SAŽETAK

GLAVNE LUKE JADRANA I NJIHOV PROMET

Ovaj rad analizira glavne luke Jadrana, njihove prihvatne kapacitete za terete, promet tereta, promet brodova, ograničenja u prihvatu brodova, te procjenu budućeg razvoja. U okviru ove analize dati će se ukupna količina ukrcanog i iskrcanog tereta po luci, ukupan broj uplovljavanja i isplovljavanja brodova po luci, promet tereta i brodova s obzirom na međunarodnu i kabotažnu plovidbu, uključujući promet opasnog tereta u Jadranu. Sukladno podacima o prometu opasnih tereta u Jadranu, prije svega nafte i njenih derivata, definirat će se osnovni plovidbeni pravci njihova kretanja kao i mjesta s najvećim rizikom od onečišćenja. Također, ponudit će se i određene preporuke za povećanje sigurnosti plovidbe Jadranom, odnosno smanjivanja vjerojatnosti nezgoda koje mogu rezultirati većim onečišćenjima.

Ključne riječi: Jadransko more, glavne luke Jadrana, promet brodova i tereta, promet opasnog tereta.

SUMMARY

THE MAIN ADRIATIC PORTS AND THEIR TRAFFIC

This paper analyzes the main Adriatic ports, their cargo reception capacities, cargo traffic, ship's traffic, port dimensional restrictions, as well as their future development. This paper will also present the total quantity of the loaded/unloaded cargo per port, the total number of arrived and departed ships per port, ship and cargo traffic as per international and coastal sailings, and dangerous cargo traffic. Consequently the main dangerous cargo shipping routes will be defined as well as the places of high pollution risk. Furthermore, recommendations on how to improve the safety of navigation in the Adriatic will be offered including recommendations on how to minimize pollution threats.

Keywords: Adriatic Sea, main Adriatic ports, ships and cargo traffic, dangerous cargo traffic

1. INTRODUCTION
Uvod

The Adriatic Sea is a relatively small sea that is still well preserved and clean, although daily threatened by the intense growth of maritime traffic and dangerous cargo in particular.

The main Adriatic seaports are located in its northwestern part, and given the fact that the origin of most of their traffic is beyond the Adriatic, the maritime traffic is concentrated on the longitudinal seaway. This is also the main seaway for dangerous cargo through which most of crude oil traffic reaches the largest Adriatic ports. Costal traffic is also significant, especially traffic of smaller vessels in summer season. Due to an increased number of small vessels and a number of navigation dangers, coastal sailing routes – especially those on the East Adriatic coast – are very dangerous. This paper will analyze the main sailing routes of cargo ships including routes of dangerous cargos, the possibility of accidents, the main cargo

ports and, partially, sailing routes of small and no cargo vessels due to the interception of their sailing routes with the main sailing routes of large cargo vessels.

In order to protect the environment and avoid large-scale accidents in the Adriatic, it is necessary to take additional measures dealing with the environmental protection, and to improve the existing ones. Inefficiency is one of the key features of the existing measures whereas the reason for difficulties in planning new ones is a poor cooperation among coastal states and the impossibility of reaching mutual agreement concerning the matter.

2. THE MAIN ADRIATIC PORTS
Glavne luke na Jadranu

The largest commodity and ship traffic is located in the northwestern Adriatic. Large ports in this area include the Italian ports of Trieste, Monfalcone, Porto Nogaro, Venezia, Chiogga, and the Slovenian port of Koper. The Italian port of Ravenna is situated on the border between the northwestern and western part of the Adriatic while the Croatian port of Rijeka lies between the northwestern and eastern Adriatic. Larger seaports on the western coast are Ancona, Bari i Brindisi. Other, less significant ports, on the western coast include Pesaro, Pescara, Ortona, Vasto, Manfredonia, Barletta, Molfeta, Monopoli and Otranto. On the other hand, the eastern coast is home to Croatian ports of Pula, Raša, Koromačno, Zadar, Šibenik, Split, Ploče and Dubrovnik, Montenegrin ports of Bar and Kotor; and Albanian ports of Durres, Shengjin and Vlore. Figure 1 shows larger Adriatic seaports and their locations.

Figure 1. Adriatic ports
Slika 1. Luke Jadranskog mora
Source: Fairplay Ports Guide, CD-Version 8.4.1, 2001.

3. TRAFFIC OF THE ADRIATIC PORTS
Promet Jadranskih luka

This section presents basic data concerning the main Adriatic seaports statistics, including technical data and dangerous cargo traffic. The analysis refers mostly to 2006 but, for larger ports traffic movement, the analysis covers the period between years 2000 and 2007.

a) Italian ports
Talijanske luke

The largest and most significant seaport on the Adriatic is the port of Trieste. It is located on the northernmost part of the Adriatic, in the Bay of Trieste. In 2006 it had 48mil tonnes of traffic, out of which 43mil tonnes were imported while 6% of cargo traffic was of domestic origin. There were 2,000 ships on arrival while passenger transport was limited to 100,000 [25].

Trieste is a very important destination when liquid cargoes, especially crude oil, are concerned. The quantity of imported crude oil and its products reached around 38mil tonnes in 2006 (of which imported crude oil 36,8mil tonnes). Oil terminals in Trieste are able to berth ships with draught up to 16,5 meters [6, 16].

The Bay of Trieste is also home to the port of Monfalcone, able to handle various commodities including crude oil and its products. In 2006 it had traffic of 4,5mil tonnes (of which 91% was discharged). The annual frequency of visiting ships was around 600 to 700, and liquid cargo traffic amounted to around 1,4mil tonnes in 2006. Monfalcone is able to accommodate ships with draught up to 11,7 meters [24].

