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Ports and hinterland connections: what do we really know? An empirical analysis in South-Eastern Europe

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Abstract

The role of ports relative to the territory seems to be not well addressed by existing analytical approaches regarding multimodal transport networks. Available port statistics usually report sea-side point transport data, while data about multimodal hinterland connections (inbound and outbound) is scant or simply non-existent. At the same time, land-based origin-destination transport data traditionally does not include port-related information determining a misspecification of existing land-based transport models. There is then the need to address such gaps by proposing approaches and methods to improve the analytical framework of multimodal transport networks and support effective EU, regional and national transport policies. The paper aims at filling such gaps with regards to a specific geographical area, e.g., the South-Eastern Europe. An approach is proposed to collect currently missing data so as to elaborate geographical modelling tools to support an improved analytical framework and policymaking in the area. Data collection processes are carried out based on a questionnaire format to get original, on-the-field added value data. Geographical tools (GIS) are then employed to support a strategic assessment of the role of ports relative to the territory. Results provide insights to get a better picture of the multimodal transport networks in the region, thus, supporting more effective policies at the EU level.

Keywords: Multimodal Transport, Ports, South-Eastern Europe, Hinterland Connections

1. Introduction

Transport Geography represents a truly dynamic area within Economic Geography (Shaw and Sidaway, 2011; Capineri, 2004), which shows a renewed scientific and applied development (Rodrigue et al., 2016; Rodrigue, 2016; Keeling, 2007, 2008; Hoyle and Knowles, 1998; Taaffe et al., 1996; Merlin, 1992). It consists of a multidisciplinary field of research addressing the issues of transport and logistics

networks and global supply chains (Black, 2003), which are seen as complex systems at spatial level (Goetz, 2009). Different territorial dimensions are considered (Capineri and Tinacci Mossello, 1996), including urban, regional and global ones (Shaw and Sidaway, 2011; Keeling, 2007, 2008; Rimmer, 1985). A specific field of interest consists of the port and maritime sectors (Ducruet and Bunel, 2017; Ng et al., 2014; Ng, 2013; Notteboom and Rodrigue, 2012), notably the container industry (Notteboom and Rodrigue, 2014; Tadini, 2012). The container industry is directly related to global economic growth (Conti et al., 2022; Amato and Galeota Lanza, 2018; Tadini, 2017; Guerrero and Rodrigue, 2014) and it determines relevant territorial impacts, both in port and hinterland regions.

Currently, the analysis of freight transport and logistics networks relative to the territory is among the most promising research opportunities (Rodrigue, 2017; Rodrigue et al., 2016). However, although some strategic scenarios have been developed at geographical levels – particularly at European (Mazzarino, 2012), Mediterranean (Amato, 2017; Ugolini, 2015; Mazzarino, 2013) and global ones (Hennig, 2016) – such issues are nevertheless poorly addressed by existing analytical approaches about multimodal transport networks (Haralambides, 2017; Musso and Ghiara, 2007), particularly with regards to port areas. There is also the need to address the policy dimensions of such systems over the territories (Prezioso, 2019). More specifically, available port statistics usually report sea-side point transport data, while data about multimodal hinterland connections is scant, fragmented or simply non-existent. At the same time, land-based origin-destination transport data traditionally does not include port-related information, thus, determining a misspecification of existing land-based transport models[1].

As a result, a "rift" between ports and territories is in place. Some relevant data is missing to get a comprehensive picture of the multimodal transport networks at spatial level. There is then the need to address such gaps by proposing approaches and methods to improve the analytical framework of multimodal transport networks and support effective EU, regional and national transport policies, namely in the framework of the TEN-T and Macro Regional Strategies (Borruso et al., 2006).

Our paper aims at filling such gaps with regards to a specific geographical area, e.g., the South-Eastern Europe. While some studies report results about geographical regions or logistics chains (e.g., container – Notteboom and Rodrigue, 2014), the area of South-Eastern Europe turns out to be rather poorly analyzed. Some EU projects (e.g., Watermode) focus on South-Eastern ports to develop data collection activities. However, they mainly address specific "logistics" attributes by collecting data on the type of port activities and services, type of companies operating in the port, port dimensions, ownership structure, etc. Moreover, they collect traditional sea-side statistics on traffic flows. At the same time, not much attention is paid on port-related multimodal land-based generated/attracted transport flows (both inbound and outbound). Our paper specifically focuses on the latter issue, thus, filling a relevant gap in data availability and providing an enriched picture of the multimodal transport networks in South-Eastern Europe.

Based a comprehensive literature review, an approach is proposed to collect currently missing data to elaborate geographical modelling tools supporting an improved analytical framework and policymaking in the area. Relevant missing data is specified, consisting of transport attributes of port-related road and rail flows. Data collection processes are carried out based on a questionnaire format to get original on-the-field added value data. Questionnaires are submitted to an extensive sample of ports in the area, which includes Durres, Varna, Burgas, Rijeka, Split, Piraeus, Igoumenitsa, Thessaloniki, Venice, Trieste, Bar, Constanza, Koper. Collected data is then organized in a structured data set and elaborated to get a comprehensive picture of port-related hinterland flows. Geographical tools and GIS techniques are employed (Hennig, 2016; Borruso, 2001) to support a strategic assessment of the role of ports relative to the territory. Main results

[1] Especially when they are calibrated to pinpoint land-based bottlenecks in transport networks.

highlight relevant features and specializations of port-related land-based connections.

2. The background: the multimodal transport networks in South-Eastern Europe

In this section, the territorial context is briefly described. It mainly refers to the development of the TEN-T networks in the region, which represent a main strategic policy goal by the EU (Hall, 2010; Borruso et al., 2006; Tolley and Turton, 1995). Multimodal transport networks are essential infrastructures to ensure a sustainable development in modern economies (Borruso, 2011). European policies aiming at developing Trans-European transport networks (so-called TEN-T) date back to the Maastricht Treaty of the 90's, which aimed at fostering the development of a single EU market. Ambitious goals and targets were established, including significant reduction in CO2 emissions, the optimization of multimodal logistics chains and the development of IT tools in the transport field. The TEN-T strategic policy eventually has the aim of creating an integrated EU multimodal transport network (Tadini, 2010). In 2013, a TEN-T Regulation was adopted by the EU introducing the definitions of "global" and "central" TEN-T network, thus, following a geographical approach to policymaking (Prezioso, 2019). The "global" network should be accomplished by 2050 and it consists of nine corridors (two North-South, three East-West and four diagonals). The "central" network is expected to be realized by 2030 and it consists of the most strategic components of the global network. The EU Commission supports such goals through specific funding programs, namely the CEF. Based on estimates, some 1,500 bn euros are needed by 2030. As for the main corridors of the central network, it is estimated by the EU Commission that some 700 bn euros are needed targeting some 2,500 projects to be accomplished by 2030.

