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WP1.1: INLAND WATERWAY TRANSPORTATION AND ITS PROSPECTS IN RUSSIA AND FINLAND

Project «Future potential of inland waterways» («INFUTURE»)

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INTRODUCTION

Russian Federation

In situation of limited capacity of roads and railways, the fullest use of the potential of inland waterways of Saimaa canal, Volgo-Balt and others of Unified Deepwater System (UDWS) of Russia, which are and potential integral parts of the North-South international transport corridor, can be a significant factor in reducing logistics infrastructure costs as component in the price of goods, reducing the negative impact of transport on the environment.

Further UDWS development for its integration into the international transport corridors will contribute to the growth of the transport of foreign goods by inland waterway transport, help to increase the competitiveness of transport and business companies throughout Saimaa and Volgo-Balt waterways and promote of international cooperation between Finland and Russia in the field of transport services.

At the meeting of the Presidium of the State Council of the Russian Federation on August 2016 on the issue «On the development of the inland waterways of the Russian Federation», among the main tasks it was noted that it is necessary to shift part of the transportation of construction, oil, grain cargo, ferrous metals and others, based on economic feasibility from land-based modes of transport to inland waterway transport, with the removal of infrastructure restrictions and a fair competitive tariff policy. At the same time, it is advisable to make greater use of the capabilities of the regions to promote inland waterway transport among consignors.

This study was carried out within the framework of the section WP1.1: Study on Commercial Inland Waterways Potential (INFUTURE) project Saimaa Lakes – Volgo-Balt. The study is starting in the first working package of the specified project.

Finland

The Maritime Transport Strategy for Finland 2014-2022 says it clearly: Finland will be prosperous, because the Maritime transport will retain its position as an environmentally friendly, energy-efficient and cost-efficient transport mode (Ministry of Transport and Communications, 2014).

Inland Waterways (IWW) should be part of this bright future of Finland. Inland waterway transport (IWT) has proven to be environmentally friendly, energy-efficient and cost-efficient transport mode. Despite its clear benefits "Inland Waterway and River-Sea Shipping (IWT) still does not play the adequate role in the transport system to its potential … "too often, inland shipping is not even considered as an alternative transport by many forwarders and stakeholders in the transport sector" (EMMA Project, 3.10.2018).

The "Future potential of Inland Waterways" ("InFuture", South-East Finland - Russia CBC) project takes a wide-ranging approach for finding solutions for sustainable and cost-effective inland waterway traffic. The project identifies the most efficient ways of handling cargo and examines the legislation on freight traffic as well as Finnish and Russian cargo regulation. In addition, the project takes part in ITC system development that offers customers a quick and easy way to find the most suitable service for their cargo transport needs (Kotka Maritime Research Centre, INFUTURE – Merikotka).

This review brings together information and best practices that will help IWT stakeholders to focus on possible changes in the near future. The existing waterway systems in Finland, EU and Russia offer a large potential to manage increasing transport flows and decrease congestion of road and railways.

1. GENERAL CHARACTERISTICS OF INLAND WATERWAY TRANSPORT

Russian Federation

Inland waterways (IWWs) of Russia and associated shipping fairways and hydrotechnical sites are state owned and used for shipping purposes by any legal entities and persons [1].

IWWs has complex usage to meet the needs of individuals and legal entities, industries, regions, in addition providing society with drinking and industrial water supply, irrigation, sanitary flooding of rivers.

At the present, the total length of the inland waterways of the Russian Federation is 101,7 thousand kilometers, they goes on the territory of 60 administering entities of the Russian Federation, and in order to ensure the IWWs maintenance are divided into 15 Basins. Each basin has common navigable waterways, climate, navigational and hydrographic settings for the vessels sailing and hydrometeorological conditions.

The main inland waterways are White Sea-Onega, Volga-Balt, the Volga, the Moscow, the Kama, the Volga-Don and the Azov-Don basins, which form the United deep-water system of inland waterways of the European part of Russia (hereinafter – UDWS) connecting the Baltic, White, Caspian, Azov and Black Seas. The total length of the UDWS is about 6500 km.

Deep waterways have large throughout capacity, they can be compared with multi-track railways (or motorways), and they are well-adapted to mass transportation of goods and passengers. It worth to be reminded that branches of UDWS with a total length of 5357,6 km of inland waterways are included in the list of inland waterways of international importance [2].

Vessels flying the flag of the foreign countries allowed sailing by inland waterways [3] of Russia totaling 20630 km.

In order to ensure the navigable conditions of inland waterways there 741 navigable hydro-technical sites are operated providing integrated solutions in:

navigation, water supply (including drinking water), sanitary flooding of rivers, irrigation and reclamation engineering protection of territories and populations from man-made disasters and natural floods.

On the territory of the European part of Russia are the largest artificial hydrotechnical constructions (sites) – the inland shipping canals: the Volga-Balt Canal, the Moscow Canal, the Volga-Don Canal, the White Sea-Onega Canal.

State regulation in the field of inland waterways and shipping hydrotechnical sites located on them is carried out by the Ministry of Transport of the Russian Federation [1].

Organization of works on navigation and hydrographic conditions providing for the vessels sail by inland waterways, as well as carrying out maintenance of inland waterways and navigable hydraulic engineering constructions situated on them rests with the Federal Agency of Sea and River Transport.

Direct keeping and maintenance of inland waterways and located on them navigable hydraulic engineering structures, functions of port State control and other functions in the inland waterway basins shall implement the Administrations of Basins Waterways [1].

There are 134 river ports operated on the territory of the Russian Federation. The business entities of inland waterway transport carrying out cargo works in there exceed the number of 200 companies. River ports are the main link in interaction with railway and road transport, among them 58 river ports are rail accessed.

As it can be noticed on Fig.1 in 2008 was reached the maximum amount of goods transported by inland waterways since the beginning of the century – 151.0 million tons (fig. 1). However, under the influence of the global financial crisis and subsequent economic recession, the volume of inland waterway transport falls in 2009 on 36% to 97 million tons. From the 2010 volumes of transported cargoes were increasing again, making it in 2012 about 142.4 million tons. Since then, however there has been slow but steady trend of cargoes declining till 2018, when transportation by inland waterways consisted of 116,2 million tons (115,1 million tons by other sources).

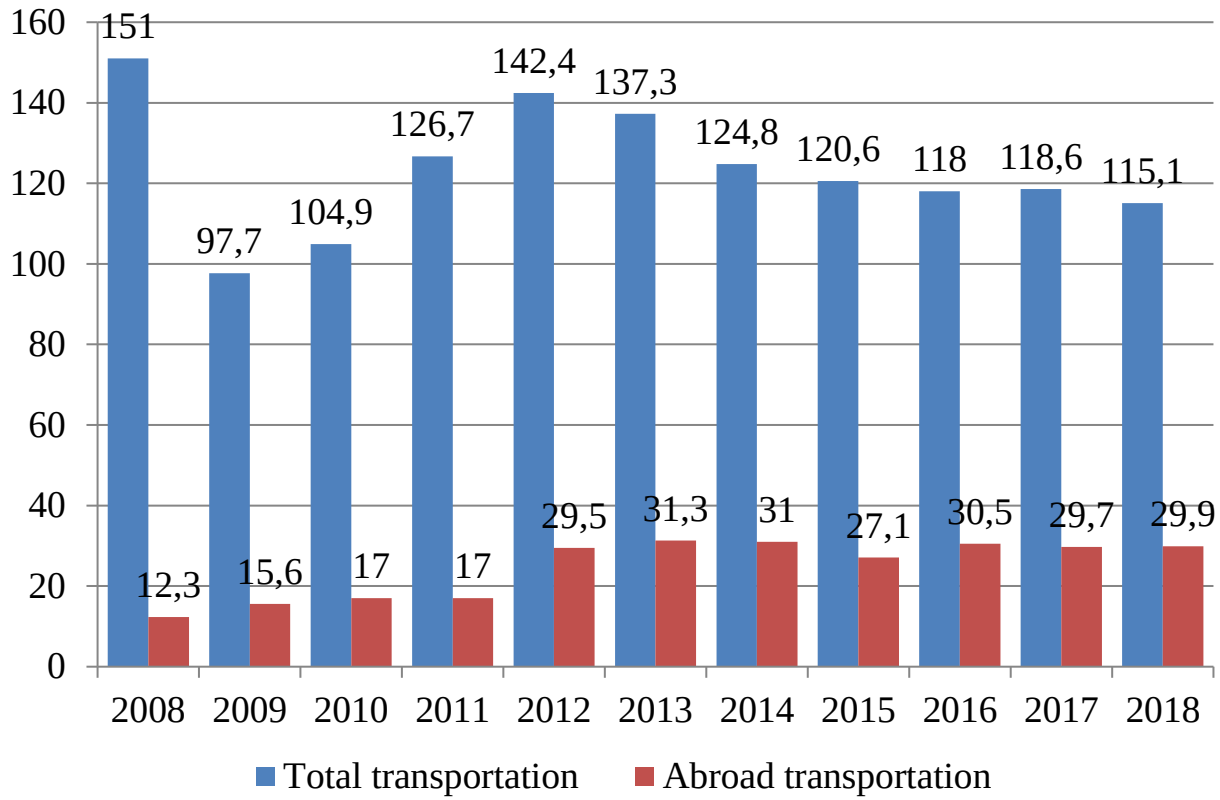


Figure 1. Development of volumes of goods transportations by inland waterway transport of Russia in the years 2008-2016, million tons

At the same time, the amount of foreign (abroad) transportation by inland waterway transport in 2016 amounted up to 30,5 million tons, which is nearly 2,5 times higher compared to the same indicator of year 2008, when growth in the years 2008-2012 and stabilization in a subsequent period were reached (fig. 1).

The share of the goods transported by inland waterways of the UDWS is about 75% of the total traffic volume, whereas the volume of export-import cargoes (petroleum products, wood, metal, fertilizers, etc.) amounts about 25% of the total traffic.

River ports are mainly focused on handling of bulk cargoes, their share is about 93-95%, remaining 5-7% falls on oil and petroleum products, processed at specialized berths. In recent years out of the total volume of cargo handling works, the share of export-import cargoes is about 6-8%.

There are 13022 cargo and passenger vessels registered in the Russian River Register, and 641 vessels of combined “river-sea” going class (of classes II-SP and

III-SP) are registered in Russian Maritime Register of Shipping, which are operated under the national flag [5].

Finland

”Approximately 8 300 kilometers of coastal fairways and 8 000 kilometers of inland waterways are maintained by the Finnish Transport Infrastructure Agency. The total length of waterways maintained by the Agency, 16 300 kilometers, includes nearly 4 000 kilometers of fairways used for merchant shipping. In addition to the Saimaa Canal, which connects the Saimaa Lake District to the sea, the waterway network has 31 other canals” (Finnish Transport Agency, Waterways, 3.10.2019).

The Vuoksi waterway is the part of Finland, where inland waterway freight transport is concentrated. The waterway includes Saimaa on the Finnish side and Lake Ladoga on the Russian side. The Saimaa Canal connects the waterway to the Gulf of Finland. For these reasons, the Canal is vital for the development of inland waterway transport.

The Baltic Sea Region with its growing transport volumes, especially between East and West, needs innovative and pragmatic solutions to cope with future transportation requirements. Rivers, canals and also the Baltic Sea have huge capacity reserves, whereas road and rail infrastructure are (at least in some parts of the Baltic Sea Region) overloaded (The Finnish Waterways, 30.1.2019).

There are strategic conditions for future IWT growth, the fulfilment of which is believed to increase the freight flows. One of the key elements will be year-around waterborne transport in Saimaa area and in the Canal. “Another strategic possibility is consolidated shipments serving all shippers in the Saimaa region. The third possibility is to develop Saimaa’s internal transport system, particularly with the transport of future wood-based fuels in mind,” states the development strategy for IWT in Saimaa (Koskinen, 2010, 7-8). The biggest increase in renewable energy production is already coming from forest industry black liquor and by-products: “Finland has become a global leader in the utilization of forest-based biomass for energy production, thanks to our exceptionally strong forest sector and extensive

investments in bioenergy R&D&I since the 1980's. We have here a unique platform for bio-based production and partnering, said Jari Tielinen, Senior Advisor at Finpro's Invest in Finland unit (Bioenergy International, 26.2.2017).

In an interview, Ministerial Adviser Kaisa Kuukasjärvi from the Finnish Ministry of Transport and Communications (MINTC) says that any assessments on possible shift of transport from roads to inland waters and railroad have not yet been made. For the time being, assessments on the impact of increased IWT on the environment and energy-efficiency are missing as well: "Environmental impact assessment, just like all other impact assessments, is being developed all the time to meet better the challenges presented by, for example, the climate targets" (Kuukasjärvi 2019).

The growth potential of the Saimaa Canal and Vuoksi waterway, however, has been assessed: "According to the 2016 service analysis of freight traffic in Saimaa, the estimated growth potential is 1.5 million tonnes. The growth forecast is based on the assumption that the Saimaa Canal locks are extended, the water level is raised and the navigability season is extended," Kuukasjärvi says. The service analysis anticipates that part of the project shipments currently on wheels could be shifted on inland waters.

Inland waterway transport can be divided into four types of traffic: timber floating, freight transport by cargo vessels and barges, and passenger transport.

"At the moment, only the Saimaa Canal provides opportunity to carry out transport to the sea from the Vuoksi water system area. Kokemäki river and Kymi river are mainly used for passenger transport and leisure boating", says the "Sisävesiliikenteen katsaus 2018-2030" review (Kyykkänen et al. 2018, 4).

Log floating is a traditional transport method of raw wood but nowadays only one forest industrial company in Finland are using it constantly and it is done in lake Saimaa. In addition of raw wood, other products such as ores or paper are transported too (Finnish transport and communications agency, 2019). Other product groups are less significant.

Cyclical changes in international trade and economic situation of Russia and Central Europe reflected directly to shipping in the lake Saimaa area and canal. In years 2001-2008 when economic growth was strong transportation volumes were higher being at least 2,054,057 tonnes in 2007 and even 2,368,334 tonnes in 2004. Financial crisis in 2009 halved shipments in one year. In 2010-2013 volumes improved but challenges of slow economic growth and in heavy industry are visible over the next few years. In year 2018 the canal were open shorter period than normal year because of renewing of bottom gates and therefore transportation volume of the year does not show the exact situation.