The port of Venezia is located at the far northwestern part of the Adriatic in a natural lagoon and it is the second largest Adriatic seaport. In 2006 its traffic amounted to around 31 mil tonnes (of which 84% was discharged) while there were 3.655 ships on arrival (of which 1.377 passenger liners). In 2006 the traffic of crude oil and its products reached 11,4mil tonnes (of which 7mil tonnes of imported crude oil). The port of Venezia can handle ships of 250 m of length and 13,5 m draught [27].

The Venetian lagoon is also home to the port of Chioggia which is one of the most significant fisherman ports but is also important for its general and bulk cargo traffic (there are no tanker terminals). Export from the port of Chioggia is mostly directed towards Mediterranean and Black Sea ports. Its traffic in 2006 reached 2,7mil tonnes [30] (most of it was imported while there were 750 ships on arrival [23]). Depths in port basin are up to 7 m [4, 547].

A small river port of Porto Nogaro lies between Venezia and Monfalcone. It can handle ships of 4,5 m draught and it usually handles general and bulk cargoes and containers [4, 563]. In 2004 it handled 1,7mil tonnes (1,0mil tonnes were discharged) while there were 757 ships on arrival [14].

Further south of the port of Venezia there is the port of Ravenna which had 26,8mil tonnes of traffic in 2006 (of which 23,9mil tonnes were discharged) while there were 4.161 ships on arrival. The quantity of handled liquid cargoes amounted to 5,2mil tonnes (4,8mil tonnes were unloaded). Discharged oil products and liquid chemicals in bulk reached 2,7mil

tonnes whereas there were 0,1mil tonnes of such cargo loaded. Liquefied gas transport amounted to 0,5mil tonnes and crude oil around 0,1mil tonnes. 29% of total cargo traffic was of domestic origin. The port of Ravenna can handle ships with draught of up to 8,5 m [26].

The port of Ancona is a large seaport on the western Adriatic coast. It can handle ships with 12,2 m of draught and 250 m in length. The oil terminal in Falconara is beyond the main port and can handle ships of 95.000 DWT and up to 12,5 m draught. There is also the possibility of berthing tankers of 400.000 DWT and 30 m draught at special buoys. In 2006 the port of Ancona had traffic of 9,2mil tonnes, of which 6,7mil tonnes were discharged from ships. Oil and its products amounted to 4,8mil tonnes in 2006 of which 0,9mil tonnes were loaded (3,3mil tonnes of crude oil unloaded). In 2004 there were 3.298 ships on arrival, many of them being passenger liners which carried over 1,5mil passengers in 2006 [10].

Significant ports south of Ancona include Bari and Brindisi, as well as smaller ports of San Benedetto Del Tronto, Pescara, Ortona, Vasto, Manfredonia, Barletta, Monopoli and Otranto.

In 2006 the port of Bari had traffic of 5,2mil tonnes (of which 65% was unloaded from ships) while there was neither crude oil nor its products handled. The annual ship frequency was around 3.000, most of them being passenger / ro-ro liners for the Adriatic's east coast (everyday line with Albanian ports and ports of Dubrovnik and Bar). In 2006 the passenger transport carried more than 1,5mil passengers [21]. The port of Bari handles general cargo, dry bulk cargo, containers, liquid cargoes, ro-ro ships and passenger ships. It is restricted for ships of up to 12,2 m draught [4, 490].

In 2006 the port of Brindisi handled 10,5mil tonnes of cargo (over 80% was unloaded), of which 0,6mil tonnes of liquefied gas and over 2 mil tonnes of crude oil and oil products [22]. This port can handle ships with draught of up to 12,5 m. In addition to dry cargo and passenger terminals, there are several terminals in the port of Brindisi for crude oil and its products that are restricted to ships with draught of up to 11 m [4, 485]. In 2004, there were 2.818 ships on arrival, majority of them being passenger liners.

The port of Ortona can handle ships with draught of up to 6,5 m and 200 m in length [4, 509]. In 2004 the traffic reached 1,4mil tonnes (96% discharged) and there were 371 ships on arrival [14]. Unloaded cargoes are mostly coal, crude oil and oil products.

In 2004 the port of Manfredonia handled 1,1mil tonnes of cargo (62% discharged) while the number of ships on arrival was 464. The port can handle ships with draught of up to 9,5 m. It also has tanker terminals including a terminal for liquefied gas [4, 499].

In 2004 the port of Barletta reached the traffic of 1,3mil tonnes (61% discharged) while the number of ships on arrival was 446 [14]. The port is restricted to ships with draught of up to 6,2 m. Besides general and dry bulk cargo terminal, there is also a tanker terminal [4, 496].

Other Italian ports have no significant cargo traffic (less than 1mil tonnes) but most of them are equipped for handling dangerous cargoes, e.g. Pesaro, Benedetto del Tronto, Pescara, Vasto, Manfredonia, Molfetta, etc.

