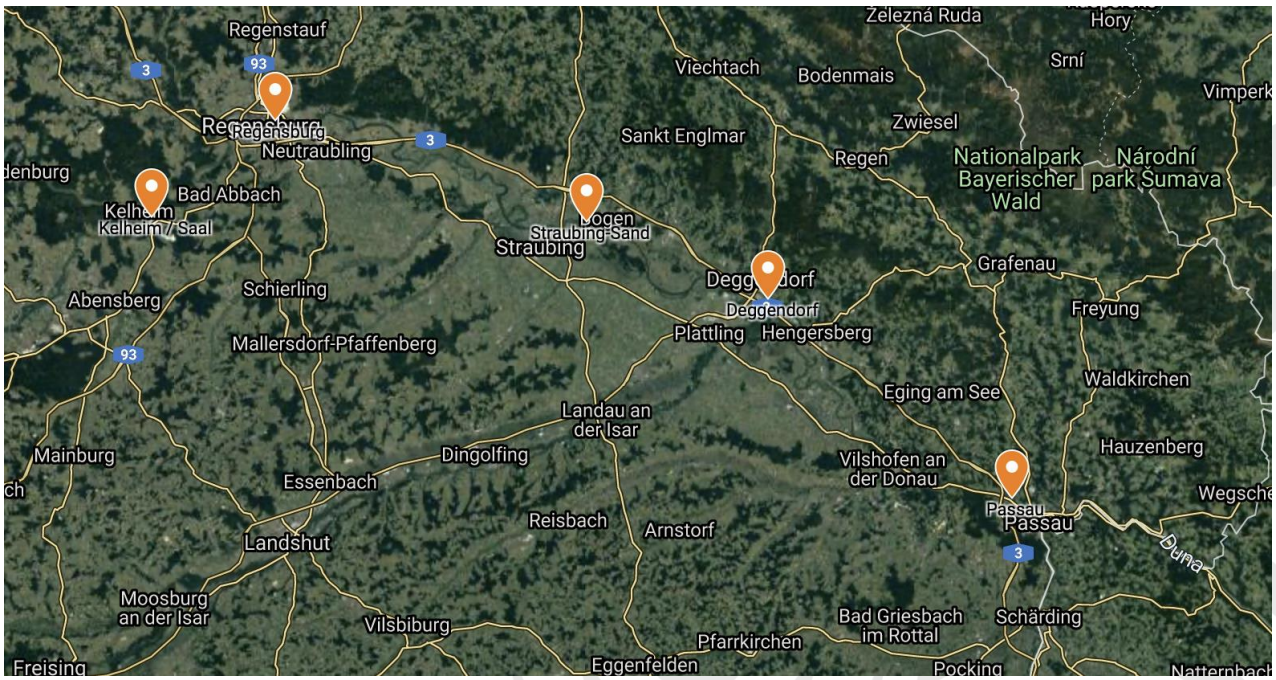
[45] Source: https://webapps.itc.utwente.nl/librarywww/papers_2010/msc/wrem/yin.pdf

4 The use of transportation modelling

4.1 Ports of Danube

Germany

Port	Km	Website E-Mail	General cargo	Bulk cargo	Liquid cargo	Containers	Ro-Ro
Kelheim	2411	www.hafen-kelheim.de post@hafen-kelheim.de	√	√	√	√	√
Regensburg	2373-2379	www.donauhafen.de regensburg@bayernhafen.de	√	√	√	√	√
Straubing	2312,3	www.hafen-straubing.de info@straubing-sand.de	√	√	X	√	√
Deggendorf	2282,92-2283,87	www.hafen-deggendorf.de info@hafen-deggendorf.de	√	√	√	√	√
Passau	2228,38-2233,45	www.bayernhafen.de passau@bayernhafen.de	X	√	X	√	√



Kelheim is a Medium-sized Port. The types of vessels regularly calling at Kelheim are Inland, Motor Freighter (50%), Inland, Unknown (12%), Inland, Passenger Ship, Ferry, Cruise ship (10%), Inland, Passenger Ship without Accommodation (2%). Maximum length of the vessels recorded to having entered this port is 172 meters. The maximum draught is 2.5 meters. *[46]* Kelheim is located at Inland, Europe, Inland, Europe in Germany at coordinates N 48° 54' 40.20" - E 011° 53' 38.97". The official UN/Locode of this port is DEKEM. *[46]*

Regensburg is a Large-sized Port. The types of vessels regularly calling at Regensburg are Inland, Motor Freighter (51%), Inland, Passenger Ship, Ferry, Cruise ship (14%), Inland, Unknown (13%), Inland, Cruise Ship (6%), Inland, Motor Freighter Pushing Freighter(s) (3%). The maximum length of the vessels recorded to having entered this port is 213 meters. The maximum draught is 3.2 meters. The maximum Deadweight is 6400t. *[46]*

Regensburg is located at Inland, Europe, Inland, Europe in Germany at coordinates N 49° 01' 17.39" - E 012° 06' 03.59". The official UN/Locode of this port is DEREG. *[46]*

Straubing is a Medium-sized Port. The types of vessels regularly calling at Straubing are Inland, Motor Freighter (46%), Inland, Passenger Ship, Ferry, Cruise ship (15%), Inland, Unknown (10%), Inland, Cruise Ship (7%), Inland, Pushtow, two cargo barges (5%). The maximum length of the vessels recorded to having entered this port is 190 meters. The maximum draught is 2.7 meters. *[46]*

Straubing is located at Inland, Europe, Inland, Europe in Germany at coordinates N 48° 53' 33.00" - E 012° 34' 21.00". The official UN/Locode of this port is DESTB. *[46]*

Deggendorf is a Medium-sized Port. The types of vessels regularly calling at Deggendorf are Inland, Motor Freighter (43%), Inland, Passenger Ship, Ferry, Cruise ship (14%), Inland, Unknown (14%), Inland, Pushtow, two cargo barges (6%). The maximum length of the vessels recorded to having entered this port is 190 meters. The maximum draught is 2.5 meters. *[46]*

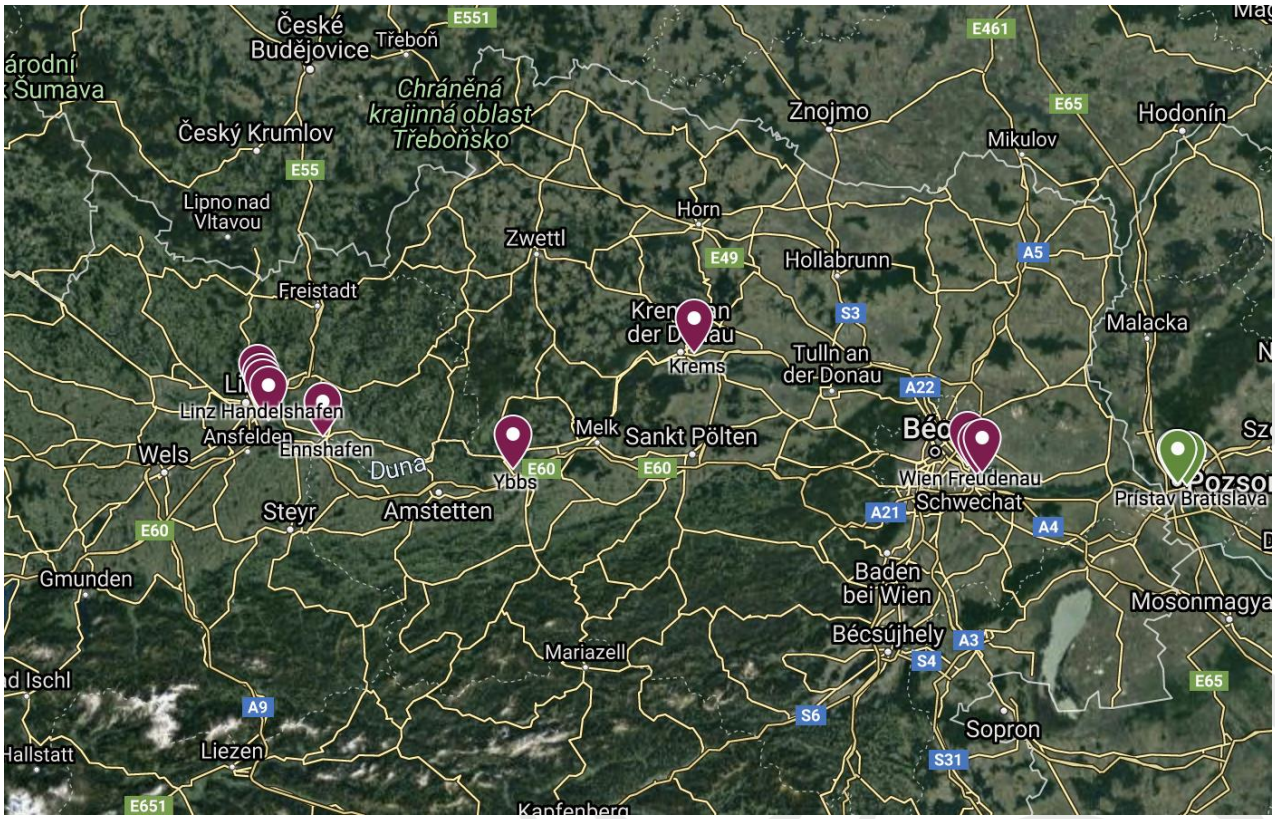
Deggendorf is located at Inland, Europe, Inland, Europe in Germany at coordinates N 48° 48' 46.79" - E 012° 57' 34.19". The official UN/Locode of this port is DEDEG. *[46]*

Passau is a Large-sized Port. The types of vessels regularly calling at Passau are Inland, Motor Freighter (35%), Inland, Passenger Ship, Ferry, Cruise ship (25%), Inland, Cruise Ship (12%), Inland, Unknown (12%), Inland, Pushtow, two cargo barges (3%). The maximum length of the vessels recorded to having entered this port is 190 meters. The maximum draught is 2.6 meters. The maximum Deadweight is 248t. *[46]*

Passau is located at Inland, Europe, Inland, Europe in Germany at coordinates N 48° 33' 57.60" - E 013° 26' 20.40". The official UN/Locode of this port is DEPAS. *[46]*

Austria

Port	Km	Website E-Mail	General cargo	Bulk cargo	Liquid cargo	Containers	Ro-Ro
Linz	2128,1-2130,7	www.linzag.at hafen.linz@linzag.at	√	√	√	√	√
Linz Ind.-Hafen	2124,73	www.felbermayr.cc hafen@felbermayr.cc	√	√	√	√	√
Enns-Ennsdorf	2112	www.ennshafen.at office@ennshafen.at	√	√	√	√	√
Ybbs	2057,67	www.hafen-ybbs.at office@schaufler-metalle.com	√	√	X	√	X
Krems	1998	www.mierka.com office@mierka.com	√	√	X	√	X
Wiener Hafen	1917-1918-1920	www.wienerhafen.com office@wienerhafen.com	√	√	√	√	√



Linz is a Medium-sized Port. The types of vessels regularly calling at Linz are Inland, Motor Freighter (33%), Inland, Passenger Ship, Ferry, Cruise ship (20%), Inland, Unknown (9%), Inland, Cruise Ship (6%), Inland, Pushtow, two cargo barges (6%). The maximum lengthof the vessels recorded to having entered this port is 283 meters. The maximum draught is 2.8 meters. The maximum Deadweight is 4585t. *[46]*

Linz is located at Inland, Europe, Inland, Europe in Austria at coordinates N 48° 18' 47.05" - E 014° 18' 49.84". The official UN/Locode of this port is ATLNZ. It is also known as Hafen Linz. *[46]*

Meldorfer Hafen is a Small-sized Marina/Local Harbour. The maximum length of the vessels recorded to having entered this port is 23 meters. *[46]*

Meldorfer Hafen is located at UK Coast & Atlantic, North Sea in Germany at coordinates N 54° 05' 27.95" - E 008° 57' 24.01". The official UN/Locode of this port is DEMEL. It is also known as MELDORF. *[46]*

Ybbs Persenbeug is a Large-sized Port. The types of vessels regularly calling at Ybbs Persenbeug are Inland, Motor Freighter (36%), Inland, Passenger Ship, Ferry, Cruise ship (20%), Inland, Unknown (11%), Inland, Pushtow, two cargo barges (6%), Inland, Cruise Ship (6%). The maximum length of the vessels recorded to having entered this port is 283 meters. The maximum draught is 2.7 meters. The maximum Deadweight is 4585t. *[46]*

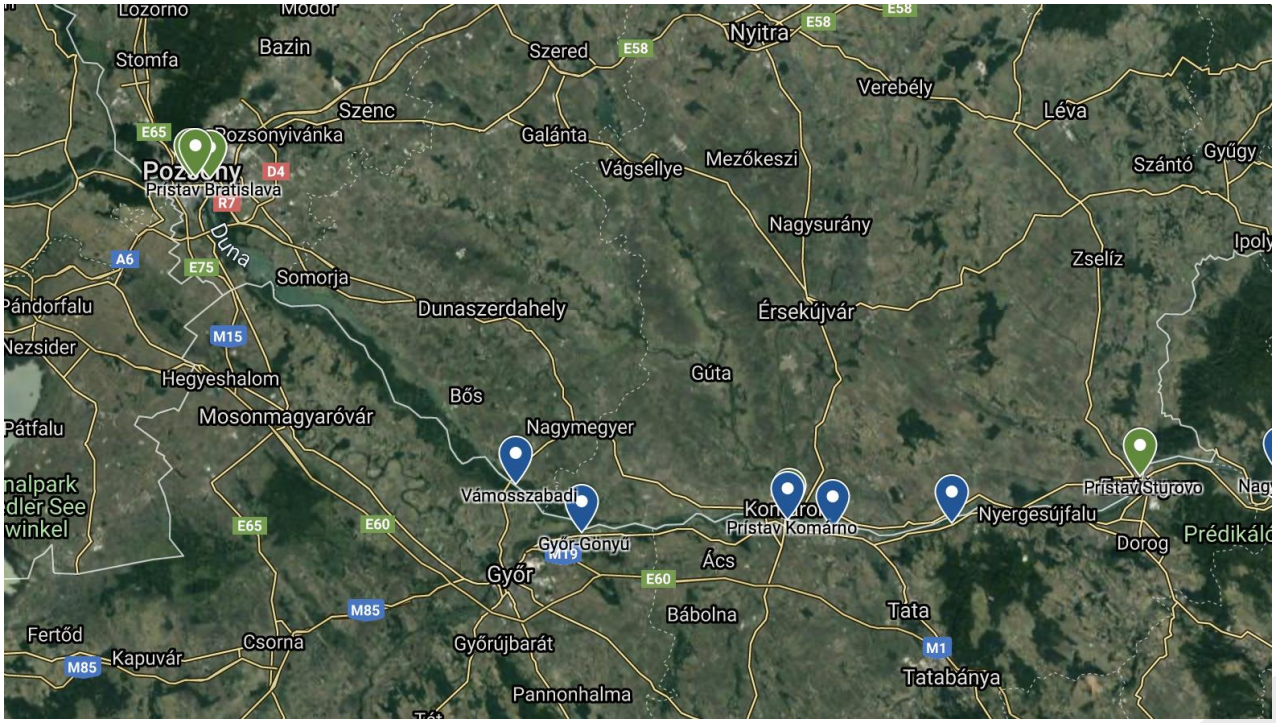
Ybbs Persenbeug is located at Inland, Europe, Inland, Europe in Austria at coordinates N 48° 11' 29.39" - E 015° 03' 59.39". The official UN/Locode of this port is ATPBU. *[46]*

Krems is a Medium-sized Port. The types of vessels regularly calling at Krems are Inland, Motor Freighter (37%), Inland, Passenger Ship, Ferry, Cruise ship (16%), Inland, Unknown (13%), Inland, Pushtow, two cargo barges (8%), Inland, Cruise Ship (3%). The maximum length of the vessels recorded to having entered this port is 283 meters. The maximum draught is 2.7 meters. The maximum Deadweight is 6400t. *[46]*

Krems is located at Inland, Europe, Inland, Europe in Austria at coordinates N 48° 24' 18.73" - E 015° 38' 36.43". The official UN/Locode of this port is ATKRE. *[46]*

Slovakia

Port	Km	Website E-Mail	General cargo	Bulk cargo	Liquid cargo	Containers	Ro-Ro
Bratislava	1867	www.spap.sk spap@spap.sk	√	√	√	√	√
Komarno	1769	www.spap.sk spap@spap.sk	√	√	X	√	X



Bratislava is a Large-sized Port. The types of vessels regularly calling at Bratislava are Inland, Passenger Ship, Ferry, Cruise ship (27%), Inland, Motor Freighter (19%), Inland, Unknown (11%), Inland, Cruise Ship (9%), Inland, Pushtow, two cargo barges (7%). The maximum length of the vessels recorded to having entered this port is 283 meters. The maximum draught is 2.8 meters. The maximum Deadweight is 2500t. *[46]*

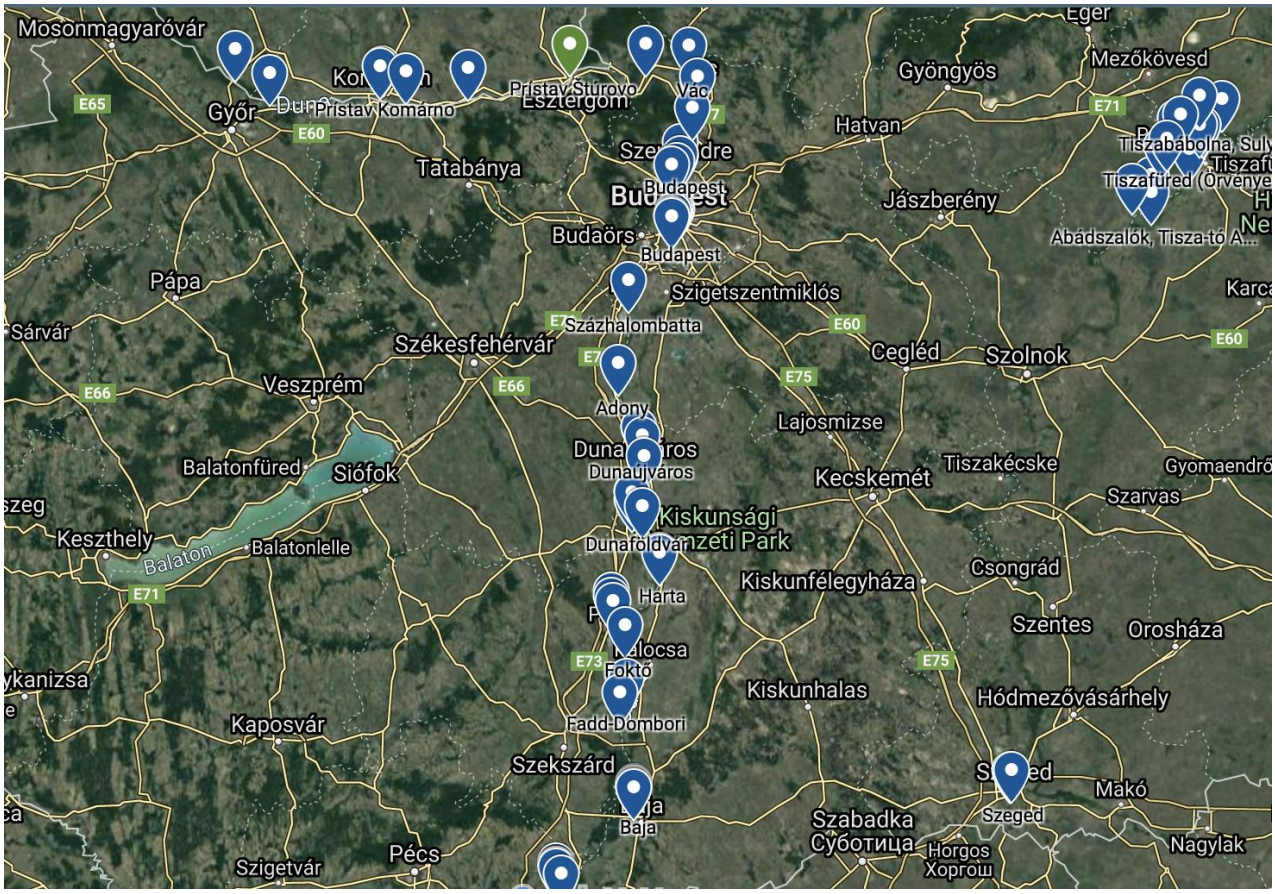
Bratislava is located at Inland, Europe, Inland, Europe in Slovakia at coordinates N 48° 08' 07.79" - E 017° 07' 44.40". The official UN/Locode of this port is SKBTS. *[46]*

