

Dr. sc. Zvonimir Lušić / Ph. D.
Sveučilište u Splitu / *University of Split*
Pomorski fakultet u Splitu /
Faculty of Maritime Studies - Split
Zrinsko-Frankopanska 38
21000 Split

Dr. sc. Serđo Kos / Ph. D.
Sveučilište u Rijeci / *University of Rijeka*
Pomorski fakultet u Rijeci /
Faculty of Maritime Studies Rijeka
Studentska 2
51000 Rijeka
Hrvatska / *Croatia*

Izvorni znanstveni rad
Original Scientific Paper

UDK / *UDC*: 656.61.052

Primljeno / *Received*:
10. rujna 2010. / *10th September 2010*

Odobreno / *Accepted*:
23. listopada 2010. / *23rd October 2010*

IZBOR KURSOVA U OBALNOJ NAVIGACIJI

PLOTTING COURSES IN COASTAL NAVIGATION

SAŽETAK

Ovaj članak bavi se ispitivanjem načina planiranja putovanja u obalnoj navigaciji od strane zapovjednika broda i časnika plovidbene straže, te njihovim postupanjem u skladu s propisima i preporukama prilikom crtanja kursova kod obilaženja opasnosti i prolazaka područjima ograničene širine. Dobiveni rezultati trebali bi ukazati na glavne nedostatke postojećeg sustava obveza i preporuka kod planiranja obalne plovidbe, ponuditi dodatne preporuke te donekle standardizirati način povlačenje kursova. S ovim dodatnim preporukama primarno bi se smanjila potencijalna opasnost od sudara prilikom mimoilaženja brodova u nasuprotnim kursovima.

Ključne riječi: *planiranje putovanja, obalna navigacija, povlačenje kursova*

SUMMARY

This article examines the ways of passage planning made by captains and officers of the navigation watch in coastal navigation, and their acting in line with regulations and guidelines when plotting courses in narrow passages and avoiding dangers. The obtained results should point out the main drawbacks of the existing system of duties and guidelines in short-sea navigation planning, suggest additional guidelines and, to a certain extent, standardize course plotting. The aim of these additional recommendations is primarily to reduce the potential risk of collision when two vessels are meeting on reciprocal or nearly reciprocal courses.

Key words: *Passage planning, coastal navigation, plotting courses*

1. UVOD

Planiranje putovanja broda te izbor plovidbenih putova i kursova danas se najvećim dijelom temelji na subjektivnoj procjeni zapovjednika broda. Na ovu procjenu, pored neizravnih formalnih propisa, utječu i odgovarajuće preporuke kojih bi se zapovjednici i časnici plovidbene straže trebali držati. S obzirom na različito tumačenje ovih preporuka u praksi je prisutna prevelika raznolikost u povlačenju kursova. Ova raznolikost sama po sebi ne predstavlja problem, međutim neizravno uzrokuje preveliko približavanje obali, te nepotrebno preklapanje kursova s povećanim brojem potencijalnih opasnosti od sudara, tj. potrebe da se poduzima odgovarajuća radnja izbjegavanja sudara. Neke od preporuka kod ucrtavanja kursova na izabranom plovidbenom putu su [1, 429-430] [6, 251-252]:

- izbor polazne pozicije mora omogućiti sigurno dovođenje broda na nju,
- kursove ucrtavati po najkraćem i najsigurnijem putu,
- kursove ucrtavati na povoljnoj udaljenosti od obale da raspored objekata omogući sigurno određivanje pozicije,
- kursove ucrtavati na sigurnoj udaljenosti od svih navigacijskih opasnosti,
- kursove ucrtavati na sigurnim dubinama s obzirom na gaz broda i dodatni uron u plitkoj vodi uslijed brzine broda,
- ako je moguće, kursove ucrtavati tako da vode na markantne objekte ili pokrivene smjerove, a izmjene kursova vršiti subočice na markantne objekte (noću svjetionike),
- za noćne plovidbe ucrtati kursove na većoj udaljenosti od navigacijskih opasnosti,
- noću nije uputno ucrtavati dužu liniju kursa ako su točke okreta nesigurne, već je bolje ucrtati dva kursa i imati neznatno duži put, ali sigurne točke okreta na svjetionik,
- plutače i brodove svjetionike izbjegavati na udaljenosti ne manjoj od 0,5 M,
- opasnosti čija je pozicija nesigurna izbjegavati na udaljenosti ne manjoj od 1 M, ili više kod smanjene vidljivosti i ostalih nepovoljnih uvjeta plovidbe,
- ne oslanjati se na nepotpune i neproverene informacije,