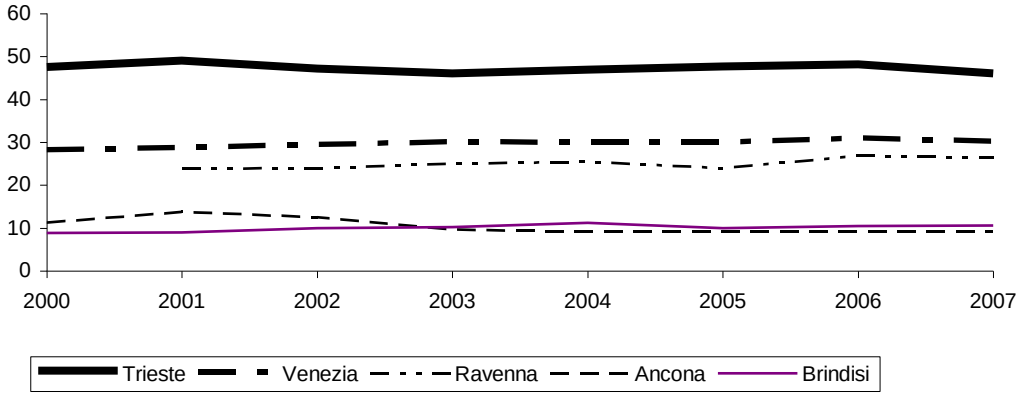

Figure 2. Traffic of the main Italian ports in the Adriatic (million tonnes)
Slika 2. Promet većih talijanskih luka na Jadranu (mil.t.)

Table 1. Traffic of the Italian ports in the Adriatic (2004)
Tablica 1. Promet talijanskih luka na Jadranu (2004)

Port	Total ships arrived	*Cargo vessels arrived and total DWT (000)**		Total traffic (000 t)	Unloaded (000 t)	Local traffic (000 t)	Passengers (000)
Trieste	5117	*477*	*64217*	41516	38383	1248	320
Venezia	4830	*1229*	*53090*	28883	25537	7205	1030
Ravenna	4389	*1235*	*39817*	25406	22538	6111	6
Anconna	3298	*240*	*16041*	4680	3117	359	1355
Falconara M.	333	*53*	*5358*	5658	4521	1016	/
Brindisi	2818	*453*	*19517*	10798	9321	513	537
Bari	2809	*261*	*9933*	2585	1720	308	1057
Monfalcone	634	*301*	*7234*	3961	3486	60	/
Chioggia	730	*354*	*3574*	2515	1794	186	/
Porto Nogaro	757	*329*	*1751*	1712	988	64	/
Barletta	446	*73*	*898*	1332	819	622	/
Ortona	371	*109*	*1472*	1380	1322	1038	4
Manfredonia	464	*104*	*973*	1070	664	423	7
Molfetta	NA	*104*	*973*	72	56	72	/
Vasto	NA	*35*	*171*	80	56	80	7
Pescara	NA	*15*	*421*	265	264	265	/
Pesaro	NA	*25*	*442*	255	254	255	/
Molfeta	NA	*37*	*157*	72	56	72	/
Monopoli	NA	*59*	*246*	NA	NA	NA	NA

Source: www.istat.it (statistical yearbook 2006 - values for 2004.)
**Source: Admiralty Sailing Directions-NP 47, 2005.*

b) Slovenian ports
Slovenske luke

The port of Koper is the largest Slovenian port. In 2006 its traffic reached 14,0mil tonnes, of which 76% was discharged. There were 2.262 ships on arrival (in 2004 there were 599 ships with 22,1mil DWT in total [4, 462]). In 2006, 2,1mil tonnes of crude oil and oil products were handled (all imported) [16]. The port has terminals for containers, general cargo, dry bulk cargoes and liquid cargoes (including oil and oil products). Depths in the port basin are up to 18 m at the dry bulk cargo terminal [6, 20].

Other Slovenian ports (Piran, Izola) have no significant cargo traffic.

c) Croatian ports
Hrvatske luke

The largest and most significant port in Croatia is Rijeka. Other larger ports include Ploče, Split, Zadar, Šibenik, Dubrovnik, Pula, Raša and Koromačno.

In 2006 the port of Rijeka reached the traffic of 5,0mil tonnes of dry cargo and 5,9mil tonnes of crude oil and oil products [15]. The port of Rijeka includes Rijeka, the Bay of Bakar and the Omišalj oil terminal. Main port facilities are located in the city of Rijeka handling passengers and dry cargo. Depths in the port basin are limited to 8 m. The Sušak basin, southeast of the city, has depths up to 6,5 m. Further to the east there is a container / ro-ro terminal with depths around 12 m. Before entrance to the Bay of Bakar, on its western part, there is the tanker berth in Urinj for handling crude oil. This terminal is able to handle ships of around 200.000 DWT. On entrance to the Bay of Bakar, in the small cove of Sršćica, there is a terminal for liquefied gas with depth around 9,7 m. In the Bay of Bakar there are several oil terminals, dry bulk terminals and a ro-ro terminal. Depths at tankers berths are around 10 m while at dry bulk berths depths are around 17,5 m [6, 76-87]. On the island of Krk there is the tanker terminal Omišalj which in 2006 handled 5,9mil tonnes of crude oil and oil products. There were 111 ships on arrival [15]. The terminal in the Bay of Omišalj is able to accommodate ships of 350.000 DWT while depths at berth are up to 29 m [6, 88].

In 2006 the cargo traffic in the port of Zadar was 423.366 tonnes (220 ships) [15]. The City port of Zadar has berths with depths of 6 m. The industrial port of Gaženica (2,7M SE of Zadar) can handle ships with draught of up to 11 m. It has a liquid cargo terminal for crude oil, oil products and liquefied gas, and a terminal for dry bulk and general cargo [6, 185].

In 2006 the port of Šibenik handled 1,2mil tonnes of cargo (334 ships). The port of Šibenik is able to handle general cargo, dry bulk cargo, ro-ro ships and ferries. Depths in port basin are around 10 m [15]. The port is accessible only through the Sv. Ante channel, which is 1,4M long, 220m wide at its entrance and only 140 m at its narrowest point. Here, the limiting access factor is not the draught, but rather the ship's length and breadth [6, 204].