Transports of international trade, January-December 2018										
Source: Finnish Customs										
28.2.2019										
		Ship transports			Other transports					
	S I T C (REV4)									
										Transports
		Sea	Inland waterway	Total	Rail	Road	Air	Post	Other	total
	Imports (1000 t)	**46 710**	**404**	**47 114**	**6 969**	**3 957**	**33**	**5**	**1 852**	**59 930**
0	Food and live animals	2 328	-	2 328	39	84	0	0	-	2 452
1	Beverages and tobacco	248	-	248	-	1	0	0	-	249
2	Crude materials, inedible, except fuels	11 529	397	11 925	4 649	3 058	0	0	-	19 632
24	Cork and wood	2 725	397	3 122	3 146	2 912	0	0	-	9 179
27	Crude fertilizers and crude minerals	3 942	-	3 942	5	70	0	0	-	4 017
28	Metalliferous ores and metal scrap	4 023	-	4 023	1 498	13	0	0	-	5 534
3	Mineral fuels etc	20 947	-	20 947	487	48	0	0	1 812	23 294
32	Coal, coke and briquettes	4 332	-	4 332	-	42	0	0	-	4 375
33	Petroleum and products	16 442	-	16 442	376	5	0	0	-	16 824
4	Animal and vegetable oils and fats	406	-	406	1	1	0	0	-	408
5	Chemicals and related products, n.e.s.	4 779	-	4 779	1 392	160	3	0	-	6 334
6	Basic manufactures	4 506	7	4 513	396	536	4	0	-	5 450
7	Machinery, transport equipment	1 458	-	1 458	4	55	17	2	40	1 576
8 + 9	Miscellaneous articles	509	-	509	2	16	8	1	-	536
	Exports (1000 t)	**44 199**	**129**	**44 328**	**343**	**3 255**	**234**	**1**	**86**	**48 246**
0	Food and live animals	996	-	996	10	90	1	0	-	1 097
1	Beverages and tobacco	90	-	90	0	17	0	0	-	107
2	Crude materials, inedible, except fuels	12 838	36	12 875	87	1 021	2	0	-	13 985
24	Cork and wood	5 192	30	5 222	2	892	0	0	-	6 116
25	Pulp and waste paper	4 043	3	4 046	49	23	0	-	-	4 119
3	Mineral fuels etc	8 859	-	8 859	16	119	0	0	0	8 994
4	Animal and vegetable oils and fats	14	-	14	-	1	0	0	-	15
5	Chemicals and related products, n.e.s.	4 607	-	4 607	99	552	4	0	0	5 262
6	Basic manufactures	15 134	93	15 226	123	1 268	6	0	-	16 623
63	Wood and cork manufactures	836	1	837	2	51	0	0	-	890
64	Paper, paperboard and articles thereof	9 455	92	9 546	99	662	1	0	-	10 309
67	Iron and steel	3 749	-	3 749	20	319	0	0	-	4 088
7	Machinery, transport equipment	1 083	-	1 083	7	140	29	1	86	1 346
8 + 9	Miscellaneous articles	579	-	579	1	45	192	0	-	817

Table 1. Transports of international trade 2018.

The State of Finland has leased the Saimaa canal area from the state of Russian Federation, which is very special arrangement in global context. When the canal was built leasing contract was been signed for 50 years and that was extended in 2013 for

equally long period. Because of this fact, potential investments for the canal infrastructure are topical.

The Finnish Transport Agency is responsible for the maintenance and development related to hydrography in Finland: “The Agency publishes electronic and printed nautical charts of Finland’s sea areas and lake districts, manages the automatic nautical chart updating service, handles the updating of online and printed publications related to nautical charts, and implements the government services and navigation information services related to hydrographic data”, the agency´s internet site tells (Finnish Transport Agency, 15.7.2019).

“The maintenance of waterways covers the servicing of maritime aids to navigation, as well as their repair, rehabilitation and construction. The waterway maintenance services also include dredging activities and the fairway planning and surveys conducted to support the maintenance activities”.

The Finnish Transport Agency has approximately 25,000 aids to navigation installed along the 16,000 kilometres of waterways under its management within Finland’s sea areas and lakes. The aids to navigation may be of the fixed or floating kind. The maintenance services of the Finnish Transport Infrastructure Agency cover 39 lock canals.

Saimaa waterway is part of Trans-European Transport Network (TEN-T). It comprises of two levels: the core network, to be completed by 2030 and the comprehensive network to be completed by 2050. The TEN-T core network focuses on the most important connections and hubs. The network covers all forms of transport as well as platforms enabling a combination of different forms of transport. (Finnish Transport Agency, 15.7.2019)

The core network includes:
• The Saimaa Waterway area
• The Helsinki and Turku hubs
• Helsinki and Turku airports

• The ports of HaminaKotka, Helsinki, Turku, and Naantali
• The Kouvola combined road and rail transport terminal

(Finnish Transport Agency)

Table 2. TEN-T core network in Finland.

2. STRATEGIC DIRECTIONS OF THE DEVELOPMENT OF INLAND WATERWAY TRANSPORT

Russian Federation

The basic strategy document defining priorities, goals, objectives and indicators for the development of the transport industry is the Transport Strategy of the Russian Federation for the period until 2030 [4], where the imbalance in the development of the unified transport system of Russia is identified as one of the most significant problems and the scale of development of different types of transport, including a significant lag in the development of inland waterway transport.

The Strategy for the Development of Inland Waterway Transport of the Russian Federation for the period until 2030 [5], based on the strategic priorities and objectives of the Transport Strategy and based on the analysis and synthesis of the current state, problems and opportunities for the development of inland waterway transport, defines the goals for the development of inland waterway transport until 2030 of the year. In order to achieve each of the goals set, tasks were set and measures were justified to ensure their systematic solution.

Objectives and indicators of the development of inland waterway transport of the Russian Federation:

1. Creation of conditions for the shifting of cargo flows from land transport to inland waterway transport to ensure a balanced development of the transport system.

Achieving this objective (goal) will help improve the balance of the country's transport system, and

-reduce specific transport costs in the price of final products by optimizing transport and technological schemes for cargo delivery, taking into account the shift (redistribution) of part of cargo flows from land-based transport to inland waterway transport;

-reduce the overall environmental burden of the transport industry;

-develop and strengthening of ties between regions by eliminating territorial and structural imbalances in transportation;

-accelerate of the socio-economic development of the regions, especially of the Far North, Siberia and the Far East, where inland waterway transport is without alternative and life-supporting;

-increase in employment.

The fullest use of the potential possibilities of inland waterways will reduce the traffic density of roads and railways in parallel directions for the delivery of bulk cargoes, ensure the development of port facilities and the construction of logistics terminals, and create an information environment for multimodal technological interaction between participants in the transport process.

Indicators for this objective are:

-the length of inland waterways with guaranteed dimensions of ship fairways;

-the length of inland waterways with illuminated and reflective conditions;

-proportion of the length of inland waterways with limited capacity on the UDWS;

-cargo handling by river ports of Russia;

-the share of container traffic in the total inland waterway transport;

-the share of highly profitable cargoes in the structure of the inland waterway cargo base;

-labor productivity in inland waterway transport.

2. Ensuring the growth of competitiveness of inland waterway transport in relation to other types of transport.

Achieving this goal will allow creating a modern transport fleet that corresponds to the structure of transported goods and parameters of inland waterways, international and Russian standards for shipping safety, energy efficiency and environmental friendliness, provide a powerful impetus for the development of domestic shipbuilding, and create conditions for the development of passenger traffic on tourist routes.

Indicators for this objective are:

-average age of the cargo fleet;

-average age of the fleet used on tourist routes;

-total fleet capacity;

-average specific fuel (electricity) consumption per one ton-km.

3. Improving the availability and quality of inland water transport services for shippers.

Achieving this goal will allow to fully meet the needs of the country's economy in the services of inland waterway transport, including providing socially significant cargo transportation in the Far North regions and equated localities, Siberia, the Far East and remote regions of Russia. Government support for container transport by inland waterway transport will reduce the traffic density of highways and reduce the negative environmental impact from the operation of heavy vehicles. The removal of infrastructural restrictions on the inland waterways of the UDWS will ensure the growth of traffic, speeding up time and reducing the cost of shipping goods.

Indicators for this objective are:

-number of container lines;

-number of multimodal terminals;

-volume of cargo transportation to the Far North regions and similar areas;

-volume of traffic of foreign trade cargoes on inland waterways.

4. Ensuring the social function of inland waterway transport for passengers.

Achieving this objective means fully meeting the growing needs of the population in inland waterway transport, ensuring the affordability of inland waterway transport services of social importance, as well as the availability of services for citizens with disabilities.

Within the framework of this objective, it is intended primarily to ensure the transportation of passengers on socially significant routes, including ensuring their

affordability, the development of urban and suburban passenger water transport systems in large cities with inland waterways.

Indicators for this objective are:

-average age of the passenger fleet;

-volume of passenger traffic on socially significant routes;

-number of newly built or reconstructed berths and other infrastructure facilities for passenger transport.

5. Improving the level of safety and environmental friendliness of inland waterway transport.

Realization of this objective will allow to ensure the level of safety and information support of shipping that meets international and national requirements, the security of operation of inland waterway infrastructure facilities, a higher level of safety of cargo transportation that require special conditions.

Indicators for this objective are:

-share of navigable hydro technical structures that are subject to security declaration, having an unsatisfactory level of safety, in the total number of navigational hydro technical sites;

-amount of emissions of air pollutants per one ton-km;

-share of inland waterway transport organizations that has implemented environmental management systems for environmental quality management in their total number of organizations.

The dynamics of the main indicators are shown in Figure 2.

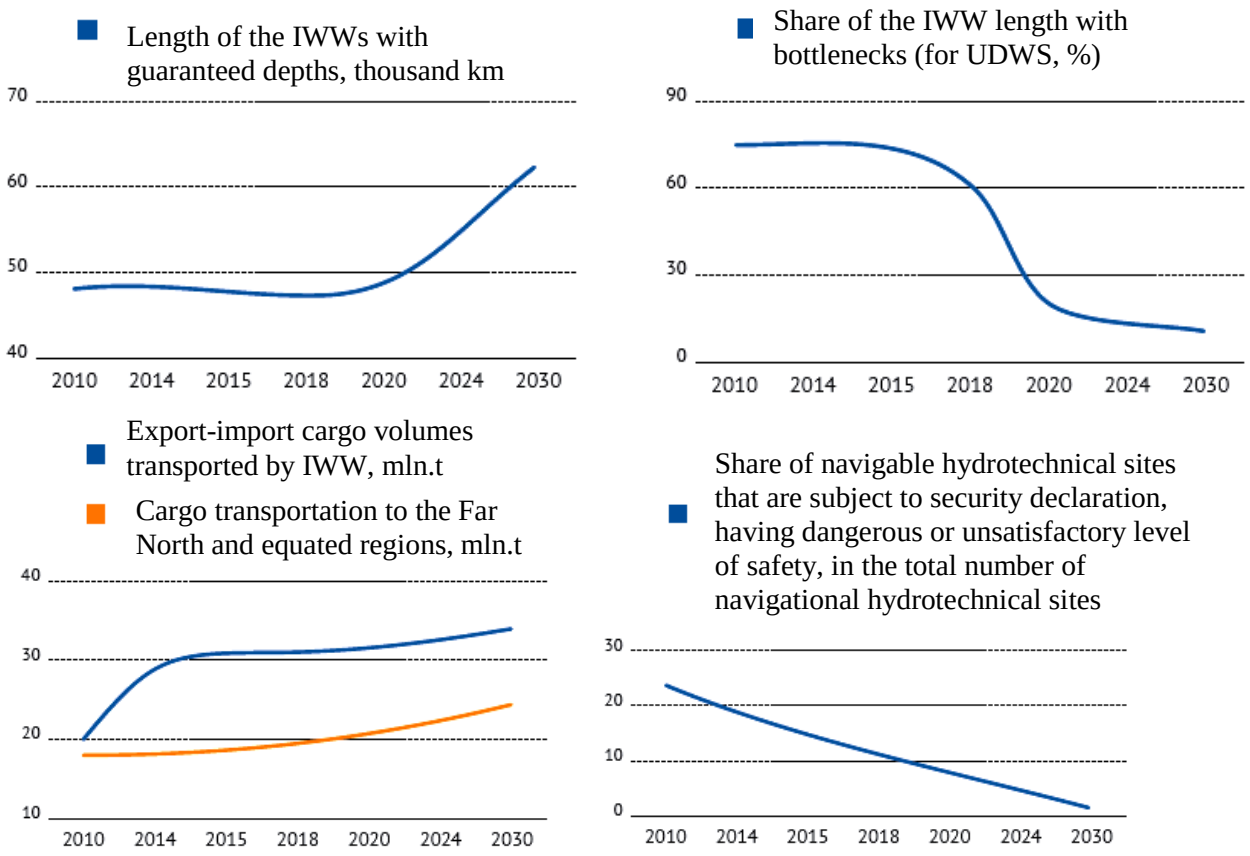


Figure 2. Dynamics of the main indicators of the Strategy of the IWW transport development of Russia

For the implementation the Strategy provides a set of measures ensuring the achievement of long-term goals and the solution of the tasks:

• Increased throughput of inland waterways:

- by improving the quality parameters of inland waterways;

- by implementation of projects for the construction of new hydro technical structures to eliminate «bottlenecks» on the inland waterways of the UDWS;

- by renovation of technical (serving) fleet vessels.

• Development of port infrastructure:

- by improvement of the property management mechanisms in river ports;

- by updating of cargo handling equipment in river ports;

- by improvement of credit and customs policy when purchasing cargo handling equipment for river ports.

• Working out and implementation of state support measures for the development of inland waterway transport:

- by development of regulatory and financial measures aimed at restricting the transportation of non-metallic building materials by road;

- by legislative restriction at the level of the constituent entities of the Russian Federation of the use of heavy vehicles in cities where there are inland waterways;

- by development and implementation of measures to attract cargo flows that potentially can be carried by inland waterways;

- by development and implementation of a system of measures to promote transportation with the participation of inland waterway transport among professionals of the transport and logistics services market and shippers.

• Ensuring competitive prices (rates) for the carriage of goods by inland waterway transport:

- by improvement of the tariff policy providing for a combination of free pricing mechanisms with control functions in the interests of protecting consumers from unreasonable discriminatory tariffs, and market participants from dumping tariffs.

• Creation of an additional cargo base on inland waterways:

- by development of industrial clusters, focused on the transportation of manufactured products and raw materials by river transport.

• Improvement of the document management system, creation of the information environment for multimodal technological interaction of participants in the transport process:

- by introduction of a system of unified electronic transport documents, development and implementation of an integrated electronic system for the design and maintenance of sea and river freight and passenger traffic.

• Ensuring renewal and growth of fleet tonnage:

- by development and implementation of state support measures for fleet renewal (interest rate compensation for borrowing and construction of ships at Russian shipyards, using the leasing mechanism to upgrade the river fleet and vessels

of river-sea navigation, including the fleet of shipowners delivering cargo to the Far North and equated areas);

- by renewal of the fleet of shipowners delivering goods to the Far North and equated areas, based on the implementation of the mechanism of operational leasing of ships;

- by development of a program for upgrading ships of the river fleet and river-sea navigation based on the introduction of a payment mechanism to Russian organizations for the purchase the cargo ships in exchange for vessels delivered for scrapping.