Figure 1 shows key features of the nine corridors. In particular:

- The Northern and Baltic Sea corridor connects Scandinavian countries through maritime and land transport systems. The so-called *Rail Baltic* represents the most strategic project in the area, connecting Riga, Tallin, Kaunas, and the Polish region;
- The Adriatic and Baltic corridor connects the Southern districts of Poland, Austria, Bratislava, and the North-Eastern Italian regions. The Koralm railway line represents the most important project;
- The Eastern Mediterranean corridor connects Northern Europe, the Baltic, the Black Sea, and Greek ports;
- The MED corridor develops over Spain, France, the Alpine regions, and Hungary;
- The Rhein-Alps corridor connects the European central regions with the EU Southern countries, mostly through the Rhein waterways and the ports of Antwerp, Rotterdam and Genoa;
- The Scandinavian and Mediterranean corridor connects major Northern and South-Eastern regions;
- The Atlantic corridor develops over the Spanish, Portuguese, and French coastal regions. The Seine represents the most strategic transport connection;
- The Northern and Mediterranean Sea corridor covers the North-Western EU regions (The Netherlands, France, Belgium and Luxemburg);
- The Rhein-Danube corridor develops over Central European regions, namely Germany, Austria, Hungary, and the Black Sea.

Relevant EU corridors for our paper turn out to be the Eastern/Mediterranean and the MED. The first (see Figure 2) is 3,700 kilometres long and covers nine EU countries, including Germany, the Czech Republic, Slovakia, Hungary, Bulgaria, Greece, and Cyprus.

The MED corridor (see Figure 3) has an overall length of some 3,000 kilometres, connecting South-Western Mediterranean ports (Algeciras, Cartagena, Valencia, Tarragona, and Barcelona) with EU regions up to the Hungary-Ukraine border. The MED corridor represents the most important

TEN-T Eastern-Western transport axis south of the Alps.

Figure 1. TEN-T Corridors. Source: Infotrasporti, TEN-T e i corridoi intermodali. https://www.infotrasporti.com/ten-t-e-i-corridoi-intermodali-le-9-linee-e-i-corridoi-che-collegano-lintera-europa/.

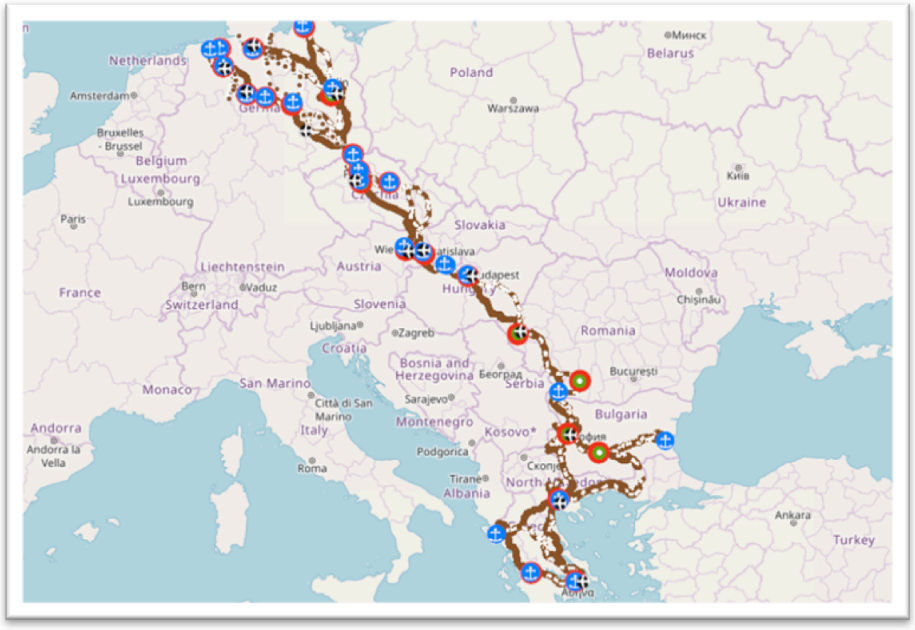

Figure 2. The Eastern Mediterranean Corridor. Source: Mobility and Transport, TENtec Interactive Map Viewer. https://ec.europa.eu/transport/infrastructure/tentec/tentec-portal/map/maps.html.

Figure 3. The MED Corridor. Source: Mobility and Transport, TENtec Interactive Map Viewer. https://ec.europa.eu/transport/infrastructure/tentec/tentec-portal/map/maps.html.

3. Focus: a literature review on South-Eastern ports

In this section, a comprehensive literature review to get the state-of-the-art of the scientific knowledge about the multimodal transport networks in the specific region of South-Eastern Europe is carried out, with particular reference to the role of ports. Major existing research gaps are highlighted, which relate to the goals of our paper.

In the main, the topic regarding the development of multimodal transport networks in South-Eastern Europe turns out to be definitely poorly analyzed in the literature. In the general framework of EU enlargement (Lucarno, 1997), Giannopoulos (2005) develops a comprehensive picture of main challenges in the transport sector in South-Eastern Europe. In particular, the need to adopt common spatial policies is highlighted, particularly with regards to the railway and road transport sectors as well as to the bottlenecks on existing cross-border connections. Lucarno (2003) addresses such issues with regards to Italy, by focusing on the infrastructure dimension. Borruso and Borruso (2012) and Borruso et al. (2003) perform in-depth analyses of port traffic and related economic impacts on the hinterland with regards to the port of Trieste. Grčić and Ratkaj (2004) emphasize the need to develop multimodal transport networks to foster territorial integration in the region. Tadić et al. (2019) address the issues of the spatial development of the so-called dry ports in the region (inland terminals) within the *Intermodal Transport Network of Central and South-eastern Europe*. Such a development is driven by existing space limitations within the port areas. Tadić et al. (2021), then, further develop such an approach by providing hybrid multi-criteria models supporting decision-making processes by relevant actors and stakeholders in the area. Niavis and Tsekeris (2012) perform an analysis to identify and assess major determinants of the technical efficiency of South-Eastern Europe container ports. Results show that port efficiency turns out to be low on overage. The authors then highlight the need to get a better understanding of the main root causes determining such a low level of efficiency. The topic is also addressed by Petrlić and Pavletić (2019) who examine the main components of port competitiveness in the

region, with particularly reference to Croatian ports. Finally, Kolios et al. (2015) develop geographical modelling tools (GIS-based) to assess main environmental indicators in port and hinterland areas in South-Eastern regions.

In the main, the need to get a better understanding of road and rail connections to/from the ports in South-Eastern Europe comes up from the literature. In particular, the role of ports relative to the territory (including the connections with dry ports) represent a major focus to be further investigated with the aim of fostering spatial integration. Moreover, the literature mostly focuses on sea-side elements in the region – including port efficiency and competitiveness – while the role of hinterland connections as major determinants of port development is neglected. Finally, the need to perform analyses supporting modelling exercises on port-hinterland connections is suggested. Our paper provides a contribution to fill these gaps raised in the literature.

4. Material and methods

A common methodological framework is developed for all the ports involved in the analysis, which consists of the following activities:

- Specifying data requirements (e.g., currently missing information);
- Designing the overall data collection process;
- Designing a questionnaire template;
- Submitting the questionnaire to a relevant sample of ports in the area;
- Collecting data and organizing a digital data set;
- Analyzing data and developing geographical tools for the analysis.