1. INTRODUCTION

Passage planning and selecting sailing routes and courses have been largely based on the subjective assessment of the master. In addition to indirect formal regulations, the assessment is affected by relevant guidelines that masters and officers of the navigation watch should comply with. As the guidelines are interpreted in different ways, there is an excessive variety of plotting courses in practice. The variety itself is not an issue but may indirectly lead to sailing too close to the coastline and unnecessary overlapping of courses, which increases the potential collision risk, i.e. the number of adequate actions aimed at avoiding collisions. Here are some of the guidelines on plotting courses on a selected sailing route [1, 429-430] [6, 251-252]:

- choice of the starting point has to enable the safe arrival of the ship to the position,
- plot courses along the shortest and safest route,
- plot courses at reasonable distance to the coast so that the arrangement of shore objects and structures allow accurate position fix,
- plot courses at a safe distance to any hazard to navigation,
- plot courses over safe sea depth given the ship draft and additional squat in shallow water arising from the ship's speed,
- if possible, plot courses so that they lead to prominent objects, transits or leading marks, and alter the course abeam to prominent objects (lighthouses at night),
- at night, plot courses at greater distance to navigational dangers,
- at night, it is not recommended to plot a long course line if the turning points are uncertain; it is better to plot two courses and have a slightly longer route with a safe turning point relative to a lighthouse,
- pass buoys and light vessels not closer than 0.5 M,
- dangers having uncertain position should be avoided at a minimum distance of 1 M; the distance should be greater in the event of reduced visibility and other adverse sailing conditions,
- do not rely on incomplete and unchecked information,

- uzeti u obzir gustoću prometa, te izbjegavati situacije mimoilaženja u suprotnim kursovima (držati se desne strane) pazeći na raspoloživi manevarski prostor,
- držati se preporučenih kursova sukladno publikacijama i priručnicima, a posebno kada su na pojedinim plovidbenim putovima označeni markantni objekti, postavljena svjetlosna i zvučne signalizacija, postavljeni pokriiveni smjerovi, itd¹.

U smislu izbjegavanja potencijalnih opasnosti od sudara u nasuprotnim kursovima posebno je bitna preporuka koja se odnosi na držanje desne strane ograničenog područja. Navedena preporuka može se promatrati i u okviru Međunarodnih pravila za izbjegavanje sudara na moru, tj. dijela koji se odnosi na uske kanale i načina kako zapovjednici, tj. časnici definiraju uski kanal. Za potrebe određivanja raspodjele kretanja brodova po poprečnoj osi plovnog puta, tj. načina povlačenja kursova, provedeno je ispitivanje među zapovjednicima i časnicima plovidbene straže. Uzimajući u obzir dobivene rezultate, ali i rezultate drugih analiza, postojeće preporuke u svezi povlačenja kursova bit će djelomično proširene, posebno one koje se odnose na držanje desne strane unutar područja ograničene širine, a s osnovnim ciljem da se smanji broj potencijalnih sudara u situacijama mimoilaženja brodova u nasuprotnim kursovima. Ove dodatne preporuke mogle bi se primjenjivati isključivo u područjima gdje ne postoje posebni sustavi regulacije plovidbe, npr. sustavi odijeljenog prometa.

2. RAZDIOBA KRETANJA BRODOVA PO POPREČNOJ OSI PLOVIDBENOG PUTA

Razdioba brodova po poprečnoj osi plovidbenog puta u nekom ograničenom području može se odrediti prikupljanjem podataka o kretanju brodovi kroz duže razdoblje. Iako su potrebni mjeseci, nekad i godine za značajnije analize današnje utvrđivanje načina kretanja brodova značajno je olakšano AIS² sustavom.

Danas, pored položaja luka, sustavi usmjerenja plovidbe, predstavljaju glavni čimbenik u

- take into consideration the traffic density and avoid head-on meeting (keep to starboard), considering the available area for safe manoeuvring,
- follow recommended courses according to publications and guidelines, particularly when they feature prominent objects, light and sound signalling, leading marks, etc. along sailing routes.¹

With respect to avoiding potential collision risks on reciprocal courses, it is particularly important that vessels keep to the starboard side of a limited waterway. This recommendation can be observed as part of the International Regulations for Preventing Collision at Sea, i.e. the section referring to narrow channels and how the masters, i.e. deck officers define a narrow channel. Within this study, to determine the manner of distribution of movement of ships in transverse axis of a waterway, a number of captains and officers of a navigational watch was surveyed. Taking into account the results obtained and the results of other analysis, the existing guidelines regarding plotting courses will be partially extended, in particular those referring to keeping to the starboard side of a limited waterway. This will eventually reduce the potential collision risk of vessels meeting head-on on reciprocal courses. The additional guidelines might especially apply to areas having no traffic regulation systems, e.g. traffic separation schemes.