Komarno is a Medium-sized Port. The types of vessels regularly calling at Komarno are Inland, Motor Freighter (22%), Inland, Passenger Ship, Ferry, Cruise ship (15%), Inland, Unknown (13%), Other (1%). The maximum length of the vessels recorded to having entered this port is 283 meters. The maximum draught is 2.7 meters. The maximum Deadweight is 1655t. *[46]*

Komarno is located at Inland, Europe, Inland, Europe in Slovakia at coordinates N 47° 45' 16.20" - E 018° 07' 08.39". The official UN/Locode of this port is SKKNA. *[46]*

Hungary

Port	Km	Website E-Mail	General cargo	Bulk cargo	Liquid cargo	Containers	Ro-Ro
Győr-Gönyű	1794	www.portofgyor.hu info@portofgyor.hu	√	√	√	√	√
Komárom	1767	www.avanti.hu avanti@axelero.hu	√	X	X	X	X
Budapest	1639,70	www.portofbudapest.hu zs.szabo@portofbudapest.hu	√	√	√	√	√
Dunaújváros	1579-1580	www.portolan.hu dfkikoto@portolan.hu www.dunaferrkikoto.freeblog.hu centroport@centroport.hu	√	√	X	X	X
Dunaföldvár	1560	www.avanti.hu avanti@axelero.hu	√	X	X	X	X
Baja	1479,5–1480	www.portofbaja.hu info@portofbaja.hu	√	√	√	√	√
Mohács	1450,1	www.bolyrt.hu sajnovics@bolyrt.hu	√	√	X	X	X



Gyor is a Medium-sized Port. The maximum length of the vessels recorded to having entered this port is 11 meters. *[46]*

Gyor is located at Inland, Europe, Inland, Europe in Hungary at coordinates N 47° 41' 00.00" - E 017° 37' 59.99". The official UN/Locode of this port is HUGYO. *[46]*

Komarom is a Medium-sized Port. The types of vessels regularly calling at Komarom are Inland, Motor Freighter (35%), Inland, Passenger Ship, Ferry, Cruise ship (13%), Inland, Pushtow, two cargo barges (9%), Inland, Unknown (9%), Inland, Motor Freighter Pushing Freighter(s) (3%). The maximum length of the vessels recorded to having entered this port is 283 meters. The maximum draught is 3 meters. The maximum Deadweight is 4585t. *[46]*

Komarom is located at Inland, Europe, Inland, Europe in Hungary at coordinates N 47° 45' 02.70" - E 018° 07' 09.12". The official UN/Locode of this port is HUKOM. *[46]*

Budapest is a Large-sized Port. The types of vessels regularly calling at Budapest are Inland, Passenger Ship, Ferry, Cruise ship (21%), Inland, Motor Freighter (20%), Inland, Cruise Ship (12%), Inland, Unknown (10%), Inland, Passenger Ship without Accommodation (3%).

The maximum length of the vessels recorded to having entered this port is 311 meters. The maximum draught is 3 meters. The maximum Deadweight is 3199t. *[46]*

Budapest is located at Inland, Europe, Inland, Europe in Hungary at coordinates N 47° 30' 08.77" - E 019° 02' 29.63". The official UN/Locode of this port is HUBUD. *[46]*

Dunaujvaros is a Medium-sized Port. The types of vessels regularly calling at Dunaujvaros are Inland, Motor Freighter (40%), Inland, Pushboat, Single (6%), Inland, Pushtow, three cargo barges (6%). The maximum length of the vessels recorded to having entered this port is 311 meters. The maximum draught is 2.9 meters. *[46]*

Dunaujvaros is located at Inland, Europe, Inland, Europe in Hungary at coordinates N 46° 58' 12.55" - E 018° 56' 43.77". The official UN/Locode of this port is HUDUU. *[46]*

Dunafoldvar is a Medium-sized Port. The maximum length of the vessels recorded to having entered this port is 24 meters. *[46]*

Dunafoldvar is located at Inland, Europe, Inland, Europe in Hungary at coordinates N 46° 48' 39.50" - E 018° 55' 37.57". The official UN/Locode of this port is HUDFV. *[46]*

Baja is a Medium-sized Port. The types of vessels regularly calling at Baja are Inland, Motor Freighter (25%). The maximum length of the vessels recorded to having entered this port is 295 meters. The maximum draught is 2.5 meters. The maximum Deadweight is 3199t. *[46]*

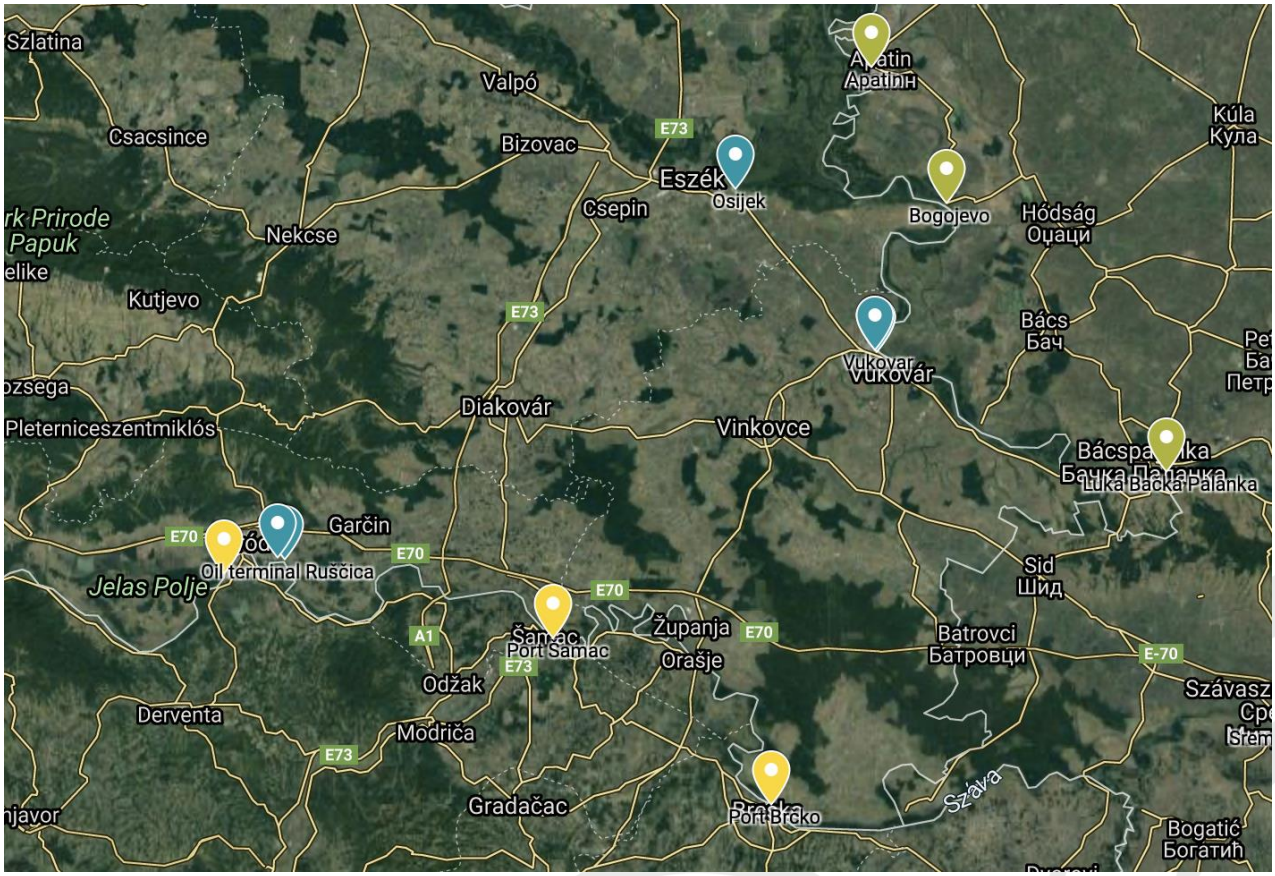
Baja is located at Inland, Europe, Inland, Europe in Hungary at coordinates N 46° 11' 16.81" - E 018° 55' 47.38". The official UN/Locode of this port is HUBAA. *[46]*

Mohacs is a Medium-sized Port. The types of vessels regularly calling at Mohacs are Inland, Passenger Ship, Ferry, Cruise ship (38%), Inland, Unknown (22%), Inland, Passenger Ship without Accommodation (5%). The maximum length of the vessels recorded to having entered this port is 258 meters. The maximum draught is 1.9 meters. The maximum Deadweight is 248t. *[46]*

Mohacs is located at Inland, Europe, Inland, Europe in Hungary at coordinates N 45° 59' 37.14" - E 018° 41' 27.62". The official UN/Locode of this port is HUMOH. *[46]*

Croatia

Port	Km	Website E-Mail	General cargo	Bulk cargo	Liquid cargo	Containers	Ro-Ro
Osijek	Drau-km 12	luka@lukatranzit.hr	√	√	X	X	X
Vukovar	1335	www.port-authority-vukovar.hr office@port-authority-vukovar.hr	√	√	√	√	X
Slavonski Brod	Sava-km 377	lucka-uprava@sb.t-com.hr	√	√	√	X	X

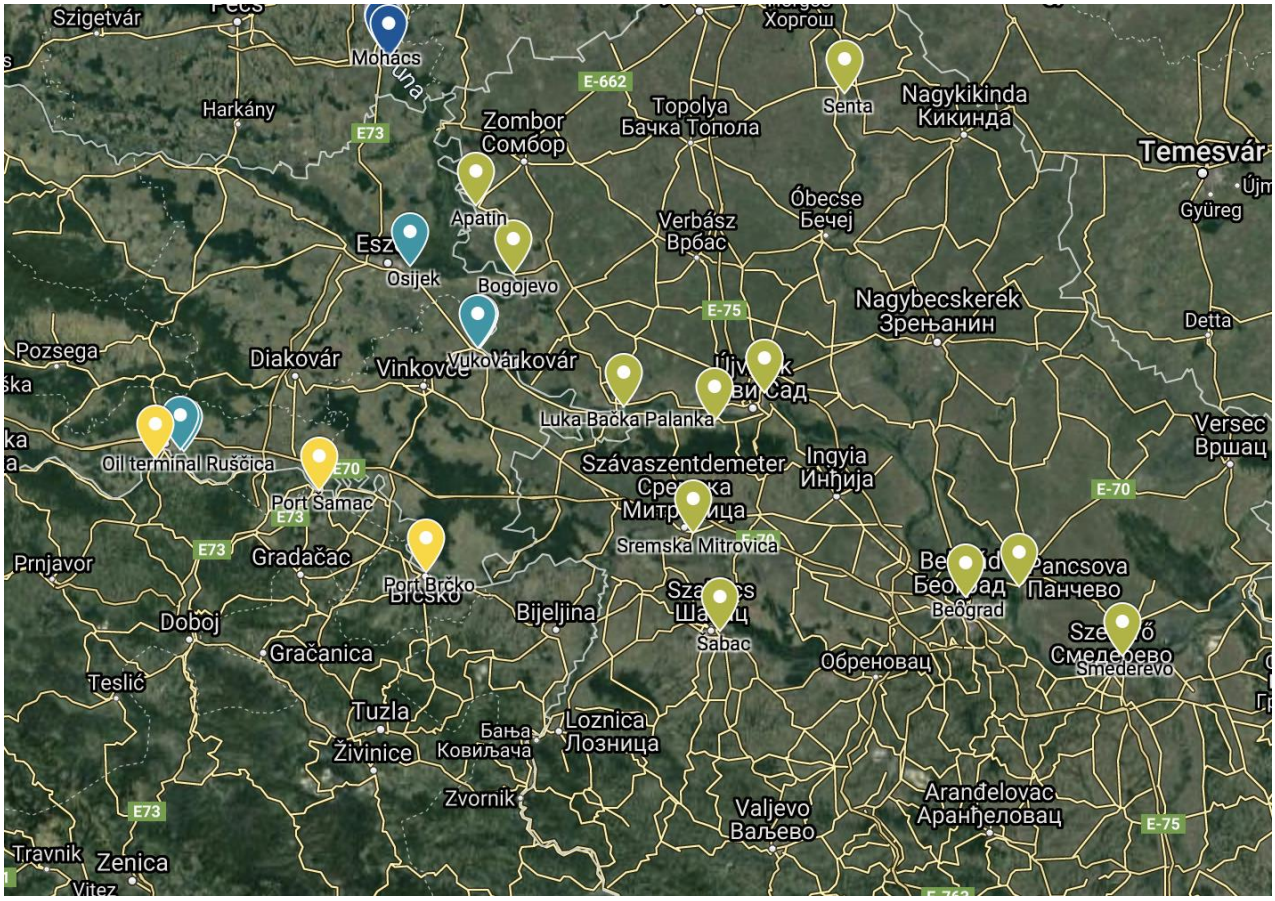


Vukovar is a Medium-sized Port. The types of vessels regularly calling at Vukovar are Inland, Motor Freighter (30%), Inland, Passenger Ship, Ferry, Cruise ship (20%), Inland, Cruise Ship (7%), Inland, Unknown (6%), Inland, Pushtow, six cargo barges (3%). The maximum length of the vessels recorded to having entered this port is 311 meters. The maximum draught is 2.7 meters. The maximum Deadweight is 3199t. *[46]*

Vukovar is located at Inland, Europe, Inland, Europe in Croatia at coordinates N 45° 21' 14.40" - E 019° 00' 28.79". The official UN/Locode of this port is HRVUK. *[46]*

Serbia

Port	km	Operator	Website E-Mail	General cargo	Bulk cargo	Liquid cargo	Containers	Ro-Ro
Bogojevo	1366	Luka Dunav Bogojevo d.o.o.	www.hibrid.rs/luka-dunav-bogojevo/	√	√	X	X	X
Bačka Palanka	1295	Luka Bačka Palanka d.o.o.	www.lukabp.com office@lukabp.com	√	√	X	X	X
Beočin	1268	Lafarge	www.lafarge.rs	√	√	X	X	X
Novi Sad	1254	DP World a.d. NIS a.d. Novi Sad	www.lukanovisad.rs office@lukanovisad.rs www.nis.eu	√	√	√	√	X
Beograd	1168	Luka Beograd a.d.	www.lukabeograd.com info@lukabeograd.com	√	√	X	√	X
Pančevo	1153	Luka Dunav Pančevo a.d. Granexport d.o.o. NIS a.d. Novi Sad Specijalna luka d.o.o.	office@lukadunav.co.rs www.granexport.rs www.nis.eu info@specijalnaluka.rs	√	√	√	√	X
Smederevo	1116-1111	HBIS GROUP SERBIA IRON & STEEL d.o.o. TOMI TRADE d.o.o. MITAN OIL d.o.o. NIS a.d. Novi Sad	www.hbisserbia.rs www.tomitrade.co.rs www.mitanoil.rs www.nis.eu	√	√	√	X	X
Prahovo	861	Elixir Prahovo d.o.o. NIS a.d. Novi Sad	www.elixirprahovo.rs office@elixirprahovo.rs www.nis.eu	√	√	√	√	X



Bogojevo is a Medium-sized Port. The types of vessels regularly calling at Bogojevo are Inland, Motor Freighter (31%), Inland, Unknown (18%), Inland, Pushtow, two cargo barges (12%), Inland, Pushtow, three cargo barges (3%). The maximum length of the vessels recorded to having entered this port is 289 meters. The maximum draught is 2.6 meters. *[46]*

Bogojevo is located at Inland, Europe, Inland, Europe in Serbia at coordinates N 45° 31' 36.37" - E 019° 05' 06.41". The official UN/Locode of this port is RSBVO. *[46]*

BACKA PALANKA is a Medium-sized Port. The types of vessels regularly calling at BACKA PALANKA are Inland, Motor Freighter (38%). The maximum length of the vessels recorded to having entered this port is 301 meters. The maximum draught is 2.8 meters. *[46]*

Backa Palanka is located at Inland, Europe, Inland, Europe in Serbia at coordinates N 45° 14' 16.82" - E 019° 25' 23.00". The official UN/Locode of this port is RSBPA. *[46]*

Pancevo is a Medium-sized Port. The types of vessels regularly calling at PANCEVO are Inland, Pushtow, six cargo barges (12%), Inland, Pushboat, Single (8%), Inland, Unknown (4%). The maximum length of the vessels recorded to having entered this port is 301 meters. The maximum draught is 2.8 meters. The maximum Deadweight is 9084t. *[46]*

Pancevo is located at Inland, Europe, Inland, Europe in Serbia at coordinates N 44° 51' 06.66" - E 020° 38' 26.64". The official UN/Locode of this port is RSPYJ. *[46]*

Smederevo is a Large-sized Port. The types of vessels regularly calling at Smederevo are Inland, Pushtow, five cargo barges (11%), Inland, Pushtow, six cargo barges (11%), Inland, Pushtow, two cargo barges (8%), Inland, Pushtow, five barges at least one tanker (2%). The maximum length of the vessels recorded to having entered this port is 311 meters. The maximum draught is 3.2 meters. The maximum Deadweight is 1500t. *[46]*

Smederevo is located at Inland, Europe, Inland, Europe in Serbia at coordinates N 44° 40' 07.79" - E 020° 55' 15.81". The official UN/Locode of this port is RSSMO. *[46]*

Prahovo is a Medium-sized Port. The types of vessels regularly calling at Prahovo are Inland, Motor Freighter (17%), Inland, Pushtow, six cargo barges (14%), Inland, General Cargo maritime (5%). The maximum length of the vessels recorded to having entered this port is 301 meters. The maximum draught is 2.8 meters. The maximum Deadweightis 1500t. *[46]*

Prahovo is located at Inland, Europe, Inland, Europe in Serbia at coordinates N 44° 17' 32.42" - E 022° 36' 38.90". The official UN/Locode of this port is RSPHO. *[46]*