4.1 Data requirements and the data collection process

Data requirements consist of:

- "core" data, which is mostly quantitative. Core data consists of attracted and generated (inbound/outbound) port traffic flows by road and rail transport. Suitable units of measurement are specified to express the two traffic categories (e.g., rail and road). As for road transport, data represents daily traffic in terms of inbound and outbound number of trucks and tons, while weekly traffic is considered for rail in terms of both number of trains and tons;
- "additional" port data, representing relevant port attributes which are mostly qualitative. Specifically, data shows strategic "specializations" of South-Eastern ports in terms of type of goods/cargo units and geographical markets (regional origins/destinations).

Data requirements are then organized in a questionnaire template, which is designed to support the overall on-the-field data collection process. Usually, such an activity turns out to be complex due to different methods to record information and the variety of conditions in various ports. Indeed, it results even more complex in our case due to the large territory to be covered and the need to address both road and rail transport flows.

The questionnaire template is submitted to a sample of relevant ports in the area. We rely upon local/regional/national representatives providing support for data collection and questionnaire fill-in activities. Table 1 shows the representatives for each port region.

In the main, support is provided by:

- Submitting the questionnaire template to local port authorities;
- Identifying contact persons and managing a constant dialogue to finalize the fill-in activities;
- Providing final data for check and harmonization. We then coordinate the overall data collection process by assessing data consistency, harmonization and managing data misspecification, cleaning, and standardization.

Table 2 shows the fulfillment percentages related to core data from each port. It can be noted that questionnaires are filled-in predominantly at 100%, while missing data is reported in some cases. Similar figures emerge also for the questionnaire as a whole – that is, including the "additional data" section.

4.2 Data analysis

A data model is then built to store and organize collected data. The data set consists of:

- Interconnected tables;
- Insert forms;
- Output queries and excel export queries.

Five interconnected tables are specified, namely:

- General;
- Road core data;
- Rail core data;
- Road additional data;
- Rail additional data.

An overall picture of the data set is presented in Figure 4. An example of filled-in questionnaire collected data is shown in Figure 5.

The port of Koper operates some 450 trucks/day outbound (consisting of 8,118 tons/day), while inbound road traffic is around 290 trucks/day (consisting of 5,202 tons/day). Outbound rail traffic amounts to 70 trains/weeks (some 70,000 tons/day), while inbound traffic is in the order of 50 trains/week (or 49,000 tons/week). The port's main outbound road type of cargoes are containers, cars, and general cargo (metals, fruit, vegetables), minerals, iron ore, chemical products and fodder. Geographical road outbound markets are Slovenia (39%), Austria (18%), Italy (5%), Germany (3%), Slovakia (5%), Czech Republic (4%), Hungary (23%), Poland (3%). Inbound road traffic consists of containers, cars, general cargo, minerals, liquid bulk, timber, livestock. Main inbound geographical markets are Slovenia (37%), Austria (26%), Italy (8%), Germany (7%), Slovakia (5%), Czech Republic (6%), Hungary (10%), Poland (11%). In the rail sector, main outbound types of cargoes are containers, cars, minerals, aluminum, iron ore, coal, chemical products, fodder, while main outbound rail geographical markets consist of Slovenia (20%), Austria (56%), Slovakia (10%), Czech Republic (3%), Hungary (11%). Main inbound types of cargo are containers, cars, paper, metals, minerals, timber, while geographical markets consist of Slovenia (11%), Austria (50%), Germany (6%), Slovakia (9%), Czech Republic (6%), Hungary (18%).

The port of Durres operates some 200 trucks/days outbound (equivalent to 3,871 tons/day) and some 290 trucks/day (or some 6,000 tons/day) inbound. As for rail, both outbound and inbound traffic is not reported. Outbound road traffic consists mainly of chrome ore (97%), other types of cargo being iron ore, scrap, cement, iron billets. Main road outbound geographical markets are Italy and Turkey. Inbound road traffic specializes on raw materials, industrial products, grocery, coal, scrap, iron nickel ore, cement, vegetal oil wheat, iron, fertilizers. Main inbound geographical markets are Albania (80%), Kosovo, Northern Macedonia, Ukraine, Italy, Greece, Spain, Turkey, Slovenia, Croatia. As for rail, no additional data is reported.

Country	Port	Representative
Albania (AL)	Durres	Ministry of Public Works and Transport of Albania
Bulgaria (BG)	Varna	Regional Administration Smolyan
	Burgas	Regional Administration Smolyan
Croatia (HR)	Rijeka	Pro-rail Alliance
	Split	Pro-rail Alliance
Greece (GR)	Igoumenitsa	Region of Epirus/Regional unit of Thesprotia
	Thessaloniki	Trainose S.A.
Italy (IT)	Venice	Venice International University
	Trieste	Autonomous Region of Friuli-Venezia Giulia
Montenegro (MW)	Bar	Ministry of Transport and Maritime Affairs
Romania (RO)	Costanza	University Politehnica of Bucharest
Slovenia (SI)	Koper	Gea College

Table 1. Local representatives supporting data collection. Source: this study.

Country	Port	% filled-in data
Albania (AL)	Durres	56%
Bulgaria (BG)	Varna	100%
	Burgas	0%
Croatia (HR)	Rijeka	100%
	Split	100%
Greece (GR)	Igoumenitsa	33%
	Thessaloniki	100%
Italy (IT)	Venice	100%
	Trieste	11%
Montenegro (MW)	Bar	11%
Romania (RO)	Constanza	100%
Slovenia (SI)	Koper	100%

Table 2. Questionnaire core data fulfillment percentages. Source: this study.

The port of Bar does not report core data. As for additional data, outbound road traffic consists mainly of zinc ore, iron scrap, crushed stones. Main outbound road geographical market is Turkey. Inbound road traffic specializes on nickel, diesel fuel, oil, aluminum ingots, alumina, fruits. Inbound geographical markets are not detailed, while the EU is indicated as main market. In the rail sector, outbound traffic mainly consists of cars, coils, and grain, being the UE as a whole the most important geographical market. Inbound rail traffic operates bulk, cement and oil coke, while Croatia represents the most significant geographical market.

The port of Rijeka operates some 600 trucks/day outbound (amounting to some 12,000 tons/day), while inbound road traffic consists of some 400 trucks/day (or 8,000 tons/day). As for rail connections, it operates some 40 trains/week (20,000 tons/week) outbound and some 30 trains/week (15,000 tons/week) inbound. Outbound road traffic focuses on general cargo and containers, with Hungary, Serbia, Croatia, Slovakia being the main outbound geographical markets. Inbound road traffic operates mostly general cargo/containers and wood. Hungary, Serbia, and Croatia represent the main geographical markets. Outbound rail connections operate general cargo and containers, while main geographical (outbound) markets are Hungary, Croatia, Serbia, Slovakia, Austria. Inbound railway connections focus on general cargo, ore, and containers, while main geographical markets are Hungary, Serbia, Austria, and Croatia.