2. TRANSVERSAL DISTRIBUTION OF THE SHIP TRAFFIC

The distribution of ship traffic along the transverse axis of a waterway in a limited area can be determined by gathering ship movement data over a longer period of time. Although thorough analyses require months, even years, determination of the ship traffic behaviour has been considerably facilitated by AIS² system.

In addition to port positions, vessel routing systems are the major factors when grouping sailing routes in certain directions. In areas where such systems do not exist, traffic tends to spread to both sides of the waterway. This

¹ Slične ili iste preporuke mogu se pronaći u drugim navigacijskim publikacijama [2], [3], [4], itd.

² AIS-Automatic Identification System. Podaci o kretanju brodova dobiveni preko AIS sustava dostupni na [13].

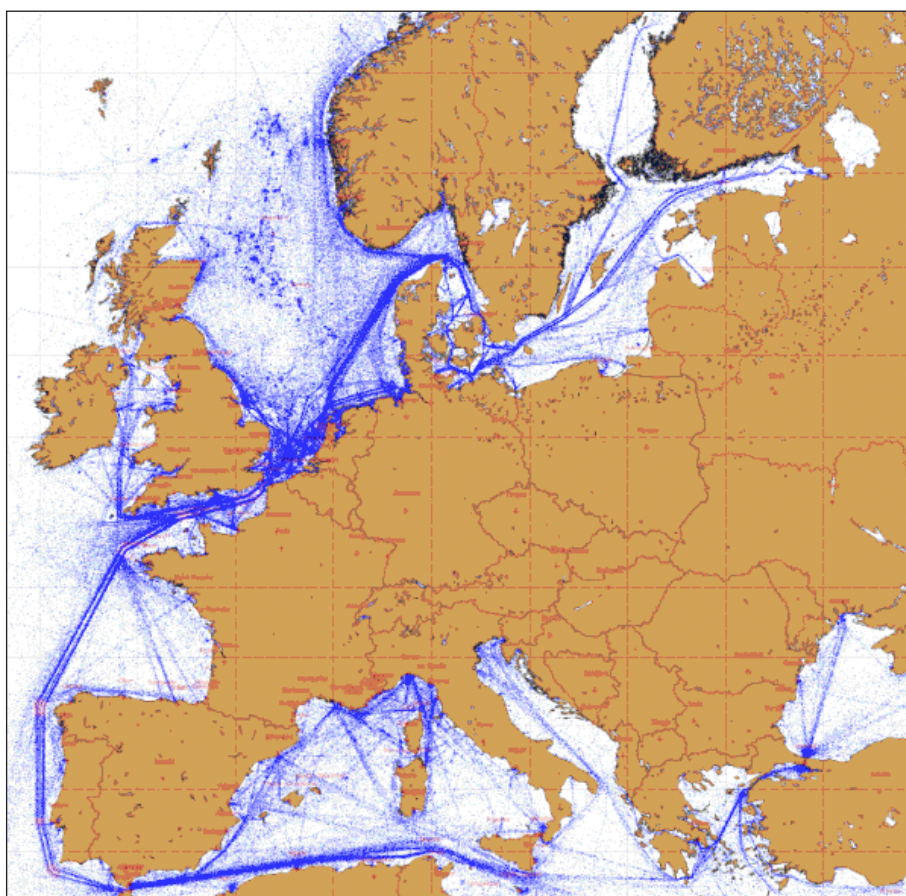
¹ Similar or identical recommendations can be found in other navigation publications [2], [3], [4], etc.

² AIS - Automatic Identification System. Ship movement data via AIS system are available at [13].

grupiranju ruta na nekom pravcu kretanja. Također, na prostoru gdje ne postoje ove mjere promet teži rasipanju po cijeloj širini plovnog puta. U konačnici to vodi velikom broju potencijalnih opasnosti, posebno u nasuprotnim kursovima i blizu nasuprotnim kursovima. Konkretno analize za pojedina mjesta to potvrđuju. Slika 1. prikazuje glavne europske brodske rute, a grafikom 1. primjer razdiobe prometa brodova po poprečnoj osi za dva nasuprotna plovidbena toka u području ograničene širine bez sustava usmjeravanja plovidbe.

eventually leads to a number of potential risks, particularly on and near reciprocal courses. The analyses for specific areas confirm the problem. Figure 1 shows the major European sailing routes, whereas Graph 1 presents an example of traffic distribution along the transverse axis for two reciprocal traffic flows in a limited waterway having no routing / tracing system.