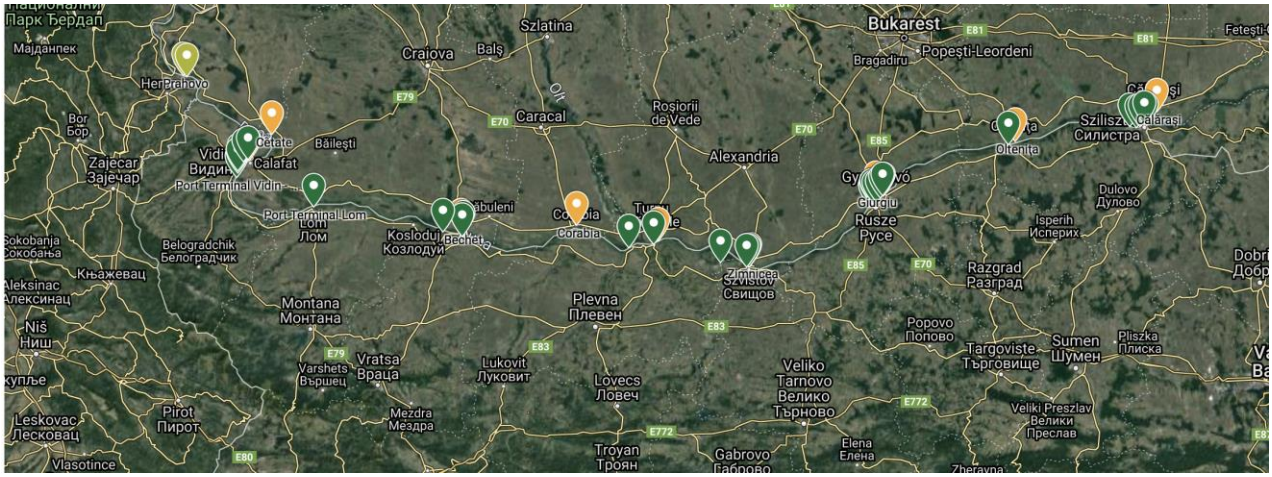
Bulgaria

Port	River km	Website E-Mail	General cargo	Bulk cargo	Liquid cargo	Containers	Ro-Ro	Passenger service
Port terminal Vidin – north	793,2 – 793,6	www.brp.bg main@brp.bg	√	√	√	√		
Port terminal Ferry complex – Vidin	792,8	www.brp.bg main@brp.bg					√	√
Port Terminal Vidin – Center	789,5 – 790,94	www.portvidin-center.com port-vd@gmail.com						√
Port terminal Vidin – south	785	www.skmportvidin.eu portvidin@skmgrup.eu	√	√				
Port Terminal Lom	742 – 742,5	www.portinvest.bg lom@portinvest.bg	√	√				√
Port terminal Oryahovo	677,8 – 678,2	trade@octopod.eu oryahovo@octopod.eu	√	√				√
Port terminal Somovit	607,500	www.port-ruse-bg.com office@port-ruse-bg.com	√	√				√
Port terminal Nikopol	597,725	www.brp.bg main@brp.bg					√	√

Port terminal Svishtov	554,730 – 553,670	www.df-istar.com dfistar@abv.bg	√	√	√		√	√
Port terminal Ruse – west	497,625 – 495,923	www.bgports.bg office.ruse@bgports.bg	√	√	√			
Port terminal Ruse – Center	495,755	www.port-ruse-bg.com office@port-ruse-bg.com						√
Port terminal "Port terminal Ruse – East-2"	490,220	www.port-ruse-bg.com office@port-ruse-bg.com	√	√	√	√	√	
Port terminal "Port terminal Ruse – East-1"	489,515	www.port-ruse-bg.com office@port-ruse-bg.com	√	√	√	√		
Port Terminal Tutrakan	432,605	www.port-ruse-bg.com office@port-ruse-bg.com	√	√				√
Ferry terminal Silistra	382,500	www.bgports.bg office.ruse@bgports.bg					√	√
Silistra Port Terminal	375,320	www.port-ruse-bg.com office@port-ruse-bg.com						√
„Duty Free Zone – Vidin"	793,6	–			√			
"Ro – Ro SOMAT – Vidin"	792,7	www.somat-sofia.com rkb_vidin@mtel.net					√	

"Ekopetrolium – Vidin (Typhoon)"	788,1	www.omv.bg			√			
Danube Dredging Fleet "Bedin" – Vidin	787,6	ddfvidin@dir.bg	√	√				
Danube Dredging Fleet "Dunim" – Kozloduy	686	www.ddfdunim.bg ddfdunim@yahoo.com	√	√				
"Ferryboat complex – Oryahovo"	676,7	www.feriboat.bg fericom_or@abv.bg					√	√
Nikopol	597,500	www.nikopol-bg.com obshtinanil@abv.bg						√
Belene	567,250	–	√	√				
Port terminal "Sviloza"	558,460	www.port-svishtov-west.business.site	√	√				
Port terminal „TEC Sviloza"	558,360	office@tpp-sviloza.bg	√	√				
"Pristis"	495,530 – 494,930 494,660 – 493,800	portpristis@brp.bg						√

„Danube Dredging Fleet – Ruse“	489,125	www.ddfbg.com ddf-ruse@abv.bg	√	√				
“Dubl Ve Co” – Ruse	488,900	www.titan.bg george.marinov@titan.bg	√	√				
„Ruse – duty free zone“	487,900	www.saksa-bg.com contact@saksa.bg			√			
„Port Bulmarket – Ruse“	484,800 – 484,150	www.bulmarket.bg port@bulmarket.bg	√	√	√			
„Ruse – Arbis oil terminal”	484,050	www.rompetrol.bg office.bulgaria@rompetrol.com			√			
„ADM Silistra”	381,850	www.portadmsilistra.com peter.savov@adm.com		√				
„Silistra – Lesil“	381,500 – 381,000	www.port-silistra.com lessil@abv.bg	√	√				
„Silistra – Polaris 8”	378,525	www.polaris8.bg polaris8@abv.bg	√	√				
„East Point”	375,755	www.hoteldrustar.com drustar@hoteldrustar.com						√
„River Service – Ruse“	497,700	www.river-service.bg office@river-service.bg	Ship repair					
Executing Agency „Слежение и поддержка на реке Дунай“ – Русе	491,000	www.appd-bg.org appd@appd-bg.org	Parking and repair of IA PPD vessels					



Vidin is a Medium-sized Port. The types of vessels regularly calling at Vidin are Inland, Passenger Ship, Ferry, Cruise ship (37%). The maximum length of the vessels recorded to having entered this port is 289 meters. The maximum draught is 2.7 meters. *[46]*

Vidin is located at Inland, Europe, Inland, Europe in Bulgaria at coordinates N 43° 59' 10.02" - E 022° 52' 55.77". The official UN/Locode of this port is BGVID. *[46]*

Lom is a Large-sized Port. The types of vessels regularly calling at Lom are Inland, Pushboat, Single (11%). The maximum length of the vessels recorded to having entered this port is 258 meters. The maximum draught is 2.4 meters. *[46]*

Lom is located at Inland, Europe, Inland, Europe in Bulgaria at coordinates N 43° 49' 49.37" - E 023° 14' 33.23". The official UN/Locode of this port is BGLOM. *[46]*

Oryahovo is a Medium-sized Port. The types of vessels regularly calling at Oryahovo are Inland, Ferry (20%). The maximum length of the vessels recorded to having entered this port is 210 meters. The maximum draught is 2.5 meters. *[46]*

Oryahovo is located at Inland, Europe, Inland, Europe in Bulgaria at coordinates N 43° 44' 20.55" - E 023° 58' 07.44". *[46]*

Svishtov is a Medium-sized Port. The types of vessels regularly calling at Svishtov are Inland, Maintainance Craft, Cableship, Dredger (18%). The maximum length of the vessels recorded to having entered this port is 289 meters. The maximum draught is 2.6 meters. *[46]*

Svishtov is located at Inland, Europe, Inland, Europe in Bulgaria at coordinates N 43° 37' 22.69" - E 025° 20' 49.36". The official UN/Locode of this port is BGSVZ. It is also known as SVISTOV. *[46]*

Ruse is a Medium-sized Port. The types of vessels regularly calling at Ruse are Inland, Motor Freighter (20%), Inland, Pushtow, six cargo barges (8%), Inland, Passenger Ship, Ferry, Cruise

ship (8%), Inland, Unknown (6%), Inland, Pushtow, five cargo barges (4%). The maximum length of the vessels recorded to having entered this port is 311 meters. The maximum draught is 3.3 meters. The maximum Deadweight is 9084t. *[46]*

Ruse is located at Inland, Europe, Inland, Europe in Bulgaria at coordinates N 43° 50' 21.35" - E 025° 56' 29.59". The official UN/Locode of this port is BGRDU. It is also known as ROUSSE. *[46]*

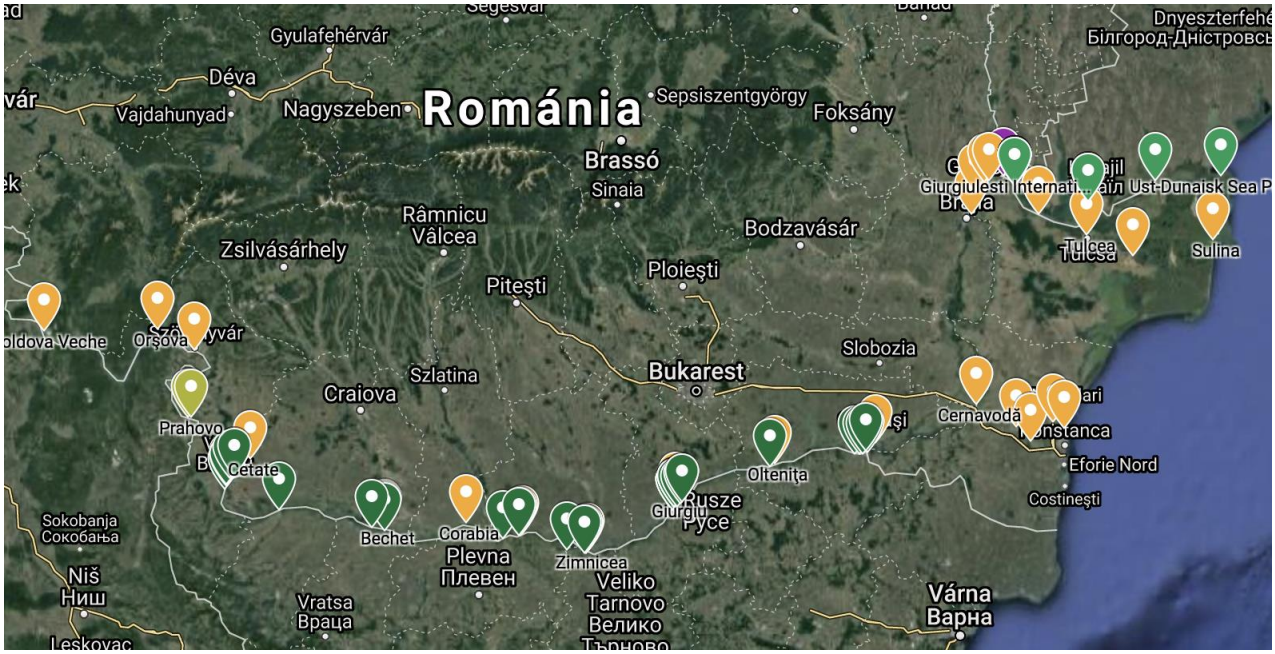
Silistra is a Medium-sized Port. The types of vessels regularly calling at Silistra are Inland, Motor Freighter (17%), Inland, Pushtow, four cargo barges (13%), Inland, Maintainance Craft, Cableship, Dredger (3%), Cargo (3%). maximum length of the vessels recorded to having entered this port is 289 meters. The maximum draught is 2.6 meters. *[46]*

Silistra is located at Inland, Europe, Inland, Europe in Bulgaria at coordinates N 44° 07' 16.67" - E 027° 16' 10.90". The official UN/Locode of this port is BGSLS. *[46]*

Romania

Port	Km	Website E-Mail	General cargo	Bulk cargo	Liquid cargo	Containers	Ro-Ro
Moldova Veche	1047-1050,50	www.apdf.ro moldovaveche@apdf.ro	√	√	X	X	X
Orşova	953 – 957	www.apdf.ro orsova@apdf.ro	√	√	X	X	X
Drobeta Turnu Severin	927- 934	www.apdf.ro severin@apdf.ro	√	√	X	X	X
Cetate	810 – 813	www.apdf.ro	Data not available!				
Calafat	793 – 796	www.apdf.ro calafat@apdf.ro	√	√	X	X	√
Bechet	678-681	www.apdf.ro bechet@apdf.ro	√	√	X	√	√
Corabia	627,6-633	www.apdf.ro corabia@apdf.ro	√	X	X	X	X
Giurgiu	489-497	www.apdf.ro secretariat@apdf.ro	√	√	X	√	X
Olteniţa	428-431	www.apdf.ro oltenita@apdf.ro	√	√	X	√	X
Călăraşi	372-377	www.apdf.ro calarasi@apdf.ro	√	√	X	√	X
Cernavodă	297,4-299,8	www.apdf.ro cernavoda@apdf.ro	√	√	X	√	X
Brăila	160-176,5	office@hercules-braila.ro	√	√	√	X	X
Docuri Galaţi	sm 80 – 80,6	www.romanian-ports.ro apdm@apdm.galati.ro	√	√	X	X	X

Bazinul Nou Galaţi	sm 79	www.romanian-ports.ro apdm@apdm.galati.ro	X	X	X	X	X
Port Mineralier Galaţi	155,4 – 157,6	www.romanian-ports.ro apdm@apdm.galati.ro	√	√	X	X	X
Isaccea	sm 53-56,5	www.romanian-ports.ro tl@apdm.galati.ro	X	√	X	X	X
Tulcea	sm 34-42	www.romanian-ports.ro tl@apdm.galati.ro	√	√	X	X	X
Mahmudia	km 86-90 : Sf. Gheorghe-Arm	www.romanian-ports.rotl@apdm.galati.ro	X	√	X	X	X
Medgidia	Donau-Schwarzmeer-Kanal, km 37,50	compania@acn.ro dobroport@gmail.com	√	√	√	√	X
Basarabi (Murfatlar)	Donau-Schwarzmeer-Kanal, km 25,00	compania@acn.ro dobroport@gmail.com	√	√	√	X	X
Ovidiu	Kanal Poarta Alba – Midia Năvodari, km 11	comprest_util@hotmail.com scut_constanta@yahoo.com	√	√	√	X	X
Luminiţa	Kanal Poarta Alba – Midia Năvodari, km 0,2	geomarstv@datanet.ro	√	√	√	X	X



Moldova Veche is a Medium-sized Port. The types of vessels regularly calling at Moldova Veche are Inland, Pushboat, Single (14%). The maximum length of the vessels recorded to having entered this port is 285 meters. The maximum draught is 2.6 meters. The maximum Deadweight is 3438t. *[46]*

Moldova Veche is located at Inland, Europe, Inland, Europe in Romania at coordinates N 44° 43' 35.48" - E 021° 36' 48.59". The official UN/Locode of this port is ROMOV. *[46]*

Orsova is a Medium-sized Port. The types of vessels regularly calling at Orsova are Inland, Passenger Ship, Ferry, Cruise ship (8%), Inland, Pushtow, one cargo barge (8%), Pleasure Craft (4%), Inland, Passenger Ship without Accommodation (4%). The maximum length of the vessels recorded to having entered this port is 311 meters. The maximum draught is 3.4 meters. The maximum Deadweight is 2132t. *[46]*

Orsova is located at Inland, Europe, Inland, Europe in Romania at coordinates N 44° 43' 40.21" - E 022° 24' 47.30". The official UN/Locode of this port is ROORV. *[46]*

Drobeta-Turnu is a Medium-sized Port. The types of vessels regularly calling at Drobeta-Turnu are Inland, Motor Freighter (14%), Inland, Motor Tanker, liquid cargo, type N (8%), Inland, Motor Tanker, liquid cargo, type C (4%), Inland, Pushtow, five barges at least one tanker (2%), Cargo (2%). The maximum length of the vessels recorded to having entered this port is 301 meters. The maximum draught is 3.6 meters. The maximum Deadweight is 3438t. *[46]*

Drobeta-Turnu is located at Inland, Europe, Inland, Europe in Romania at coordinates N 44° 36' 58.52" - E 022° 39' 07.53". The official UN/Locode of this port is RODTS. It is also known as SEVERIN, DROBETA TURNU. *[46]*

Calafat is a Medium-sized Port. The types of vessels regularly calling at Calafat are Inland, Motor Freighter (13%), Inland, Pushtow, four cargo barges (11%), Inland, Unknown (11%), Inland, Tug, single (2%), Inland, Pushtow, five barges at least one tanker (2%). The maximum length of the vessels recorded to having entered this port is 301 meters. The maximum draught is 3 meters. *[46]*

Calafat is located at Inland, Europe, Inland, Europe in Romania at coordinates N 44° 00' 03.03" - E 022° 55' 50.82". The official UN/Locode of this port is ROCAF. *[46]*

Bechet is a Medium-sized Port. The types of vessels regularly calling at Bechet are Inland, Pushtow, three cargo barges (15%), Cargo (15%), Inland, Unknown (15%), Inland, Ferry (7%). The maximum length of the vessels recorded to having entered this port is 290 meters. The maximum draught is 2.7 meters. *[46]*

Bechet is located at Inland, Europe, Inland, Europe in Romania at coordinates N 43° 44' 56.38" - E 023° 57' 25.34". The official UN/Locode of this port is ROBCT. *[46]*

Giurgiu is a Medium-sized Port. The types of vessels regularly calling at Giurgiu are Inland, Motor Freighter (20%), Inland, Unknown (10%), Inland, Pushtow, four cargo barges (7%), Inland, Passenger Ship, Ferry, Cruise ship (5%), Inland, Pushtow, six cargo barges (5%). The maximum length of the vessels recorded to having entered this port is 311 meters. The maximum draught is 3.3 meters. The maximum Deadweight is 9084t. *[46]*

Giurgiu is located at Inland, Europe, Inland, Europe in Romania at coordinates N 43° 53' 16.45" - E 025° 58' 30.71". The official UN/Locode of this port is ROGRG. *[46]*

Oltenita is a Medium-sized Port. The types of vessels regularly calling at Oltenita are Inland, Passenger Ship, Ferry, Cruise ship (28%), Cargo (14%). The maximum length of the vessels recorded to having entered this port is 289 meters. The maximum draught is 2.6 meters. The maximum Deadweight is 248t.