The port of Split reports some 200 trucks/days (4,000 tons/day) as outbound road traffic, while inbound road traffic consists of some 150 trucks/days (3,000 tons/day). Outbound rail traffic consists of 20 trains/week (10,000 tons/week), while inbound rail connections operate 14 trains/week (7,000 tons/week). Additional road traffic data reports general cargo, oil products and containers as main outbound types of cargoes, while Hungary, Croatia, Bosnia Herzegovina represent the most significant outbound road geographical markets. Inbound road traffic focuses on general cargo (70%), cereals (20%) and containers, with Hungary, Serbia, Bosnia Herzegovina, Croatia being the most important road inbound geographical markets. As for railway connections, outbound flows consist of general cargo, containers, and food/vegetables, Croatia, Serbia, Bosnia Herzegovina being the main geographical markets. Inbound rail flows consist of general cargo, coke, ore, containers, food (cereals). Hungary, Serbia, Croatia, Bosnia Herzegovina are the main inbound geographical markets for railway connections.

The port of Igoumenitsa reports some 307 trucks/day for road outbound connections, while inbound road traffic consists of 298 trucks/day. Outbound road connections operate mainly trucks, Corfu (29%), Ancona (21%), Bari (24%), Brindisi (14%) being the main outbound geographical destinations. Inbound road connections also operate mainly trucks and Corfu (30%), Ancona (16.5%), Bari (24%), Brindisi (14%) are the most important origins. As for rail connections, no data is reported.

The port of Thessaloniki operates some 170 trucks/days (4,100 tons/day) as outbound road traffic, while inbound road connections consist of 90 trucks/day (2,250 tons/day). Outbound railway connections operate three trains/week (7,500 tons/week), while rail inbound traffic consists of 1 train/week (1,800 tons/week). Outbound road connections operate coils, steel plates, containers, scrap metals, grain. Most significant geographical markets are Greece (17%), FYROM (80%), Bulgaria (3%) – for dry bulk and general cargo – and Greece (95%) and FYROM (5%) – for containers. Inbound road connections operate containers, dry bulk (coal, grain, nickel, laterite, salt, bitumen, fertilizers), fruits, vegetables, coils, steel product. Main origin markets are Greece (95%) and FYROM (5%) – for containers – and Greece (15%), FYROM (83%, Bulgaria (2%) – for dry bulk and general cargo.

The port of Varna operates outbound road connections consisting of 268 trucks/day (5,462 tons/day), while inbound road traffic is of 476 trucks/day (9,888 tons/day). Rail connections operate 64 wagons/week outbound (6,324 tons/week) and 115 wagons/week (6,019 tons/week) inbound. Outbound road connections mostly focus on containers, molasses, sugar, coal, ores and concentrates, feldspar, equipment; main outbound markets for road connections are not

reported. Inbound road flows operate containers, scrap, grain, firewood, clinker, cement, chamotte, kaolin, equipment. Main origin geographical markets are not reported. Rail connections mostly operate coal outbound. No other data on railway connections is reported.

The port of Constanza operates some 2,153 trucks/day (32,298 tons/day) as outbound road traffic, while inbound road traffic amounts to 1,987 trucks/day (29,814 tons/day). Rail traffic consists of 180 trains/week (227,050 tons/week) outbound and 180 trains/week (209,584 tons/week) inbound. Outbound rail traffic specializes on cereals, iron ore, scrap, crude oil, oil products, coal, coke, nonferrous ore, fertilizers, metal products, wood and cork, oil seeds, oleaginous fruits, fats, cement and building materials. Inbound rail traffic focuses on oil products, cement, building materials, crude oil, nonferrous ore and scrap, fertilizers, metal products, coal, coke, chemical products, machinery, transport equipment, raw and processed minerals. No additional features of rail traffic and overall road traffic are reported.

The port of Trieste reports railway traffic only, while not specifying the type of cargoes. Outbound rail traffic consists of some 96 trains/week (45.700 tons/week), while inbound rail flows consist of about 97 trains/week (some 46.000 tons/week). Railway traffic in Trieste turns out then to be rather balanced. Geographical markets are reported at very disaggregated level. Aggregated geographical markets turn out to be rather homogenous both inbound and outbound, consisting mainly of Germany, Austria, Hungary and Northern Italy.

The port of Piraeus does not report modal split data. Main inbound geographical markets consist of Italy (some 30%), Belgium (10%) and Spain (10%), while main outbound markets are represented by Italy (34%). Overall, then, Italy represents by far the most important geographical market for both type of connections.

The port of Venice reports some 1,800 trucks/day (20-30,000 tons/day) of outbound road traffic, while inbound road traffic amounts to similar figures. Outbound rail traffic consists of 30 trains/week (30,000 tons/week), while inbound is around 5 trains/week (3,000 tons/week). Outbound road traffic operates mainly containers (50%) and bulk (50%), main destinations being Western Italy/Europe (66%), Eastern Europe (17%), South Italy (6%) and Northern Europe (10%). Inbound road traffic operates container (50%) and bulk (50%), main origins being Western Italy/Europe, Eastern Europe, Southern Italy, and Northern Europe, with similar figures as the outbound traffic. As for rail connections, outbound traffic operates steel bulk, steel products, containers, agri-food, chemical products, diesel oil, main destinations being Italy (87%) and Austria (13%). Inbound rail traffic operates steel bulk, containers, agri-food, chemical products. Main geographical destination is Italy (72%).

On top of all the information above, respondents are also asked to identify main critical issues related to the current status of the connections to/from the port. Based on the responses, we rank them as follows (in decreasing order of importance):

- Poor development of railway connections (to/from geographical markets and/or to/from main inland freight villages);
- Overall efficiency of the railway sector;
- Maritime accessibility, including port seabeds and the need to accommodate large vessels;
- Poor development of port IT systems;
- Obsolete and inefficient administrative procedures;
- Delays and fragmentation of custom procedures.

Based on collected data, some geographical GIS-based modelling tools are employed to enhance the analysis and data representation. Some sample figures are shown below (Figures 6 and 7).

5. Discussion and results

From overall data analysis, some results are elaborated to provide a better understanding of the role of ports in the South-Eastern Europe.

In terms of transport modes specialization (*modal split*), a predominance of road-based connections in most of the ports in the area (including Durres, Rijeka, Split, Igoumenitsa, Thessaloniki and Venice) arises. Only Koper – and for other reasons, Trieste – shows a significant development of rail connections. Some sample figures are shown in Figures 8 and 9.

In terms of the type of goods/cargo units it can be noted that:

- the primary sector (raw materials, commodities, etc.) plays a significant role in basically all the ports;
- container traffic is significant in most of the ports, including Rijeka, Split, Thessaloniki, Varna, Constanza, Venice;
- the port of Igoumenitsa specializes in the ro-ro sector.

Some sample pictures about types of cargoes (Figures 10 and 11) are shown for the port of Thessaloniki.

From a geographical standpoint, the vast majority of the ports shows a strong "regional" – or "national" indeed – catchment area. Meaning that South-Eastern Europe ports are mainly regional/national, while long-haul connections turn out to be extremely poor or non-existent, with some notable exceptions (Piraeus and Trieste). Such a result is probably of importance for the development of EU corridors and the TEN-T policy, which somehow implicitly assume a meaningful role of long-range connections.