The above analysis of the ship traffic distribution in a limited waterway which is not provided by any particular sailing regulation sys-



Slika 1. Glavne europske brodske rute [10]
Figure 1 Major European sailing routes [10]

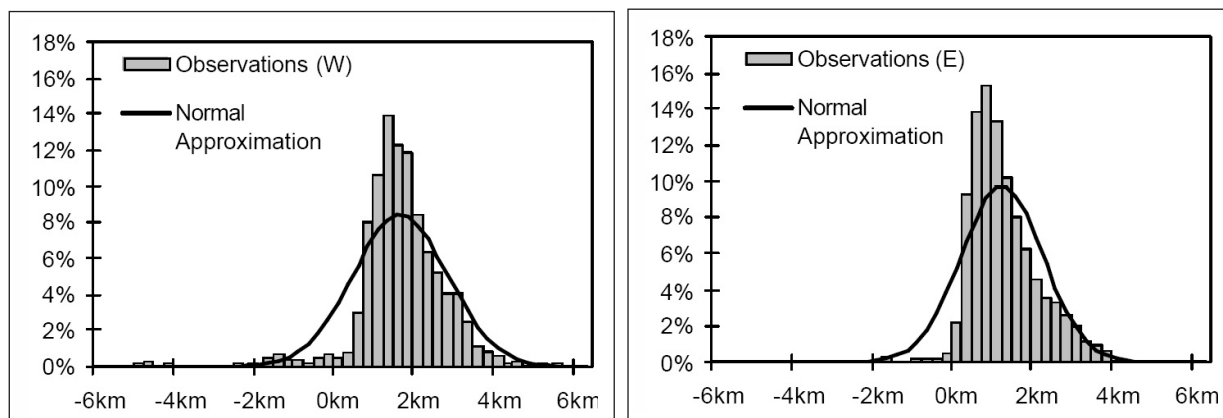
Prikazana analiza razdiobe kretanja brodova u području ograničene širine gdje ne postoje posebni sustavi regulacije plovidbe, kao i većina sličnih analiza³, potvrđuje da nasuprotni plovidbeni tokovi nisu simetrično raspoređeni u odnosu na središnjicu i da uvijek postoji njihovo određeno preklapanje. Također, za očekivati je da rastom veličine brodova standardna devijacija odstupanja od središnje linije opada, odnosno da se veći brodovi grupiraju oko središnjeg

tem, as well as most of similar analyses³, confirm that the reciprocal sailing flows are not distributed symmetrically with regard to the centre line and that there is always a degree of overlapping. Moreover, it is expected that the increase in ship size will result in the reduction of the standard deviation to the centre line, i.e. larger ships will tend to group around the central part of the limited area. Figure 2 uses normal distribution to present the ship traffic dis-

³ Primjeri: [7, 42-43], [12], [14], [15] itd.

³ Examples: [7, 42-43], [12], [14], [15] etc.

Grafikon 1. Primjer raspodjele kretanja brodova i aproksimacija normalnom razdiobom [11]⁴
Graph 1 Example of the ship traffic distribution and approximation by normal distribution [11]⁴



dijela ograničenog područja. Na grafikonu 1. uzeta je normalna razdioba za prikaz razdiobe kretanja brodova po poprečnoj osi, međutim u ovom primjeru, ali i ostalim sličnim primjerima kada se rute povlače desno od crte sredine ili neke druge referentne linije (posebno kada je označena) mogu se uzeti neke druge razdiobe, npr. rayleigheva, lognormalna, itd.