Oltenita is located at Inland, Europe, Inland, Europe in Romania at coordinates N 44° 04' 18.04" - E 026° 37' 32.24". The official UN/Locode of this port is ROOLT. *[46]*

Cernavoda is a Medium-sized Port. The types of vessels regularly calling at Cernavoda are Inland, Motor Freighter (18%), Inland, Unknown (9%), Inland, Pushtow, six cargo barges (9%), Inland, Pushtow, four cargo barges (6%), Inland, Pushtow, two cargo barges (6%). The maximum length of the vessels recorded to having entered this port is 311 meters. The maximum draught is 3.8 meters. The maximum Deadweight is 9084t. *[46]*

Cernavoda is located at the confluence of the Danube River with the Danube - Black Sea Canal, in Romania at coordinates N 44° 20' 03.41" - E 028° 02' 02.16". The official UN/Locode of this port is ROCEV. *[46]*

Braila is a Medium-sized Port. The types of vessels regularly calling at Braila are General Cargo (23%), Inland, Motor Freighter (9%), Inland, Unknown (9%), Inland, Pushtow, six cargo barges (6%), Inland, Pushtow, two cargo barges (5%). The maximum length of the vessels recorded to having entered this port is 311 meters. The maximum draught is 6.9 meters. The maximum Deadweight is 13500t. *[46]*

Braila is located at Inland, Europe, Inland, Europe in Romania at coordinates N 45° 15' 42.51" - E 027° 59' 02.45". The official UN/Locode of this port is ROBRA. *[46]*

Galati is a Medium-sized Port. The types of vessels regularly calling at Galati are General Cargo (40%), Inland, Unknown (5%), Inland, Pushtow, six cargo barges (5%), Inland, Motor Freighter (4%), Inland, Pushtow, three cargo barges (3%). The maximum length of the vessels recorded to having entered this port is 311 meters. The maximum draught is 7.1 meters. The maximum Deadweight is 14787t. *[46]*

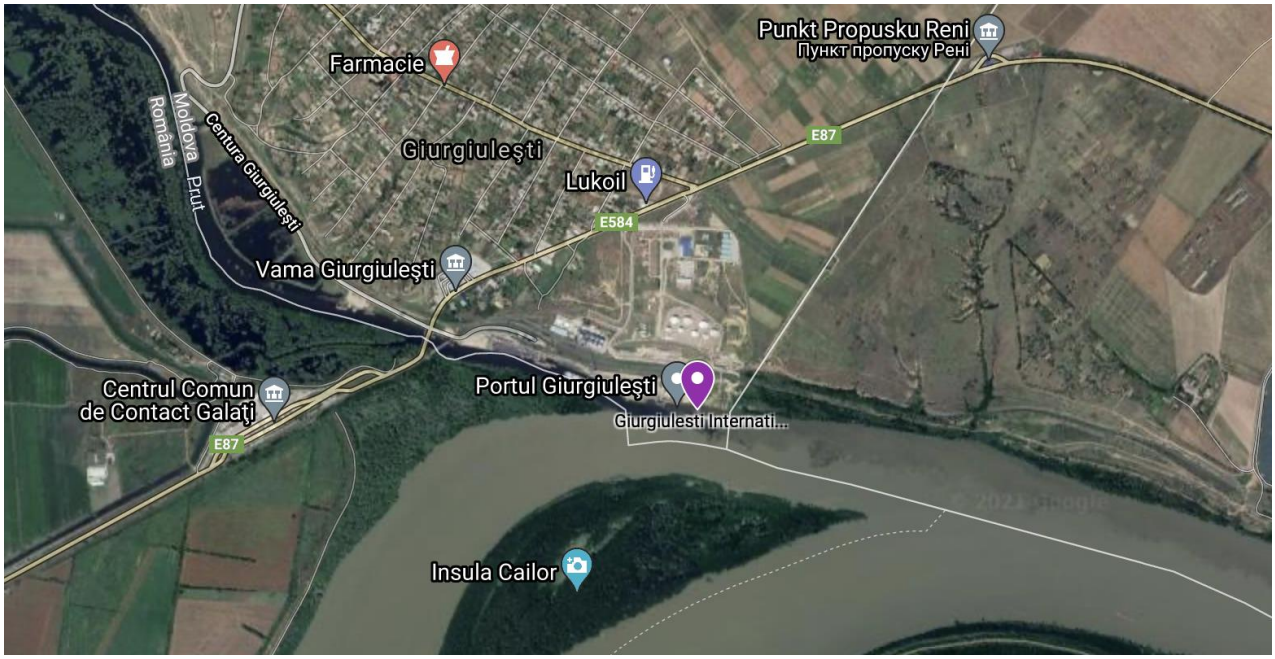
Galati is located at Inland, Europe, Inland, Europe in Romania at coordinates N 45° 25' 08.80" - E 028° 05' 59.21". The official UN/Locode of this port is ROGAL. It is also known as GALATZ. *[46]*

Tulcea is a Medium-sized Port. The types of vessels regularly calling at Tulcea are Inland, Passenger Ship, Ferry, Cruise ship (22%), General Cargo (20%), Inland, Unknown (7%), Inland, Passenger Ship without Accommodation (5%), Inland, Maintenance Craft, Cableship, Dredger (4%). The maximum length of the vessels recorded to having entered this port is 311 meters. The maximum draught is 6.2 meters. The maximum Deadweight is 8736t. *[46]*

Tulcea is located on the Danube River in Romania at coordinates N 45° 11' 35.25" - E 028° 48' 18.48". The official UN/Locode of this port is ROTCE. *[46]*

Moldova

Port	Km	Website E-Mail	General cargo	Bulk cargo	Liquid cargo	Containers	Ro-Ro
Giurgiuleşti	133,8	www.gifp.md gifp@danlog.md	X	√	√	X	X



Giurgiulesti is a Medium-sized Port. The types of vessels regularly calling at Giurgiulesti are General Cargo (37%), Oil/Chemical Tanker (11%), Inland, Motor Tanker, liquid cargo, type N (5%), Inland, Motor Tanker, liquid cargo, type C (3%), Inland, Tug, Freighter (1%). The maximum length of the vessels recorded to having entered this port is 250 meters. The maximum draught is 6.4 meters. The maximum Deadweight is 10052t. *[46]*

Giurgiulesti is located at Inland, Europe, Inland, Europe in Moldova at coordinates N 45° 28' 12.45" - E 028° 12' 25.08". The official UN/Locode of this port is MDGIU. *[46]*

Based on the processed literature and what was said at the workshops, we were able to make the recommendations above without a questionnaire.

[46] Source: https://www.marinetraffic.com/
[47] Source: https://www.danubecommission.org/dc/en/danube-navigation/ports-on-the-danube/

5 Selecting a model

5.1 Regional WORKSHOP: Ports & Agricultural Products Traffic in the Upper Danube Region Countries [AT / DE / SK]

The event was focused on the management of ports and agricultural products traffic in the Upper Danube Region. It was attended by various port operators, storage operators, agricultural producers, and logistics service providers. The workshop analyzed the current and future traffic flows in the region's ports and their potential impacts on the economy.

The event was attended by over 45 participants. Many of them were government officials, representatives of public and private organizations, and executives from various companies.

The event was held under the theme "Dionysus Project: Regional Workshop" and was attended by representatives of the project's partner Wieser Consult and Pro Danube Romania. The project's activities were presented in detail. The representative of the company stated that the company has carried out various projects in the field of agriculture.

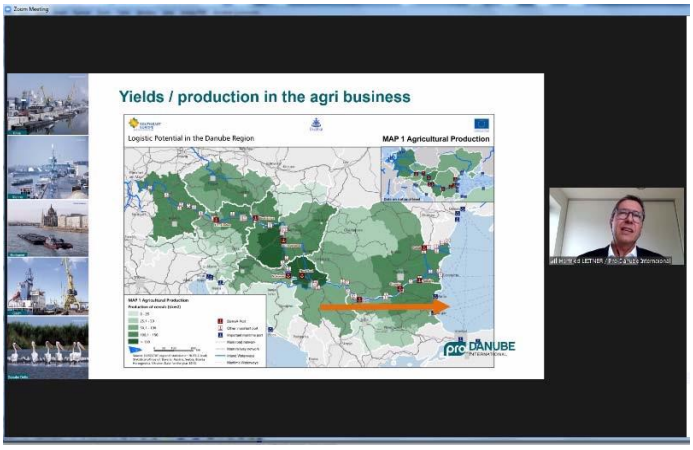
The main topic of the event was the implementation of the Common Agricultural Policy 2023-27, which is a key component of the European Green Deal. Mr. Silviu Meterna, the project's representative, gave his presentation on the various goals and objects of the project. This event was the third and final workshop that the project partners arranged on the Upper Danube. The event's goal was to generate a comprehensive report that will be presented in

2022 and will contain recommendations on how to improve the movement of agricultural products on the Danube. Due to the complexity of the project, Meterna asked the audience to regularly check the project's website.

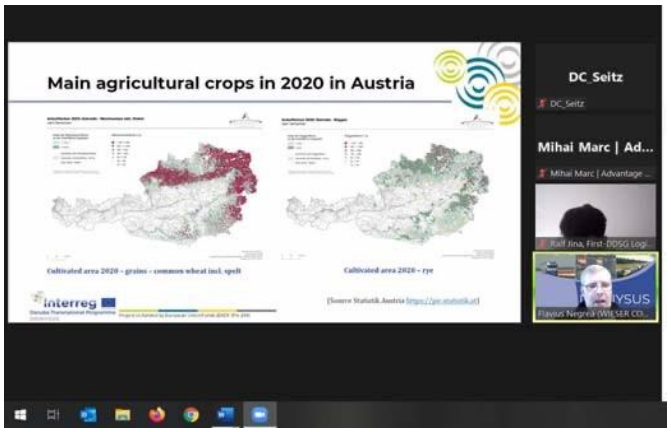
The event was moderated by Mihai Marc, the project manager of Advantage Austria in Romania. The key-note presentations provided an overview of the various aspects of the workshop, and the general framework for the discussions was created. Hacksteiner discussed the challenges of meeting the goals of the 2050 carbon emission reduction. She noted that the road freight should be shifted to rail and IWT by 2050.

In order to meet the goals of the IWT, rail should account for 25% of total freight by 2030 and 50% by 2050. For her own assessment, IWT has the potential to generate significant modal shift and is in need of various support measures. Seitz also provided an overview of the various policies and programs that were adopted within the European Union for the development of IWT. He provided an overview of the IWT's Lead Project Platina 3, which is a key project that will be held in Budapest and Brussels in the next couple of years. He also noted the impact of climate change on the river basin.

Mr. Leitner provided an overview of the various aspects of the Upper Danube region's agricultural production and logistics potential. He also indicated that the various factors that affect the development of water transport for agricultural goods are expected to have a strong impact on the industry. He also called for more investments in the IWT and its infrastructure. He also mentioned the need for the organization to improve its internalization of external costs.



Flavius Negrea of Wieser Consult noted that the development of Austrian agriculture is expected to continue. Various statistics were provided in the overview of the various aspects of agriculture. He also talked about the impact of climate change and the Green Deal on Austrian agriculture. Negrea also talked about the various aspects of the Austrian market, including the production and trade of animal feed and fertilizer. He also noted that the development of IWT and the Danube's freight potential can help boost the country's agricultural production.



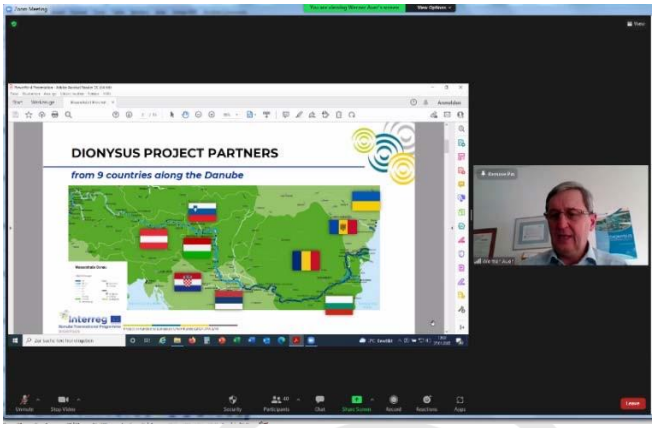
Soya Market Analyst Bertalan Kruppa discussed the potential impact of the European soybean market on the IWT. He noted that the organization Donau Soja/Danube Soya is working on a sustainable and safe supply of soybeans. He mentioned that the European soybean production could reach 15 million tones by 2030. He noted that many of the companies operating in the Donau Soja group are located along the Danube. He also stated that the waterway is a great transportation option for agricultural products.

Michael Duspiwa of Fixkraft Futtermittel discussed the current flows of European agricultural products and the various challenges involved in handling these goods. Duspiwa noted that the origin of some of the feed products used by his company, including wheat, corn, and soybeans, are mainly from the countries located in the upper, middle, and lower Danube. He also talked about the various activities and support services that are available to the industry along the waterway.

Austrian forestry and agricultural commodities took the second-largest share of Danube transport in 2020. Reinhard Hartl of Via Donau noted that the organization coordinates with various agencies and organizations to improve the efficiency of its operations. First-DDSG's Sales Manager Ralf Jina gave an overview of the company's various services, including its fleet and infrastructure.

The company's fleet includes a total of 214 ships that can transport up to 300.000 tons of cargo. Most of these vessels are used for the transportation of agricultural products from Hungary, Serbia, and Croatia. For his presentation, Jina highlighted the company's achievements in 2015, 2016 and 2021. He also talked about the various projects that the company is currently carrying out to improve the efficiency of its fleet and overall operations.

Werner Auer, the managing director of Ennshafen, gave an overview of the company's achievements and the goals of the project. The port's modern infrastructure, which includes a modern cargo terminal, is ideal for handling various types of cargo. He noted that it's located in an area that's considered an industrial center.



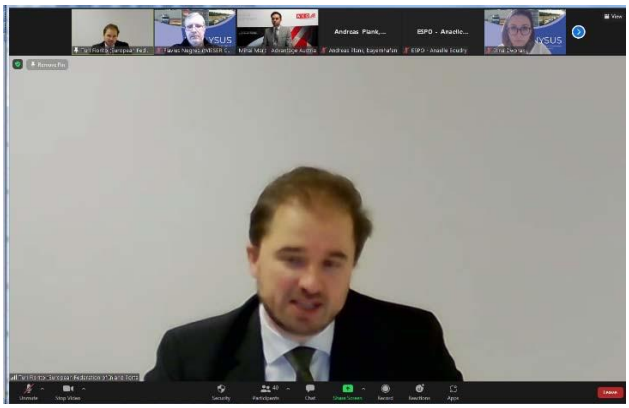
The port's container terminal can also be used for the transportation of alternative fuels, such as LNG. This facility was the first to be constructed in Austria in 2017. Auer also talked about the various statistics related to the movement of agricultural commodities through the port. He concluded that Ennshafen is well-equipped to handle these types of cargo.

Andreas Plank of Bayernhafen highlighted the various locations in the port that are strategically located close to various economic centers. These areas include Aschaffenburg, Nrenberg, Regensburg, and Passau. In 2020, the ports handled over 8 million tons of cargo, which included over 60 million tons of agricultural products. These goods represented a significant portion of the total cargo volume. He also mentioned that the company invests heavily in its infrastructure and cooperates with other port operators and stakeholders. As an example, he mentioned the expansion of the Danube between Vilshofen and Straubing.

Igor Barna, the senior project manager of public ports JSC, discussed the various factors that affect the movement of agricultural commodities through the ports. The company is a part of the Dionysus project, which is a project that aims to improve the efficiency of the Slovak agriculture. For his presentation, Barna provided data on the country's agricultural production and trade volumes. Unfortunately, due to an unstable Internet connection, he was not able to finish his presentation. As a result, the slides of his presentation were made available for the workshop participants.

The EFIP's Turi Fiorito also talked about the various policies and measures that will affect the growth of the IWT traffic. Through the EFIP, inland ports can improve their visibility and exchange of information with European institutions and national governments. For his

presentation, Fiorito focused on the importance of the movement of agricultural commodities through the ports. He provided an overview of the various measures related to the European Green Deal. Fiorito also introduced the Vienna port's statistics and capacity to discuss the movement of agricultural products.



Based on the processed literature and what was said at the workshops, we were able to make the recommendations above without a questionnaire.

5.1.1 Discussion – Q&A and recommendations

The audience had the opportunity to ask questions and discuss the inputs after each presentation. The questions were mainly posted in the chat box and forwarded by the moderator Mr. Mihai Marc to the speaker. This way, some interesting discussions could take place.

Below an excerpt of the Q&A round posted in the chat box:
11:43:18 From Ralf Jina, First-DDSG Logistics Holding to Everyone:

question, Theresia has said it is necessary to allocate 75% of the commodities moving by truck to rail and water to reach the climate goals. on the other hand, fuel should be taxed. that seems contradictory? if we tax fuel for inland navigation, the commodities will leave the river and not vice versa because we won't be competitive anymore.

The question was answered by Ms. Theresia Hacksteiner.

12:18:49 From Capt.Béla Szalma to Everyone:

Yearly volume on Danube should be 80 million tons, 31 million is a mistake. Austria has 10, Hungary 8 million, etc.

12:24:47 From Simon Hartl, viadonau to Everyone:

@Capt. Bela Szalma: viadonau calculated 36.2 Mio. tons for 2019 (latest data). The national statistics include volumes which have been registered multiple times.

13:20:40 From Herfried LEITNER / Pro Danube International to Everyone:

yes, there were important improvements in the fairways along the Danube. Can only confirm. And such common efforts shall continue.

13:45:21 From Srdja Lješević to Everyone:

interesting idea for transforming self-propelled vessel to motor pusher These comments related to the presentations in the panel Grain transport on the Upper Danube –

Infrastructure, administrative and tariffs bottlenecks.

14:22:06 From Herfried LEITNER / Pro Danube Internaional to Everyone:

@Mr. Plank: Statistics only showed Rail and IWT. Can it be true that trucks to not have a share? Otherwise, would be interested in the share of trucks. Thanks.

14:37:31 From Herfried LEITNER / Pro Danube Internaional to Everyone:

Solutions for this stretch were studied for 15 years and decided against ....

14:38:26 From Herfried LEITNER / Pro Danube Internaional to Everyone:

As you are the most important Group of ports in Bayern, do you have more details when Stage 2 of Pfelling works (Deggendorf - Vilshofen) will be started / finished?

The question was answered by Mr. Andreas Plank.

4:51:34 From Herfried LEITNER / Pro Danube Internaional to Everyone:

@Mr. Barna: The shares were for the ports, but would great to know how much of the agri products are sent/received via waterways?

The question was answered by Mr. Igor Barna.

15:06:41 From Herfried LEITNER / Pro Danube Internaional to Everyone:

@Turi: CEF funding is great, but it is infrastructure. But what the sector need - is supported to ensure maintenance of the highway (waterway). Any program there?

15:07:33 From Herfried LEITNER / Pro Danube Internaional to Everyone:

dredging ... yes
The question was answered by Mr. Turi Fiorito.

5.1.2 Conclusion. Next steps. Closing of the meeting.

The meeting was resumed by Mr. Silviu Meterna, Lead Partner of the project and Mr. Mihai Marc, the event moderator. Mr. Meterna and Mr. Marc took the chance to appreciate the high level of cooperation among all stakeholders and thanked all participants and speakers for the interesting and productive inputs.