The port of Split consists of Gradska luka, City port, for ferries and passenger ships, and Sjeverna luka (North port) in the Bay of Kaštela, for cargo ships. Sjeverna luka has berths for general cargo, dry bulk cargo, ro-ro ships, a cement terminal and a tanker terminal for crude oil and oil products. It is oriented mostly to satisfy the needs of the city and industry in the Bay of Kaštela with its own terminals (cement factory, steel factory and shipyard). Depths at berths in Sjeverna luka and Gradska luka are up to 10 m [6, 233-236]. In 2006 the port of Split (both Gradska luka and Sjeverna luka) handled around 3,5mil passengers while cargo traffic reached 3,0mil tonnes, of which 0,4mil tonnes of crude oil and its products [28].

The port of Ploče is the second largest port in Croatia. It handles export and import of commodities for neighboring Bosnia and Herzegovina. It has terminals for general cargo, containers, dry bulk cargo, ro-ro ships, passenger ships and tankers. Depths in port basin are up to 10,5 m [4, 246]. In 2006 cargo traffic reached 3,2mil tonnes (551 ships) [15], of which 0,4mil tonnes were liquids [20].

The port of Dubrovnik handles mostly passenger traffic. In 2006 the total number of arriving passenger ships including cruisers amounted to 777 and the total number of passengers amounted to around 2mil. The port can handle ships with draught of up to 9,7 m [15].

The port of Raša handles mostly livestock and general cargo. Depths at the general cargo berth are around 10 m, and 6 m at the livestock terminal [6, 52]. In 2006, the total traffic reached 456.084 tonnes (167 ships) [15].

Koromačno is a port for handling cement. In 2006, it had cargo traffic of 0,3mil tonnes (169 ships) [15]. Depths in the port basin are around 10 m (new berths) [6, 57].

Plomin comprises a ro-ro terminal and a dry bulk terminal for imported coal. Depths at the dry bulk berth range from 15 to 17 m [4, 373]. In 2006 cargo traffic reached 1,0mil tonnes (15 ships) [15].

In 2006, cargo traffic in the port of Pula amounted to 876.120 tonnes (364 ships). Depths in the port basin are limited to 7,6 m [15].

The traffic frequency in Croatian ports is much higher if all ships (small cargo ships, yachts, fishing vessels, etc.) are taken into consideration. Table 2 shows traffic of main Croatian ports according to harbor masters reports.

Table 2. Traffic of the Croatian ports (2006)
Tablica 2. Promet hrvatskih luka (2006)

Port	Total ships arrived	GT (000 t)	Total traffic (000 t)	Unloaded (000 t)	Passengers (000)
Pula	3307	1645	971	109	454190
Raša-Bršica	700	1150	1515	92	/
Rijeka	2771	8275	2418	1142	223689
Bakar	1019	3613	3898	1661	16
Omišalj	237	4268	5972	5959	5293
Zadar	11346	16948	945	627	2001813
Šibenik	11336	3203	1280	497	564118
Split	17130	42586	2811	1304	3544832
Ploče	2110	4252	3117	2182	129359
Dubrovnik-Gruž	10126	25088	12	11	2028281
Croatia - total	223967	247560	26325	15505	24534667

Source: Statistical yearbook of the Republic of Croatia, 2007

The traffic of large ocean going ships through the Croatian ports are relatively small, less then 2000, but if we take into consideration all traffic (as per harbor office reports), the number exceeds 200.000. The vast majority of these vessels are small tourist vessels whose concentration is highest during summer season. Sailing routes of these vessels are mainly along the East Adriatic Coast and through the island areas with higher concentration near large cities (Split, Dubrovnik, Šibenik, Zadar, Rijeka, etc.) where main cargo ports are also situated. Accordingly, the main coastal sailing routes are commonly used by large cargo ships and all other ships. In 2006, harbor offices issued 52.667 foreign approvals for sailing through Croatian territorial waters. At that point, there were 95 marinas with a total of 225.576 berthed vessels [8, 451- 452].

In 2004 the available capacity in marinas were: Croatia 15.303 (2,6 berths/km of coast), Slovenia 1.820 (56,9 berths/km of coast), Montenegro 1.740 (6,4 berths/km of coast), Italy 47.800 (Adriatic and Mediterranean coast – an average of 6,3 berths/km of coast) [9].

d) Ports of Montenegro and Albania
Crnogorske i albanske luke

The port of Bar is the largest in Montenegro; the annual cargo traffic ranges from 2 to 2,5mil tonnes [19] and the ship traffic ranges from 250 to 300 [4, 186]. The port can handle ships of up to 90.000 GT and 260 m in length. Depths are up to 14 m, at the tanker berth. There are reception facilities for general cargo ships, container ships, ro/ro passenger ships, bulk carriers and tankers [6, 314]. Other ports in Montenegro have no significant traffic.

The port of Durres is the largest Albanian port. In 2005 the annual cargo traffic was 3,1mil tonnes (import about 90%); there were 325 ships on arrival. The oil traffic was about 0,2mil tonnes [11]. Depths in the port are up to 9 m [4, 179]. Other Albanian ports have much less traffic, Vlore about 0,3 and Shengjin about 0,3mil tonnes. [13].