• Improving the safety, environmental and energy efficiency of inland waterway transport:

- by equipping ships of inland and river – sea going class with satellite navigation equipment of GLONASS or GLONASS / GPS, electronic mapping systems, government finance support for equipping transport ships with navigation systems;

- by reconstruction of navigation laboratories for creating and updating electronic navigational charts in the basins of inland waterways, creating electronic navigational charts on side and smaller rivers;

- by development of a program for the modernization of vessels and infrastructure of inland waterway transport to reduce their negative environmental impact;

- by development of measures to stimulate the modernization of vessels with the installation of modern engines and fuel consumption control systems;

- by improving the integrated services of inland water transport vessels, including the reception and treatment of sewage and oily wastewater, and other wastes;

- by development and implementation of a program for the construction of technologically advanced ships (bilge water collectors, integrated ship cleaning stations and oil and sewage collectors) to replace the existing environmental fleet;

- equipping ports with means to protect the environment.

• Development of passenger traffic on tourist routes:

- by development of measures of state support for the renewal of the tourist fleet;

- by construction of modern vessels for use on tourist routes.

• Ensuring the availability of transport services for the carriage of goods in the Far North, Siberia and the Far East:

- by creation of a mechanism to support the initiatives of regional executive authorities of the constituent entities of the Russian Federation on the development of navigation on side and smaller rivers in the eastern regions;

- by development of standard designs of vessels for the eastern basins, including the shallow draft fleet, based on the proposed grid, taking into account the requirements of cargo owners and shipowners;

- by development of a set of measures aimed at the systemic use of the transport potential of the Northern Sea Route and inland waterways of Siberia to ensure the growth of traffic volumes;

- by improvement of the tariff policy in the framework of the delivery of goods to the regions of the Far North and equivalent areas.

• Creating conditions for switching container flow from congested road sections to inland waterway transport:

- by development of a mechanism for state support of projects for the creation and development of trimodal terminals using the mechanism of public-private partnership.

• Development of measures for the effective use of the potential of the UDWS as the most important waterway of international importance:

- by justification of a set of measures aimed at the implementation of the transit potential of the UDWS;

- by modernization of the system of international agreements on navigation on inland waterways, primarily in the context of the opening of certain sections of the inland waterways of the Russian Federation for the access of vessels flying a foreign flag;

- by development of container and contrailer (piggyback) transportation of container-like cargoes along the North-South international corridor by inland waterway transport.

• Ensuring the social function of inland waterway transport of passengers:

- by development of passenger traffic on socially significant routes, including speed lines;

- by development of intracity and suburban passenger transportation by inland waterway transport in large cities with waterways:

- by development and implementation of purposed programs for the development of urban and suburban passenger transport by inland waterway transport in large cities with waterways.

• Improving the level of safety and environmental friendliness of inland waterway transport:

- by development and implementation of integrated projects for the reconstruction of hydro-technical sites, other infrastructures and inland waterways of the UDWS basins, Siberia and the Far East;

- by modernization and equipment of the navigational aids of inland waterways with geographic information systems for monitoring positioning and technical condition;

- by reconstruction and development in basins of the departmental technological communication networks on inland waterways based on international standards of river information services;

- by increase the level of safety of transportation of goods required special conditions;

- by meeting the need for specialists with qualifications that meet the requirements of safety and sustainability of the transport system, including international ones.

Large investment and infrastructure projects implemented under the Strategy: the construction of the Bagayevsky hydrotechnical site on the Don River and the construction of the Nizhny Novgorod hydrotechnical site on the Volga River.

The implementation of the projects will provide a unified guaranteed depth of 4 meters on the main inland waterways of the UDWS, increase their throughput up by 56 million tons, and create incentives for updating cargo and passenger fleet.

Finland

Finland joined the European Union in 1995 and is a member of the European Economic and Monetary Union. For European matters, Finland has a special Cabinet Committee on European Affairs. It is supported by the Committee for EU Affairs and EU bodies. Finland's prime minister is a member of the European Council (European Parliament in pain language, 2019).

In 2011 European Commission published the White Paper on Transport. Its purpose is to show paths towards a competitive and resource-efficient transport system (European Commission, 10.3.2019):

"The European Commission adopted a roadmap of 40 concrete initiatives for the next decade to build a competitive transport system that will increase mobility, remove major barriers in key areas and fuel growth and employment. The proposals will dramatically reduce Europe's dependence on imported oil and cut carbon emissions in transport by 60% by 2050. Key goals will include:

- No more conventionally-fueled cars in cities.
- 40% use of sustainable low carbon fuels in aviation; at least 40% cut in shipping emissions.
- A 50% shift of medium distance intercity passenger and freight journeys from road to rail and waterborne transport.

All of which will contribute to a 60% cut in transport emissions by the middle of the century.

The EU transport policy aims at a form of mobility that is sustainable, energy-efficient and respectful to the environment. These goals can be achieved by using multimodal transport that combines optimally the various modes of transport, exploiting each one's strength and minimizing the weaknesses.

A Single European Transport Area should ease the movements of citizens and freight, reduce costs and enhance the sustainability of European transport. 30% of medium-distance road freight km should shift to other modes such as rail or waterborne transport by 2030, and more than 50% by 2050, facilitated by efficient and green freight corridors. To meet this goal, appropriate and required infrastructure should also be developed.

By 2050, connect all core network airports to the rail network, preferably high-speed; ensure that all core seaports are sufficiently connected to the rail freight and, where possible, inland waterway system (European Commission, 2011, 2.5./6).

- Cost-efficiency and IWT potential

The White Paper recognizes the strategically important role of IWT for the international business:

"On the coasts, more and efficient entry points into European markets are needed, avoiding unnecessary traffic crossing Europe. Seaports have a major role as logistics centers and require efficient hinterland connections. Their development is vital to handle increased volumes of freight both by short sea shipping within the EU and with the rest of the world. Inland waterways, where unused potential exists, have to play an increasing role in particular in moving goods to the hinterland and in linking the European seas" (European Commission, 2011, 2.1./27).

"Logistics costs in trade and manufacturing were 40.3 billion euros in 2015 of which approximately 27 billion euros were directed to Finland. In relation to the Finnish gross national product, logistics costs of trade and manufacturing were about 12.2% in 2017," states the Finland State of Logistics 2018 by the Turku School of Economics (Solakivi et al. 2018, 14).

In the analysis, businesses were able to assess the operating conditions based on five different elements: "Regional differences are greatest in assessments with regard to transport infrastructure operating conditions. Here, the difference between the best (Helsinki–Uusimaa) and worst (Northern and Eastern Finland) is almost an entire unit." It was also discovered that the level of satisfaction on transport

infrastructure has decreased in all areas including, for example, technical condition, capacity and connections. (Solakivi et al. 2018, 89-92).

There are several advantages from the points of view of cost efficiency:

- IWT routes follow existing rivers, so there are not problems of land acquisition involved;
- Development costs per kilometer are significantly lower when compared to railroad or road transportations; the maintenance costs are also significantly less (Table 4.);
- IWT is energy efficient, as and inland vessel is able to carry one tonne of cargo almost four times further than a truck;
- Sustainable propulsion technologies can offer reductions in emissions and even higher energy efficiency;
- The costs linked with pollution and its damages are much lower than in other modes;
- IWT offers cost-effective ways to tackle congestions and accidents;
- Inland navigation vessels have a loading capacity equivalent to hundreds of trucks;
- Waterway maintenance costs are significantly lower than in other modes of transport (The Finnish Information Centre of Automobile Sector (AuT), 2018):

Maintenance costs								
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Road	495,9	540,6	552,7	560,1	568,7	578	604,1	744,3
Railroad	276,9	285	288,9	332,3	331,9	324,1	369,9	419,6
Waterways	74,7	86	79,3	86,2	80,3	68,9	87,4	108

Table 3. Transport maintenance costs in Finland 2010-2017.

The cost-benefit analysis, made by M4 Traffic AB and commissioned by Finnish Waterway Association also show IWT strong sides. This socio-economic analysis covered the social costs (emissions, accident costs, infrastructure

maintenance etc.) related to the different transport scenarios that society values and can put a price on. (M4traffic, 2018)

The assignment was to analyze a typical freight transport between Joensuu (Finland) and Dusseldorf (Germany). The calculations based on actual transport volumes of pulp between two cities. The assumptions in the calculations based on studied effects of actual transports by truck, train and ship. All alternatives were calculated one-way direction from Joensuu to Düsseldorf and on a condition of fully loaded vessel, truck or train for a yearly volume of 200 000 mt.

The results of the socio-economic calculation show that direct vessel transport from Joensuu to Dusseldorf is the most profitable. This applies both to the total costs as well as the costs that affect society in terms of wear and tear, accident costs and emissions. "The increase in ship size occurs after 5 years, and is a result of the proposed investments in The Saimaa Canal", the analysis points out (M4traffic, 2018, 3).

- Saimaa canal

The investments in the Saimaa Canal enable navigation by longer ships and transport of bigger cargos. The cargos will be approximately 3,100–3,200 tonnes – lifting the Canal water level by 10 cm allow the increase of cargo volumes. Better cargo capacity means better profitability. At the same time, the number of ship types that fit the Canal will increase. (Finnish Transport Agency, 24.1.2018)

- Concerns over canal renovation

From the Finnish Transport Infrastructure Agency's perspective, the responsibility for the selection of the mode of transports lies with the shippers.

"They must specify what they want and promise in case the Saimaa Canal investment takes place. If there are cargo consignments, service will be provided. Up to this date, the speed and functionality of the service have been guaranteed," says Tero Sikiö from the Finnish Transport Agency (Sikiö 2019).

One concern has to do with the renovation work of the Saimaa Canal planned to be implemented in two 6-month long periods.

“If the canal lock extension work is started, it will stop the traffic for the two periods. This raises the question of whether the transports will return to the Canal if they are shifted to other modes of transport. The transports will return back if the service and prices are right,” Sikiö concludes.

- Navigability

In the current situation, the fairway maintenance cannot guarantee fully year-round navigability season for the Saimaa Canal. The average service break is currently 2.5 months, but this average will be shorter.

“There have been winters during the last 10 years that have facilitated year-round navigation. It is likely that there will be more of these warm winters to come,” says Tero Sikiö from the Finnish Transport Infrastructure Agency.

“The locks of the Canal are already technically suitable for winter use. Streams of compressed air move the ice, the so-called “bubbler” lifts warm water to the surface, the walls are heated to prevent ice from sticking in confined spaces and, if necessary, steam containers can be brought in to melt the ice. In addition, our employees are the best in the world when it comes to operating locks in winter” (Sikiö 2019).

The problem is the sections between the locks that require a supply of warm water to prevent them from freezing. It is not efficient to establish a thermal power plant for a need that lasts only a couple of months a year.

- Icebreaking

The ice classification of the vessels has created problems as enough vessels of the IA and IB classes suitable for winter traffic in Saimaa has not been available:

- Vessel of the IA ice class: structure, machine power and other properties are such that the vessel is, if necessary, able to travel in difficult ice conditions assisted by an icebreaker.
- Vessel of the IB ice class: structure, machine power and other properties are such that the vessel is, if necessary, able to travel in medium-difficult ice conditions assisted by an icebreaker.

(Finnish Transport Agency, 21.12.2018)

The icebreaking situation affects the competitiveness of the waterway area. Current situation will be improved along the adoption of the new self-propelled removable-bow. In the near future, icebreakers are expected to be agile, more powerful and of full breadth (12.6 m). The reformers of the icebreaking equipment are also waiting for the realization of the Saimaa Canal investment.

- Ecology and energy efficiency

Grounds for the development of IWT ships and inland waterways can be found, for example, in the publication of the Committee for the Future 1/2018, "Suomen sata uutta mahdollisuutta 2018–2037" ("100 Opportunities for Finland and the World 2018–2037"). The publication states that "Finland should be especially actively involved in technologies that solve significant societal issues, for such technologies also create global business opportunities and, at the same time, benefits for mankind and society". (Linturi & Kuusi, 2018)

Environmental technologies and energy efficiency provide solutions to challenges brought about by the global driving force. Energy efficiency is also considered in the publication by the committee for the future: "The draught and hull design of ships can be influenced through the latest technology. The draught determines the energy demand when the ship displaces water. The energy demand depends on the weight of the ship and cargo, the model, surface structure and shape of the hull and the speed of the ship. (Linturi & Kuusi, 2018, 264).

Making the IWT business sustainable has its obvious benefits for the environment. Besides those benefits it has other positive effects that are no less important for the further growth of business:

- Improved brand image makes the business more competitive;
- Sustainability attracts talents and investors;
- Shareholders will be more committed to the business.

"Though a fossil fuel, LNG will be the prevalent fuel solution in the beginning. Biogas and electricity come into play in the longer term. The technological development of transport over land also steers transport towards greener shipping,"

thinks Hannu Kaipainen, Director, Service production at Oy Saimaa Terminals Ab (Kaipainen 2019).

In addition to the fuel solutions, loading automation and conveyor solutions for conventional vessels are expected to be other areas for development.

- Containers and intermodality

The European Union aims to promote the intermodality and interoperability of transport (SPC Finland, 15.7.2019). According to the EU definition, intermodality in freight transport means transporting the cargo door-to-door using two or more transport modes, the functionality, efficiency and integration between the transport modes are of a high level.

Inland waterway transport can be used to reduce costs to the industry, at least somewhat. Tero Sikiä from the Finnish Transport Infrastructure Agency reminds that while inland waterways are not suitable for all transport, they have been found cost-efficient in, for example, factory-to-factory transport: “There are many ships travelling on the Baltic Sea that will fit the new dimensions of the Saimaa Canal. In future, these could be utilized in round-trip transport” (Sikiö 2019).

Containers are a practical way to transport both general cargo and bulk. They play a significant role in European goods transport. Even though the level of inland waterway port infrastructure is generally good, container handling options are limited. This is an important consideration with regard to the development of inland waterway transport because containers, being units that are compatible with other modes of transport, provide at least a framework for a smooth way to move cargo from ship to road or rail. This makes onward transportation around the world possible.

- International marketing

To increase demand, marketing is needed. Since any discussion of Finnish inland waterway transport also includes overseas transports, the marketing also must be international. Finnish enterprises and organizations have often been criticized for poor marketing. This is not necessarily a problem that has nothing to do with wrong

attitude, but lack of expertise instead. Finland has just entered the world of digital marketing. It takes time for top expertise to emerge.

Development of inland waterway transport requires an extensive cooperation group, and the services and expertise it provides must be marketed to potential customers. Due to the multitude of actors involved, one solution for the design and implementation of marketing could be an in-house type marketing team tasked to collect up-to-date information from the partners and compile it into marketing packages suited to the target groups. The team would be responsible for establishing the necessary relationships with the domestic and foreign media and mastering digital and other marketing communication channels.