6. Conclusions

The paper has provided a contribution to fill some notable gaps in current knowledge – port-related missing data and information – hindering the understanding of the role of ports within the multimodal transport networks in South-Eastern Europe. On-the-field data has been collected and organized in an original data base. Moreover, data has been elaborated by employing geographical tools. Results provide useful insights to get a better picture of the multimodal transport networks in the region, which in turns could support more effective policies at the EU level, including TEN-T and Macro Strategies.

However, some remarkable limitations are in place since some ports did not report part of core as well as additional data.

Future research efforts should address some issues, including:

- applying the proposed approach to other geographical regions, where similar missing information exists;
- further developing modelling exercises based on collected data and GIS-tools to enhance analysis and policymaking in the area (for instance, South-Eastern transportation graphs);
- including freight villages in the overall approach. In fact, inland ports share similar issues in terms of missing data.

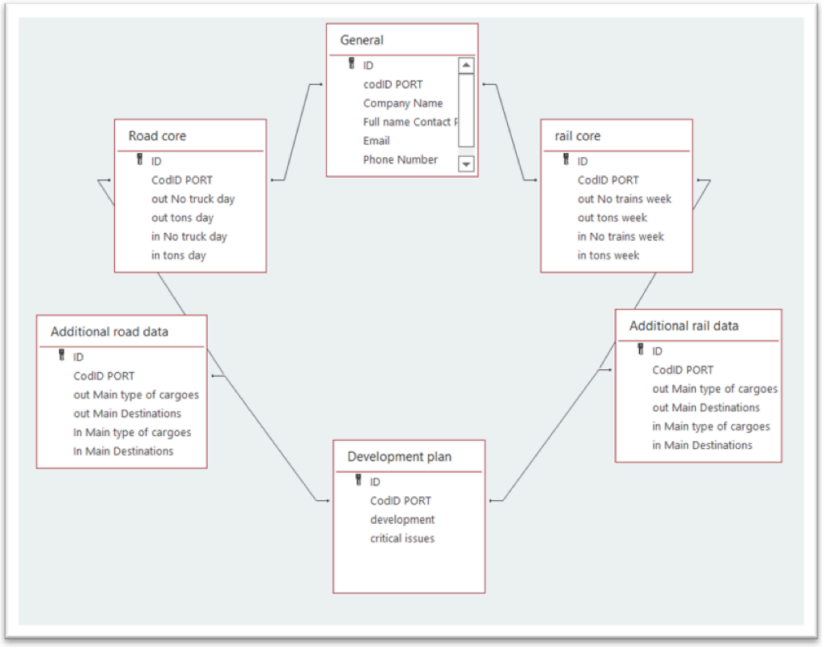

Figure 4. Diagram entity relation (Access). Source: this study.

			CONTACT PERSON DETAILS
Full name			*****
E-mail			*******
Phone number			*******
			1. GENERAL INFO
1.a - Name of your company			Luka Koper, port and logistic system, d,d.
1.b - Total 2012 throughput			17.880.697 tonnes
			2. CORE DATA INPUT
2.a - OUTBOUND	**ROAD**	No. trucks /day	451
		tons / day	8118
	RAIL	No. trains /week	70
		tons / week	70000
2.b - INBOUND	**ROAD**	No. trucks /day	289
		tons / day	5202
	RAIL	No. trains /week	49
		tons / week	49000
2.c - PORT CAPACITY	Please indicate the (annual) capacity values per terminal's tyopology (Container, Ro.Ro, bulk, ...). [Capacity=maximum throughput that can be technically and operationally managed at each terminal]		General cargo 1.438.833 tonnes, Containers 5.292.047tonnes (571.000 TEU),Cars 674.692 tonnes, Liquid cargo 3.194.636 tonnes, Dry bulk cargo 7.280.490 tonnes
			3. ADDITIONAL ROAD TRAFFIC RELATED DATA
3.a - OUTBOUND	Main type of cargoes (cargo units or type of goods)		Containers, cars, general cargo (all kinds: metal products, fruit, vegetables), minerals,iron ore, coal, chemical products, fodder
	Main destinations (%)		SLOVENIA(39%), AUSTRIA (18%), ITALY(5%), GERMANY(3%), SLOVAKIA(5%), CZECH REPUBLIC(4%), HUNGARY(23%), POLAND(3%)
3.b - INBOUND	Main type of cargoes (cargo units or type of goods)		Containers, cars, general cargo (all kinds: metal products,fruit, paper), minerals, cereals,liquid bulk cargo, timber, livestock
	Main origins (%)		SLOVENIA(37%), AUSTRIA (26%), ITALY(8%), GERMANY(7%), SLOVAKIA(5%), CZECH REPUBLIC(6%), HUNGARY(10%), POLAND(11%)
			4. ADDITIONAL RAIL TRAFFIC RELATED DATA
4.a - OUTBOUND	Main type of cargoes (cargo units or type of goods)		Containers, cars, minerals,alumina,iron ore, coal, chemical products, fodder
	Main destinations (%)		SLOVENIA(20%), AUSTRIA (56%), SLOVAKIA(10%), CZECH REPUBLIC(3%), HUNGARY(11%)
4.b - INBOUND	Main type of cargoes (cargo units or type of goods)		Containers, cars, paper, metal products, minerals, timber
	Main origins (%)		SLOVENIA(11%), AUSTRIA (50%), GERMANY(6%), SLOVAKIA(9%), CZECH REPUBLIC(6%), HUNGARY(18%)

Figure 5. Questionnaire collected data: an example. Source: this study.