5.1.3 Regional WORKSHOP: Ports & Agricultural Products Traffic in the Upper Danube Region Countries [AT / DE / SK] List of Participants

#	First Name	Surname	Organisation
1	Vadim	Nantoi	Technical University of Moldova
2	Anaëlle	Boudry	European Federation of Inland Ports
3	Ralf	Jina	First-DDSG Logistics Holding GmbH
4	Karin	Voglsam	Ennshafen OÖ GmbH
5	Bence	Buday	Ex Ante Consulting Ltd.
6	Hermann	Wieser	Austrian Agricultural Cluster
7	Yuriy	Bondiuchenko	SE USPA
8	Anneta	Ohanesian	Ukrainian sea ports authority
9	Dragos	Apostol	Wieser Consult
10	Serban	Dumitrescu	Cooperativa Roua
11	Nicoleta Valeria	Niculae	WIESER CONSULT
12	Irina	Cruceru	CRUCERU OANA IRINA PFA
13	Catalina Andreea	Maftei	WIESER CONSULT SRL
14	Luminita	Meterna	Pro Danube Romania - Association for the promotion of transports on the Danube
15	Silviu	Meterna	Pro Danube Romania - Association for the promotion of transports on the Danube
16	Victor	Cheban	Technical University of Moldova
17	Miroslav	Mađarac	Port Authority Vukovar
18	Hennadii	Meltsov	USPA
19	Irina	Dworak	AAC Austrian Agricultural Cluster
20	Miglena	Molhova	SpotVessels
21	Bertalan	Kruppa	Donau Soja
22	Flavius	Negrea	WIESER CONSULT SRL
23	Leonard	Cotiga	AAOPFR

24	Ruxandra	Matzalik Florescu	Pro Danube Management
25	Robert	Rafael	PDM
26	Markus	Eppich	Pro Danube
27	Christian	Stark	PDM
28	Srđa	Lješević	Port Governance Agency
29	Martin	Goliaš	Verejné prístavy, a.s.
30	Werner	Auer	Ennshafen OÖ GmbH
31	Igor	Barna	Verejné prístavy, a.s.
32	Vuk	Perovic	Port Governance Agency
33	Srdja	Ljesevic	Port Governance Agency
34	Ksenija	Hajdukovic	Port Governance Agency
35	Simon	Hartl	viadonau - Austrian Waterway Company
36	Vladimir	Petkov	BRCCI
37	Herfried	Leitner	Pro Danube International
38	Desislava	Pencheva	BRCCI
39	Mihai	Marc	Advantage Austria - Austrian Embassy to Romania, Commercial Section
40	Boyan	Bonev	Port Bulmarket JSC
41	Theresia	Hacksteiner	European Barge Union EBU
42	Michael	Duspiwa	Fixkraft Futtermittel
43	Werner	Auer	Port Ennshafen
44	Andreas	Plank	Bayernhafen
45	Turi	Fiorito	European Federation of Inland Ports (EFIP)

5.2 Regional WORKSHOP: Ports & Agricultural Products Traffic in the Middle Danube Region Countries [HU / HR / RS]

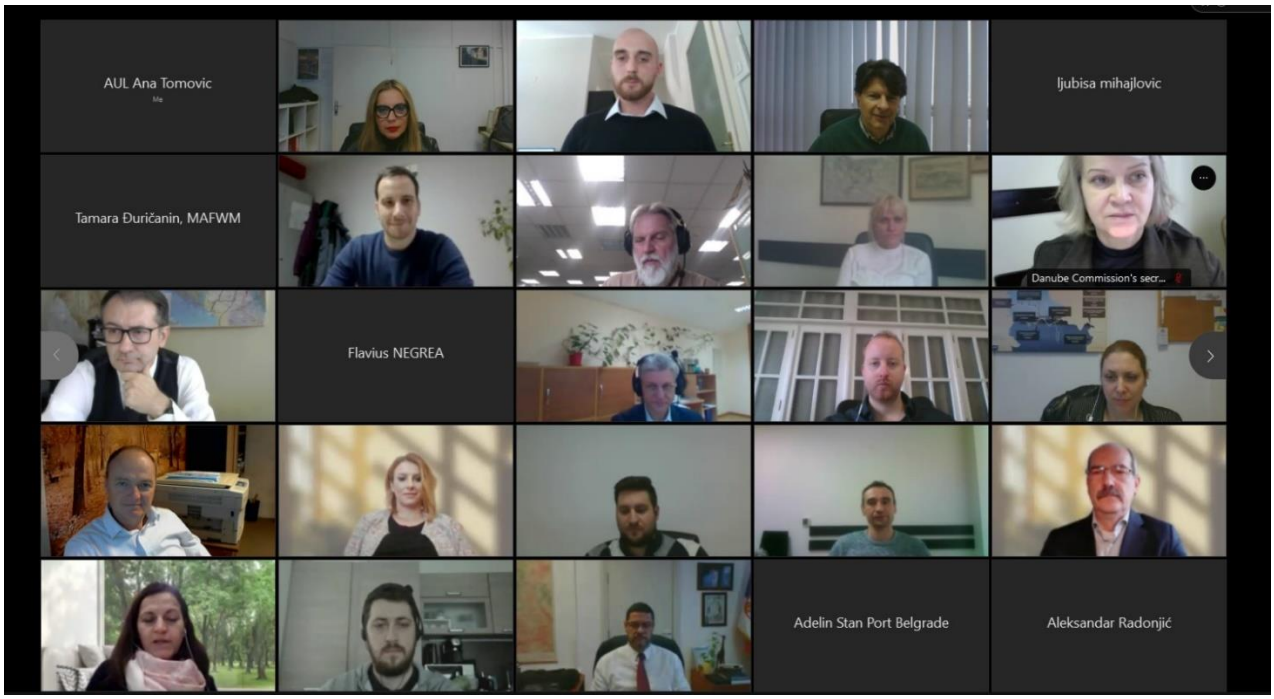
5.2.1 Meeting Purpose:

The event was organized to target various groups of individuals involved in the transportation of agricultural products in the Middle Danube Region.

The workshop focused on the various aspects of the traffic flows in the ports located in the Middle Danube. The participants also discussed the role of the ports in supporting the growth of agriculture in the region.

5.2.2 Meeting Minutes

The participants are professionals from various sectors such as public institutions, private companies, universities, and research organizations.



The head of the Ports Authority of Serbia (PGA) Vuk Perovic stated that the Danube is considered one of the most important European rivers. The four ports in Serbia handled more than a million tons of cargo annually in 2020, which is five percent more than in 2019. According to the Agency, the total volume of transshipped goods in the country reached 16 million tons in 2020.

Perovic noted that the participation of the Agency in the DIONYSUS project, which is focused on developing the ports on the Danube, will allow them to connect with other ports in the region. Silviu Meterna, the head of the project's partner Pro Danube Romania, addressed the attendees of the workshop and introduced the various aspects of the project.

He stated that the main objective of the project is to make the Danube Region a smart and sustainable multi-modal transportation network. Through the event, participants were able to share their ideas on how to improve the connectivity of the ports. In November 2021, the first regional workshop on the traffic of agricultural products was held in Serbia. The next one will be held in January 2022.

The event's organizer, the Danube Region Improvement Project HFIP, plans to organize a follow-up workshop in 2022 to summarize the results of the three workshops. Horst

Schindler, the project's officer, said that the future projects of the Danube Region will mainly focus on the improvement of the administrative cooperation and the smart Danube.

A call for proposals for the next project will be published in 2022, according to the event's organizer. During the workshop, the head of Serbia's Ministry of Agriculture presented the country's various policies and programs related to agriculture. Ljubisa Mihajlovic, from the Directorate for inland waterways in Plovput, gave a presentation on the various projects related to the Danube's improvement.

Srdja Ljesevic, the head of the Center for Port operations in the PGA, presented the various ports in Serbia that are mainly used for the transportation of agricultural products. He noted that these ports are the most productive for transshipment of these goods. Mark Cernela, an external expert from the Port Authority of Vukovar, presented the characteristics of the Croatian ports that are used for transshipping of agricultural products.

He also highlighted the importance of the port's terminals for the storage and transshipment of bulk cargo, such as cereals and oilseeds. Mr. Cernela also presented various studies related to the agricultural sector in Croatia.Vupik Plus Ltd. is a leading producer of agricultural products in Croatia. The company has been in business for over 60 years and is known for its quality and success. Aside from these, it also provides various raw materials for industrial facilities.

Vupik's management team attributes its success to the company's continuous improvement through the use of modern agricultural techniques and equipment. Peter Kiss, the president of the Hungarian Grain and feed Association, presented the country's agricultural production and export figures. The debate focused on the need for the IWT to increase its share in the total transport of goods. Bela Szalma noted that the organization currently has 3 percent of the market.

The participants then agreed that the improved connectivity between the Danube region and the global market is very important for the development of the region's agricultural industry. As for the Danube's navigation, the experts noted that it is crucial that the river's draft does not go beyond 2.5 meters. Dejan Trifunovic of the Danube Commission said that the main type of cargo that most frequently used to be transported through the waterway was agricultural products.

Thanking the attendees for their participation, Gordana Bekcic, the event's moderator, noted that the speakers presented valuable information.

5.2.3 Regional WORKSHOP: Ports & Agricultural Products Traffic in the Middle Danube Region Countries [HU / HR / RS] List of Participants

#	First Name	Surname	Organization
1	Vuk	Perovic	PGA
2	Srdja	Ljesevic	PGA
3	Ksenija	Hajdukovic	PGA
4	Nevena	Matic	PGA
5	Biljana	Maslarevic	PGA
6	Irena	Al Atarji	PGA
7	Ana	Tomovic	PGA
8	Miljan	Miljanic	PGA
9	Zivana	Lukovic	PGA
10	Marica	Milosevic	PGA
11	Ljubomir	Miskovic	PGA
12	Silviu	Meterna	Pro Danube Romania - Association for the promotion of transports on the Danube
13	Ljubisa	Mihajlovic	Directorate for inland waterways - Plovput
14	Tamara	Djuricanin	Ministry of agriculture, forestry and water management (RS)
15	Horst	Schindler	Danube Transnational Programme
16	Dejan	Trifunovic	Danube Commission
17	Cristian	Dobritoiu	Ministry of Transport, Infrastructure and Communications
18	Hennadii	Meltsov	State Enterprise "Ukrainian Sea Ports Authority"
19	Leonard	Cotiga	AAOPFR
20	Miroslav	Madarac	Port Authority Vukovar
21	Iva	Horvat	Port Authority Vukovar
22	Serban	Cucu	AAOPFR
23	Christian	Stark	PDM
24	Flavius	Negrea	WIESER CONSULT
25	Vladimir	Petkov	BRCCI
26	Desislava	Pencheva	BRCCI
27	Milica	Nikolic	viadonau
28	Mark	Cernela	Logoteam Ltd
29	Andrej	Jovicic	Vupik plus Ltd

#	First Name	Surname	Organization
30	Bence	Buday	Exante
31	Bela	Szalma	HFIP
32	Vladislav	Maras	FTTE
33	Danijela	Pjevcevic	FTTE
34	Aleksandar	Radonjic	FTTE
35	Bobak	Fanni	HFIP
36	Ion	Cotruta	
37	Janza	Gabor	
38	Mate	Vincze	
39	Peter	Kiss	Hungarian grain and feed association
40	Tatijana	Rakocevic	
41	Vladan	Misic	MPAC- representative in the Republic of Serbia
42	Lilia	Burdila	
43	Claudiu	Negreanu	DP World a.d. Novi Sad
44	Victor	Ceban	Technical university of Moldova
45	Gordana	Bekcic	Blumen Group Ltd

Following the workshop, we sent out a questionnaire of 35 questions to the participating partners. Based on the proportion of unanswered questions after completion, the survey is not considered to be a representative statement. As a resolution of the study, we continued to work by processing the available resources. A summary table of the completed version of the questionnaire can be found in Annex 1.

6 Model Calibration

6.1 Model Calibration in general

The process of developing travel forecasts is known as calibration. This step involves estimating the values of the various parameters and constants in the model structure.

The model equation for constants and coefficients is usually formulated after supplying the observed values of both the independent and dependent variables. The model is then subjected to a trial-and-error effort to find the optimal set of values. *[48]*

Usually, this step is carried out using statistical programs designed for this purpose. However, it can also be performed by importing the model parameters from another model. This strategy is only performed by experienced practitioners. After the models have been thoroughly checked to ensure that they perform their intended functions, they are then subjected to validation. This step is carried out to establish the credibility of the model.

The validation process involves comparing the estimated traffic of the various models to the actual traffic on the road and transit systems. This step also involves testing the models' accuracy by taking into account various factors such as transit ridership. These are often referred to as cordon lines or screen lines. They run in areas where the central business district is located. A transit ridership estimate is then derived by comparing it to the actual cordon lines within the region.

The importance of having comprehensive and accurate data on transit and traffic counts for model validation is very similar to the requirements of a travel survey. *[48]*

6.2 Overview of transportation modelling

Transport models are representations of the complex transport and land use system that are present in the real world. They can help planners identify the most effective ways to use transportation infrastructure in the future.

The development of transport models is a vital step in the evaluation of various transport initiatives. It provides a framework to assess the current and future demands of the transport system. Through these models, planners can gain a deeper understanding of the various factors that influence travel decisions. They can then use these findings to develop effective strategies for addressing the future demand. A transport model is generally composed of three main components: a demand model, a trip generation model, and a highway assignment model.

The development of a transport model involves the use of a set of requirements. These include a functional specification and a technical specification. *[48]*

6.3 Statement of requirements

A Statement of Requirements is a document that describes the requirements for a transport model. It usually includes the interfaces between the model and other models, as well as the hierarchy of transport model applications. *[48]*

6.4 Objectives of the model

The objectives of a transport model are defined as the steps that the model must take to achieve its goals. These include developing procedures to evaluate and test various transport initiatives. This report aims to assess the strategic justification for various transport infrastructure projects. It also allows flexibility in terms of covering regional centers.

The objectives of a transport model are also established to test the effects of various transport initiatives on a particular location. This step involves establishing a clear and precise statement of objectives. *[48]*

6.4.1 Hierarchy of transport modelling applications

Transport modelling is a broad category that includes various activities related to planning and implementing transport strategies. These include the formulation of a comprehensive land use and transport strategy, the investigation of various projects, and the detailed planning for delivering these projects. *[48]*

Land use and transport interaction modelling	Examines and evaluates the impacts of transport policy and land use changes on urban form and transport
Strategic modelling	• Examines 'what if?' questions in policy development and the definition of strategies • Identifies and assess broad metropolitan-wide impacts if land use, socio-economic, demographic and transport infrastructure changes

	• Assists in transport infrastructure project generation • Provides metropolitan-wide forecasts of trip generation, trip distribution, mode choice and assignment of trips to the transport network • Considers travel needs, and multi-modal consideration of whether and how these are best satisfied • Models and assesses pricing issues	
Scenario modelling	Assesses the implications of particular strategies at the metropolitan scale	

Project modelling	• Assesses strategy components, individual projects, specific land use strategies and transport corridor issues • Assesses the performance of the transport network along specific corridors and for nominated projects	
Operational design	• Assesses the detailed operational performance of specific transport infrastructure projects and initiatives (e.g. ramp metering), land use developments and local area traffic management	

	• Prioritise allocation of road capacity between different users (e.g. bus priority or pedestrian signal phasing) • May assist in identifying the effects on delays and queues resulting from changes in transport system variables (i.e. signal phasings, lane configurations, ramp metering)	

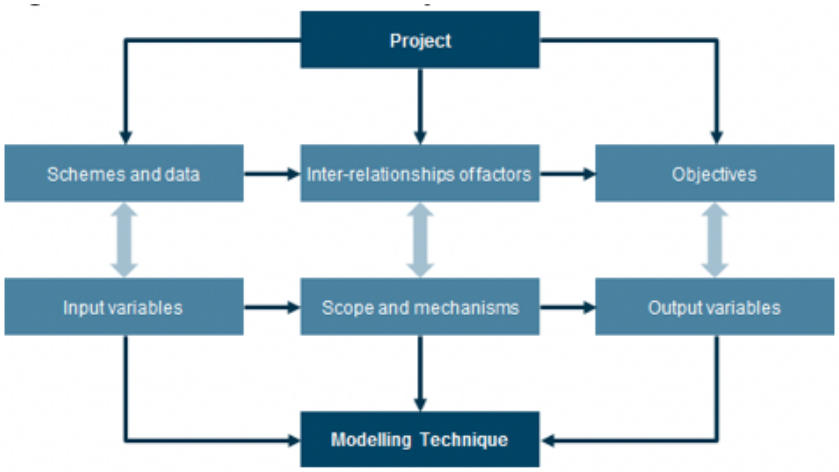
[48] Source: https://www.atap.gov.au/tools-techniques/travel-demand-modelling/2-overview

The goal of these applications is to evaluate the effects of various land use strategies on the performance of the transport network. The goal of these applications is to determine the optimal capacity utilization of the waterborne transport system in response to the needs of various users, such as shipping companies. *[48]*

The selection of a modeling technique is an important step in the Statement of Requirements, as it involves carrying out studies that are related to the project's objectives. Having a good balance between the various requirements is also important. Sometimes, the blend of requirements can be delivered using multiple models. However, ensuring consistency in the implementation of these models can be a bit challenging. The selection of a modeling technique is also related to the need to evaluate the value for money of the project. For instance, if the funding decisions are based on the user benefits derived from consumer surplus theory, then a microscopic model is generally not suitable. *[48]*

The advantages of microsimulation tools are their ability to provide precise representations of the various design options and their ability to show how the infrastructure would operate. The selection of a modeling technique is also related to the project's context. Before proceeding, it is important to identify the key elements of the project that can be used to construct the model. These can include the data, objectives, and schemes of the project. *[48]*

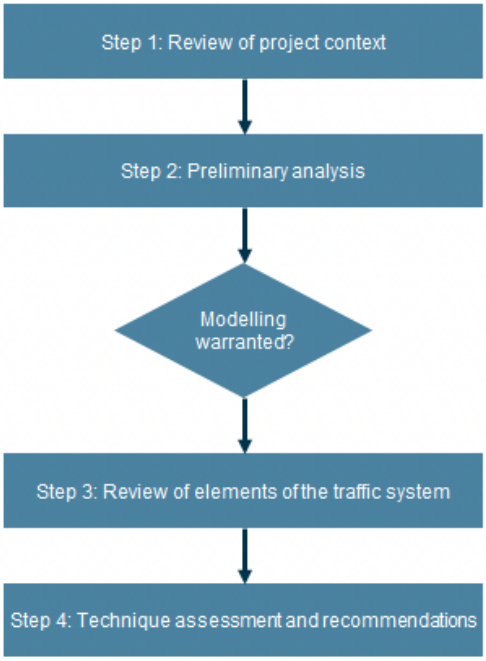
One of the most important considerations is ensuring that the input variables are sensitive to the proposed schemes. They should also include the various characteristics of the transport network, such as waterway geometry and waterborne traffic control. The scope and mechanisms of a project are also related to the factors that are considered in the design of the model. For instance, the project's temporal and geographic scope. The outputs should also be able to represent the project's objectives. They should also include the necessary accuracy requirements and indicators. *[48]*



[48] Source: https://www.atap.gov.au/tools-techniques/travel-demand-modelling/2-overview

There is no clear scientific reason why a particular transport modelling technique should be used. The selection process should be based on the need for rigorous analysis and the cost. The ATAP Guidelines do not identify a particular technique. Instead, they provide a framework for assessing the various factors involved in technique selection. *[48]*

The first step is to carefully consider the project objectives. In step 2, the analyst should perform a high-level preliminary analysis to identify the expected impacts of the project. This step will allow the analyst to form a more complete view of the project's potential outcomes. Following an initial decision to use some modelling, the next step is to consider the various aspects of the transport system. This step also involves considering the methods that can best represent these aspects. This should be followed by a focus on ensuring that the chosen technique is capable of carrying out the necessary analysis and modeling. *[48]*



[48] Source: https://www.atap.gov.au/tools-techniques/travel-demand-modelling/2-overview

6.5 Alternatives to modelling

If modelling is not necessary to analyze specific applications, then sketch planning methods are more suitable. Sketch planning exercises are commonly used to identify and eliminate various alternatives. This eliminates the need for further analysis.

An example of sketch planning is presented by Van Hecke et al. in 2008. This method was used to deploy various operations technology such as water traffic flow management and weather information systems. The decision-making process was based on the data collected and analyzed using various criteria, such as traffic volume, weather conditions, and accident records. It is presumed that a technology would be cost-effective under certain conditions. *[48]*

A sketch planning method involves the use of prescribed warrants. These are usually used to determine the intersection's number or combination of warrants. The warrants include various factors such as the type of wading obstacles and sluice data. Another approach is to perform a qualitative comparison of the various possible alternatives. This method can help identify the advantages and disadvantages of each possible solution. It can also highlight various factors that could affect the decision-making process. *[48]*

Although modelling is generally a time-consuming and expensive process, it is still important to perform a preliminary analysis of the various alternatives before proceeding with more detailed studies. Although the preliminary analysis can help identify the best course of action, it often doesn't identify the optimal solution. Doing so could lead to a project that's not well-considered. *[48]*

[48] Source: https://www.atap.gov.au/tools-techniques/travel-demand-modelling/2-overview

7 Case studies conclusions

7.1 A comparison of the application potential of waterborne platooning for the Danube and the Rhine corridors

The goal of this study is to investigate the feasibility of implementing the waterborne platooning concept in two of Europe's largest inland navigation corridors, namely the Rhine and the Danube. The various environmental and geo-economic features of these regions are compared and studied. The concept of the vessel train is a waterborne platooning system that aims to reduce crew cost by moving the navigation responsibilities to the leading vessel. The concept of the vessel train is evaluated using a developed model that allows the evaluation of its viability. It compares the annual cost of transporting a vessel to a specific route with the cost of transporting the same vessel as a part of a platoon. *[49] [50] [51]*

The results of the study indicate that the implementation of the waterborne platooning concept on the Rhine is more feasible than on the Danube. However, the low wages and the use of large push tows are some of the factors that prevent the system from being widely adopted in the region. The reduction in the transport cost of waterborne transport is expected to make it more attractive. However, other factors such as the integration of the vessel train into the overall supply chain are also considered to determine its success. In the Danube region, the implementation of the vessel train concept would require the addition of push convoys to the vessel train. This method of transport is more prevalent than self-propelled vessels. *[49] [50] [51]*

A vessel train consists of a fully manned lead vessel that takes over the navigation responsibilities of the vessels following it. This allows the vessel to operate with a smaller crew and lower its operational costs. The vessel train concept is similar to a train that has a predictable route. In this article, we discuss the various operational conditions that are required for the operation of the vessel train. These include the setting of a regular departure schedule and the ability to leave the train at a predetermined point. The frequent departure intervals and the potential lower operating speed of the vessel train are some of the factors that increase the voyage times of the vessel train's users. These factors can only be overcome if the cost of the vessel control system and the savings achieved through the crew reduction are taken into account. *[49] [50] [51]*

Due to the increasing importance of sustainability in the transport sector, various policies have been formulated to make the European inland navigation industry more competitive. Despite the various advantages of the vessel train, the inland navigation sector is still experiencing declining volumes. One of the factors that has been identified as a contributing factor to the declining performance of the inland navigation industry is the various barriers that it faces. According to Rogerson, these include the regulatory environment, the quality of service, and the market characteristics. *[49] [50] [51]*

In their study, the authors noted that the lack of good integration of the inland water transport (IWT) system into the supply chains is one of the factors that contribute to the declining volumes.

