



# Sustainable goods transport – inland navigation

Andrej David

 [0000-0002-4820-6521](#)

Zilina University

Zilina, Slovakia

[andrej.david@uniza.sk](mailto:andrej.david@uniza.sk)

## Abstract

Inland navigation plays a crucial role in goods transport, facilitating the movement of goods via rivers and canals. Sustainability in Goods transport involves reducing environmental impact, promoting social responsibility, and enhancing efficiency. Sustainability in goods transport includes optimising transportation routes, investing in fuel-efficient vehicles, and promoting alternative fuels. Green technologies such as GPS tracking and route optimisation software can improve efficiency. Encouraging sustainable packaging materials and carbon offsetting can further reduce environmental impact. Inland navigation can be greener by adopting alternative fuels, improving vessel efficiency, and optimising routes. Maintenance and modernisation of infrastructure, environmental protection measures, and modal shifts from road transport also contribute to sustainability. Various factors influence the performance of inland navigation, including infrastructure, water levels, vessel characteristics, regulations, economic conditions, technological advancements, environmental factors, and social considerations. Integrating sustainable practices and addressing these factors can lead to a more environmentally friendly and efficient goods water transport system. This paper investigates the connections between inland goods transport and sustainability, identifying the main factors. Some basic statistics were collected and analysed to show the performance of inland navigation. The analysis showed that inland navigation is very diverse in Europe, Western Europe is more developed than Eastern European countries. In conclusion, it can be stated that many factors influence the development of Eastern European inland navigation.

## Keywords

goods transport, inland navigation, sustainability

## 1. Introduction

Freight transfer is a service industry involving the coordination and transportation of goods from one place to another on behalf of the shipper. Freight forwarders act as intermediaries between freighters and various transportation services such as shipping lines, airlines, truck companies, and railways (Naumov, 2018). The primary function of a freight forwarder is to facilitate the smooth movement of goods from the origin to the final destination and to ensure that the goods reach the recipient in a timely and cost-effective manner. Freight forwarders negotiate rates and secure bookings with carriers for freight transportation through various modes of transport, including sea freight, air freight, road freight and rail freight. Freight forwarders handle all documentation necessary for goods transportation, including freight bills, commercial invoices, export and import permits, customs documents and origin certificates. They also assist in customs clearance procedures, ensure that freight complies with all relevant customs regulations and facilitate the smooth passage of goods through customs checkpoints. Goods transporters usually provide or organise cargo insurance to protect goods from loss, damage or theft during transport. Some freight forwarders provide warehouse and distribution services, including storage, inventory management and order processing, to support their clients' logistics needs. Overall, freight forwarding plays a key role in international trade by simplifying cross-border cargo transport and ensuring that goods reach their intended destinations efficiently and cost-effectively (Ma *et al.*, 2023).

Sustainability refers to the ability of future generations to meet their own needs without compromising their ability to meet present needs. It involves a holistic approach that balances economic, environmental and social considerations to ensure long-term viability and resilience. Environmental protection includes reducing resource consumption, pollution and waste generation, preserving biodiversity, and combating climate change by reducing greenhouse gas or NO<sub>x</sub> emissions (Savu *et al.*,



*al.*, 2022). Sustainability means promoting equitable, inclusive, environmentally responsible economic growth and development (*Lavuri et al.*, 2023). It often involves adopting sustainable business practices, investing in renewable energies and green technologies, and promoting fair trade and ethical supply. Sustainability is designed to improve the quality of life of all people by ensuring access to basic needs such as clean water, food, health care, education and housing. It also involves the promotion of social justice, diversity, inclusion and respect for human rights. Achieving sustainability requires cooperation between governments, enterprises, communities, and individuals. It involves making informed decisions and proactively addressing the planet's interconnected problems, such as climate change, resource degradation, biodiversity loss, and social inequality (*Scholz et al.*, 2023). In summary, sustainability is about balancing economic prosperity, environmental protection, and social equity to meet the needs of today's generations without compromising the ability of future generations to meet their own needs.