3. ANALYSIS OF CARGO VOLUMES DYNAMICS AND ITS STRUCTURE TRANSPORTED BY INLAND WATERWAYS

Cargo transportation in White Sea – Onega and Volgo-Balt Basins

The diagram below shows the cargo volume dynamics in these basins for the period of 2008–2017 (fig.3). It can be seen that the cargo volume in the Volga-Baltic basin in 2016 and 2017 has reduced in comparison with 2008, but still from 2015 tendency upright is positive.

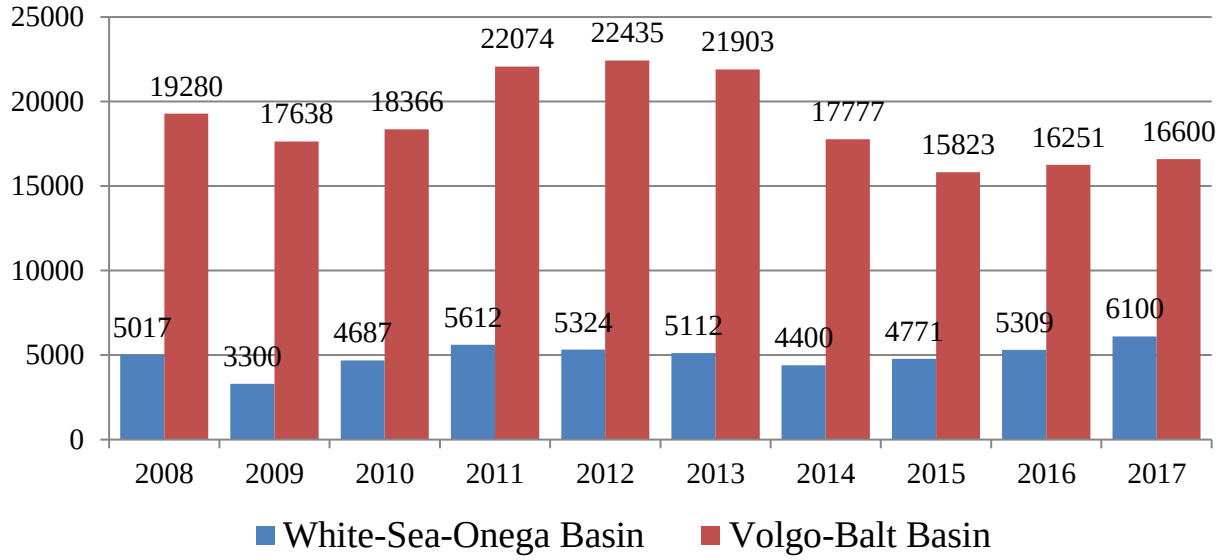


Figure 3. Dynamics of cargo flow in the White Sea-Onega and Volga-Balt basins from 2008 to 2017, thousand tons

The wood products harvested in the White Sea-Onega and Volga-Baltic basins are transported either within the basin to the woodworking or pulp and paper mill (PPM), or for export to Sweden, Finland, England, Germany, and the Netherlands. Export shipments of wooden cargo by river-sea going vessels in 2016 amounted to 539 thousand tons.

In 2016 the total volume of cargo transported in the White Sea-Onega basin was about 5300 thousand tons. The main cargo was building or construction cargoes

accounted for 88% of the total cargo volume. The detailed transport structure is shown in the diagram below (fig. 4).

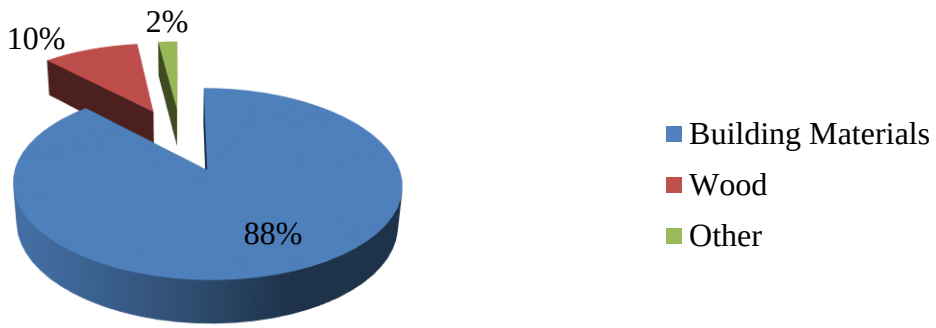


Figure 4. Structure of cargo transportation in the White Sea-Onega basin in 2016, %

In 2016 about 16200 tons of cargo has been transported in the Volga-Balt basin. The main cargo was construction cargo accounted for 54 % of the total cargo volume. The detailed transport structure is shown in the diagram below (fig.5).

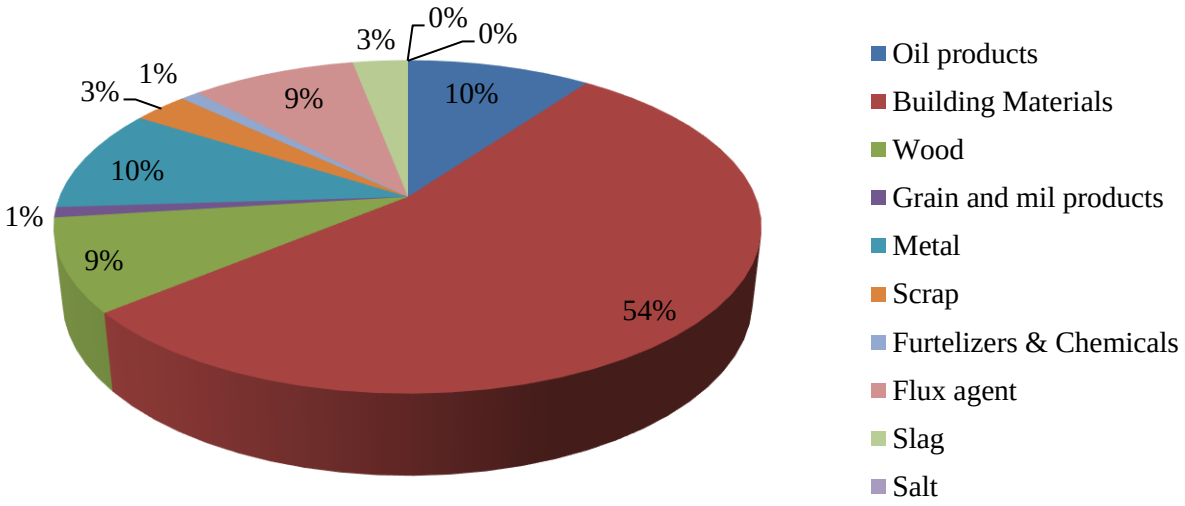


Figure 5. Structure of cargo transportation in the Volga-Balt basin in 2016, %

The regions of the Russian Federation bordering the territory of Finland are the Murmansk region, the Republic of Karelia and the Leningrad region. The main inland shipping passes through the territories of the Republic of Karelia and the Leningrad region.

From Russian Federation to Finland

Analysis shows that the entire cargo volume transported from Russia to Finland is represented mostly by wooden cargo. For example, in 2016 around 307 thousand tons of cargo has been delivered by inland waterway transport to the ports of Finland (fig. 6).

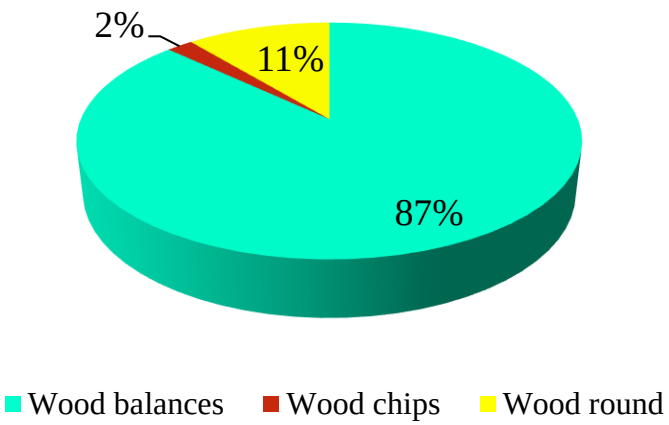


Figure 6. Structure of cargo transportation to Finland in 2016, %

The main destination ports on the territory of Finland in 2016 were the following ports: Imatra, 107 thousand tons of cargo were delivered there, which accounted for 35% of the total cargo volume, Lappeenranta – 60 thousand tons of cargo, which accounted for 20% of the total cargo volume, Kaukas – 36 thousand tons of cargo, which accounted for 12% of the total cargo volume. A detailed structure showing all the destination ports of Finland is shown in the diagram below (fig. 7). Some of the mentioned ports are maritime and some were not identified.

The main departure ports on the territory of the Russian Federation in 2016 were the following ports: Bely Ruchey, 68 thousand tons of cargo was shipped from there, which accounted for 22% of the total volume. Belousovo and Shala, 44 thousand tons of cargo, which accounted for 14% of the total volume, Mondoma – 37 thousand tons, Vytegra – 31 thousand tons, which accounted for 12% and 10% of the total volume, respectively. All these Russian river ports are very small and has limited capacities for development without additional investments.

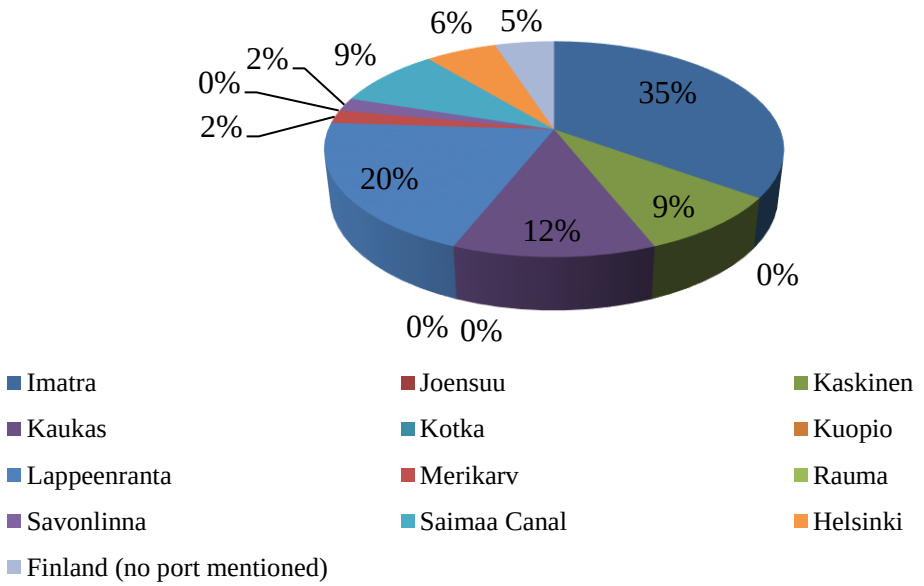


Figure 7. Structure of cargo volume by destination ports of Finland, %

A detailed structure showing all the departure ports in Russia is shown in the diagram below (fig. 8).

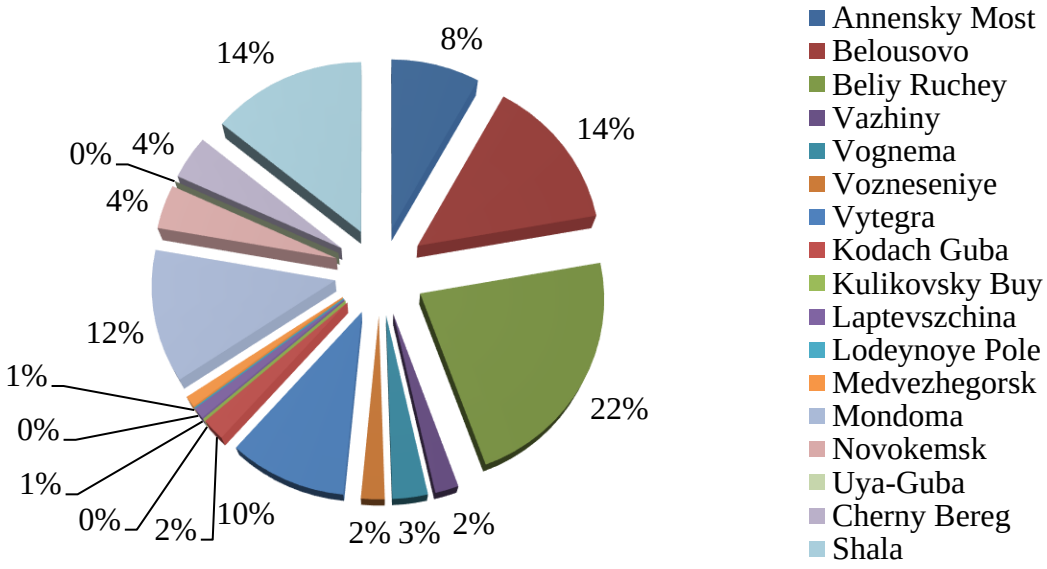


Figure 8. Structure of cargo volume by departure ports of the Russian Federation, %

The main carriers for export-import cargoes in 2016 were companies “Neva-Group” — 135 voyages, “Hangut Marine Agency” — 39 voyages and “Astra Shipping Agency” — 37 voyages. In total there were made 235 export-import voyages (see Appendixes 1-4).

Transportation is going by fleet consisted of five vessel's types and its modifications (Tabl. 4).

Vessel's Type (project)	View of the vessel
10523	
1743.1	
2-95A 2-95A/P1	
P168 P-168M-п	

326.1 326.1/00 326.1/M	

Table 4. Main current vessel's types transported cargos from Russia to ports of Finland

Existed fleet in average is more than 25 years old and getting elder. Coming new international requirements on emission can soon put these outdated tonnage off the market. In the interests of shipowners to seek for the new vessel's concepts, operable in Finish Gulf and inland waterways of Finland and Russia. Perspective overview on recommendations regarding technical requirements to the newbuilding vessels to be designed and build under Russian Flag and Russian Maritime (or River) Register of Shipping is given in the Appendixes 5.

It should be noted that the main cargo-generating points of the North-West region are the inland ports of the White Sea – Baltic Sea Canal, Volga-Baltic Waterway, Onega Lake. Inland ports are located in the White Sea-Onega and Volga-Baltic basins.

From Finland to other countries

The vessel traffic using the Vuoksi waterway is important for the Finnish industry especially in regard to international cargoes. The Finnish Government believes that the role of waterborne transport will be emphasized in the future as environmental requirements grow and people and businesses become more aware of environmental issues (Ministry of Transport, 2014, 34).