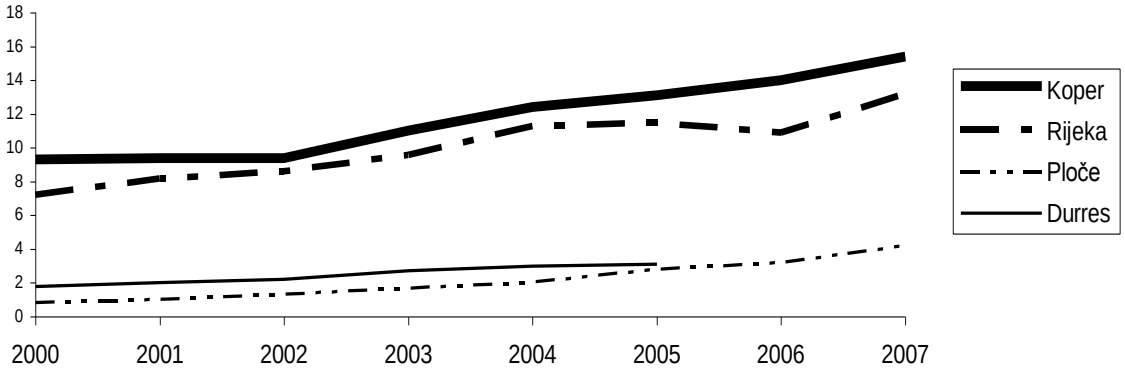

Figure 3. Cargo Traffic of the main East Adriatic ports
Slika 3. Promet tereta glavnih luka istočne obale Jadrana

4. DANGEROUS CARGO SAILING ROUTES
Plovidbeni putovi opasnog tereta

The main ports are situated at the far northwestern part of the Adriatic. As these ports mainly operate with vessels arriving outside the Adriatic, the main cargo traffic flow passes over the central part of the Adriatic, between east and west coast. The main Adriatic ports, i.e. the largest ports are also the main ports for handling dangerous cargo such as oil and oil products; accordingly, the main Adriatic sailing route is also the main route for dangerous cargo. The main oil import ports in Adriatic are Trieste, Venezia, Ancona (Falconara Marittima), Omišalj and Koper, with a total traffic of about 55mil tonnes of crude oil. If we take oil products into account, then we have to include the ports of Ravenna and Brindisi in this group. Together they make traffic of oil and oil products amounting very close to 70mil tonnes. Many of other smaller ports along the east and west Adriatic coast have facilities for dealing with dangerous cargo, so that the total annual dangerous cargo traffic in the Adriatic amounts to more than 70mil tonnes.

In addition to the main longitudinal sailing route over the central part by open sea of the Adriatic, there are others [2, 202]:

- Longitudinal sailing routes close to the west Adriatic coast,
- Longitudinal sailing routes close to the east Adriatic coast (outside of outer edge of islands by open sea or between outer islands and mainland or between the islands),
- Transversal sailing routes, between east and west coast,
- Coastal and irregular routes (small cargo vessels, fishing vessels, cruisers, yachts, etc.)

Figure 4. The main crude oil sailing route in the Adriatic (import)
Slika 4. Glavni plovidbeni put sirove nafte na Jadranu (uvozni)

Significant traffic of dangerous cargo is also noticeable on the coastal sailing routes and longitudinal routes close to the shores, providing products and chemicals for main cities and industrial centers. Statistics show that the coastal routes, especially those along the east Adriatic coast, are most dangerous, i.e. with largest number of accident, mainly groundings. As for the possibility of accident, the main longitudinal sailing route by open sea is safer, but taking into consideration the consequences in case of accident of a large tanker, this route represents the most probable place where a catastrophic impact on the environment can occur.

On the main longitudinal sailing route by open sea the concentration of vessels increases continuously, including the transversal traffic between the east and west Adriatic, this causes a large number of course crossing situations. On the main central sailing route a collision is the most likely type of accident; yet, when approaching to the coast or very near to the coast, groundings become very likely.

One of the recent analyses by Det Norske Veritas has estimated the probability of accidents in the Adriatic by comparing the number of accidents per density of traffic with the world. It has been concluded that the Adriatic belongs to the areas with the highest frequency of maritime accidents [12, 353]. Although the number of maritime accidents in the Adriatic is high, there have been no catastrophic consequences so far, but some accidents could have lead to disastrous outcomes. Here are some of significant accidents:

The tanker "Brigita Montanari" (1.548 DWT) capsized and sunk in 1984 in the south part of the Murtersko more. The ship carried about 1.300 tonnes of liquefied gas (vinyl chloride monomer – VCM).

The collision of mv "Cavtat" of 5.183 DWT and mv "Lady Rita" in Otranto in 1974. MV Cavtat, carrying about 270 tonnes of dangerous cargo (lead products), sunk.

In 1987 the tanker "Hestia" (1.887 DWT) with 1.121 tons of VCM ran aground in the Murtersko more. There was no leakage into the sea.

In 1977 the tanker "Olib" (1.762 DWT) ran aground on the islet of Visovac, near the island of Murter.

In 1975 the tanker "Loanno" (15.260 DWT) ran aground on Galiola island, in Kvarner.

In 1989 there was a collision of vessels near Palagruža island; mv "Selin" (3.500 DWT) hit the mv "Deval" (3.100 DWT) amidships. Both ships were loaded but fortunately neither carried liquid cargo.

Table 3 shows the number of accidents along the east Adriatic coast (Croatian coast) as per search and rescue operation.

Table 3. Search and Rescue operations on the East Adriatic coast from 1999 to 2005
Tablica 3. Akcije traganja i spašavanja na istočnoj obali Jadrana od 1999. do 2005.