This paper will focus on sustainable goods transport, especially in inland navigation. The paper's research question is: What possible options for greening inland navigation do we have? Therefore, the author investigated the state-of-the-art scientific literature. The second chapter describes the main challenges of sustainable goods transport. The third chapter shows the performance of inland navigation in the EU. The fourth chapter shows the analysis and conclusion.

## 2. Sustainable goods transport

Goods transport can be more sustainable through various practices and initiatives to reduce environmental impact, promote social responsibility and improve overall efficiency. Goods transporters can optimise transport routes to reduce fuel consumption, emissions, and transportation costs. This may involve using advanced logistical software to find the most efficient route, combining the transport modes to reduce the number of vehicles on the road and, when possible, promoting the transportation of goods by rail or sea. Good transporters can invest in modern fuel-efficient vehicles for their fleets, such as hybrid or electric vessels (*Majerčák et al.*, 2024). Using low-emission vehicles reduces the carbon footprint of goods transport and contributes to environmental sustainability. Implementing alternative fuels such as biodiesel, compressed natural gas (CNG), and hydrogen can help goods transporters reduce dependence on fossil fuels and greenhouse gas emissions from transportation activities. Goods transporters can use green technologies such as GPS tracking systems, route optimisation software and telematics to improve operational efficiency, reduce fuel consumption and reduce emissions. They may encourage clients to use sustainable packaging materials and practices, reducing waste and reducing the environmental impact of goods transport. These include using recycled materials, minimising packaging waste and choosing reusable or biodegradable packaging solutions (*Upadhyay*, 2024). Goods transporters can invest in carbon reduction projects, such as reforestation, renewable energy projects, and energy efficiency projects, to offset carbon emissions from transportation activities. This contributes to reducing the environmental impact of goods and transport and contributes to global efforts to combat climate change. Goods transporters can work with suppliers and transport partners to promote sustainability throughout the supply chain. This includes a strong selection of environmentally and socially responsible suppliers and certifications to demonstrate commitment to sustainability, such as ISO 14001 (environmental management) or ISO 26000 (social responsibility). By implementing these and other sustainable practices, freight forwarding companies can reduce their environmental footprint, improve their social impact and contribute to a more sustainable and resilient global supply chain ecosystem.

Inland navigation, which involves transporting goods and passengers through rivers, canals and other inland waterways, can be more sustainable through various strategies to reduce environmental impacts, improve efficiency and enhance safety (*Maternová et al.*, 2023). There are several ways to achieve sustainability in inland navigation. Encouraging alternative fuels such as biodiesel, natural gas liquefied (NGL), and hydrogen can help reduce ship emissions (*Palomba et al.*, 2017). Investment in developing and adopting cleaner driving technologies and support for low-emission engines can further contribute to sustainability (*Zalacko et al.*, 2020). Designing and reorganising ships to improve energy efficiency and reduce fuel consumption can significantly reduce the environmental impacts of domestic navigation. This may include measures such as the optimisation of the ship's structures, the installation of energy-saving devices and the use of hybrid propulsion systems. The optimisation of logistics and route planning can help to minimise fuel consumption, reduce greenhouse gas emissions and improve the overall efficiency of internal navigation operations. Advanced navigation technologies, route optimisation software, and real-time monitoring systems can help schedule and transport ships and cargo more efficiently (*Nilsson et al.*, 2009). Investments in the maintenance, modernisation and expansion of waterway infrastructure, such as boats, dams and navigation channels, can improve navigation's safety, reliability and efficiency (*Maternová et al.*, 2022).