Through the use of alternative waterborne concepts, researchers have been able to identify various factors that can help improve the performance of the inland navigation industry. One of these is the use of sea-river vessels. According to Charles, these vessels can efficiently avoid transshipment and lower their transport costs. They also noted that the use of sea-river vessels in the UK- Germany corridor can be problematic due to the varying river conditions. They suggested the use of push barges to overcome these issues. The lack of skilled crew members is also a concern for the IWT sector. This issue can affect the reliability and safety of the newly developed technologies used in the industry. *[49] [50] [51]*

A technology that can allow vessels to operate with fewer crew members could be regarded as a cost-saving measure that can also help address the issue of crew shortages. It could also serve as an intermediate step toward the development of autonomous inland vessels. Two studies on the concept of waterborne platooning have been conducted. One of these involved the study of the societal and direct costs of this type of transportation. The authors of the study also discussed the various advantages and disadvantages of vessel train technology. They also analyzed the effects of various operating modes and the speed of the vessel train on its performance. *[49] [50] [51]*

A study conducted by Notteboom et al. compared the geographical and economic aspects of the Rhine and Yangtze River barge networks. They also looked into the various governance factors that affect the development of the inland navigation industry. This study focused on the feasibility of the vessel train concept in different geographical regions, such as the Danube and Rhine corridor. It analyzed the various factors that affect the viability of the technology in these regions. The study also looked into the various factors that affect the viability of the concept of the vessel train in different regions. *[49] [50] [51]*

The article is divided into six sections. The first one provides a literature review and a summary of the various factors that affect the feasibility of the vessel train. The next section explores the various case studies that were conducted to analyze the viability of the technology. The last section provides a breakdown of the various factors that were analyzed in order to come up with a viable solution for the industry. The second section of the study discussed the environmental and geographical characteristics of the Danube and Rhine corridor. The main reason for this discussion is due to the emergence of a rift between Europe's transportation sectors during the Cold War era. Due to the various factors that affect the business structure and operations of waterborne freight vessels, the development of new types of vessels has been hindered in certain regions. *[49] [50] [51]*

The next section focuses on the geopolitical and geo-economic factors that affect the development of the vessel train industry. This section will be used to develop case studies that will analyze the various factors that affect the industry's viability. In terms of wages, the difference between the wages in the Danube and Rhine countries can still be identified in the

various sectors of the inland waterway cruise industry. This is because the crew cost reduction that the vessel train concept provides is very important to the profitability of the industry. There are no uniform regulations regarding the composition and size of the crew of vessels operating in Europe. These regulations are usually handled by the states that are involved in the operation of the vessels. *[49] [50] [51]*

The minimum crew requirement for different types of vessels operating in Europe is similar to that of the two extreme sailing regimes. When compared to the two regimes, the crew requirements of a vessel can be reduced by up to four members by moving to an A1 regime. One of the factors that differentiate the regions is the type of employee that the vessels are employing. On the Danube, the majority of the employees are mobile workers. Due to the lack of skilled workers in the region, the average age of captains on the Danube is increasing, which is threatening the existence of family-owned businesses in the area. *[49] [50] [51]*

The average cost of hiring a crew member in the countries along the Rhine is around 40.000 per year. In contrast, the cost of hiring a crew member in the Danube region is around 8.000 per year. This difference is mainly due to the varying cost of various roles. The number of vessels that are used along the Rhine and Danube corridors is also influenced by the cargo volume that's transported through them. In 2017, the Rhine carried 186 million tons while the Danube carried 39 million tons. The Rhine's international trade flows are both regional and global. On the Danube, however, the majority of goods are transported internationally. *[49] [50] [51]*

The concept of the vessel train is currently focused on self-propelled vessels. This is because the majority of the inland vessels that operate in the region are barge convoys. Using the records of the vessels that pass through the ports and locks of the two regions, the Danube fleet is estimated to be around 2900 vessels. On the other hand, the Rhine fleet is composed of around 8200 vessels. The majority of the vessels that operate on the Danube are owned and operated by large companies. They mainly carry dry bulk and are used for long-term contracts. As the barges are decommissioned, the remaining vessels are replaced by second-hand vessels. *[49] [50] [51]*

The composition of the vessels in the Rhine fleet is significantly different from that of the Danube. On the other hand, the liquid cargo market in the region is significantly larger. In 2017, the volume of container goods transported through the Rhine reached 17 million tons. Due to the varying nautical standards in the two regions, the efficiency of the waterborne transportation has been affected. In recent years, the region has been investing in the Danube to comply with regulations related to waterway dimensions, bridge height requirements, and minimum draught. *[49] [52] [53]*

The length of the Danube is approximately 2415 kilometers, which is 2.7 times longer than the section of the Rhine that spans over 885 kilometers. The Rhine has several tributaries, such as the Main or the Aare. The Netherlands' estuary, which is also referred to as the Rhine,

connects to a vast network of waterways. These conditions allow cargo to reach its intended destination and deliver to nearby industrial plants. While the main river arm of the Danube carries large volumes of goods, it only has a few tributaries. This means that the transportation of goods through the waterway is restricted to specific regions. The average population density in the area around the river is 140 people per kilometer2. *[49] [52] [53]*

Despite the length of the Danube, its tributaries contribute to the region's higher population density. This increases the waterborne traffic density in the region. The locks along the upper sections of the Danube are important navigational facilities that allow vessels to pass through the waterway. Most of the locks along the Danube have European dimensions of 230 meters by 24 meters. *[49] [52] [53]*

The Danube's central arm can be reached by using the Iron Gate locks, which are located between Serbia and Romania. It is expected that the Danube's vessel train will pass through the Iron Gate locks. This facility allows the train to reach the most traffic-prone section of the waterway. There are only ten locks in the Rhine that have the last downstream lock. These facilities are designed for large vessels, which are usually referred to as self-propelled ships. Due to the length of the Rhine and its tributaries, the passage of the vessel train through these regions can take longer than expected. Navigation on the rivers can also be temporarily suspended due to strong winds, high water, and ice. According to historical data, the average suspension of navigation on the two rivers ranges from 5% to 6%.*[49] [52] [53]*

Low water levels can also cause vessels to have restricted draft, which can increase the cost of the transport unit and increase the risk of accidents. Although there are no official guidelines for dealing with low water conditions, vessel operators are usually left to determine their own actions. The lack of a minimum water depth of 2.5 meters along the length of the Danube can cause major navigational issues. On the other hand, the Rhine has a depth of 3.5 meters. The various business models available on the Danube allow operators to consider different strategies when it comes to their operations. On the other hand, the majority of the vessels in the Rhine are owned by large state-owned companies. *[49] [52] [53]*

In most countries along the Danube, only a few companies own more than 10 vessels. The various business models available on the Danube allow multiple companies to consider forming a joint venture (VT) for their own operations. On the other hand, the platform-based model of the Rhine is mainly used by third-party organizers. European vessels are classified according to their class. On the Rhine, the majority of the vessels are equivalent to the sizes of ships that are classified as CEMT class IV and V. In addition, there are numerous convoys of vessels carrying CEMT class VI and VII cargo on the lower Danube. These vessels are similar in size to the vessels commonly used on the Rhine. However, due to the shallow water conditions on the Danube, these vessels can only reach speeds of around 20 knots. *[49] [52] [53]*

The ports along the Danube are well-equipped to handle transshipment. They can accommodate up to 40 inland E-ports, which are international facilities. An investigation conducted by the PINE organization revealed that the ports along the Rhine are 2.5 times more

effective than those along the Danube. Despite the advantages of the ports along the Danube, the higher traffic volume can cause congestions at the ports. According to an operator, the wait times on the river are similar to those experienced on the Rhine. The study also identified various factors that could affect the viability of the proposed VT concept. This is done through a quantitative model that can be used to evaluate the economic viability of the proposed venture. *[49] [53]*

The study also looked into the various costs involved in running a joint venture. It was concluded that the net savings of the participating vessels would cover the costs of the venture. The study also noted that the number of vessels that would participate in the proposed joint venture does not meet the necessary conditions for the operation of the corridor. The viability requirements for a proposed VT are also influenced by the operational choices of the operator. These include the length of the route, the frequency of the departure and arrival times, and the number of vessels. *[49] [54]*

The study also looked into the various operating conditions and boundary requirements that could affect the viability of the proposed venture. Through the cost model, the study was able to identify the various factors that could affect the operation of the proposed venture. The model was then used to evaluate the viability of the proposed joint venture by comparing the annual cost of transporting a ton of cargo to a vessel that sails on the same route. The study also took into account the various factors that affect the navigation day suspension and lock passage delays. These factors were added to the model in order to improve its efficiency. The calculation of the annual cost of the cargo transported is then carried out using the data collected from case studies. The calculation of the maximum FV cost is then carried out to ensure that the operation of the proposed venture is at least as efficient as that of the reference vessels. *[49] [54]*

The calculation of the operation's viability is then carried out using the corridor features that were identified in the study. The study also performed a sensitivity analysis to study the various factors that could affect the viability of the proposed joint venture. It was concluded that the updated model and the various factors that were taken into account could be used to determine if the concept of the vertical transportation corridor could be applied in the Danube and Rhine regions. The input data section presents the various parameters used in the assessment model for the proposed vertical transportation corridor in the Danube and Rhine regions. *[49] [54]*

The various parameters that are used in the model are based on the various features of the proposed corridor. Some of these require more detailed explanation. Due to the size of the Danube, it is considered the most representative route for the proposed vertical transportation corridor between the Rhine and the Danube. For instance, the route length of the Danube in its case is equivalent to that of the route between Belgrade and Cernavoda. The route length of the proposed corridor is computed by taking into account the length of the

lower Danube and the route length of the Rhine. In both case studies, the FVs are allowed to continue their journey on their own once they reach their destination. *[49] [54]*

In the case of the Danube, the operators of the proposed joint venture will have different BMs depending on the route. This allows them to measure the savings they could realize from the proposed corridor. The business model for the proposed vertical transportation corridor in the Rhine region assumes that the coordinator of the venture will be the operator of the vessel. This model also requires that the platform cost be evenly distributed among the various vessels in the system. The dimensions of the vessels used in the proposed corridor remain the same regardless of the route. The difference in the speed of the vessels is also set since the shallow water on the Danube prevents them from sailing at the same speed as their deeper counterparts. *[49] [54]*

The proposed vertical transportation corridor's operating speed should be between 15 and 18 kilometers per hour. In the case of the Danube, the proposed joint venture's vessels should be able to reach their destination at a speed of 15.5 kilometers per hour. On the other hand, in the Rhine region, the proposed joint venture's vessels should reach their destination at a speed of 17.2 kilometers per hour. The table below shows the various properties of the vessels used in the proposed corridor. The cost information for the control system used in the model is also provided in Table 5. This section shows the annual cost of the control system. *[49] [54]*

Although it is difficult to determine the exact cost of the crew for the proposed vertical transportation corridor, the authors of this article use Dutch wages to arrive at an acceptable figure. *[49] [54]*

The rough estimates of the Serbian wages were obtained through interviews with the operators of the vessels used in the proposed corridor. The annual cost of the crew is computed assuming that the employment related cost and the indirect crew cost are the same. The cost of the crew is considered to be inclusive of all costs related to the operation of the vessel, such as fuel, insurance, and other expenses. In Serbia, the crew members receive additional bonuses for international travel. This can make up a substantial portion of their salary. Given that the Danube route runs through Romania, the crew members are expected to receive a bonus of around one-third of their operating time. Since the crew members' cost can make up to 40% of the total cost of operating a class V inland vessel, the overall savings from this component of the operation can be significant. *[49] [54]*

The study shows that the various conditions have positive impacts on the viability of the proposed vertical transportation corridor. The annual cost savings achieved by the Rhine region are equivalent to around 389.100 euros. This shows that the region can achieve significant benefits despite the uncertainty in the data. *[49] [54]*

A sensitivity analysis has also been added to the calculation of the annual cost savings. The results are stated in terms of percentage change compared to the base case. The maximum savings are provided at the point where the vessel stops and completes the trip. *[49] [54]*

The various parameters that are taken into account when calculating the annual cost savings have a negative impact on the FV's efficiency. For instance, the water depth and the number of navigation days are both negative factors that can affect the efficiency of the vessel. *[49] [54]*

The navigation day suspension has a negative effect on the productivity and FV savings of inland vessels. It can also discourage cargo owners from choosing waterborne transport. *[49] [54]*

The results of the study show that the unreliable waterborne conditions can affect the choice of transport mode for customers. This is because if the conditions become too unpredictable, the customer will not return. *[49] [54]*

The study also showed that a vertical transportation system can be composed of as few as one FV. This means that the system can fit into a single lock cycle. *[49] [54]*

The addition of additional locks along the proposed vertical transportation corridor can also affect the efficiency of the FV. For instance, if the vertical transportation corridor gets too long, the additional lock cycles will have to be added. *[49] [54]*

The goal of the vertical transportation system is to reduce the load on the FV crew. However, if the crew is constantly on the bridge to perform lock maneuvers, the benefit of the system decreases. *[49] [54]*

The changes in the departure intervals and the sailing distance can also affect the annual cost savings. For instance, the increase in sailing distance can increase the average savings by up to 56%. However, the income variation can also have a negative effect on the savings. For instance, if the income drops to an equivalent level to that of the Danube, the annual cost savings can decrease by almost 80%.*[49] [54]*

The feasibility checks also identify the minimum distance that a FV has to stay in the proposed corridor and the number of FVs that are required to operate within the system. The results of the studies on the Rhine and Danube cases are summarized in Table 9. The adjusted Danube case shows that the trip distance to Budapest has increased to 1400 kilometers. These adjustments allow a class IV vessel to operate within the proposed vertical transportation system. Even with the higher platform cost, the system can still be financially viable. *[49] [54]*

The operating cost of a class IV vessel on the Danube is lower than that of a self-propelled vessel. However, the required fleet share increases to 11% due to the presence of larger companies operating on the waterway. This can be feasible since it allows the system to represent a larger group of operators. One of the most significant changes that can be made to the departure intervals is to allow the system to operate on a departure on-demand basis. This will allow the operators to better coordinate with each other and with the vessels. This article compares the geo-economic and geographical characteristics of the Rhine and Danube inland

navigation corridors with the potentials of the vertical transportation concept. It also explores the various impact factors that can affect the implementation of the concept. *[49] [54]*

The advantages of both the Danube and the Rhine are acknowledged by the article. However, the latter provides favorable conditions for the development of the vertical transportation system due to its lower traffic density and crew income levels. The studies also indicated that the Rhine case could support the development of a vertical transportation system. A reduction in the transport cost associated with this concept could make it more attractive. Other factors such as the integration of the system into the supply chain could also contribute to its successful implementation. Although the potential benefits of the vertical transportation system can be realized in the Danube case, the traffic density on the waterway is not high enough to support its full implementation. One of the ways to increase the traffic density is by adding push convoys to the train. *[49] [54]*

Further studies are also needed to determine the potential benefits of the vertical transportation system for the inland water transportation sector. One of these studies should involve the integration of push barge operations into the proposed vertical transportation system. The article also explored the potential applications of the vertical transportation concept in other regions. For instance, the Yangtze River could be considered as an example of a potential waterway that could support the development of this system. *[49] [54]*

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[49] https://etrr.springeropen.com/articles/10.1186/s12544-022-00526-5

[50] Al Enezy, O., van Hassel, E., Sys, C., & Vanelslander, T. (2017). *Developing a cost calculation model for inland navigation In Research in transportation business & management*. (pp. 64–67). *https://doi.org/10.1016/J.RTBM.2017.02.006*

[51] Argonics Gmbh. (2017). *ArgoTrackPilot*. http://www.argonics.de/en/argoTrackPilot

[52] Bačkalić, T., Maslarić, M., & Bojic, S. (2015). Analysis of possible draught size of container vessels on the lower Danube. *International Journal of Mechanical, Aerospace, Industrial, Mechatronic and Manufacturing Engineering, 9*(7), 1147–1179.

[53] Beelen, M. (2011). *Structuring and modelling decision making in the inland navigation sector*. Universiteit Antwerpen.