HARBOR OFFICE ACTION DUE TO														
	SINKING	COLLISON	FLOODING	GROUNDING	FIRE	DISABLE, FLOATING	MAN OVERBOARD	SWIMMERS	DIVERS	SURFERS	MEDICAL	PLANE	OTHER	TOTAL ACTION
1999	3	0	4	17	11	52	5	1	9	4	3	0	27	136
2000	7	3	5	34	4	57	10	5	14	8	7	3	24	181
2001	3	1	5	28	3	72	11	6	18	7	10	0	38	202
2002	7	2	3	43	6	64	3	6	15	6	25	2	37	219
2003	9	0	6	37	6	70	7	3	16	9	24	0	56	243
2004	9	5	7	43	5	72	15	16	16	5	56	0	44	293
2005	12	15	15	43	7	61	15	12	14	5	55	1	32	287

Source: www.mmtpr.hr

Table 4. Type of vessel in danger on the east Adriatic coast
Tablica 4. Vrsta plovila izložena pogibelji na istočnoj obali Jadrana

HARBOR OFFICE ACTION AS PER TYPE OF VESSEL IN DANGER										
	PASSENGER	CARGO	FISHING	YACHT	SAILING VESSEL	RUBBER BOAT	BOAT	OTHER	PLANE	TOTAL
1999	2	2	2	20	25	4	53	6	0	114
2000	1	1	7	27	35	8	70	17	3	169
2001	2	3	7	11	44	10	48	17	0	142
2002	6	1	4	34	53	12	61	13	2	186
2003	4	3	3	24	42	16	82	29	0	203
2004	13	3	3	29	49	19	66	76	0	258
2005	5	5	17	40	54	14	46	28	1	210

Source: Studija razvoja nautičkog turizma Republike Hrvatske, Split, 2006. (www.hhi.hr)

Looking at the statistics above, it is obvious that the annual number of accidents on the east Adriatic coast, i.e. Croatian coast is too large. Although majority of these accidents relate to smaller ships, usually with small or negligible impact on the environment, a real danger arises from their sailing routes crossing with main sailing routes of large cargo vessels, especially those carrying dangerous cargo.

5. ASSESMENT OF FUTURE DANGEROUS CARGO TRAFFIC
Procjena budućeg kretnja prometa opasnih tereta

Most of dangerous cargo traffic in the Adriatic consists of crude oil, mainly directed to the main import ports of Trieste, Venezia, Ancona, Rijeka, and Koper. If we take oil products into account, ports of Ravenna and Brindisi have significant traffic as well. The port of Trieste handles the traffic of oil and oil products amounting to about 38mil tonnes, which is more than all other ports together. A huge amount of this oil is carried inside the continent by the Trans-alpine pipeline.

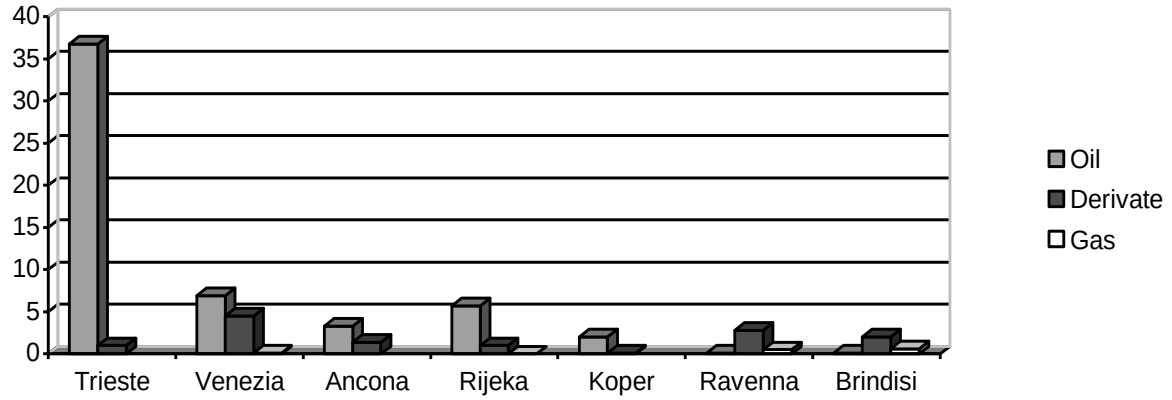

Figure 5. Comparison of oil traffic among the main Adriatic ports (million tons)
Slika 5. Usporedba prometa nafte i derivata većih luka Jadrana (mil.t.)

As for the global increase of demand for oil, it is realistic to expect further increasing of oil traffic in the Adriatic. Present ports will quite likely increase their capacities, including building of new terminals. Also new ports able to handle dangerous cargo (crude oil, oil products, chemicals, gas, etc.) will develop. This is due to European needs for additional energy flows, Russian intention to export oil and gas over the Adriatic, as well as new geopolitical structure of the Balkan region. This is especially relating to the east Adriatic coast and ports like Ploče (the shortest way to Bosnia and Herzegovina), Bar (the biggest port of Montenegro and the shortest way to Serbia), Albanian ports, etc.

However, the main reason for the future increase of dangerous cargo traffic through the Adriatic can be found in the global demand for new energy lines (oil and gas pipeline), to satisfy European energy import needs and to allow export of Russian oil and gas. About three quarters of the Russian oil export (about 62mil tonnes), after loading in the Black Sea ports, pass through the Bosporus and Dardanelles Straits, today one of the most congested and limited places in the global oil traffic [3, 344]. For this reason, and also due to recent misunderstandings between Russia and Ukraine (main pipelines passing through Ukraine), we can soon expect increased efforts for the realization of new projects. The alternatives to the existing pipelines are the pipelines heading to the Adriatic or to West Europe.

One of the projects is the oil pipeline from the Bulgarian port of Bourgas (the Black Sea) to the Albanian port of Vlore. The name of the project is AMBO, Albania-Macedonia-Bulgaria and its intention is exporting Caspian oil over the Adriatic. The second project is named *Družba Adrija* and it aims to facilitate the export of the Russian (Ural) oil through the Croatian port of Omišalj. There is a plan to connect the port of Odessa (the Black Sea) with the port of Omišalj, for the export of Caspian oil. There is also a project named the Pan-European pipeline (PEOP) whose intention is connecting the Romanian port of Constantza with the port of Trieste, directly connecting the middle Europe countries over the existing

Trans-alpine pipeline with Caspian oil [3, 345-346]. If the Adriatic becomes place for oil export, significant increase of dangerous cargo will occur including extremely dangerous ballast water discharge from incoming empty tankers.