3. POVLAČENJE KURSOVA

Ispitivanjem zapovjednika i časnika plovodne straže pokušat će se odrediti razdioba povlačenja kursova po širini plovidbenog puta i pripadajuća standardna devijacija. Za potrebe ispitivanja korišteni su preslici odgovarajućih karata uz mogućnost korištenje ECDIS⁵ sustava. S obzirom da se ispituje način povlačenja kursova kroz ograničena područja, minimalna udaljenost povlačenja od obale i pridržavanje pravila desne strane kod prolazaka ograničenim područjem, ispitanici su podijeljeni u dvije grupe. Razlika jedne grupe od druge isključivo je u zadanom smjeru kretanja broda. Svim ispitanicima naznačena je veličina broda i gaz⁶, napomenuto je da se kursovi povlače isključivo prema informacijama s karte, te da se pridržavaju uobičajenih preporuka i pravila za izbjegavanje sudara na moru. Cilj i svrha ispitivanja, ispitanicima nije navedena, odnosno ne prije

tribution along the transverse axis. However, in this example as in all similar cases when routes are plotted to the starboard side of the centre line or any other reference line (particularly if it is marked), various distributions may be used, e.g. Rayleigh distribution, lognormal distribution, etc.

3. PLOTTING COURSES

A survey of captains and officers of the navigation watch was used to determine the distribution of courses plotted across the waterway width and their standard deviation. Copies of relevant charts and ECDIS⁵ system were used during the survey. Since the aim of the survey was to examine the ways of plotting courses through limited waterways, minimal plotting distance to the coast and compliance with the rules in meeting situations, the respondents were divided into two groups, each having a different ship direction. The respondents were familiar with the size and draft of their respective ships⁶, they were told to plot courses relying exclusively on chart information, and to comply with standard guidelines and rules of the road. The respondents did not know the goal and the purpose of the survey until the very end of the process. The respondents were divided into two groups in order to obtain maximum independence and accuracy of the results regarding the

⁴ Rezultati istraživanja prometa brodova za Fehmarn Belt (20 km širok prolaz između otoka Fehmarn u Njemačkoj i otoka Lolland u Danskoj), podaci prikupljeni tijekom 1998. i 1999. godine.

⁵ ECDIS-Electronic Chart Display Information System, Transas 2002.

⁶ Brod ne manji od 10 000 BT, gaz 10 m i veći, u normalnim vremenskim uvjetima, pri punoj/ekonomskoj brzini.

⁴ Results obtained during a 1998-1999 research of ship movement in Fehmarn Belt (20 km wide passage between Fehmarn island in Germany and Lolland island in Denmark).

⁵ ECDIS - Electronic Chart Display Information System, Transas 2002.

⁶ Ships not less than 10000 GT, draft 10m and more, in normal weather conditions, with full/economical speed.

kraja ispitivanja. Dijeljenjem ispitanika u dvije grupe nastojala se postići maksimalna neovisnost i točnost rezultata u svezi preklapanja nasuprotnih plovidbenih ruta. U ispitivanju je sudjelovalo 60 časnika plovidbene straže i 48 zapovjednika i prvih časnika [5, 98-107].

Za područje iz primjera I. (Slika 2.) odabrane su četiri referentne točke od kojih je mjerena minimalna udaljenost prolaska svakog pojedinog kursa. Dobiveni rezultati povlačenja kursova grupirani su u razrede kako slijedi: od 0,5 M do 1,49 M prvi razred, od 1,5 M do 2,49 M drugi, itd.

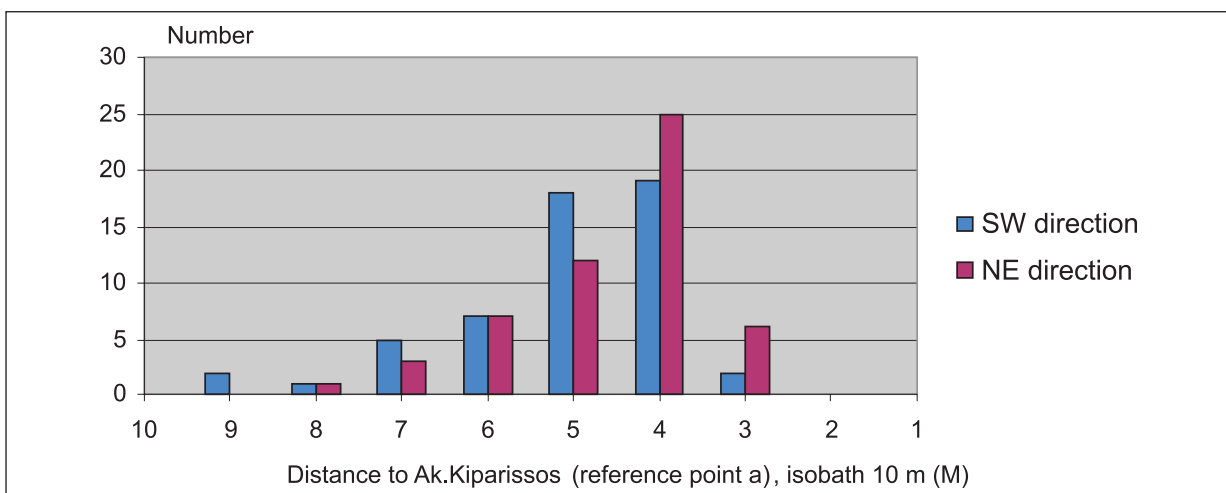
overlapping of the reciprocal sailing routes. The survey included 60 officers of the navigation watch and 48 masters and first mates. [5, 98-107].