Maritime transport of goods through Saimaa								
Year	**Domestic transport**			**International**				**Total**
	Export	Import	Total	Export	Import	Total	Transit	
2008	94428	56328	150756	713525	1251457	1964982	11760	**2115738**
2009	47271	24117	71388	473350	538554	1011904	1035	**1083292**
2010	93466	24533	117999	586883	955074	1541957	0	**1659956**
2011	86266	38501	124767	654390	984234	1638624	0	**1763391**
2012	23958	14522	38480	579668	1100135	1679803	0	**1718283**
2013	42990	132	43122	571509	1148993	1720502	0	**1763624**
2014	56602	20579	77181	569820	948051	1517871	0	**1595052**
2015	50968	10108	61076	596440	659631	1256071	0	**1317147**
2016	62524	34014	96538	512766	587872	1100638	0	**1197176**
2017	74886	25515	100401	502992	668639	1171631	0	**1272032**
2018	54571	18774	73345	378696	851942	1230638	0	**1303983**

(Traficom, 2019)

Table 4. Domestic and international maritime transport through the Saimaa Canal

Year	Timber, raw wood, chips	Sawn wood	Paper, cardboard	Woodpulp	Plywood, veneer	Crude minerals	Chemicals, fertilizers	Coal, coke	Metals, metal products	Other merchandize	Total
2008	831137	42082	216419	231600	2285	488921	83549	136806	3193	79746	2115738
2009	272472	33791	166067	74730		406812	39650	58731	1001	30038	1083292
2010	676993	43160	157315	124170		465723	95342	66406		30847	1659956
2011	736421	43624	149137	116981		473712	120878	87394		35244	1763391
2012	806465	48447	143118	105408		347569	133003	101107	221	32945	1718283
2013	856480	65270	132473	90018		368314	134049	81972	3482	31566	1763624
2014	726826	53204	130066	79796		372827	151027	39268	16125	25913	1595052
2015	442672	43859	100902	86466		396950	168623	22039	25179	30457	1317147
2016	363739	43009	125187	68720	154	313636	163517	56373	33883	28958	1197176
2017	400478	49338	124467	62248	105	399540	142207	37802	27956	27891	1272032
2018	583411	34951	87159	49175		370580	104898	42058	10853	20898	1303983

(Traficom)

Table 5. Major transport products in Saimaa canal (incl. transit traffic)

Raw wood, timber, chemicals, fertilizers, paper and cardboard are among the main transport products in Saimaa area. The biggest trade partners using the inland waterway transportations are located in Russia, Netherlands, Estonia, Germany and Sweden. In the year 2018 the international transportation volume through Saimaa was 1 230 638 tonnes in total. (Finnish Transport Agency, 2019, 15).

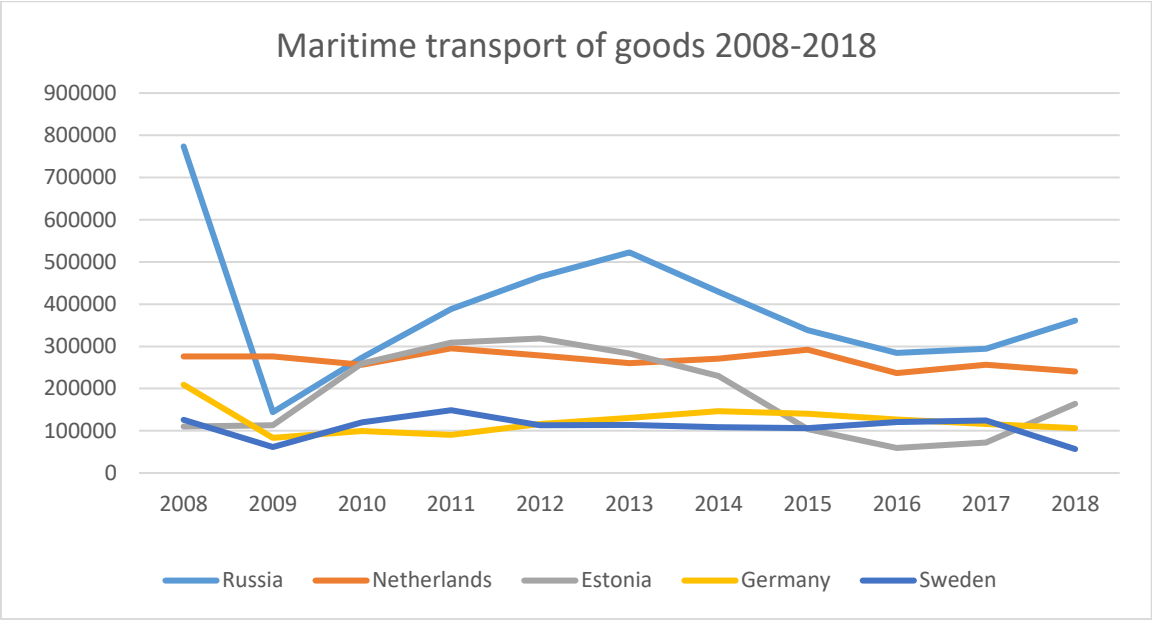


Figure 9. Transport volumes between Finland and other countries.

During the 10 years period from 2008 to 2018 the Russian Federation have offered the biggest volumes in IWT cargo traffic. It has also shown the biggest and most sudden changes in transport volumes. In the case of Russia, the quantity of goods consists mainly of raw wood, which the forest industry brings to the ports of Saimaa.

Compared to Russia, the second largest trading partner, the Netherlands, has shown exceptional stability. Finland transports, for example, talc and fertilizers to the Netherlands. In return, Finnish chemical industry gets raw materials from the Dutch partners.

Transportations between Finland and Estonia is an interesting example of potential for growth. During the years from 2008 to 2013, the volume of maritime transport through Saimaa grew strongly every year. The record volume was more than 280 000 tonnes (reached in 2013) after which the transportations started to slow down. In 2018 the volume of transportation was 164 187 tonnes.

- International flow

“The regions of Eastern Finland are cooperating in preparing the Corridor of Main Road 6, the identification of the nodes along the Corridor being one of the main themes. In prioritising the nodes, the more forms of transport the node includes, the

greater the significance it can receive," explains Jukka Hasu from the Regional Council of North Karelia (Hasu 2019).

According to him, the infrastructure for multimodal transport is in place, but the service offering should be expanded to cover the ports with the most potential.

"Of the city-owned ports, Joensuu's deep water port and Lappeenranta's Mustola have the biggest potential. Of the industry ports, Kitee's Puhos Port and Imatra's Vuoksi Port have equivalent potential," thinks Hasu.

Better capacity to handle containers also facilitates seamless combining of various forms of transport and opportunities to tap into international goods flows.

- Cargo vessels

The total amount of cargo ships going through the Saimaa Canal was 1162 in 2018. According to the Finnish Transport Agency's statistics, the share of Netherlandic and Antiqua & Barbudan vessels of the traffic in 2018 was 54 %, that of Russian 28 % and that of domestic 8 %." states the publication. (Finnish Transport Agency, 2019, 18)

For economic reasons, vessels of foreign origin normally abide by the Saimaa Canal's maximum dimensions. "Typically, vessels in internal traffic are of the tug-barge combination type," states the MINTC's "Review on Inland Waterway Traffic 2018–2030" ("Sisävesiliikenteen katsaus 2018–2030"). "Based on the traffic statistics, the average age of foreign vessels travelling in Saimaa is approximately 23 years" … "Finnish vessels travelling in Saimaa are older by comparison, with an average age above 30 years" (Kyykkänen et al. 2018, 21-22).

- Old vessels, new requirements

Finnish inland ships are old (with an average age above 30 years), but in that respect, the situation is not much worse than in other countries. Other European countries also have fleets consisting of old vessels, and it takes several decades before they are replaced with new ones.

The EU has funded a project ("MoVe IT") examining the best ways to modernise the old vessels. Though it is not possible to change the hull of a ship

without considerable costs, outdated equipment can be replaced. The MoVe IT! project looked for concepts that would be best suited for inland vessel modernisation:

”The ship owners expressed very little interest in power-related retrofits. The reason behind this is that emission abatement techniques such as filters and catalysts can only lead to very limited fuel savings”…”Other solutions like LNG, CNG, Fuel sell, diesel-electric or all electric propulsion all require major modifications to the engine room and large investments”…”The options that are deemed most interesting by the ship owners are those that lead to reduction in fuel consumption, and thereby to a reduction in fuel cost, but do not require a major investment.

This implies that the ship owners were primarily interested in optimizing the flow of water around the ship by means of solutions that do not require major adaptations to the shape of the hull itself. Especially replacement of rudders is deemed an interesting option by several ship owners, while two owners are also interested in using a pre-swirl stator in front of the propeller”, says the project report. (Hekkenberg & Thill, 10.9.2014). Pre-swirl stator is a static structure “consisting of multiple fins attached to the ship's hull that were designed to shift part of the wake downward for a better angle of attack. Though the basic theory behind the PSS was sound, early examples on the market couldn't effectively control the water's flow direction and weak structural design left them prone to cracking or breaking off at the first sign of rough weather” (Wärtsilä, 2017).

When designing new vessels, it should be remembered, that the service life of inland vessels has traditionally been exceptionally long. With careful design, modernisation taking place decades from now will be much easier and cheaper to carry out.

The designers should also bear in mind that the intended use of the vessel may change over the decades. If the vessel has been designed flexible also from this point of view, it makes it much easier for the owner of the ship to react quickly on any changes in the business environment.

- Examples of ship design

If the IWT will take its place among other transportation modes, it will undoubtedly promote the growth of ship-building industry. Here are some examples of how technical challenges have tackled:

"NYK SUPER ECO SHIP 2050"

The resistance of the vessel was reduced by 35% by remodeling the hull to decrease water friction, by reducing the weight of the hull, and by minimizing air resistance. The improvements where validated with CFD calculations. Further improvements were made by introducing fuel cells for electric propulsion, relying on other highly efficient propulsion devices, and the generation of renewable energy on board the vessel.

The energy demand of the vessel was cut by approx. 70% by eliminating energy and operational waste. The minimized energy demand enables truly emission-free operation. Instead of fossil fuels, the ship is powered by hydrogen produced from renewable energy sources. Some other futuristic elements in the concept include lightweight bionic design found in nature, the use of 3D printing for building materials, a digital twin of the vessel, and flapping foils inspired by dolphins to replace less efficient traditional propellers. (Elomatic, 29.11.2018)

"WÄRTSILÄ DUAL-FUEL MEDIUM-SPEED ENGINE"

Wärtsilä has been contracted to supply a complete power system, including two of its 6-cylinder Wärtsilä 20DF dual-fuel medium-speed engines, for a new dry cargo inland waterway vessel. This order extends the benefits of gas fuelled operation to an inland waterway vessel, and represents a strong endorsement of gas as a marine fuel. The vessel will be part of the ECO2 Inland Vessel project. This will be the first ever medium speed, dual-fuel, mechanically driven inland waterway vessel capable of operating for 95-99 percent of the time on LNG fuel, with a minimum of pilot marine gas oil (MGO) used for ignition. The engines are also capable of operating fully on MGO. In addition to the two Wärtsilä dual-fuel engines, the scope of the

order includes two fixed pitch propellers in a nozzle, the coldbox, and the LNG tanks. (Wärtsilä, 8.5.2012)

"LAFFCOMP BIOSHIP 1"

The concept is based on a self propelled vessel for year-around traffic, the shallow draught of which allows it to use the natural harbours that were earlier used for launching wood in bundle rafts. In addition the vessel transports onboard the pneumatical/cargo crane or conveyer belt system necessary for loading so that no special loading equipment is needed ashore. Novelties of Laffcomp ship design: Vessel monitoring system, lock sysrem, loading and unloading system, LNG fuel system, light weight components. (Laffcomp, 30.4.2009)

"YARA BIRKELAND AUTONOMOUS SHIP"

The vessel YARA Birkeland will be the world's first fully electric and autonomous container ship, with zero emissions. KONGSBERG is responsible for development and delivery of all key enabling technologies including the sensors and integration required for remote and autonomous ship operations, in addition to the electric drive, battery and propulsion control systems. A 120 TEU (Twenty-foot Equivalent Units) open top container ship. It will be a fully battery powered solution, prepared for autonomous and unmanned operation. The vessel will reduce NOx and CO2 emissions by reducing diesel-powered truck transport by around 40,000 journeys per year. This eco-initiative will help to meet the UN sustainability goals, and improve road safety and congestion. (Kongsberg, 29.9.2017)

"SELF-PROPELLED VESSEL - NEWS"

NEWS is capable of carrying three layers of containers stacked and four side-by-side. NEWS is able to operate on at least 80% of the European Inland Waterways. Logistical and technical features: Re-design of the vessel´s hull (transport efficiency), adaptable draught allows crossing low bridges and reacting to altering water-levels due to a ballast tank (increase days of navigability), adjustable LNG-electric energy

– and propulsion system (increase resource efficiency – up to 30% - and decrease of harmful exhaust emission), adapted logistics-system for the respective demands of target markets, possibility of adapting the container vessel NEWS for multi-purpose use such as a river-sea vessel or a car carrier. (ScienceDirect, 2015)

"WINTECC – INNOVATIVE WIND PROPULSION FOR CARGO VESSELS"

The WINTECC project aimed to demonstrate an innovative wind propulsion technology for cargo vessels. An automatically controlled towing kite system would be used and tested during the regular operation of a cargo vessel for the first time on a full-scale. The innovative wind propulsion technology, that was developed with the WINTECC project, achieved 5% fuel savings – corresponding to 165 tonnes/year of fuel and correspondingly 530 tonnes of CO2 per year for the vessel Beluga Skysails on an average route mix, and10-12% savings on North Atlantic and North Pacific routes. Larger 'kites', which will be available soon, will provide higher savings. For fish trawlers also higher yields are expected due to lower ship speed. (Koutsoutos, 2009)

4. DYNAMICS OF CARGO TRANSPORTATION IN LAKE SAIMAA

In 2018, the volume of freight traffic in the Saimaa Canal was 1.3 million tonnes. The total amount was 32 000 tonnes more than in the previous year 2017 (+2,5 %). The share of international waterborne transport was 1.23 million tonnes and domestic transport reached 0.07 million tonnes. The export of forest industry products was 169 000 tonnes, which was 60 000 tonnes less than year before. The import of raw wood increased by 184 000 tonnes and the total was 543 000 tonnes. The amount of fertilizers and raw minerals decreased a bit. (Finnish Transport Agency, 2019).