Figure 6. Oil pipelines and projects relating to the Adriatic
Slika 6. Naftovodni pravci i projekti koji se odnose na Jadran
Source: www.ijf.hr

Liquefied gas traffic in the Adriatic is relatively small for the time being, but it is realistic to assume that it will be significantly bigger in the next ten years. LNG terminals in Laguna di Venezia (Isola di Porto Levante) and in the port of Brindisi are almost completed. The realization of the project to connect Albania and Italy by gas pipeline (TAP-Trans Adriatic Pipeline) will be started soon, and should be completed by 2010, according to the plan [12]. In addition, the Republic of Croatia is planning to install gas pipeline net in the coastal area, including terminals not only for domestic needs. There are also plans for

installation several LNG terminals in the Gulf of Trieste. In the following years, Europe will definitely find alternatives to the existing gas pipelines for the import of the Russian gas, constructing brand new pipelines to satisfy market demands. The Adriatic, as we can see from existing projects and plans, is one of the main solutions for new routes of gas.

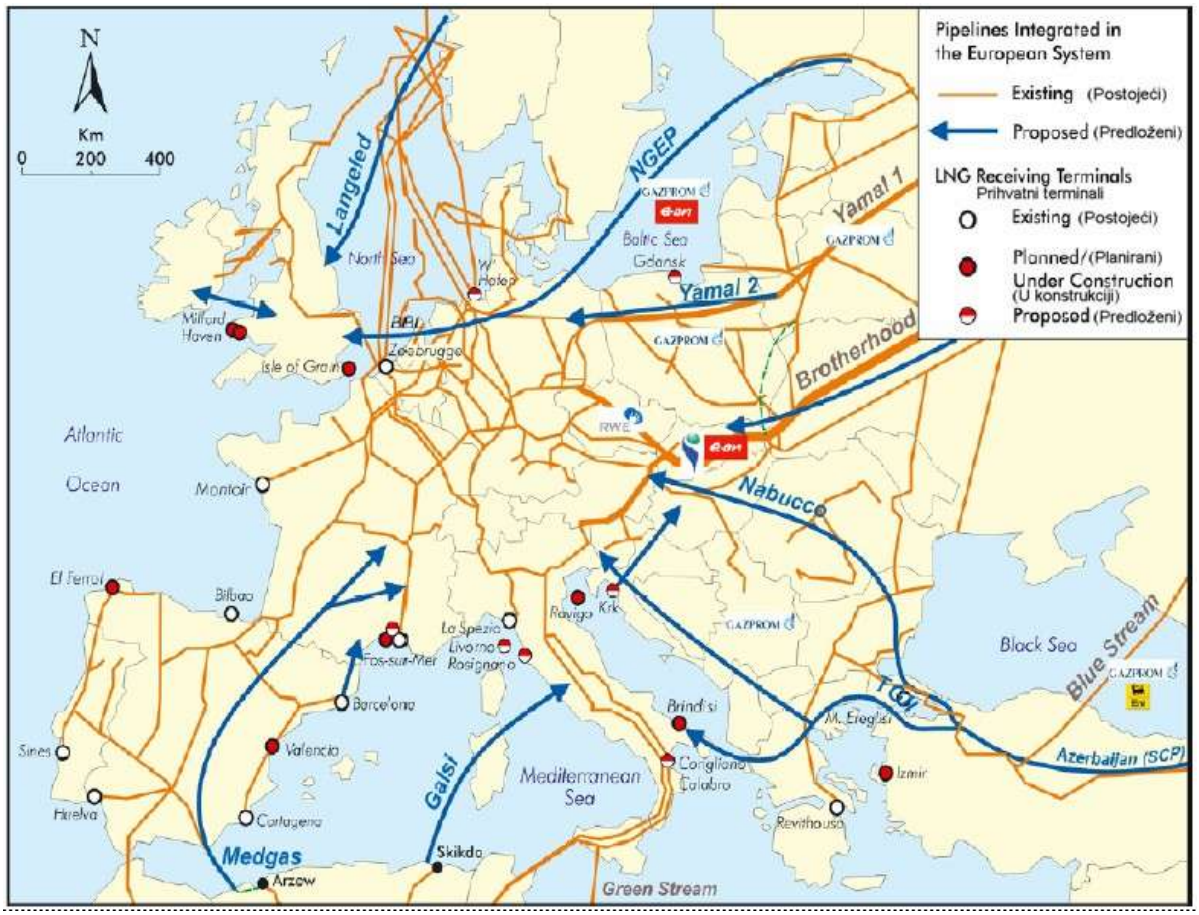

Figure 7. Present and planned LNG pipelines in Europe
Slika 7. Sadašnji i planirani plinovodi Europe
Source: www.ijf.hr

Fortunately, serious maritime accidents with catastrophic impact on the Adriatic Sea have not yet occurred, but certain amounts, sometimes even large quantities, of oil and other pollutants enter into the Adriatic. Statistics referring to the World and to the Adriatic show that the main sea pollutions enter from the shorelines. As for maritime traffic, the largest pollutions occur during cargo operations (loading, discharging, etc…). Some analyses indicate that, from 1999 to 2002, there were between 200 and 300 oil discharges from ships in the Adriatic. Satellite pictures confirm that daily oil discharge into the Adriatic is sufficient to cover the surface area of 1.228 km², i.e. a surface tree times bigger than the largest Croatian island [3, 354].