The area from the Example I (Figure 2) features four reference points from which the minimal distance to each plotted course was measured. The obtained results were grouped in classes as follows: from 0.5 M to 1.49 M first class, from 1.5 M to 2.49 M second class, etc.

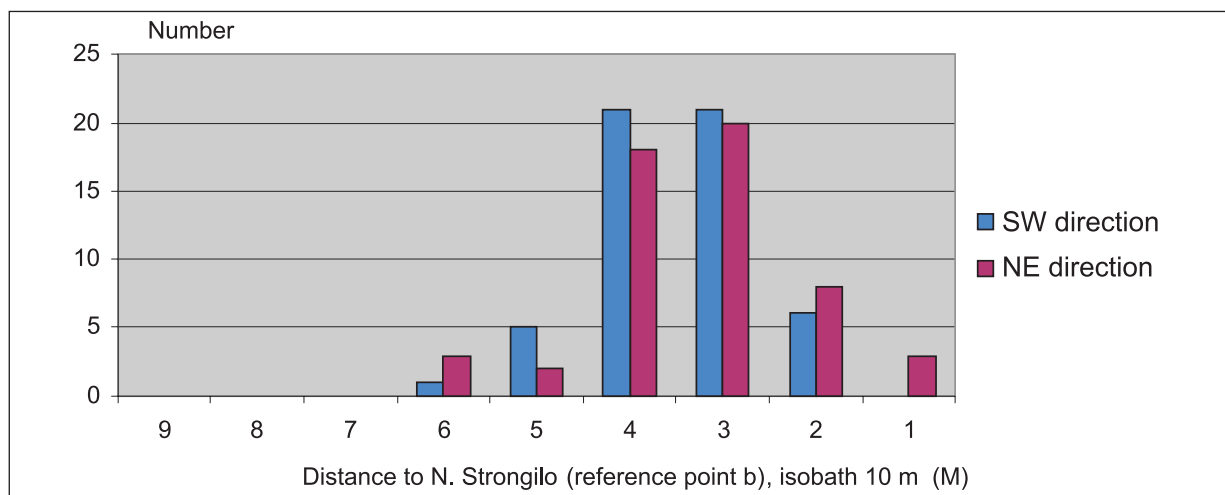


Slika 2. Područje ispitivanja za primjer I., Grčka - južno Egejsko more (referentne točke: a, b, c, d)
Figure 2 Research area in Example I, Greece-South Aegean Sea (reference points: a, b, c, d)

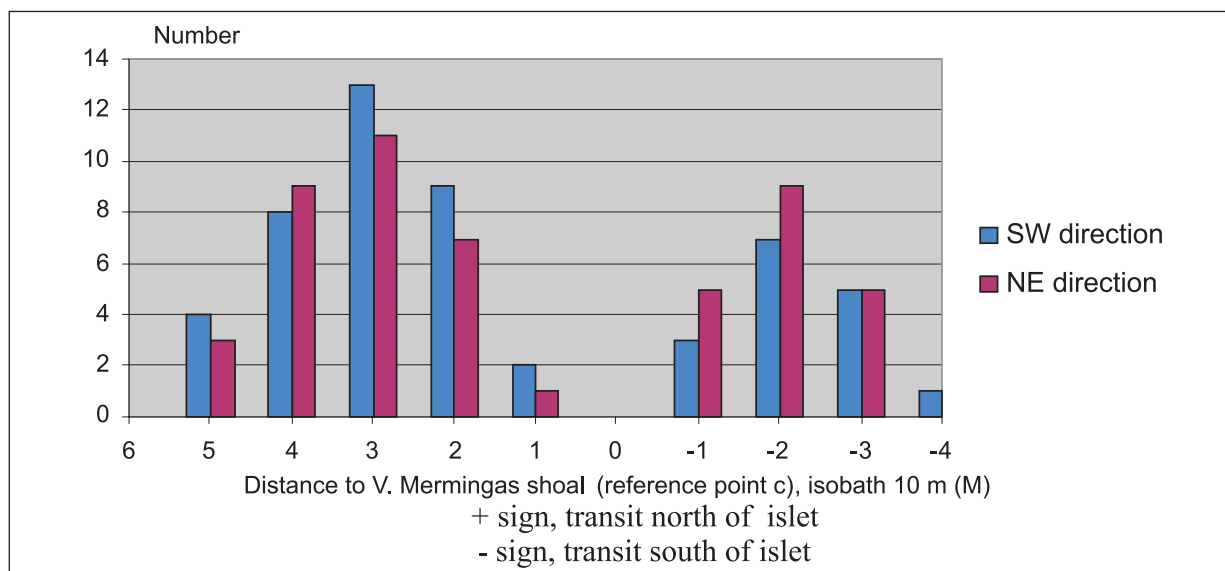
Grafikon 2. Rezultati razdiobe kursova za prolaz a) primjera I.
Graph 2 Results of the distribution of courses for Passage a) in Example I