[54] BMVI. (2019). Inland waterway transport masterplan. *In Inland Waterway Transport*. https://doi.org/10.4324/9781315739083

7.2 Intermodal Inland Waterway Transport: Modelling Conditions Influencing Its Cost Competitiveness

The goal of this paper is to develop a model that will allow the transport industry to compare the costs of road-only and inland waterway transport. The economic factors that influence the profitability of inland waterway operations are taken into account. The model takes into account various factors such as the share of empty kilometers and the capacity utilization of terminals. It then aims to analyze the sensitivity of the costs of inland waterway transport to different conditions. It is also possible to analyze the competitive advantages of intermodal freight transport compared to road-only transport. [55] [56] [57]

The results of the study show that the profitability of inland waterway transport can be significantly improved by the use of drop & pick operations and pre- and end-haulage services. However, the high costs of small terminals prevent the profitability of inland waterway transport. Over the years, the growth of European freight transport has been mainly driven by the increasing number of road vehicles. In 1980, road transport accounted for 65% of the total transport in the European Union, while in 2010, its share dropped to 7%. Aside from its numerous advantages, road freight transport also causes various issues such as congestion, accidents, and air pollution. However, it can be significantly improved by using other modes of transportation. [55] [56] [57]

Despite the increasing number of road vehicles, the profitability of road-only transport remains the main factor that influences the choice of mode of transport. In addition, scientific studies have shown that the cost of transport services is also one of the most important factors that influence the decision-making process of consumers. In addition, the economies of scale offered by inland waterway transport are significantly greater than those of rail transportation. This is one of the reasons why it is considered as a more cost-effective mode of transportation. [55] [56] [57]

Despite the advantages of inland waterway transport, it is still not clear if it is as cost-competitive as road-only transport. Various studies have been conducted to analyze the profitability of inland waterway transport. However, the exact relationship between the costs and operations of the transport chain is not clearly defined. [55] [56] [57] [58]

Unfortunately, most studies on the costs of inland waterway transport fail to include detailed information about the operations and costs of this type of transport. This makes it difficult to compare the costs of road-only and inland waterway transport. The paper presents a model that takes into account the various factors that affect the profitability of inland waterway transport. The study also takes into account the economies of scale offered by this mode of transportation. The paper aims to develop an integrated framework that will allow researchers to analyze the costs and operations of inland waterway transport. It will then be used to develop a model that will show the various factors that affect the competitiveness of this type of transport. [55] [56] [57] [58]

The costs of providing a transport service should be considered in terms of all the factors that are required to deliver the transportation service. For instance, the cost of acquiring the necessary equipment is one of the most significant factors that affect the profitability of inland waterway transport. Despite the importance of the various factors that affect the profitability of a transport service, the exact allocation of costs has not been studied. [55] [56] [57] [58]

The various categories of costs that are considered in this study are: direct costs, variable costs, and activity-based costs. In order to arrive at an accurate cost allocation, the paper will use a system known as the fixed and variable cost method. The number of business hours that a transport service provides should also be taken into account in order to determine the exact cost of providing the same service. The total variable costs of a transport service are also affected by the distance that it takes to reach its destination. For instance, if a transport service goes over a long distance, the higher the variable costs will be. [55] [56] [57] [58]

The factors that affect the cost of a transport service are the time spent in a trip and the distance covered. A cost calculator can then be used to determine the exact cost of a transport service. A kilometer cost coefficient can also be derived to determine the total variable costs of a transport service. This is the sum of the various types of variable costs that are included in the calculation. The cost of a transport service is also affected by the various factors that are involved in the production of the transportation service. These factors include the type of equipment that's used, the type of labor, and the cost of materials. [55] [56] [57] [58] [59] [60]

The efficiency of a transport service is also affected by the various factors that are involved in the production of the service. For instance, if a transport company uses a certain type of operations, the time it takes to deliver the same service might be affected. The factors that affect the profitability of inland waterway transport are presented in terms of the various links of the chain. These include the main haulage by IWT, the terminal handling, and the end-haulage by truck. The high costs of operating a terminal and the competitive structure of inland waterway transport are some of the factors that have been identified as affecting the profitability of this type of transport. [55] [56] [57] [58] [59] [60]

The cost of operating a ship is divided into two parts, namely the variable and fixed costs. The former comprises of the various expenses related to the operation of the vessel, while the latter includes the capital and labor costs. The labor costs are mainly affected by the type of vessel and its length. On the other hand, the capital costs are mainly related to the various expenses incurred by the ship such as insurance, repairs and maintenance, and port dues. [55] [56] [57] [58] [59] [60]

Although the fixed costs of a ship are usually lower than the variable costs, they can still increase depending on the level of operation. The other factors that affect the cost of a vessel's repairs and maintenance are its fuel consumption and its price. Various factors such as the size and shape of the vessel, its speed, and the power of its engine are also taken into account to determine the exact cost of fuel. Fuel costs can also vary depending on the conditions of the waterway where the ship is docked. [55] [56] [57] [58] [59] [60]

The load factor of a vessel is also taken into account when calculating the fuel costs of a ship. The fixed costs are the most significant factors that affect the cost structure of an IWT operation. They include the interest and depreciation costs of the vessel. High fixed costs can also lead to a high load factor. [55] [56] [57] [58] [59] [60]

It is also important to consider the utilization rate of a vessel when calculating the cost of operating a ship. This rate is related to the time it takes to deliver the goods and services that the client requires. A shorter roundtrip time allows a transport company to have more trips in the same period of time. The time it takes for a vessel to pass through various locks and bridges is also a major factor that affects the cost of transporting a load. [55] [56] [57] [58] [59] [60]

Another factor that can affect the cost of an IWT operation is the performance of the terminal. The performance of the facility can also affect the cost of transporting a load. In addition, the variable and fixed costs of a truck operation are also taken into account when calculating the PEH operation's cost structure. The various expenses that are included in the variable costs include fuel, maintenance, and road taxes. The cost structure of a PEH operation is also affected by the various factors that are related to the time and variable costs. On the one hand, this is the goal of the transport company to maximize the productivity of its staff and equipment, while on the other hand, it is also trying to minimize the cost of transporting a load. [55] [56] [57] [58] [59] [60]

The goal of a PEH operation is to minimize the number of vehicle kilometers that are empty. This is done through the use of various methods such as drop-and-pick operations and stay-with-trips. In these operations, the tractor remains attached to the semi-trailer during the unloading and stripping of a container. After unloading a customer's container, the combination of the truck and the container can drive back to the terminal. It can then return to the customer's location and load the container at the same address. The share of empty transport varies depending on the type of trip and the destination. In most cases, the fixed costs of this type of transport are higher due to the time it takes for the driver and tractor to load the container. [55] [56] [57] [58] [59] [60]

After unloading the container, the tractor can then return to the terminal and pick up another semi-trailer. It can also move on to another shipper to fetch another container. Although the time and cost of this type of transport are lower than stay-with trips, the kilometer costs are higher due to the number of empty containers. This type of transport can also increase the share of empty trips. [55] [56] [57] [58] [59] [60] There are various types of equipment that are commonly used in container terminals. These include cranes, reach stackers, and mobile equipment. In most cases, container terminals have more facilities that are designed to support container transshipment. In addition, different types of equipment and configurations are also commonly used in different terminals. In order to analyze possible scale economies, we have included the factors that affect the cost of transshipment at IWT terminals. These include the land, equipment, and other expenses. [55] [56] [57] [58] [59] [60]

The cost differences between different terminals can be attributed to the different types of equipment they use. They can also be caused by various factors such as the size of the terminal, the development phase of the facility, and the service offerings of the terminal. In addition, government subsidies can also lower the initial investment costs of a new container terminal. For instance, in the Netherlands, the government provides up to 25% of the total cost of establishing a container terminal. [55] [56] [57] [58] [59] [60]

The cost of establishing a terminal is also influenced by the location of the facility and the amount of land required for its construction. Also, local governments might impose restrictions on the operation of the terminal due to noise and air quality concerns. Severe weather conditions can also affect the efficiency of a container terminal's operations. For instance, if a vessel is late in arriving at the terminal due to delays in inland waterway transport, this can lead to additional waiting times for employees and equipment. [55] [56] [57] [58] [59] [60]

Another factor that can affect the efficiency of a container terminal's operations is the volume of moves it receives. Since fixed costs are a large portion of the terminal's total operating costs, the number of moves can have a significant impact on the facility's cost per move. In this section, we analyze the cost structure of inland waterway transport. We then compare it with road-only transport. [55] [56] [57] [58] [59] [60]

We then develop a cost model that takes into account the various factors that affect the cost of inland waterway transport. These include the distance traveled by the vessel, the driving distance, and the terminal handling and end-haulage operations. The cost comparison of the IWT chain and road-only chain is carried out by assuming that the chain is a so-called hinterland transport. This type of transport chain is commonly used by container terminal operators and is characterized by having only one truck driver. [55] [56] [57] [58] [59] [60]

The costs of handlings at seaport terminals will vary depending on the type of equipment and processes used to put containers on vessels. Since the deep-sea line charges a flat rate for both types of handling, the costs of handlings at seaport terminals do not have to be included as part of the overall cost of inland waterway transport. The cost comparison of the IWT chain and road-only chain is carried out by assuming that the chain is a pure shuttle service. This type of transport chain is different from an IWT service, which involves collecting and distributing containers at multiple terminals in a seaport. [55] [56] [57] [58] [59] [60]

Currently, most inland waterway transport (IWT) services have these features in their operations at seaport terminals. This type of transport chain is also considered as part of the base scenario of a facility's operations. The vessel used for inland waterway transport is typically a container vessel that has a cargo capacity of 208 TEU. [55] [56] [57] [58] [59] [60]

The average load factor of a vessel used for inland waterway transport is around 70%. This figure is considered close to the minimum required to operate a profitable operation. The profitability of an IWT service is based on the operation model of continuous operations. This method takes into account the regular departure times of the vessels used for the operation.

This ensures that the costs of the service are not significantly affected by the vessel's idle time. [55] [56] [57] [58] [59] [60]

The average time it takes to visit several ports to collect and deliver containers is around 10 hours. This figure is affected by the time spent waiting at the terminals and the additional sailing time that the vessel has to take. The routes of inland vessels do not include low bridges and locks. This ensures that the transit time of the vessels does not include additional time passing these facilities. The cost of handlings at an inland container terminal is mainly determined by the performance of a medium-sized facility. In Northwest Europe, most of the inland IWT terminals have a capacity of up to 80.000 containers. [55] [56] [57] [58] [59] [60]

The utilization rate of a container terminal is typically around 80%. This figure is considered a preferred rate of operation for container terminals as it allows them to handle peak volumes efficiently. The base scenario operations used to compare the costs of an IWT service, and a road-only transport chain are assumed to be based on the various representative chains. The chains are defined as those that have a sailing distance of 50 kilometers, 200 kilometers, or 600 kilometers. One of the most common activities that an IWT service performs is to collect and deliver containers from a seaport to an inland terminal. This involves sailing from the port to the facility, unloading the containers, and returning them to the inland terminal. [55] [56] [57] [58] [59] [60]

In road-only transport, the container is transported from the seaport to its destination in the hinterland. After completing its single trip, the container is stripped and delivered to the inland terminal. Road-only transport involves unloading the containers at the customers' Premise and returning them to the seaport. [55] [56] [57] [58] [59] [60]

The results of the model show that for most operations, the cost of road-only transport is lower than that of an IWT service. The model also shows that for operations with a 600-kilometer intermodal transport chain, the cost of this method is the most cost-effective option. The costs of single-trip operations are lower than those of road-only transport. However, the high PPH costs of road-only transport are still considered significant factors that can affect the cost advantage of IWT. [55] [56] [57] [58] [59] [60]

The high PPH costs of road-only transport are also considered significant factors that can affect the cost advantage of IWT. In most cases, the low sailing costs of IWT are more beneficial than those of road-only transport. This is because the total cost of operations is significantly affected by the difference in trucking costs. The size of the load unit used by an IWT service is also considered a factor that can affect the cost competitiveness of the operation. For instance, if a 40-foot container is transported, the sailing costs will increase due to the additional slots required on the vessel. [55] [56] [57] [58] [59] [60]

The costs of trucking a 20- or 40-foot container are the same regardless of the type of vehicle used. However, carrying two 20- or 40-foot containers is not allowed in most cases since the total gross weight of the container exceeds the allowed limit. The representative chains analyzed so far show that the IWT operations are carried out by a vessel that has a total cargo

area of 208 TEU. Although this is a common-used size, larger vessels and smaller vessels are also used. The decision about the size of the vessel is also influenced by the available container volumes and the physical limitations of the waterway. [55] [56] [57] [58] [59] [60]

The cost performance of an IWT operation is shown in Figure 6 for situations where a vessel has a capacity of 90 TEU. Compared to other methods, such as road-only transport, IWT can compete well with this method at long and middle-distance distances. The road-only transport chain involves the truck waiting for the container to be stripped before proceeding with the other trips. This process can be similar to the IWT chain, but it can also make the truck more productive. The cost performance of these different operations is shown in Figure 2. The high share of environmental costs in the total chain costs of an IWT operation is considered a major factor that can affect the competitiveness of this mode. [55] [56] [57] [58] [59] [60]

The savings achieved by drop & pick operations are shown in Figure 6. These methods can be very cost-effective for shorter end-haulage distances. In most cases, they can help improve the competitiveness of IWT operations. The features of a terminal are also taken into account to determine its cost performance. These factors include the land use, capital requirements, and labor needs of the facility. To evaluate the impact of these factors on the cost competitiveness of an IWT operation, different scenarios have been developed. [55] [56] [57] [58] [59] [60]

The profiles of different types of terminals are labeled according to their handling capacity. For instance, the profiles for a small terminal are labeled as S-term, while those for a medium-sized facility are labeled M-term. These types of facilities are commonly referred to as small terminals, which are simple and cost-effective to operate. The overview of these types of terminals in this annex shows that they can offer significant economies of scale. [55] [56] [57] [58] [59] [60]

The share of handling costs that a terminal has to pay is also considered a major factor that can affect the cost competitiveness of an IWT operation. This issue is most prevalent in small terminals, which are usually under-utilized. Having sufficient throughput in these facilities can help make the IWT chain more competitive. The customer base of the freight transport industry generally believes that road-only transport is the best option for freight transportation in Europe. This is because it consistently delivers better quality of services and lower costs. [55] [56] [57] [58] [59] [60]

In this paper, we present a model that can be used to compare the costs of road-only and IWT transport. The results of the study show that the claim that road-only transport is more competitive than IWT is not always accurate. The factors that influence the cost competitiveness of an IWT operation are also taken into account. The level of transport cost is also taken into account to analyze the sensitivity of various transport cost elements to an operation's operations. [55] [56] [57] [58] [59] [60]

Through this method, it is possible to analyze the competitive position of IWT freight transport against road-only transport in terms of their costs under specific operations. This allows users to make informed decisions regarding their operations. The cost of end-haulage

is a major factor that can affect the competitiveness of an IWT operation. Compared to road-only transport, roundtrips can significantly improve the profitability of an IWT operation. In certain cases, the share of handling costs that a terminal has to pay exceeds the share of sailing costs. This issue is most prevalent in small terminals. [55] [56] [57] [58] [59] [60]

The ability to perform drop and pick operations in end-haulage is very important for an IWT operation's cost competitiveness. The increasing number of FEUs in the freight transport industry has significantly reduced the cost competitiveness of IWT operations. [55] [56] [57] [58] [59] [60]

Although the break-even distance for intermodal freight transport does not exist, it is still a multi-point phenomenon. The study found that the ability to perform drop and pick operations in end-haulage and pre- and post-haulage significantly improves the profitability of IWT operations. However, the high cost of operations in small terminals can reduce the competitiveness of IWT. Further studies are also needed to analyze the various factors that affect the cost competitiveness of IWT operations. For instance, studies are also needed to analyze the range of distances that IWT can be cost competitive. [55] [56] [57] [58] [59] [60]

7.3 Strategic Recommendations of Waterway Transport

The Recommendation Target System

The recommendation calls for the objective of encouraging modal change by increasing the share of waterway freight transport and integrating it into the combined intermodal transport system, divided into sub-areas. The subdivisions are built on top of each other, considering all the elements necessary for the formation of the transport system.

Improving port accessibility:

In order to guarantee connectivity to the combined/intermodal transport system, the recommendation calls for last-kilometre connections to ports to be accessible by road, rail and waterway.

Increase loading and storage efficiency:

Due to the increase in the share of waterway freight transport, ports need to be prepared for the most efficient ways of handling goods. To this end, the recommendation proposes to adapt to technological developments in the road, rail, pipeline, and ship fleets, considering alternative propulsion options and modernization of storage and loading technology.

Sustainable port:

• As part of the adaptation of ports to climate change, the recommendation supports preparations to deal with extreme water levels and weather.

• The recommendation calls for the automation and digitalization of port processes, with the help of which the development of the Global Port Information System and the need to connect to a unified international system.

• To increase the share of waterway transport, the recommendation proposes to develop a targeted market information and promotion campaign.

• To achieve and maintain a more favorable position in the transport market competition, the recommendation encourages continuous and targeted market research and monitoring of international developments in the logistics sector relevant to ports.

In order to generate additional demand, the recommendation calls for additional demand for port services in two sub-areas. To achieve this objective, the future development of market services is urged by the recommendation according to the following components:

Market adaptation, agricultural industrialization

Adapting port services to the market by expanding and expanding the potential commodity base and examining compatible cargo transport solutions. During market adaptation, the recommendation also promotes cooperation with industry and port industrial deployment.

Service development

The development of port services is supported by the recommendation in two aspects, including the inclusion and development of services other than traditional port services and the development of servicing activities.

In order to create the objective of the funding system, the recommendation sets out four sub-areas, which, in addition to building on each other, are also prerequisites for each other. The system to be established should be followed when assessing the order and importance of grants and investments.

• The recommendation clarifies in advance the concepts used in the ranking process and thus also defines port types.

• Concepts clarified in advance by the recommendation and the properties of the benchmarking system can be used to justify potential improvements

Port Common Advocacy

To achieve the human resources development objective, the recommendation calls for addressing the labour shortage in the port by including several sub-areas.

Supply of shortage occupations

•The port profession has a significant labour shortage, which means that the recommendation calls for this problem to be resolved as soon as possible.

Development

• With a view to developing human resources in ports, the recommendation supports the development and extension of the training programme to as many port jobs as possible. This is necessary so that the changes due to digitization can be put into practice.

To meet the objective of developing a sustainable regulatory system, the recommendation calls for intervention in sub-areas, as follows:

• In the spirit of global operational development and cooperation, the recommendation calls for the completion of joint port advocacy.

•Standardizing the tasks of public authorities will shorten procedural times and make them more efficient. The need for national authority tasks will shorten processing times.

Improving port availability

In order to deal with the additional transport capacity associated with the increase in freight traffic in ports, it is necessary to create associated transport access routes with appropriate qualitative and quantitative characteristics.

Of particular importance among transport links is the infrastructure that represents the immediate surroundings of the ports, a few kilometres long, which, if not sufficiently developed, can be a bottleneck compared to the main lines that would otherwise have adequate capabilities.

Multimodal transports affecting the road account for a significant part of the traffic of domestic ports, therefore it is necessary to ensure road connections that can withstand a long-term axle load of 11.5 tons, as well as to create access to the expressway network within 30 minutes, which is beneficial from an environmental and logistical point of view. For ports that are wedged into the urban fabric, road accessibility should be developed in accordance with the quality of life, tourism and economic aspects of the settlements and parts of settlements concerned.

In order to properly serve the ports by rail, it is necessary to establish a railway link with an axle load of 22.5 tons, connected to the global main network. At strategically important points, in the current and planned TEN-T network ports, where all market players have the possibility of loading in ports and the physical facilities allow, a network of tracks capable of receiving directional trains of standard size should be built.

Waterway accessibility requires ensuring the navigability of the Danube River waterway at least 300 days a year. The Governments prepares the necessary interventions within the framework of a separate recommendation and plans of waterway transport improvement.

In the immediate vicinity of the ports, as well as in the case of basin ports, in the entrance canals and in the port basins, it is necessary to ensure the continuous maintenance of the riverbed depth of 25 dm above, even in the case of small water. Due to silting, these characteristics must be maintained by continuous maintenance of the riverbed.

In areas where there is a significant flow of liquid goods near the port and could be transported economically by waterway, a pipeline connection must be established on the route concerned to ensure that the volume of goods transported also affects the water side in multimodal transport.

Increasing loading and storage efficiency

One of the key areas for encouraging mode switching is to increase the quality and efficiency of the loading and storage service. These are the characteristics that determine the competitiveness of intermodal transport, which also integrates waterborne freight transport. In order to achieve this strategic goal, significant investments are needed in terms of both storage and loading capacities, covering not only the infrastructure and equipment, but also the automaticization of processes.

Port terminals must be able to serve the technological developments of the coming years and decades, which will affect the physical characteristics of transport vehicles, the proliferation of alternative propulsion modes and the development of self-driving capabilities. Ports need to create a physical and digital environment that addresses these technological changes.

In response to the challenges of freight transport and the efficiency needs of intermodal loading, new types of railcars are emerging that require specially designed terminals. The deployment of appropriate infrastructure at network-relevant points such as TEN-T comprehensive and core network ports and where demand induces it becomes necessary.

In ports, shunting locomotives with alternative propulsion are to be expected. By applying this special type of railway plant, the environmental impact of shunting within the industrial area can be significantly reduced. Ports should have the additional equipment, service background and expertise necessary for operation.

The basic technical characteristics of ships, barges, other loading machines have not changed much in recent decades, but alternative propulsion, as well as technologies of digitalization and self-driving, are bringing significant changes to the logistic area. These changes primarily require technological preparation from the ports side. The use of alternative fuels in ports should be extended in two areas. On the one hand, the use of alternative means of propulsion arises in the case of machines and equipment used in the movement of goods (e.g., cranes, forklifts, loaders, conveyors). In parallel with the provision of the necessary fuels, the possibility of charging goods vehicles, whether electric or gas-powered (LNG, CNG, hydrogen) vehicles, should be built up as a service.