Upgrading infrastructure to accommodate larger vessels and improving connectivity with other modes of transportation can further promote sustainability. Implementing measures to protect and preserve the ecological health of inland waterways can help mitigate the environmental impact of navigation activities. This can include initiatives such as habitat restoration, erosion control, water quality monitoring, and invasive species management to safeguard biodiversity and ecosystem integrity (Károlyfi *et al.*, 2021). Encouraging a modal shift from road and rail transport to inland navigation can help reduce congestion, alleviate pressure on road infrastructure, and lower carbon emissions. Offering incentives, such as subsidies or tax breaks, to encourage businesses to choose inland waterway transport for their freight can support this shift toward more sustainable transportation modes.

### 3. Performance of inland navigation

As shown in Fig. 1, in most cases, the performance of inland waterborne transport has decreased between 2012 and 2021. The attraction of inland navigation dropped, and competition between transport modes became more crucial.

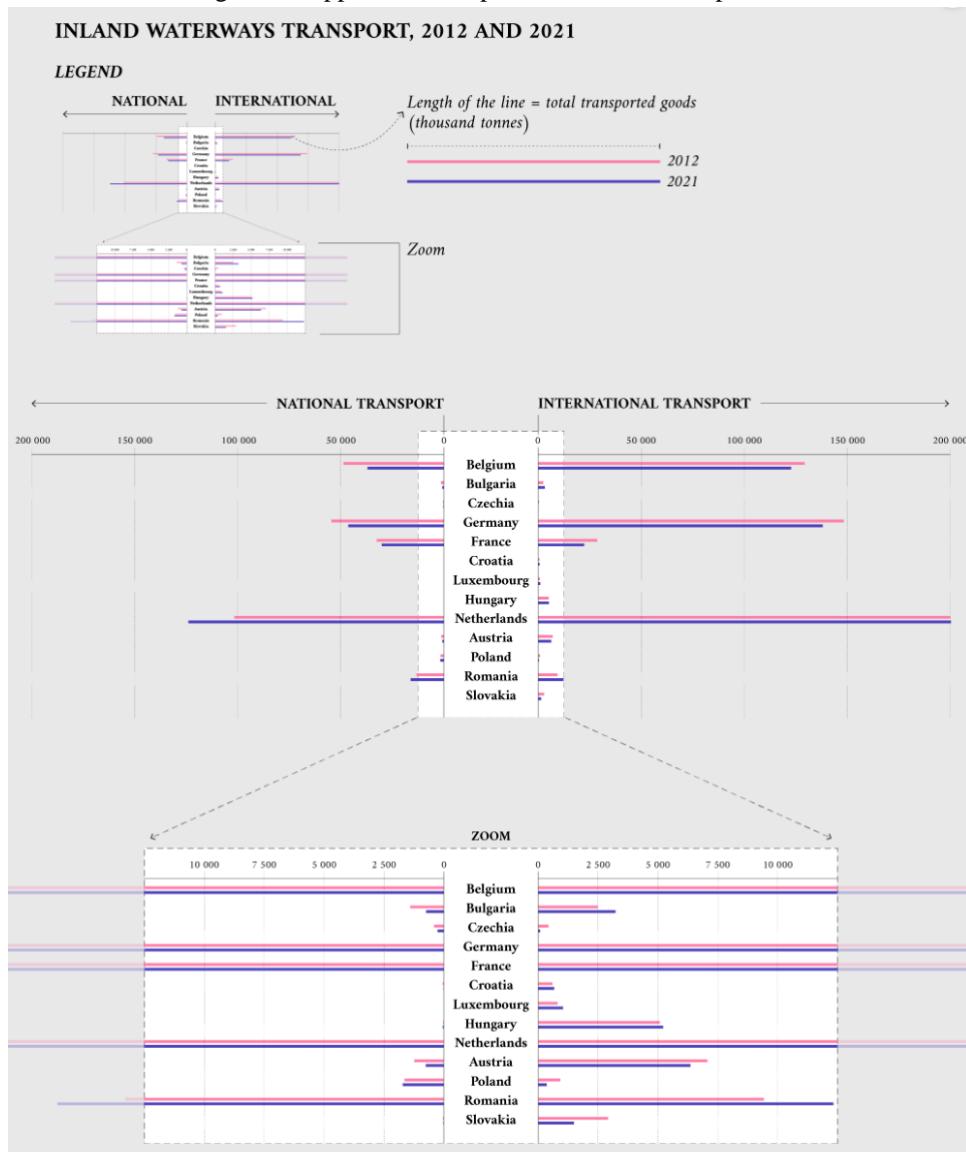


Figure 1 Performance (in thousand tonnes) of Inland Waterway Transport in 2012 and 2021