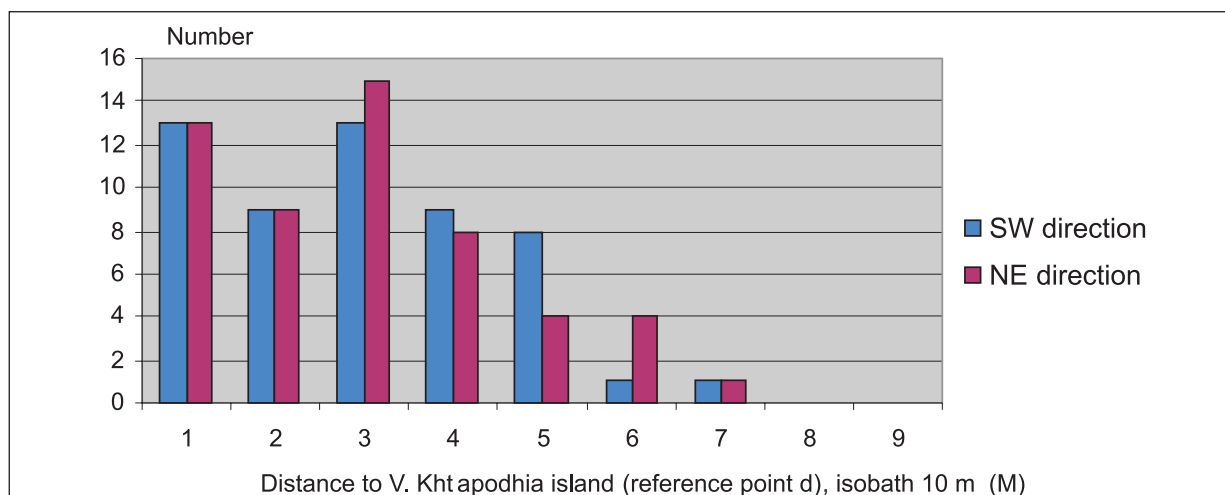
Grafikon 3. Rezultati razdiobe kursova za prolaz b) primjera I.
Graph 3 Results of the distribution of courses for Passage b) in Example I



Grafikon 4. Rezultati razdiobe kursova za prolaz c) primjera I.
Graph 4 Results of the distribution of courses for Passage c) in Example I



Grafikon 5. Rezultati razdiobe kursova za prolaz d) primjera I.
Graph 5 Results of the distribution of courses for Passage d) in Example I



Ostala područja (referentne točke):

- Primjer II., prilaz luci Rijeka uz obale Istre:
 - a) najmanja udaljenost od pličine Albanež,
 - b) spojnica Hr. Galijola – Rt Marlera, udaljenost od Hr. Galijola,
 - c) spojnica Rt Pernat – Škvaranska, udaljenost od Škvaranske.
- Primjer III., Japan, prolaz sjeverno od otoka To Shima, najmanja udaljenost do otoka To Shima.
- Primjer IV., Malacca, zapadni prilaz, najmanja udaljenost od sjeverne i južne obale otoka Rondo.
- Gibraltar, najmanja udaljenost od Europa Pt.

Other areas (reference points):

- Example II, approach to the port of Rijeka along the coastline of Istria:
 - a) minimal distance to Albanež shoal,
 - b) junction Galijola rock – Marlera point, distance to Galijola rock,
 - c) junction Pernat point – Škvaranska, distance to Škvaranska.
- Example III, Japan, passage north of To Shima island, minimal distance to To Shima island.
- Example IV, Malacca, west approach, minimal distance to north and south coast of Rondo island.
- Gibraltar, minimal distance to Europe Pt.