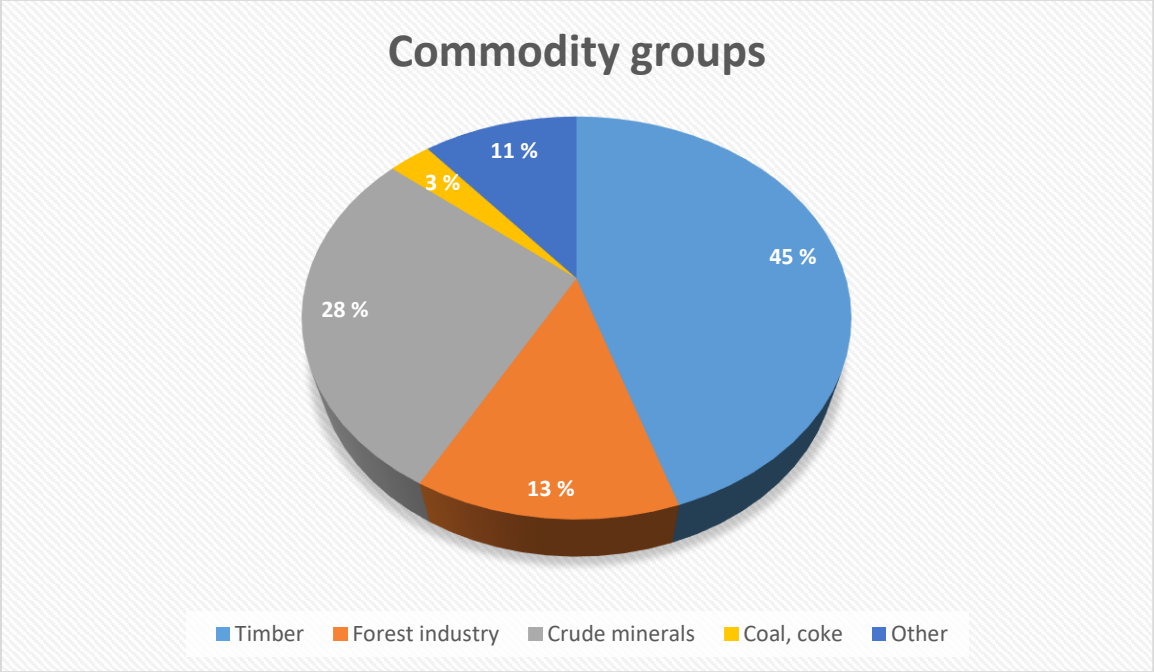


Figure 10. Saimaa cargo flow – commodity groups

- Saimaa canal investment

"There is not much opposition to the Saimaa Canal development, but whether there is enough support for it in the next Government, that is another matter entirely. The Government will have many other transport projects to consider as well," points out Tero Sikiö, Head of Inland Waterways Unit, Finnish Transport Agency (Sikiö 2019).

“If the canal investment is realized, the profitability and competitiveness of IWT will increase. The situation of the industry in the Saimaa region will naturally have an effect on the matter. Remembering that the current transport amounts to approximately 1.3 million tonnes and that the record from years back is approximately 2.4 million tonnes, I would suspect that the amount will settle somewhere between these two figures after the investment”. In that scenario the transport volume could be a bit more than 1.8 million tonnes shortly after the investment.

The estimation is quite modest, but since there is no wide public-private understanding about the IWT future, it might be safer to keep the guesses level-headed. Nevertheless, some people are ready to make braver statements.

“The traffic volumes in the Saimaa Canal may easily be tripled by 2030, but it requires political guidance”, says a representative of Finnish forest industry. On the other hand, the Finnish Government seems to be waiting for more initiatives from the businesses.

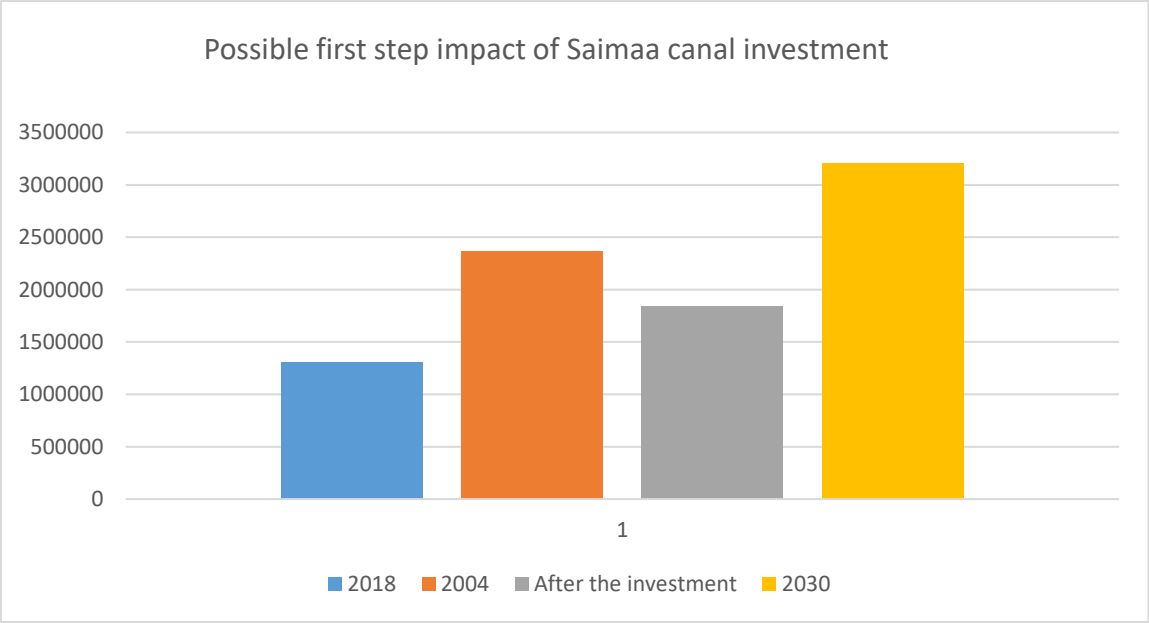


Figure 11. An estimate of canal investment effect on IWT volume

The combined effect of the Canal, forest, mining and steel industry investments is believed to double the amount of cargo through the Saimaa Canal.

Representatives of Finnish industries expect the transport volumes to increase to over 3 million tonnes by 2030. The growth makes investments in new vessels topical. The need is believed to be realized within 5 years of the Saimaa Canal enlargement.

The investments in the Saimaa Canal enable navigation by bigger ships and transport of bigger cargos. The cargos will be approximately 3,100–3,200 tonnes – lifting the Canal water level by 10 cm allow the increase of cargo volumes. Better cargo capacity means better profitability. At the same time, the number of ship types that fit the Canal will increase. (Finnish Transport Agency, 24.1.2018)

Factor	Old Saimax	New Saimax
Length	82,5 m	93,2 m
Breath	12,6 m	12,6 m
Draught	4,35 m	4,35 (4,45*) m
DWT (max.)	2500 t	3200-3500 t

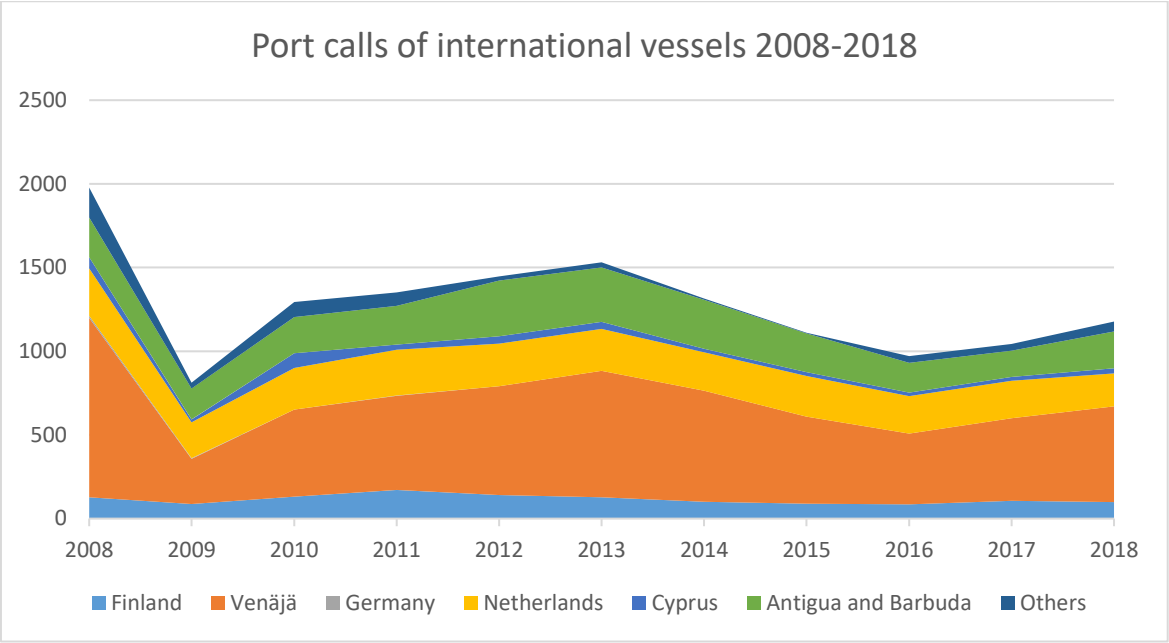
Table 6. Old and new Saimax-standards

- Cargo vessel traffic

Finnish experts in forest industry matters believe that the biggest companies in Saimaa area, UPM and Stora Enso, are ready to increase the yearly use of cargo ships:

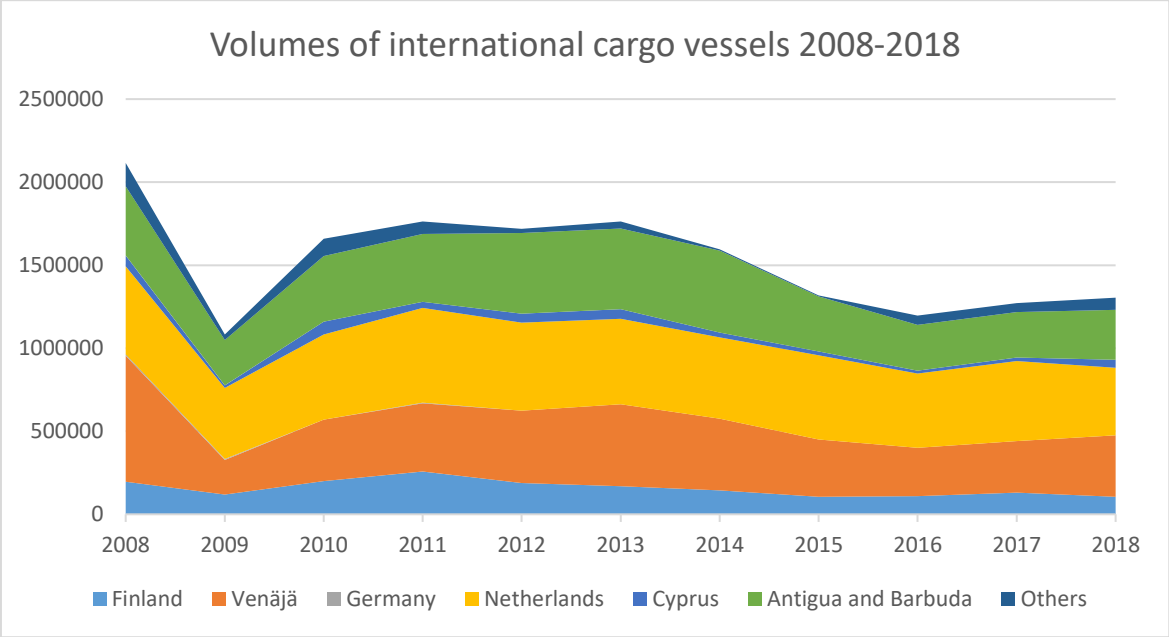
“UPM has yearly about 100 ships on Russia’s inland waterways and about 20 in the Baltic region. The amount is estimated to increase approximately 20% in the next few years, depending on the price trend for raw wood in Finland, Russia and the Baltic countries”.

”Stora Enso may increase the use of ships every year in the amount of about 2 ships per month = 20 ships per year if the navigability season is longer. That is an increase of about 10%”. In 2018 the total amount of cargo ships was 1162 and total cargo volume 1 303 983 tonnes.



(Traficom)

Figure11. Port calls of international vessels 2008-2018.



(Traficom)

Figure12. Volumes of international cargo vessels 2008-2018.

Mr. Tero Sikiö from the Finnish Transport Infrastructure Agency estimated, that the cargo volume might grow shortly after Saimaa canal investment from 1.3

million tonnes (2018) to proximately 1.8 million tonnes. On that ground, the amount of cargo ships should grow from 1161 to near 3000.

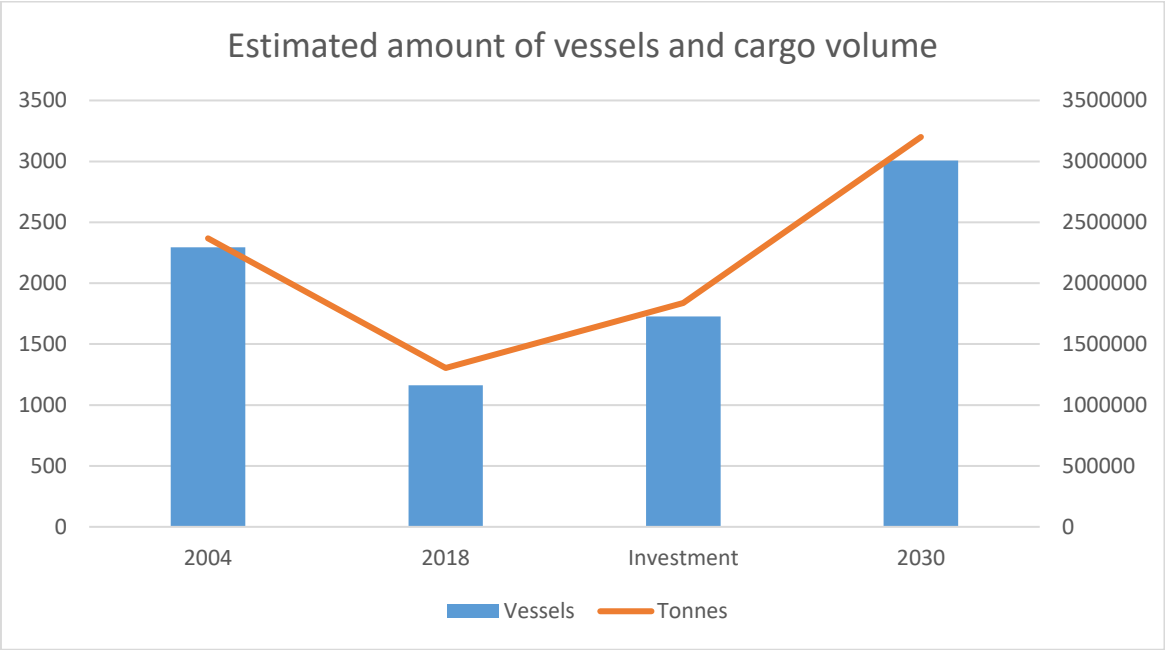


Figure13. Estimated amount of vessels and cargo volume.

- Saimaa as a part of global flow

"Conventional handling of full containers and project shipments using own equipment in Saimaa ports is currently not possible. In Joensuu, there is a reach stacker that can be used for handling at the shore. At the moment, conventional handling of containers or project cargos requires a mobile crane to be ordered outside the port," says Jukka Hasu from the Regional Council of North Karelia (Hasu 2019). "That said, new concepts can be tried out under quite a tight schedule as small ports, and their operators can react quickly to the needs of the customers".