Source: Mancino (2023)

Figures 2 and 3 show the spatial distribution of the performance of inland navigation in the EU. The data show that economically more advanced countries are utilising their channel and river systems for goods transport.

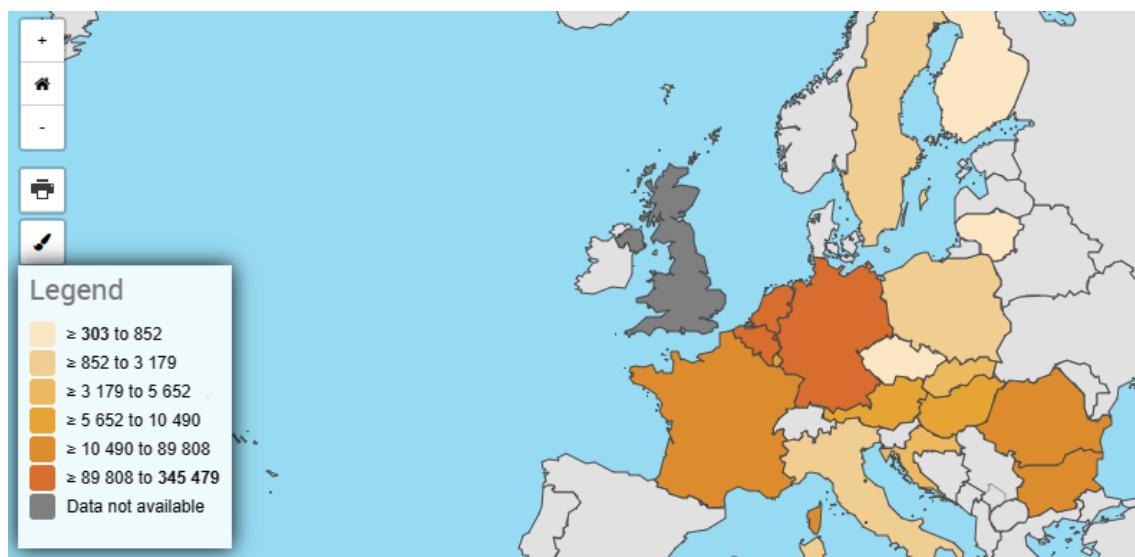


Figure 2 Performance (in thousand tonnes) of Inland Waterway Transport in 2022

Source: Eurostat (2022)

As shown in Figures 2 and 3, the spatial distribution of performance of inland navigation is very diverse. Eastern European countries such as Poland and Hungary could not utilise the geographical advantages. Although France, Germany, the Netherlands, and Belgium have long histories of utilising rivers and building channels,