In addition to adapting to external technological trends, the technological modernization of operations and service processes in ports is essential. In addition to the modernization of loading technology and storage technology, port developments must be handled in a complex approach, bearing in mind the additional functions. The aim of the loading technology upgrades is to reduce service times, reduce the scrap rate and increase loading capacities. As a means of doing this, it is necessary to modernize and automate cranes, conveyors, hoppers, other material handling devices. And in the case of services related to loading, such as weighing, a high degree of digitalisation should be pursued.

To increase the efficiency of intermodal loading, it is necessary to expand the technologies and capacities for loading semi-trailers and containers. In the field of storage technologies, commodity safety, capacity building and diversification are priorities in the developments. In the case of bulk, palletized, containerized, semi-trailer goods, the aim is to introduce automatic storage solutions in ports, which take the above aspects into account. In addition, it is necessary to carry out developments in the field of quality control during storage, which measure and monitor the parameters of the goods during storage using INDUSTRY4.0 solutions.

Due to the significant quantity and value of goods appearing in ports, and to serve vehicle traffic efficiently, it is also necessary to improve access control, traffic control and protection systems.

Digital port

The automation and digitalization of domestic ports is a particularly important area of the port development recommendation. The aim of the developments is to create a digital operating environment in ports, following international good practices and through innovation, which increases the efficiency of processes, reduces administrative burdens, and guarantees the safety of goods and personnel. The digitalisation of ports must take place in conjunction with other transport information systems.

Ports can prepare for the efficient management of the surplus goods that appear by increasing the share of freight transport by waterways with a high degree of automation of loading, storage, and ancillary processes. Industry 4.0 technology is also extremely well suited in port environments, contributing to increasing process efficiency. The next step in

the efficiency increase achieved by automation is integration into complex erp systems, which also helps business operation and administration with the tool of digitalization.

For the terminals to be integrated into the global freight transport system, it is necessary to build an international port information system. The EMS shall be established and operated in a manner that can subsequently be connected to the international system.

In the case of low water levels, limited accessibility, and difficult loading, and in the case of high-water levels, coastal areas may be submerged, which also threatens loading and storage. This factor should be taken into account in the development of waterfront areas of ports. The impact of water level fluctuations must be addressed by building vertical shore walls, while flood protection solutions designed to meet waterside loading needs protect the loading and storage areas of the port. Preparing for extreme weather conditions in ports means protecting personnel, goods, and infrastructure.

Occupational safety and operating regulations guarantee that ports can operate safely even in unpredictable weather conditions. In addition to physical hazards, bearing in mind the economic risks, it is necessary to build warehouse capacities on a scale that means adequate capacity to deal with the loss of supplies in terminals exposed to agricultural performance.

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[55] A.S. Bergantino, M. Bierlaire, M. Catalano, M.Migliore, S. Moroso
Taste heterogeneity and latent preferences in the choice behavior of freight transport operators
Transport Policy, 30 (2013), pp. 77-91

[56] Cooper and Kaplan, 1999
R. Cooper, R.S. Kaplan
The design of cost management systems
(2nd edition), Prentice Hall, Upper Saddle River, New Jersey (1999)

[57] Danielis and Marcucci, 2007
R. Danielis, E. Marcucci
Attribute cut-offs in freight service selection
Transportation Research Part E: Logistics and Transportation Review, 43 (5) (2007), pp. 506-515

[58] Decisio, 2002
Decisio (2002), Tussenevaluatie Subsidieregeling Openbare Inland Terminals, Eindrapportage, Amsterdam.

[59] Dorsser, 2005
Dorsser, C. (2005), Amsterdam Barge Shuttle, Economische haalbaarheid van het AMSbarge project, afstudeerscriptie, Zwijndrecht.

[60] Drewry, 2010
Drewry Shipping Consultants Ltd, (2010), Container terminal capacity and performance benchmarks, London, Drewry Shipping Consultants.

8 Environment protection in waterway transportation

8.1 Inland waterways and environmental protection

At the Prague Council in 2000, transport ministers from across the European Union agreed to develop a common approach to address the issue of sustainable transport policies. This was done in order to improve decision-making processes and to provide a framework for assessing the environmental impacts of various transport projects. This report aims to examine the various aspects of environmental protection when it comes to the maintenance and expansion of waterways. *[61]*

This study aims to identify current and potential policy issues related to environmental protection and to suggest ways to improve decision-making related to the development of inland waterways. The study provides a basis for developing a strategy for improving the management of inland marine transport. It also addresses issues that will be presented at a conference in September 2006. The objective of the study was to identify and discuss the various approaches and challenges related to the protection of the environment in the inland waterway transport industry. *[61]*

The CCNR is responsible for developing the regulations for inland navigation on the Rhine. The Convention on the Rights of Navigation on the Rhine was also updated in 1868. The Danube Commission's objective is to promote the freedom of navigation and the development of inland shipping. It is focused on ensuring that navigation channels are regularly maintained and are free from obstacles. The Danube Convention aims to provide for free navigation on the river Danube in accordance with the rights of the parties to it. *[61]*

The objective of this organization is to promote the interests of navigation in the region by planning and implementing major projects. It also plans and reviews the proposals submitted by the member States. Establishing a uniform system of navigation regulations for the entire region. The Directorate General for Environment has powers to improve the quality of surface waters in the Union. The ICPDR works on issues related to the management of the Danube River and its tributaries. These include the protection of aquatic life and the development of inland waterways. *[61]*

The Danube River Protection Convention was created in 1998. It is the main legal framework for managing the water resources of the river basin. The Commission aims to safeguard the river's water resources for the future generations. *[61]*

In 2003, the Convention on the Protection of the Rhine was consolidated. This Convention was also adopted following the establishment of the Rhine Water Co-ordination Committee. The UNECE has various Committees responsible for overseeing various aspects of water protection. These include the Environment Committee and the Inland Transport Committee.

The Committee is responsible for carrying out environmental impact assessments and decision-making procedures. *[61]*

8.2 Environmental Assessment Procedures

Aside from being used as waterways, some of these systems also have other important roles such as supplying water for cities and towns, as well as helping preserve natural habitats. The development of inland waterways presents various challenges in terms of balancing the environmental impacts with the water management objectives of different users. Waterways are vital to the navigation of vessels. They must have certain characteristics such as depth, width, alignment, and current velocity to ensure their reliability and ecological character. *[61]*

While the main environmental impacts will be identified during the project planning stage, their significance during the operation and construction phases can also be managed. SEA is a requirement for certain plans and programs that have significant environmental impacts. It is usually required at the level of planning and at the project level. The public has the right to have their opinion, and the results of the planning procedure are integrated into the overall plan or program. After the plan has been adopted, the public and environmental authorities are informed about the decisions and the way they were made. *[61]*

Various environmental impacts are considered when assessing the effects of climate change, human health, the environment, and cultural heritage. The SEA Directive defines these issues as narrowly as possible. This tool can also be used to identify impacts that go beyond a project's initial goals and procedures. It can also be utilized as an early warning system for potential issues. SEA is most effective when it is integrated into the planning process. This can be done in various stages of the planning process. *[61]*

SEA is a tool that can be utilized to facilitate a decision-making process if it is linked to a planning decision. However, if the process is not linked to a decision, SEA is not required. Joint SEA is a way to overcome the limitations of national focus in addressing environmental assessment methodologies. It can help avoid duplication of efforts and reduce the costs of doing so. SEA exercises can also help develop effective methodologies and procedures for assessing the capabilities of non-government organizations. The Environmental Impact Assessment Directive (EIA) is a regulation that aims to identify and assess the effects of a project on the environment. It is often referred to as an impact statement. *[61]*

For IWT projects, the objective is to minimize the environmental impacts of the project. The development alternatives identified during the planning stages can help minimize these impacts. *[61]*

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[61] Source: https://www.itf-oecd.org/sites/default/files/docs/06waterenv.pdf

9 Appendix 1: Survey Questionnaire

	Question	Name: Silvena Krumova Company: Port complex Ruse JSC Nationality: Bulgaria Contact: office@port-ruse-bg.com	Name: Boyan Bonev Company: PORT BULMARKET JSC Nationality: Bulgaria Contact: Boyan Bonev / boyan.bonev@bulmarket.bg	Name: Iliyan Iliev Company: Bulgarian River Shipping JSCo Nationality: Bulgaria Contact: trade1@brp.bg	Name: Igor Barna Company: Verejné prístavy, a.s. / EN: Public ports, JSC / PP5 VPAS Nationality: Slovakia Contact: igor.barna@vpas.sk	Name: DANIEL JARNEA Company: Compania Nationala Administratia Porturilor Maritime S.A. Constanta Nationality: Romanian Contact: djarnea@constantza-port.ro
1	Please define on a scale from 1 to 5 how utilized are agricultural water transport integration opportunities in your area?	3	3	3	4	5
2	How much critical shipping points can be found in your area?	11-30	0-10	0-10	0-10	11-30
3	List which agricultural products have the most water transport potential in your area?	Crops (corn, soybeans, hay, etc.)	Crops (corn, soybeans, hay, etc.)	Crops (corn, soybeans, hay, etc.)	Crops (corn, soybeans, hay, etc.)	Crops (corn, soybeans, hay, etc.)
4	How would you rate your current agricultural water transportation model, if 5 is the most and 1 is the least ideal?	2	3	3	3	4
5	How many new agricultural water transportation development needs have raised in 2021 in your area?	N/A	0-10	0-10	0-10	N/A
6	Are there any modeling tools used in agricultural transportation planning and implementation in your area?	Not informed	No, there are not	No, there are not	No, there are not	No, there are not
7	What are the main components which must be taken into account through a water transportation modeling phase?	N/A	N/A	N/A	Transhipment of agricultural production is based on current demand. Market players are motivated mostly by the price and available transhipment technology.	N/A
8	How many waterway connections can be found in your area?	11-30	0-10	0-10	0-10	0-10
9	Which part of agricultural products changed the most in your area since 2019?	Crops (corn, soybeans, hay, etc.)	Crops (corn, soybeans, hay, etc.)	Crops (corn, soybeans, hay, etc.)	Crops (corn, soybeans, hay, etc.)	Crops (corn, soybeans, hay, etc.)
10	What agricultural changes appeared in your area in 2021?	For 2021 our port have 19% increase in processed cereals in comparison with 2020.	N/A	N/A	N/A	N/A
11	Please define the agricultural changes which had positive impact on your area	N/A	N/A	N/A	N/A	N/A
12	Please define the agricultural changes which had negative impact on your area	N/A	N/A	N/A	N/A	N/A
13	What kind of human resource challenges do you face regarding agricultural transportation?	Both	Both	Both	Mainly physical	N/A
14	Please select which TMS (Transportation Management System) tools are used in your area.	IoT fleet monitoring, Blockchain	IoT fleet monitoring	IoT fleet monitoring	N/A	N/A
15	Please define the least developed water transportation methods in your area.	N/A	N/A	N/A	Transhipment of agricultural production is done either by grapple crane or by pouring into a container and then to vessel. Available conveyer belt is in very bad technical condition.	N/A
16	List and define the monitoring tools included in agricultural transportation in your area	N/A	N/A	N/A	Transhipment of agricultural production is based on current demand. Market is not actively monitored by any methodology or hardware/software solution.	N/A
17	Which participants of the agricultural water transportation uses TMS (Transportation Management System) in your area?	N/A	N/A	Companies that provide logistics services, such as third-party and fourth-party logistics (3PL and 4PL) companies and logistics service providers (LSPs)	N/A	N/A
18	What is the balance between land and water use of transportation infrastructure in your area?	Water transportation infrastructure usage: 20 % Land transportation infrastructure usage: 80%	N/A	Water transportation infrastructure usage: 50% Land transportation infrastructure usage: 70%	Water transportation infrastructure usage: 3,4% Land transportation infrastructure usage: 96,6%	N/A
19	Please define the opportunities of maintaining a good balance between land and water agricultural transportation usage in your area.	Transportation of Livestock, Edible forestry products, Dairy (milk products), Fish farming in lower Danube is totally absent. Port complex Ruse mostly import cereals from Romania, Moldova and Hungary. The distribution between imports and exports of cereals in our largest port is 80% imports and 20% exports.	N/A	N/A	Public port of Komárno can be used as good example, since it has ideal position for transportation of agricultural commodities as it is located in the region with the highest agricultural production. Transhipment of agricultural products have very long tradition there. Usage of transportation depend on the length of the trip to be taken. Slovak section of Danube is short, therefore regional transportation (within borders) does not make economic sense. Short length / inter-regional transportation is therefore provided by land infrastructure, either rail or road.	N/A
20	What are the most critical points of transport to connect land and water use in your area?	Faster and easier land transportation. Lack of lobbying for the development of river transport.	N/A	N/A	Both cargo public ports in Slovakia, Bratislava and Komárno are trimodal, therefore accessible by rail and road sufficiently.	N/A
21	How would you describe the balance between land and water agricultural transportation in your area?	Fairly balanced	Well balanced	Good	Badly balanced	Medium
22	How well utilized are the infrastructural water use and port developments in your area?	11-30%	51-80%	51-80%	11-30%	31-50%
23	What are the numbers of the critical points of transport to connect land and water use in your area?	31-50	31-50	0-10	0-10	11-30
24	Please list 3 investment decisions that providing financial, economic, environmental and other relevant input.	N/A	N/A	N/A	Public port of Bratislava Project idea of reallocation of the The Bulk (dry) Terminal from Winter port to basin Pálenisko (newer location, further from the city centre) in the proposed area of 1 800 m2. Area had already served for this purpose in the past. In terms of capacity, this location is able to accommodate current transhipment volumes and based on the demand analysis it is expected slight increase in transhipment in the future. However, there is still a capacity reserve that can enable the possible expansion of these activities in its new location. Relevant demand analysis pointed out the demand for an air-conditioned warehouse, which should be a part of a new Break-Bulk terminal. The land is currently not used and can potentially be available for further expansion as well. Project has not been realized yet.Public port of Komárno Objective of this project is to reallocate transhipment from current location to	N/A

24	Please list 3 investment decisions that providing financial, economic, environmental and other relevant input.	N/A	N/A	N/A	Public port of Bratislava Project idea of reallocation of the The Bulk (dry) Terminal from Winter port to basin Pálenisko (newer location, further from the city centre) in the proposed area of 1 800 m2. Area had already served for this purpose in the past. In terms of capacity, this location is able to accommodate current transhipment volumes and based on the demand analysis it is expected slight increase in transhipment in the future. However, there is still a capacity reserve that can enable the possible expansion of these activities in its new location. Relevant demand analysis pointed out the demand for an air-conditioned warehouse, which should be a part of a new Break-Bulk terminal. The land is currently not used and can potentially be available for further expansion as well. Project has not been realized yet.Public port of Komárno Objective of this project is to reallocate transhipment from current location to	N/A
25	Which are the most critical factors and inputs in your area regarding agricultural waterway transportation?	Evaluation & Prioritization of strategies Development of transpiration improvement programs Project development System operations (implementation)	Regional vision and goals	Regional vision and goals Alternate improvement strategies Evaluation & Prioritization of strategies	Development of transpiration improvement programs	Development of transpiration improvement programs
26	Please list the key transportation, economic, and land use issues, you are facing in your region	Our services don't include transportation of agricultural goods.	N/A	N/A	Transhipment of agricultural production is negatively affected by outdated transhipment infrastructure (facilities, silos) and low demand for transhipment over the quay (from/to water). Supply chain and flow of goods have changed in past decades and long-distance transport is not currently that strong as few decades ago (namely import).	N/A
27	Define goals, objectives, and criteria regarding a transportation planning scenario	N/A	N/A	N/A	Transhipment of agricultural production is based on current demand. Planning of transhipment is primarily up to owners of the product, not ports.	N/A
28	Please provide metrics (measuring number) for the present status of the transportation system and its use in consideration of:-Traffic Data: -Water transportation statistics: -Census information: -Agricultural industries travel patterns»	N/A	N/A	N/A	See Tables in OT3.3_Questionnaire_09032022_VPAS. -Census information: Population of Slovakia in 2021: 5 449 270 Population of Bratislava: 475 500 Population of Bratislava self-governing region: 659 598 (2 052,6 km²)Population of Komárno: 33 539 Population of Nitra self-governing region (location of Komárno): 676 672 (6 343,4 km²). -Agricultural industries travel patterns:» In recent years, the role of providing logistical transportation of goods has passed from the manufacturer to an intermediate link in the whole chain – wholesalers. A large part of the companies actively uses water transport especially for export (especially relevant for the Port Komárno). The level of possible transshipment in ports is highly volatile and difficult to estimate as it depends	No metrics were provided N/A
29	«Please provide data and information about surface runoff in your area» Surface runoff (also known as overland flow) is the flow of water occurring on the ground surface when excess rainwater, stormwater, meltwater, or other sources, can no longer sufficiently rapidly infiltrate in the soil. Please define in 2-3 sentences.	N/A	N/A	N/A	Bratislava The Danube watercourse flows through the assessed area. The alpine character of the upper course of the Danube (from the source to Devín) is manifested mainly in the distribution of its water capacity during the year. The most conclusive month is June, with a long-term average monthly flow rate of 2 789 m3.s-1, the driest month of October, with a long-term average monthly flow rate of 1527 m3.s-1. Summer floods are the most typical for the Danube, mostly in the months of June - August. During the floods in 2013 (in the period from 31.5. to 11.6.) the highest maximum flow rate in 100 years in Bratislava was 10 640 m3.s-1, and the Danube level reached 10, 34 m. Komárno The determining type of permeability is inter-grain in all these regions. The permeability of the subsoil depends on local conditions, mainly k = 1.10-3	N/A

30	« Please provide data and information about subsurface flow in your area» Subsurface flow refers to the flow of water below earth's surface as part of the hydrologic cycle. Subsurface flow may return to earth's surface as perched flow, such as from a spring or seep, or subsurface (baseflow) return to streams, creeks, and rivers. Please define in 2-3 sentences.	/A	N/A	N/A	Bratislava The assessed area and its wider surroundings belong to the hydrogeological region 51. quaternary of the western edge of the Danubian Plain with inter-grain permeability. In terms of hydrogeological regionalization, the evaluated area lies in the Q 051 area, at the boundary of sub-area VH 00 with usable amount of groundwater 1,00 – 1,99 l.s-1.km-2 and sub-area DN 00 with usable amount of groundwater greater than 9,99 l.s-1.km-2. Komárno The fluvial sediments of the Danube River form the most important groundwater collectors in the Danube Plain. The groundwater level is in direct hydraulic connection with the level of the river Danube. Sediments of the fluvial gravel formation, located below relatively few thick layer of alluvial soils, due to their high filtration coefficients	N/A
31	«Please chose models that are used to simulate and forecast traffic flow in your area.» Please use the underline tool to select your answer. You can select more than one option:	/A	N/A	Trip distribution	None of the above	N/A
32	«How would you describe the port workload utilization in your area?» Please use the underline tool to select your answer.	/A	81-100%	31-50%	11-30%	31-50%
33	«Please provide a scope of industrial travel behavior in your area using flowchart modeling» The flowchart should consist of all the units, which are involved in agricultural transportation. Please consider marking the critical intersections of the flow. Please define in 6-12 sentences.	/A	N/A	N/A	N/A	N/A
34	«Please provide aims of establishing how to reduce fuel consumption during agricultural water transportation in your area» During this question please provide data from 2020 and 2021. Please try to provide data units that are comparable. Please define in 6-12 sentences.	/A	N/A	N/A	N/A	N/A
35	«Please provide aims establishing how to improve water quality regarding agricultural water transportation in your area» Please define in 2-3 sentences.	/A	N/A	N/A	N/A	N/A