In the near future, a demand for the wood biomass and other circular economy products are expected to grow. There could also be need for IWT project shipments. Project cargo usually contains heavy objects and cases with various kind of sizes. This kind of cargos demand special equipment, like multipurpose cranes and handling system. The work also requires good planning, scheduling and flexible

labour, that has skills and experience to carry out demanding tasks. In the case of Saimaa, the required equipment and price levels are major issues.

Jorma Mäntynen, Director at WSP Finland Ltd, suggests that container transport could be developed by introducing international port pairs like, for example, Joensuu and Gdansk: “A ship would have a week’s turnaround time” (Mäntynen et al. 2018, 12). According to Mäntynen, the problem related to the availability of containers should be solved through balanced traffic and a “container depot” model. The model includes container reception, reporting of the location and condition to the owner and carrying out of any repair work needed.

The size of ships in Saimaa limits the capacity of the container vessels compared to those used at sea: “If the current Saimax type vessel cargo capacity is approximately 2,500 tonnes, a quick calculation tells us that the vessel can accept 82 containers weighing 30.4 tonnes each. Correspondingly, the 3,200 cargo tonne vessels travelling in the extended Canal can accept 105 containers by calculation. Containers with lighter load could even be loaded with more than this, taking into account any other dimensional limitations the vessel may have,” calculates Elias Altarriba, R&D Specialist at the South-Eastern Finland University of Applied Sciences (Altarriba 2019). Containers can also be used to carry a wide range of goods, including cold products or liquids in special containers – providing opportunities to diversify the current flow of goods consisting mainly of raw material.

“IWT barges can be loaded and unloaded with a reach stacker, provided the reaching distance is not too long. It must be made sure that the reach stacker is heavy enough if it is used to lift heavy cargo from few meters away. Reach stackers can be equipped with front support legs that make it possible to lift heavier cargos from greater distances,” recalls Ville Henttu, who has studied intermodal transport at the South-Eastern Finland University of Applied Sciences. “Probably a maximum of 60 TEU containers on one barge so that they can be in three rows and the reaching distance is not too long,” adds Director of Research Henttu (Henttu 2019).

- Circular economy and biomass

"New types of goods to be transported are being surveyed – goods that are related to the circular economy", says a representative of Finnish industry.

"In Finland, most of the bio-based energy is derived from wood as a by-product of forest industry" … "Growth targets have been set in particular for forest chips, that is, wood biomass collected in connection with final felling and thinning of forests," states the "Review on Inland Waterway Transport 2018–2030" by the MINTC (Kyykkänen et al. 2018, 16). As the global demand grows, the wood biomass must be collected ever further away from the power plants.

According to the MINTC, "Wood energy transport by barge in open water conditions is competitive with road transport on transport journeys in excess of 100 km, provided that the initial terminal transport does not exceed 50 km." For transports in excess of 100 km, both waterborne and railroad transport are competitive options.

The total transport potential of wood fuel in the Saimaa region is 2.5–3 million tonnes. Connecting the Kymijoki waterway to the wood fuel transport network would require investments in loading and unloading sites, fairways and equipment.

- Timber floating

There are plenty of old 2.4-metre channels in Saimaa that formed the backbone network in the days of the old Canal. Utilizing these so-called timber-floating channel routes, especially in raw wood pickup, would increase the transport volumes. That means, their development requires suitable vessels and a sufficient number of consignors.

The LAFFCOMP BIOSHIP mentioned earlier in the "Examples of ship design" chapter is an example of a vessel designed to operate in such a shallow water environment. It is capable of approaching the shore even at shallow points and loading and unloading goods using an onboard crane. Finnish Lakeland islands are an interesting proposition for a vessel that can load raw wood cargo in shallow water.

Timber floating is an inexpensive way to transport raw wood and, simultaneously, store it. At the moment, only UPM floats raw wood to its production plants. Floated tonnage has decreased from 1.0 million tonnes to 0.25 million tonnes. "If timber-floating stops completely, the price of raw wood transport will go up,"

predicts “Review on Inland Waterway Transport 2018–2030” by the MINTC (Kyykkänen et al. 2018, 14).

- Saimaa icebreaking

Another factor that affects the competitiveness of the waterway area is the icebreaking situation that will be improved along the adoption of the new self-propelled detachable bow. In the near future, icebreakers are expected to be agile, more powerful and of full breadth. The reformers of the icebreaking equipment are also waiting for the realization of the Saimaa Canal investment.

The Finnish Transport Agency and ILS Oy, company that designs vessels for winter navigation, have developed the new detachable bow. The bow is 25.3 meters long and have a beam of 12.6 meters. The bow has its own propulsion system, which improves the efficiency and maneuverability (Aker Arctic, 3/2018).

- Regional development and IWT

In the lake Saimaa basin including lake Kallavesi area, there are seven significant population centers, which are medium-sized cities on a Finnish scale. In addition, there are significant forestry and mining industrial in the area. For example, industrial mill of UPM Kaukas in Lappeenranta is one of the largest forestry industrial integration in Europe. In Table 14. there are listed most important cities, their ports and most important industrial plants that significantly exploits waterway transportation.

City	Population	Major industrial plants and harbours
Lappeenranta	72661	UPM Forestry, harbours of Mustola, Joutseno and Kaukas
Imatra	26905	Stora Enso forestry, Harbour of Imatra
Savonlinna	33580	Harbour of Savonlinna, Laitaatsilta dry dock
Mikkeli	53781	UPM Forestry, harbour of Pellos
Varkaus	20830	Stora Enso forestry, harbour of Akonlahti
Joensuu	76543	Stora Enso forestry, harbour of Ukonniemi
Kuopio	118667	Harbours of Kuopio and Siilinjärvi, mining industrial

Table 7. Lake Saimaa basin towns and industrial plants

It is extremely important for these population centers to attract business and talents. It is no less than a question of life and death. IWT is one dimension of regional development that can help cities to survive in competition:

“Inland waterways are often viewed in terms of a single function – usually freight transport, which is of course why most inland waterways were made navigable in the first place”…”However, in reality, inland waterways form a multi-functional resource that delivers a range of services and benefits to society”, tells a report of “Waterways for Growth” that operated under the Interreg IVB North Sea Region Programme (Waterways for Growth, 1.8.2013).

Waterway banks and towpaths provide “blue” and “green” space around which people live and work. On basis of that, waterways act as a catalyst for urban and rural regeneration. They have unique mix of landscapes, natural environment and heritage. All of this will influence business location decisions and activation of SME´s.

The logistics and industrial production are not the only sectors that benefits from waterways. Marinas, hire boat companies, trip operators, boat builders, equipment manufacturers, construction companies and even not-for-profit companies, delivering social and community activities, have proven to grow together with waterways.

5. BRIEF CHARACTERISTICS OF INLAND WATERWAYS IN LENINGRAD REGION AND INLAND PORTS OF REPUBLIC KARELIA AND LENINGRAD REGION

The length of the operated inland waterways in the Leningrad Region is 1843,5 km. The main route is the waterway from St.-Petersburg to Cherepovets, with a length of 856 km, of which 438 km goes on the territory of the Leningrad Region (St. Petersburg–Voznesenie).

The inland waterways navigable area includes following: 2 river ports – Podporozhsky port, «Fleet Repair and Maintenance Workshop JSC LSR Base» (Otradnoe town), 3 navigable locks – Volkhovsky, Nizhnesvirsky and Upper Svirskiy.

An integrated project for the reconstruction of the Volga-Balt Waterway is under development. There are included seven of the nine stages of reconstruction related to transport infrastructure facilities located on the territory of the Leningrad Region.

Republic of Karelia, bordering the Leningrad region and Finland, has a network of inland waterways (as part of Volgo-Balt inland waterway system) and inland ports, located both on rivers and lakes.

The ports of Petrozavodsk, Kondopoga, Medvezhyegorsk, Nadvoitsy, Segezha and the Shoksha berth, which are ports of common use, are located on the territory of the Republic of Karelia. Railway approaches have ports Medvezhyegorsk and Segezha, making them three-modal inland ports.

The cargo handling capacity of the ports for navigation period is evaluated by experts as follows:

Petrozavodsk – 500 thousand tons;

Medvezhyegorsk – 200 thousand tons;

Kondopoga – 150 thousand tons;

Nadvoitsy – 100 thousand tons;

Segezha – 50-100 thousand tons;

Shoksha berth – 700 thousand tons.

The Port of Petrozavodsk (its Northern Cargo Port) is the largest cargo handling complex in the region and is located directly in the city of Petrozavodsk on the shore of the Petrozavodsk Bay of Onega Lake. Since 2006 Petrozavodsk Shipping Company LLC – the successor of the White Sea-Onega Shipping Company – has been doing business in the port.

By the order No. 734-p of the Government of the Russian Federation dated 05/05/2012, the port of Petrozavodsk was included in the List of ports opened for entering of vessels under the flags of foreign states.

The port provides handling of sand and crushed stone (gravel) of various fractions, timber cargo, packaged cargo, universal containers, Karelian granite and building stone (including boulder), as well as grain cargo arriving from the southern regions. Large-sized assemblies for the construction of berths and other facilities on the islands of Ladoga and Onega lakes are being assembled in the port. In addition, the products of Karelian producers (wood pellets) are being loaded for transportation to Denmark and Sweden.

The length of berths is 118 meters, the total area of open storage areas is 281,368 m² (2008).

Compared with its potential capacity stated above, the volume of cargo handling at the port of Petrozavodsk, in 2016 has been as low as 39,1 thousand tons. In 2017 the volume of cargo handling dropped sharply and amounted only about 18,5 thousand tons, in 2018 – 19,6 thousand tons.

The port of Kondopoga is located on the coast of Onega Lake in the Matguba Bay. The quay length (three berths) is 152,3 meters. The port carries out operations of handling bulk cargoes, mainly gravel (crashed stones).

The port of Nadvoitsy is located on the route of the White Sea – Baltic Sea Canal (1244 km of the navigable channel). The port carries out operations with packaged and bulk cargoes. The quay length is 183 meters (of which a wood berth is 77 meters, barge converted to the berth is 60 meters, bunker berth is 25 meters, and

refueling berth is 21 meter). There is a covered warehouse (0.6 thousand m²) and two open areas (with a total area of 12 thousand m²).

In 2012 about 31,4 thousand tons of cargo were handled by Port of Nadvoitsy LLC. Data for the period of 2013-2018 is need to be checked out.

The port of Medvezhyegorsk is located in the Big Gulf of the Povenets Bay of Lake Onega. The port performs operations with packaged and bulk cargoes, as well as with universal containers. The total quay length is 300 meters (two berths); the open storage area is 14,5 thousand m². The advantage of this port is the availability and access to railway track (line of 960 meters) from the station Medvezya Gora of the Oktyabrskaya Railway.

The port of Segezha is located in the northwestern part of the Vygozersko-Onda reservoir (lake). There are two business entities – JSC Segezha Sawmills (loading packaged timber cargo) and JSC Segezha PPM (transshipment of wood chips, pulpwood and round wood). Each enterprise has its own separate quay – the quay of the JSC Segezha Sawmills has a length of 100 meters, and the quay of the JSC Segezha PPM is 436,5 meters. Access to railway tracks of the Segezha Station of the Oktyabrskaya Railway adjoins the quay of the JSC Segezha Sawmills. The quay of the Segezhsky Pulp and Paper Mill does not have access to the railway. JSC Segezha Sawmills has an open storage area (3100 m²).

Shoksha berth is located on the shores of Onega Lake in the Prionezhsky region of the Republic of Karelia (1,2 km north of Quartzitny town) and specializes in loading fractional stones on vessels. The quay length is 146,5 meters. Since 2007 when there were handled 688,8 thousand tons of cargo the latest available data is to be further checked out.

The challenge for the future studies to check out tendencies in cargo handling in the inland ports of Kondopoga, Medvezhyegorsk, Segezha and the Shoksha berth, since its owners do not provide information in the prescribed manner.

On the territory of the Leningrad Region there are four sea trading ports located in Ust-Luga, Primorsk, Vysotsk, and Vyborg.

Sea port of Primorsk is the largest specialized port for the export of oil and its products in the North-West region of Russia. The port is the final link of the Baltic pipeline system providing oil transportation from the Timan-Pechora field, from Western Siberia and the Ural-Volga region and the Sever (North) oil pipeline (Kstovo-Yaroslavl-Kirishi-Primorsk pipeline).

At the sea trade port of Vysotsk the main volume of cargo turnover is provided by the oil terminal of the RTC Vysotsk LUKOIL-II. The terminal is a complex for transshipment of petroleum products and has its own industrial railway station. The prospect of an increase in the terminal cargo turnover is connected with the laying of an oil product pipeline from the port of Primorsk to the transshipment complex for the delivery of petroleum products via the North main oil pipeline.

The coal terminal (Port Vysotsky LLC) performs coal transshipment for export. In 2011 the terminal completed work of cargo transshipment technology modernization. The access canal and the terminal water area depth is 12 meters; today, the port is open for vessels up to the Panamax size.

Recently the studies and design works were being carried out in the port about construction of a marine terminal for the production and shipment of liquefied natural gas to European countries in the amount of 600 thousand m^3 per year.

Sea trade port Vyborg – is the oldest port of Russia (as early as in 1527 Vyborg was officially recognized as a «slipway city» with the right to service foreign ships). The port is universal and processes a large range of general, bulk cargoes (mineral fertilizers, metal, ore, cast iron, scrap metal), food and chemical bulk cargoes. During the summer navigation, the port hosts passenger ships and small crafts mainly with Russian and Finnish tourists. The port is capable of handling up to 2 mln.t of various cargoes.

Newly built Ust-Luga sea tade port develops rapidly. The port construction is implemented on the basis of public-private partnership. The main partners in the project implementation are FSUE Rosmorport, JSC Russian Railways, OJSC AK Transneft, OJSC SIBUR Holding, Gunvor Group Company, OJSC NOVATEK,

OJSC Kuzbassrazrezugol, Global Ports Group (NKK), United Metallurgical Company CJSC, Russian Transport Lines OJSC.

The large depths by the quays and in the operational areas (up to 17,5 meters) in combination with two short approach canals, as well as a short ice navigation period, provide the port with significant competitive advantages. Currently the port is capable to handle any large-capacity tankers (with deadweight up to 160 thousand tons), ones which being draft loaded are capable to cross the Danish straits when entering the Baltic Sea, as well as service ocean-going Ro-Ro vessels of any type.

In the future, the handing capacities will be enhanced due metal products and mineral fertilizers transshipment; the terminals for these cargoes are under construction. Work is also underway on auxiliary fleet base construction.

The external railway approaches are constructing and the Ust-Luga railway connection is being constructed joining five port approaching stations and the information management logistics center of the Luzhskaya railway station complex. In years ahead, the railway connection will be the largest and most modern in Europe; its handling capacity is planned of up to 120 mln.t of cargo per year.