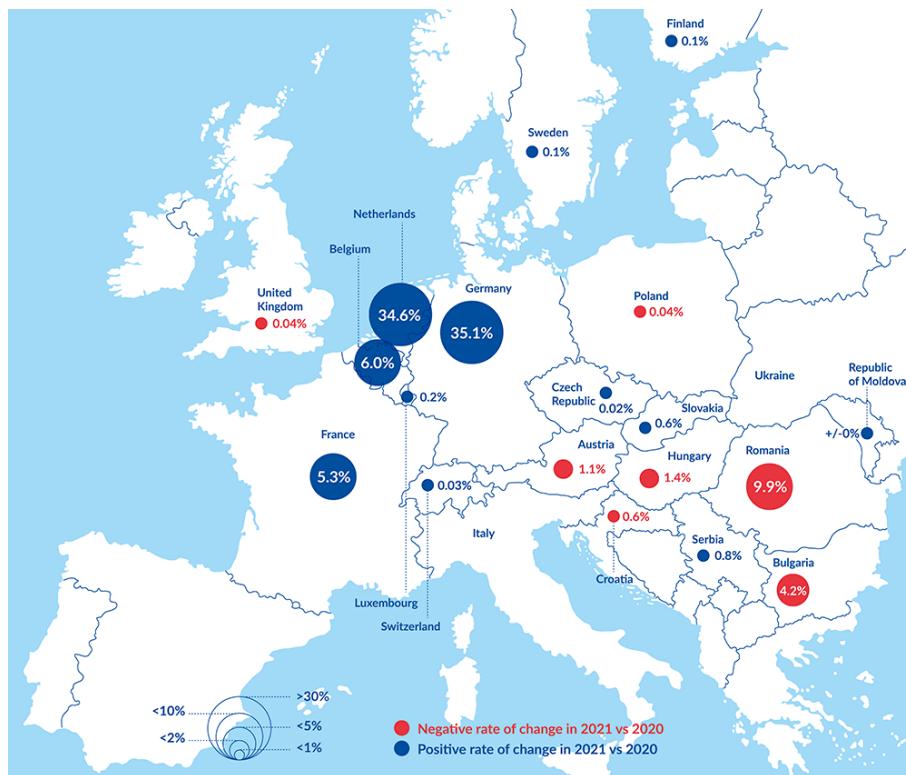


Figure 3 Share of the countries' tonnes-km (tkm) in total transport performance in Europe (in %)

Source: Central Commission for the Navigation of the Rhine (2022)

#### 4. Analysis and Conclusion

Several factors can influence the performance of inland navigation, impacting its efficiency, reliability, safety, and overall effectiveness. The condition and capacity of inland waterway infrastructure, including locks, dams, navigation channels, and



port facilities, significantly affect the performance of inland navigation. Well-maintained and modernised infrastructure can support efficient navigation, minimise delays, and enhance safety. Fluctuations in water levels due to seasonal variations, precipitation, and hydrological factors can impact navigation conditions, vessel draft, and operational schedules. Adverse weather conditions such as storms, fog, ice, and high winds can also affect the safety and reliability of inland navigation operations. The size, type, and condition of vessels used in inland navigation are crucial in determining performance. Vessel design, propulsion systems, cargo capacity, manoeuvrability, and navigational equipment influence efficiency, speed, and safety during navigation. Regulations, policies, and legal frameworks governing inland navigation, including safety standards, environmental regulations, navigation rules, and trade agreements, can impact performance. Clear and consistent regulatory frameworks that promote safety, environmental protection, and efficiency are essential for the sustainable development of inland navigation. Economic conditions, market demand, trade patterns, and freight rates influence the volume and nature of cargo transported via inland navigation. Changes in economic trends, such as fluctuations in commodity prices, shifts in consumer preferences, or disruptions in global supply chains, can affect the performance of inland navigation. Innovations in navigation technologies, vessel design, propulsion systems, communication systems, and automation can improve the efficiency, safety, and reliability of inland navigation operations. Adopting and integrating advanced technologies can enhance performance and competitiveness in the sector. Environmental factors, such as water quality, sedimentation, erosion, habitat preservation, and climate change, can impact the performance of inland navigation. Addressing environmental challenges and implementing sustainable practices is essential for minimising negative impacts and ensuring the long-term viability of inland waterways. Social factors, including labour availability, workforce skills, training programs, and community engagement, influence the performance of inland navigation. Cultural considerations, such as indigenous rights, heritage preservation, and local customs, may also affect navigation operations in specific regions. Overall, a combination of physical, regulatory, economic, technological, environmental, and social factors shapes the performance of inland navigation, highlighting the need for integrated and holistic approaches to address the diverse challenges and opportunities in the sector.

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