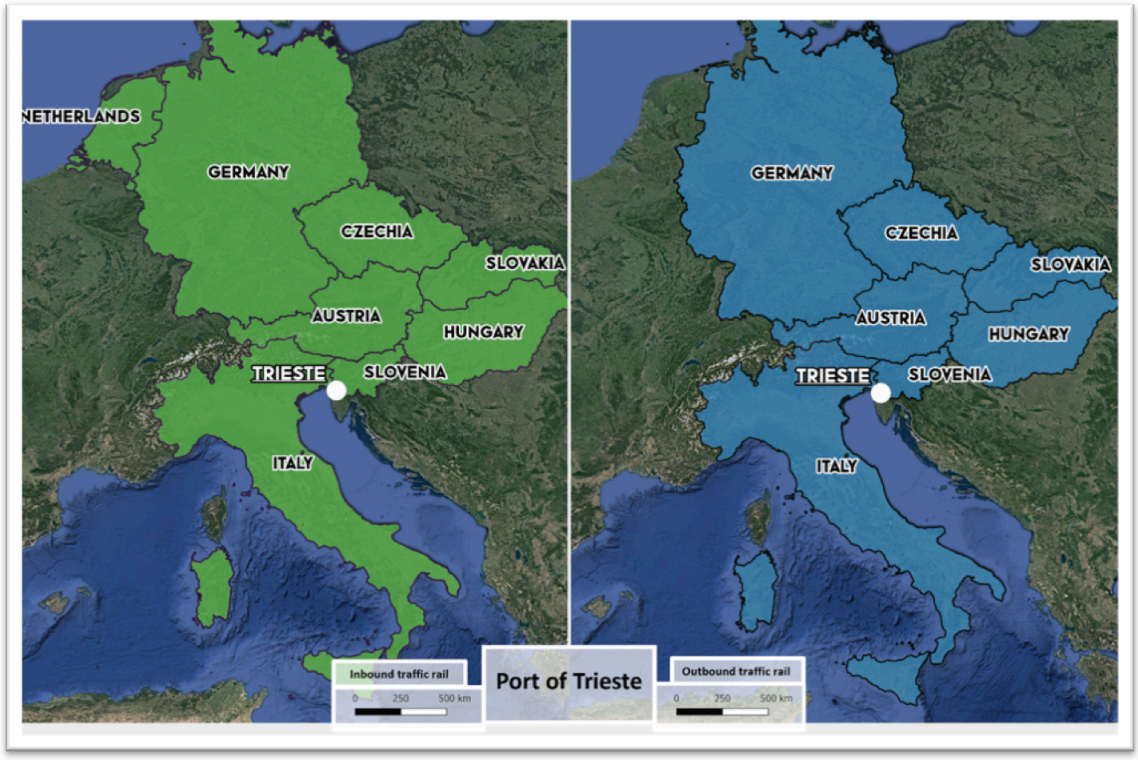

Figure 6. Port of Trieste: inbound and outbound rail traffic and correspondent geographical markets.
Source: this study.

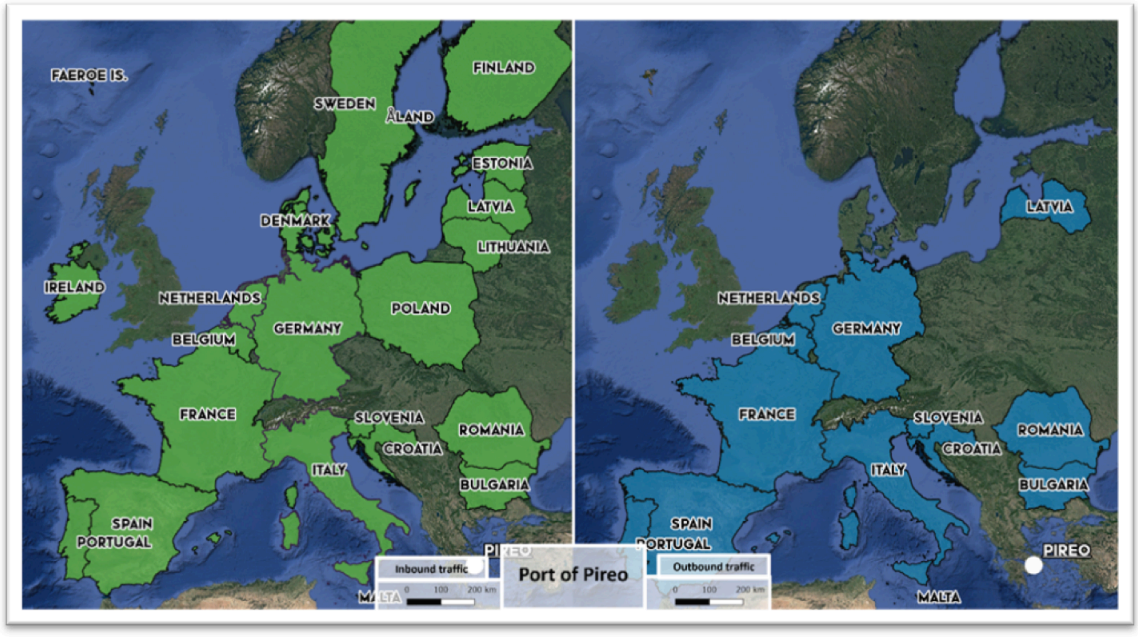

Figure 7. Port of Piraeus: inbound and outbound aggregate traffic and correspondent geographical markets.
Source: this study.

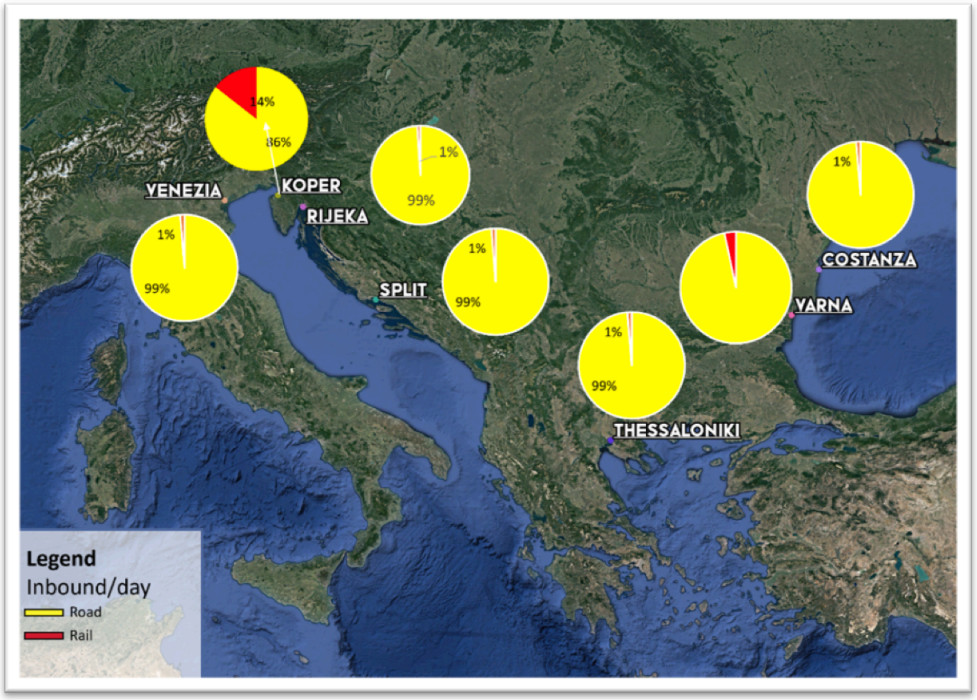

Figure 8. Modal split of selected South-Eastern ports: inbound traffic. Source: this study.