Heavy maritime traffic of dangerous cargo has a direct impact to the environment, whether it is a continuous, slow leakage or a sudden discharge in case of accident. In addition, large cargo traffic causes additional pollution due to ballast water discharges. This impact is especially characteristic for an area where empty ships are coming to load the cargo. Some analyses show that, in 2003, about 8mil tonnes of ballast waters were discharged into the Adriatic, 80% in Italian ports [3, 354]. If the Adriatic becomes a place for loading oil and other dangerous cargo, ballast water pollution will be significantly bigger.

6. PROTECTION MEASURES RELATING TO THE ADRIATIC
Mjere zaštite Jadrana

Taking into consideration the quantity of ship traffic in the Adriatic, total and dangerous cargo traffic, and the projection of the future development including accident statistics, it is necessary to urgently improve measures that can protect the Adriatic from pollution.

6.1.1. Existing measures
Postojeće mjere

The internationally accepted measures implemented in the Adriatic to increase the safety of traffic and to protect the environment include the ones that are particularly important:

- As of 1 July 2003 the Adriatic Traffic System (ATS) is in effect. This is the system of compulsory reporting for some vessels. ATS covers all the Adriatic north of 40º25'N, and is compulsory for all tankers above 150 GT and for all ships above 300 GT carrying dangerous or pollution cargo [7, 29].
- Establishment of a Routing system, especially Traffic separation schemes and other routing measures in the north Adriatic.
- The Adriatic Sea, as part of the Mediterranean Sea, is defined by MARPOL as a "Special Area" where the adoption of special mandatory methods for the prevention of sea pollution is required.

The legislation of the Republic of Croatia has introduced a number of measures related to maritime traffic. These measures include:

- Restriction measures for sailing through the especially sensitive areas inside of territorial waters of the Republic of Croatia including no entering area for ships. For example, the restriction of maritime traffic for Pelješki Kanal, Koločepski Kanal, parts of Srednji Kanal, Murtesko More and Žirjanski Kanal (vessels heading to northern parts of the east Adriatic coast are advised to use the outer edge of islands, looking towards the open sea).
- Traffic separation schemes: Vela Vrata and Palagruža.
- Own Vessel Traffic System, based on military surveillance and cooperation among military, police, harbor offices, and other involved ministry.
- Declaration of the economical zone, i.e. the protected ecological-fishing zone for non EU countries,
- Decision on Coast Guard formation,
- Investments in resources,
- Update of the old legislation sources, etc.

The problem of the above measures is their implementation. Due to lack of financial funds, poor organization, political and other reasons, many of these measures are hard to implement, or their implementation is without expected results. Accordingly, the surveillance is not adequate; the Vessel Traffic system is not fully active, the coordination among different ministry is poor, reactions in case of urgency are slow, the date of final formation of Coast Guard is questionable, etc.

6.1.2. Proposal of future protecting measures for the Adriatic
Prijedlog budućih mjera zaštite Jadrana

Among the available measures aiming to increase the safety of maritime traffic, the following are acceptable for the implementation in the Adriatic:

- full Vessel Traffic Service, to actively supervise all traffic and each part of the Adriatic,
- improvement of the existing Routing system, especially with additional Traffic Separation Schemes (missing in central and south parts of the Adriatic, as well as on approaches to some ports),
- better cooperation among Adriatic countries in planning and realization of search and rescue operations, and better cooperation generally,
- better organization of on scene operational forces, human and resource improvements,
- systematic planning and preparedness for any possible threat,
- limitation in ballast water discharge (or not any),
- additional port and coast pilotage,
- better supervision of vessels in port and during port operations,
- designating the Adriatic Sea a Particularly Sensitive Sea Area, etc.

The complete realization of the above measures requires the absolute cooperation among Adriatic countries and common approach to the international community. Also, it is necessary to achieve maximum involvement of all available resources, with significant financial investments. These investments, no matter how big they are, will be less costly than possible damages that can occur if we fail to implement proper measures.

7. CONCUSION
Zaključak

The Adriatic Sea is a small and closed sea, hopefully still without large pollutions in its history. In order to keep the Adriatic clean and biologically alive it is necessary to introduce additional protecting measures, in view of the threats from large tankers and generally large numbers of vessels. The intention of these measures is the implementation of well known standards that are internationally accepted, and used in many similar places around the world. These measures do not to reduce sea trade. The first measure is the completion of the Adriatic Routing system, especially in the central and south part of the Adriatic, followed by the full Vessels Traffic system, able to cover the entire Adriatic and to actively monitor movements of ships, especially those carrying dangerous cargo. Also, the system of on scene search and recovery, well organized and synchronized between coastal countries, should be an important part of this system. These and other available measures can be introduced separately, one by one, but it is easier and more efficient of their implementation is agreed within the international legal framework. One of the available instruments is the designation of the Adriatic Sea a Particularly Sensitive Sea Area (PSSA). When an area is approved as a particularly sensitive area, available measures to control maritime traffic and other activities within the area are: routing measures, strict application of MARPOL convention, installation of Vessel Traffic System, etc. In other words, a Particularly Sensitive Sea Area enables to define legal and political framework for the introduction of a number of internationally recognized measures that have been designed to protect sensitive areas. It also emphasizes a need for special precaution to all involved in maritime traffic.

The Republic of Croatia and Italy have the longest stretch on the Adriatic coast and it would be therefore natural that they should be the forerunners in efforts to protect the Adriatic. However, the successful protection cannot be achieved without common work and final agreement of all Adriatic countries.

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