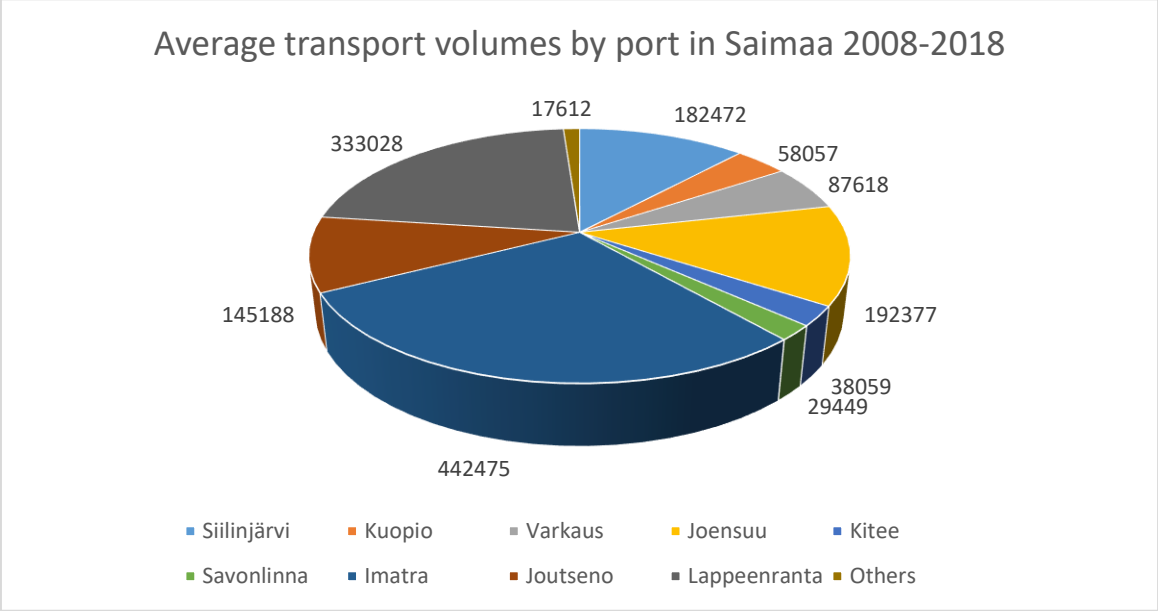
The seaport of Ust-Luga, being an intermodal transport hub, is considered as the basis for the integrated development of the adjacent territory. Therefore, further development of the port is planned to be carried out within the framework of the Project «Integrated Development of the Sea Trade Port of Ust-Luga and the Adjacent Territory» included in the list of priority investment projects of the North-Western Federal District, approved by the Government of the Russian Federation.

Recently almost all inland ports of Leningrad region and Republic of Karelia works with undercapacity to its planned in the Soviet times throughput. This technological reserve of capacity however can be of use in most of the cases after investments to infrastructural reconstruction of inland ports and nearing waterways. At the same time maritime ports on the Russian Finish Gulf area are able to serve river-sea going vessels too without significant infrastructural and technological changes, because most of the maritime ports has been renovated or under it.

6. BRIEF CHARACTERISTICS OF INLAND PORTS IN FINLAND

The Vuoksi water system includes several lakes. Lake Saimaa is one of them. The waterways are connected by canals and locks. There are several municipal and commercial ports in the Vuoksi water system area. The Mustola port is owned by the city of Lappeenranta. Besides that cities of Joensuu, Varkaus, Kuopio and Savonlinna have their own ports. Industrial companies own the Imatra, Kitee, Honkalahti, Ristiina, Kaukas, Siilinjärvi and Joutseno ports.

Within 10 years period, from 2008 to 2018, the Imatra port have had the biggest average volume of goods (442 475 tonnes), Lappeenranta port have been the second (333 028 tonnes) and the Joensuu port the third (192 377 tonnes).



(Traficom)

Figure 14. The average transport volumes by port in Saimaa 2008-2018.

In 2018 the total amount of cargo in Saimaa area ports was 1 303 983 tonnes. The order of magnitude of ports by volume (Finnish Transport Agency, 2019, 14):

- Imatra port 404 127 tonnes
- Lappeenranta port 345 187 tonnes
- Joensuu port 153 059 tonnes

- Siilinjärvi port 149 526 tonnes
- Joutseno port 111 644 tonnes
- Savonlinna 43 111 tonnes
- Varkaus port 36 848 tonnes
- Kitee port 30 248 tonnes
- Kuopio 21 764 tonnes
- Others 8469 tonnes

• Vessel traffic

In 2018 the total amount of dry cargo ships was 1162 and total cargo volume reached 1 303 983 tonnes. Besides dry cargo ships there were some barges and tugs trafficking in Saimaa. Tankers and timber rafts have not been trafficking in Saimaa after the year 1992.

• How ports could prepare for the future growth?

There has been a discussion among the Finnish IWT stakeholders about how to gather small consignments for a cargo vessel. This kind of integration would be important to introduce new product groups and actors to inland waterway transport. According to Mäntynen from WSP Finland Ltd, integration would be a natural part of the port operator's work: "It could take on a stronger role by taking responsibility for combining the various modes of transport into transport chains as well as smoothing of collection and distribution of decentralized goods flows" (Mäntynen et al. 2018, 23). As a new service, an "integrator" could gather information about the upcoming cargos from the companies in certain areas. Based on that information the "integrator" could make all the necessary reservations for the equipment and vessels. The "integrator" would also create a timetable for the shipments.

In Finland, the workforce is skilled and well educated. Transport operations can be handled safely and on schedule. The only downside is that it is difficult for Finland to compete on prices. That is why Finnish ports need to compete with efficiency and reliability.

One problem that hampers the development of inland waterway transportations is lack of investments. Well-functioning service packages would attract new investors and businesses to Saimaa area.

- Joensuu and Puhos

In 2017, shipping volumes at the Ports of Joensuu and Puhos exeeded 240.000 tons, an increase compared to the previous year (Joensuun Laivaus, https://www.joensuunlaivaus.fi/en). Last year pulp and talc were the most common products shipped at the Port of Joensuu; sawn timber was most commonly shipped at the Port of Puhos (Joensuun Laivaus, 13.6.2019).

Joensuu has one of the busiest inland waterway traffic harbours in Finland. Both ports have excellent highway and railway connections to the rest of Finland, as well as to Russia. The main articles shipped by Joensuun Laivaus Oy are forest industry products such as pulp, sheet products, sawn timber, poles, raw timber, wood pellets as well as mining industry products such as talc. Other important shipped products include urea and salt. Joensuun Laivaus Oy handles shipping at the Ports of Joensuu and Puhos.

Facts about the Joensuu Port
Vessel calls: 200/year Yearly throughput: 420,000 tn/year Throughput, international traffic: 350,000 tn/year Port's location by highway: 3 km from centre of Joensuu. Coordinates: N 62°35' E 029°45' Port's distances along water routes, measured in nautical miles: Puhos 50.76; Kuopio 132.84; Varkaus 74.52; Savonlinna 90.18; Vuoksi 170.10; Mälkiä 165.24; Vihrevoi 207.90
Facts about the Puhos Port
Vessel calls: 50/year Yearly throughput: 100,000 tn/year Port´s location by highway: 3 km from centre of Puhos and 15 km from centre of Kitee. Coordinates: N 62°06' E 029°55' Port´s distance from port of Joensuu along water route: about 50 nautical miles

(Joensuun Laivaus)

- Mustola (Lappeenranta)

The Port of Mustola is a versatile port in the area of southern Lake Saimaa, located beside the main road leading to Russia (Saimaa Terminals, 2019). The Mustola multimodal terminal integrates transport on Lake Saimaa with the road and rail network, applying the most varied services in the region:

"We use diversified machinery to handle the products of the wood-processing industry, bulk products, bagged goods, and project shipments. We have access to 8,050 m2 of guarded warehouse space and a covered storage of 1,080 m2. There are also large asphalted field areas and a fenced-in free warehouse area in conjunction with the terminal. Our warehouse also serves as a bonded warehouse. Seven berths, 600 m of quays", tells the company internet site.

- Vuoksi, Imatra

The Port of Vuoksi is a private port administered by Saimaa Terminals, operating within the area of Stora Enso. The location, which is less than 10 kilometres from the border station for road and rail transport, guarantees good communications to Russia. The port and its warehouses have been built in view of product carriage requirements (Saimaa Terminals, 2019):

"We use diversified machinery to handle the products of the wood-processing industry, bulk products, bagged goods, and project shipments. We have three berths, 200 m of quays".

- Kuopio

The Port of Kuopio is a public port with good road and rail communications. We use diversified machinery to handle products of the wood-processing industry, bulk products, bagged goods, and project shipments (Saimaa Terminals, 2019).

- Honkalahti, Joutseno

The Port of Honkalahti in Joutseno is a private port administered by Saimaa Terminals. There is only road access to the port (Saimaa Terminals, 2019).

- Varkaus

In Varkaus, Saimaa Terminals has two berths at Akonniemi and one berth at Taipale. The harbour at Akonniemi is served by good road and rail connections, whilst Taipale has a road connection (Saimaa Terminals, 2019):

"We use diversified machinery to handle the products of the wood-processing industry, bulk products, bagged goods, and project shipments. Akonniemi has a total of 5,000 m2 of terminal facilities".

- Siilinjärvi

The harbour in Siilinjärvi is the northernmost freight port within the deep-water system of Lake Saimaa. The port is a private industrial port (Saimaa Terminals, 2019).

- Savonlinna

The single-berth harbour in Savonlinna is situated within the heart of the town. There is only a road connection to the harbor (Saimaa Terminals, 2019).

- Ristiina

Saimaa Terminals operates at the harbour of Ristiina when necessary (Saimaa Terminals, 2019).

APPENDIXES:

1. Traffic analysis from Russian IWW to Finland by cargo type for 2016

Cargo type	Number of routes	Cargo volume, tons
Pulpwood	202	269081
Wood chips	9	4397
Roundwood	24	34514
Total	235	307992

2. Traffic analysis by port of destination from Russian IWW for 2016

Pulpwood		
Destination port	Number of routes	Cargo volume, tons
Imatra	69	94219
Joensuu	1	1338
Kaskinen	21	29454
Kaukas	23	31728
Kotka	1	1311
Kuopio	1	1125
Lappeenranta	45	54061
Merikarv	1	2680
Rauma	1	1159
Savonlin	3	4139
Saimaa channel	16	19868
Helsinki	13	16776
Finland (w/o port designation)	7	11223

Wood chips		
Destination port	Number of routes	Cargo volume, tons
Lappeenranta	9	4397

Roundwood		
Destination port	Number of routes	Cargo volume, tons
Imatra	9	12661
Kaukas	3	4273
Lappeenranta	1	1419
Merikarv	1	2450
Savonlin	1	1413
Saimaa channel	6	8088
Helsinki	1	1452
Finland (w/o port designation)	2	2758

3. Traffic analysis by vessel type from Russian IWW to Finland for 2016

Vessel project	Cargo type	Number of routes	Cargo volume, tons
10523	Pulpwood	12	15762
	Roundwood	1	1372
	Total	13	17134
1743.1	Roundwood	1	2450

2-95A	Pulpwood	5	7517
2-95A/P1	Pulpwood	6	12398
326.1	Pulpwood	42	51228
	Wood chips	2	979
	Roundwood	4	5228
	Total	48	57435
326.1/00	Pulpwood	27	33857
	Wood chips	4	1951
	Roundwood	1	1432
	Total	32	37240
326.1/M-	Pulpwood	5	3969
	Wood chips	3	1467
	Total	8	5436
P168	Pulpwood	90	124491
	Roundwood	15	21273
	Total	105	145764
P-168M-п	Pulpwood	15	19859
	Roundwood	2	2759
	Total	17	22618

4. Traffic analysis by ship owners and agents from Russian IWW to Finland for 2016

Ship owner	Agent	Vessel project	Number of routes
VTS Shipping	Atlantis Shipping Agency	326.1	1
		326.1/00	20
		Total	21
	VTS Shipping	326.1	2
	Gangut Marine Agency	326.1	8
		326.1/00	12
		326.1/M-	8
		Total	28
	Total		51
Neva-Balt	Astra Shipping Agency	2-95A	5
		2-95A/P1	6
		Total	11
Neva-Hagen	Neva-Group	10523	13
		P168	87
		P-168M-п	17
		Total	117
Saimensky Passat	Astra Shipping Agency	326.1	26
Northern River Shipping Lines	Gangut Marine Agency	326.1	11
North-Western Shipping Company	Universal Expeditor	1743.1	1
Freight company	Neva-Group	P168	18

5. Recommendations on technical requirements to a new vessel concept (Russian Flag State)

Class of the vessel and Flag:

Russian Maritime Register of Shipping or Russian River Register
Flag – Russian Federation (national registration)

Purpose of the vessel:

Carriage of general and dry bulk cargoes, carriage of containers (TEU & FEU), and carriage of dangerous cargoes.

Area of navigation:

Inland waterways of Finland and Russia, sea coastal areas for navigation on line Saimaa Lakes – Finish Gulf of Baltic Sea.

Navigational conditions/operability:

Ice conditions – sailing in crushed ice with 40 centimeters thickness;
Estimated temperatures for keeping normal internal climate conditions: for outer air + 35 C and moisture 65% in summer and - 21 C, moisture 85% in winter time, outer water from + 27 °C down to -2 C, consequently;
Estimated temperatures of outer air on the conditions of operability for the ship equipment:
for the ship equipment mounted in closed compartments - from 0 up to + 45 °C;
for the ship equipment mounted on open decks - from -25 up to + 45°C;
outer water from + 32°C down to 0 °C.

Autonomy:

The autonomy of the vessel in terms of fuel, oil, water and provisions is 15 days.
Autonomy under environmental safety conditions - 15 days.

Speed:

Vessel speed - at least 10 knots at 85% MDM.

Number of seats for the crew:

Provide 9 (nine) crew seats, one spare single cabin and one cabin for the pilot.

Hull

Two options for the hull of the ship's hull:
- with the highest possible coefficient of completeness;
- with the possibility of independent navigation in continuous annual ice with a thickness of 20 cm (with a high ice class).

Ship equipment, ship systems:

The specification and design of ship’s equipment and ship’s systems must comply with the requirements of the RRR or RS Rules.

Propulsion, steering and power plant:

Two options for the propulsive complex:
- the classic propulsive complex (GD-reducer-shaft-propeller) for the vessel with the maximum possible completeness coefficient;
- propulsion system with full-rotary helical-steering columns for a ship with a high ice class.

Marine Power Station:

Ship power station power network 400V, 50Hz. The electrical system is three-phase, three-wire, isolated. Provide two main diesel generators, emergency auxiliary diesel - generator. Equipment to provide power supply from the shore, when vessel berths in the port, or in repair.

Radio equipment and navigation equipment:

Must meet the requirements of the RRR or RS Rules for the intended navigation area of the vessel.

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