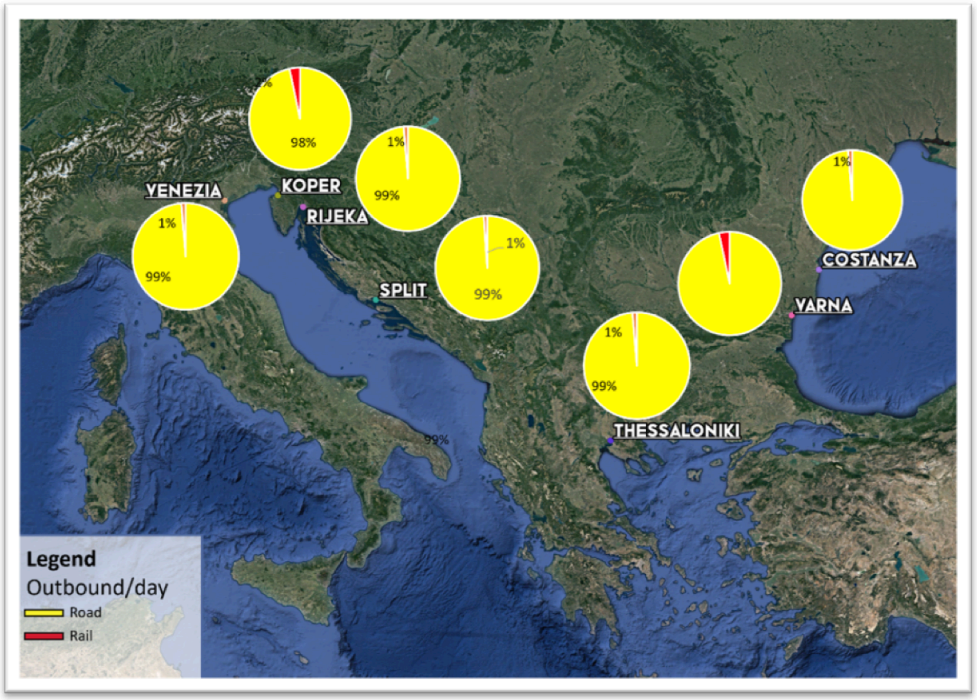

Figure 9. Modal split of South-Eastern ports: outbound traffic. Source: this study.

Figure 10. Main type of cargoes in the port of Thessaloniki: inbound traffic. Source: this study.

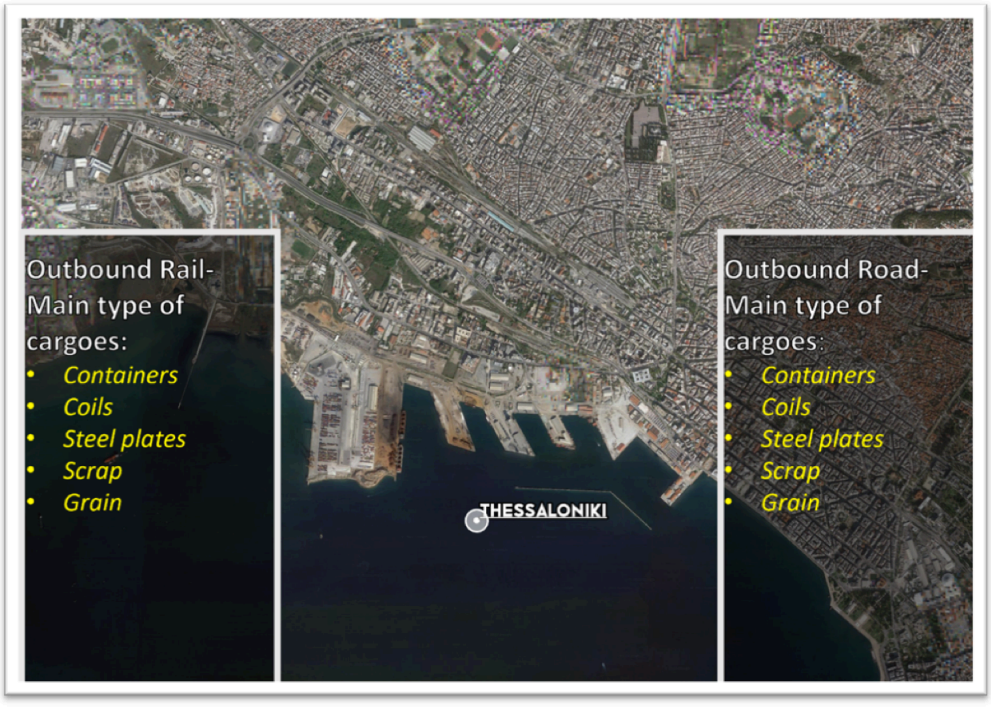

Figure 11. Main type of cargoes in the port of Thessaloniki: outbound traffic. Source: this study.

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References

1. Amato V. (Ed.), *La nuova centralità del Mediterraneo*, Rome, Aracne, 2017.
2. Black, W., *Transportation: A Geographical Analysis*, New York, Guilford, 2003.
3. Borruso G., "Informazione geografica e reti geografiche: interazioni spaziali tra fenomeni di rete e tessuto urbano", in *Atti di Input 2001, Informatica e Pianificazione Urbana e Territoriale, Democrazia e Tecnologie*, Isole Tremiti, 2001.
4. Borruso G., *Geografie di rete. Infrastrutture, regioni, città*, Bologna, Pàtron Editore, 2011.
5. Borruso G. and Borruso G., "Il porto di Trieste: analisi del traffico, impatto economico e prospettive di sviluppo", in SRM, *Trasporto Marittimo e Sviluppo Economico. Scenari Internazionali, Analisi del Traffico e Prospettive di Crescita*, Naples, Giannini Editore, 2012, pp. 235-274.
6. Borruso G., Bradaschia C. and Borruso G., "Le infrastrutture di trasporto terrestre a sostegno dei traffici portuali triestini", in Finzi R., Panariti L. and Panjek G. (Eds.), *Storia Economica e Sociale di Trieste*, II, Trieste, La città dei Traffici, LINT, 2003, pp. 759-806.
7. Borruso G., Donato C. and Nodari P., "La politica dei trasporti per l'integrazione della nuova Europa", in *Scritti in onore di Alberto di Blasi*, Bologna, Patron, 2006.
8. Camera dei deputati, "Edilizia, infrastrutture e trasporti. La politica europea dei trasporti e le reti TEN-T", https://temi.camera.it/leg17/temi/le_reti_tent.
9. Camera dei deputati, "Il Green deal, il Recovery Fund e il Piano nazionale di ripresa e resilienza", https://temi.camera.it/leg18/post/il-green-new-deal-europeo.html.
10. Capineri C., "Le reti di comunicazione e la rappresentazione dello spazio. Un percorso geografico", in *Reti, mobilità, trasporti*, Milan, Franco Angeli, 2004, pp. 151-166.
11. Capineri C. and Tinacci Mossello M. (Eds.), *La geografia delle comunicazioni: reti e strutture territoriali*, Turin, G. Giappichelli Editore, 1996.
12. Conti S., De Matteis G. and Nano F., "Geografia dell'economia mondiale", Padua, UTET, 2022.
13. Ducruet C. and Bunel M., "Le transport maritime et les ports", *L'Océan à découvert*, 1, 2017, pp. 136-137.
14. Giannopoulos G.A., "Main transport challenges in South Eastern Europe, after enlargement", *European Transport/Trasporti Europei*, 30, 2005, pp. 3-13.
15. Goetz A.R., Vowles T.M. and Tierney S., "Bridging the Qualitative-Quantitative Divide in Transport Geography", *The Professional Geographer*, 61, 3, 2009, pp. 323-335.
16. Grčić M. and Ratkaj I., "Transport corridors as a factor of integration in South-Eastern Europe", *Collection of papers of the Geographical institute "Jovan Cvijić"*, 53, 2004, pp. 7-25.
17. Guerrero D. and Rodrigue J.P., "The waves of containerization: shifts in global maritime transportation", *Journal of Transport Geography*, 34, 2014, pp. 151-164.
18. Hall D., "Transport geography and new European realities: a critique", *Journal of Transport Geography*, 18, 1, 2010, pp. 1-13.
19. Haralambides H., "Globalization, public sector reform, and the role of ports in international supply chains", *Maritime Economics & Logistic*, 19, 1, 2017, pp. 1-51.
20. Hennig B.D., "Visualising Spaces of Global Inaccessibility" in Carver S. and Fritz S. (Eds.), *Mapping wilderness: concepts, techniques and applications of GIS*. Heidelberg/New York/Dordrecht/London, Springer, 2016, pp. 103-116.
21. Hoyle B. and Knowles R. (Eds.), *Modern Transport Geography*, Second Edition, London, Wiley, 1998.
22. Infostrasporti, "TEN-T e i corridoi intermodali", https://www.infotrasporti.com/ten-t-e-i-corridoi-intermodali-le-9-linee-e-i-corridoi-che-collegano-lintera-europa/.
23. Keeling D.J., "Transportation Geography: New Directions on Well-Worn Trails",

Progress in Human Geography, 31, 2, 2007, pp. 217-225.
24. Keeling D.J., "Transportation Geography – New Regional Mobilities", *Progress in Human Geography*, 32, 2, 2008, pp. 275-283.
25. Kolios S., Stylios C. and Petunin A., "A WebGIS platform to monitor environmental conditions in ports and their surroundings in Southeastern Europe", *Environmental monitoring and assessment*, 187, 2015, 574.
26. Lucarno G., "L'allargamento dell'Unione Europea e le nuove prospettive nella geografia dei trasporti per i traffici delle merci fra C.S.I. ed Europa occidentale", *L'Universo, Rivista dell'Istituto Geografico Militare*, LXXVII, 6, 1997, pp. 750-760.
27. Lucarno G., "Flussi di trasporto fra l'Italia e l'Europa centro orientale e balcanica: linee guida per un progetto di ricerca sullo sviluppo infrastrutturale", in Calafiore G., Palagiano C. and Paratore E. (Eds.), *Atti del XXVIII Congresso Geografico Italiano, Vecchi territori, nuovi mondi: la Geografia nelle emergenze del 2000*, Rome, Edigeo, I, 2003, pp. 765-774.
28. Mazzarino M., "Strategic scenarios of global logistics: what lies ahead for Europe?", *European Transport Research Review*, 4, 1, 2012, pp. 1-18.
29. Mazzarino M., "Scenari mediterranei: il ruolo del trasporto e della logistica nell'ambito della teoria della New Economic Geography – un contributo originale", in *L'Europa e il Mediterraneo. Profili giuridici ed economici.* Bologna, Il Mulino, 2013.
30. Merlin P., *Géographie des Transports, Que sais-je*?, Paris, Presses Universitaires de France, 1992.
31. Musso E. and Ghiara H., *Ancorare i porti al territorio. Dai traffici alla marittimizzazione*, Milan, McGraw Hill, 2007.
32. Ng A.K.Y., "The evolution and research trends of port geography", *The Professional Geographer*, 65, 1, 2013, pp. 65-86.
33. Ng A.K.Y., Ducruet C., Jacobs W., Monios J., Notteboom T., Rodrigue J.P., Slack B., Tam K.C. and Wilmsmeier G., "Port geography at the crossroads with human geography: between flows and spaces", *Journal of Transport Geography*, 41, 2014, pp. 84-96.
34. Niavis S. and Tsekeris T., "Ranking and causes of inefficiency of container seaports in South-Eastern Europe", *European Transport Research Review*, 4, 4, 2012, pp. 235-244.
35. Notteboom T. and Rodrigue J.-P., "The Corporate Geography of Global Terminal Operators", *Maritime Policy & Management*, 39, 2012, pp. 3.
36. Petrlić A. and Pavletić N., "Benchmarking Analysis of Factors Influencing Container Traffic in the Port of Rijeka", *Pomorstvo*, 33, 2, 2019, 119-129.
37. Prezioso M., "Un approccio geografico alle politiche pubbliche: teorie e pratiche. Introduzione", in Salvatori F. (Ed.), *L'apporto della Geografia tra rivoluzioni e riforme*, Rome, AGeI, 2019, pp. 3129-3130.
38. Rete ferroviaria italiana, "Corridoi TEN-T. L'asse portante della Trans European Network Transport", https://www.rfi.it/it/rete/in-europa/corridoi-ten-t.html.
39. Rimmer P., "Transport Geography", *Progress in Human Geography*, 10, 1985, pp. 271-277.
40. Rodrigue J.-P., *The Geography of Transport Systems*, Fourth Edition, London, Routledge, 2017.
41. Rodrigue J.P., Comtois C. and Slack B., *The Geography of Transport Systems*, Abingdon, Taylor & Francis Group, 2016.
42. Shaw J. and Sidaway J.D., "Making links: On (re)engaging with transport and transport geography", *Progress in Human Geography*, 35, 4, 2011, pp. 502-520.
43. Taaffe E.J., Gauthier H.L. and O'Kelly M.E., *Geography of Transportation*, Second Edition, Upper Saddle River, NJ, Prentice Hall, 1996.
44. Tadić S., Kovač M., Krstić M., Roso V.E and Brnjac N., "The Selection of Intermodal Transport System Scenarios in the Function of Southeastern Europe Regional Development", *Sustainability*, 13, 10, 2021.
45. Tadić S., Kovač M., Zecevic S.E. and Krstić M., "Implementation of the dry port concept in the West Balkans region", *Proceedings of the VII International symposium: New Horizons of Transport and Communications, Doboj, Republic of Srpska*, 2019, pp. 29-30.
46. Tadini M., "Lo scenario infrastrutturale e dell'intermodalità trasportistica", in Emanuel C. and Tadini M. (Eds.), *Progettare il*

cambiamento. Analisi, scenari e strategie per il quadrante territoriale del Nord-est piemontese, Vercelli, Mercurio Edizioni, 2010, pp. 37-70.
47. Tadini M., "I flussi globali di container: la recente evoluzione della geografia portuale mediterranea e italiana", *Eyesreg Giornale di Scienze Regionali*, 2, 5, 2012, pp. 125-129.
48. Tadini M., *La geografia del sistema economico globale. Il ruolo dei mercati emergenti*, Rome, Aracne, 2017.
49. Tolley R. and Turton B., *Transport Systems, Policy and Planning: A Geographical Approach*, Burnt Mill, Harlow, Essex, Longman, 1995.
50. Ugolini G.M., "Per una (im)possibile centralità geopolitica del Mediterraneo", in Marconi M. and Sellari P. (Eds.), *Verso un nuovo paradigma geopolitico*, Rome, Aracne, 2015, pp. 345-358.