Tablica 1. Aritmetičke sredine i standardna devijacija svih opažanja (M)**Table 1** Arithmetic mean and standard deviation in all observations (M)

	Srednja udaljenost od referentne točke i σ Mean distance to reference point and σ					
	Kanali / Channels			Jedna obala / Single coastline		
	Istočni smjer East direction	Zapadni smjer West direction	Razlika* Difference*	Desno Starboard	Lijevo Port	Razlika Difference
Primjer I. (a) Example I (a)	4.6 (1.1)	5.0 (1.3)	+0.4	/	/	/
Primjer I. (b) Example I (b)	3.2 (1.0)	3.4 (0.9)	+0.2	/	/	/
Primjer I. (c) Example I (c)	3.1 (1.0) -2.2 (0.9)	3.1 (1.1) -2.2 (0.8)	+0.0 0.0	/	/	/
Primjer I. (d) Example I (d)	2.8 (1.6)	2.8 (1.5)	0.0	/	/	/
Primjer II. (a) Example II (a)	/	/	/	2.3 (1.1.)	2.4 (1.3)	+0.1
Primjer II. (b) Example II (b)	4.1 (1.0)	4.2 (1.1)	+0.1	/	/	/
Primjer II. (c) Example II (c)	2.2 (0.8)	1.9 (0.5)	+0.3	/	/	/
Primjer III. Example III	3.6 (1.1)	3.6 (1.1)	0.0	/	/	/
Primjer IV. Example IV	-5.5 (1.4)	-5.4 (1.8)	+0.1	8.7 (4.2)	8.6 (4.0)	-0.1
Primjer V. Example V	/	/	/	0.6 (0.3)	0.7 (0.4)	+0.1

* “+” Kursovi s obalom na desnoj strani bliži obali, odnosno u kanalima kursovi s obalom na desnoj strani bliži desnoj obali.

“-” Kursovi s obalom na desnoj strani udaljeniji od obale, odnosno u kanalima kursovi s obalom na desnoj strani bliži lijevoj obali.

* “+” Courses with coastline to the starboard that are closer to the coast, or courses in channels with coastline to the starboard that are closer to the starboard coast.

“-” Courses with coastline to the starboard that are more distant from the coast, or courses in channels with coastline to the starboard that are closer to the port coast.

Iz dobivenih podataka može se zaključiti sljedeće:

- kod crtanja kursova procjena kretanja brodova iz suprotnog smjera, posebno procjena mogućih sudarnih situacija, u pravilu se zanemaruje,
- većina zapovjednika i časnika teži povlačenju kursova prema središnjim dijelovima ograničenog područja,
- tendencija povlačenja kursova bliže obalama prema kojima ide izmjena kursa,
- iako se većina ruta povlači blizinom središnjeg dijela ograničenog područja značajan udio čine rute koje se povlače preblizu obale,
- kod obilaženja rtova i sličnih opasnosti postoji velika raznolikost povlačenja kursova, te
- područje preklapanja nasuprotnih plovidbenih tokova izuzetno je veliko.

Pored ispitivanja načina povlačenja kursova ispitanicima su postavljena dva dodatna pitanja u svezi izbjegavanja brodova i povlačenja kursova u obalnoj navigaciji:

- *U obalnoj plovidbi, u tranzitu kada nema posebnih opasnosti niti ograničenja plovidbe i kada plovidba bliže obali smanjuje udaljenost do odredišta, koliko blizu obale povlačite kursove:*

- a) Unutar 2 M b) unutar 5 M
c) unutar 10 M d) Ostalo:

- *Na otvorenom moru brodovima⁷ se ne približavate manje od _____ M, a usamljenim navigacijskim opasnostima ne manje od _____ M.*

Rezultate odgovora na ova dva pitanja prikazuju sljedeći grafikoni:

The following can be concluded from the gathered data:

- As a rule, estimation of the ship traffic from the opposite direction, particularly the estimation of potential collision events, is ignored;
- Most of the masters and officers tend to plot courses towards central parts of a limited waterway;
- There is a tendency to plot courses closer to the coastline points where the course is altered;
- Although most of the routes are plotted near the central parts of a limited waterway, there are still a significant number of routes plotted too close to the shore;
- When going about points and similar dangers there is a great variety in plotting courses;
- The area of overlapping reciprocal traffic flows is extremely large.

Apart from examining the ways of plotting courses, the respondents were asked two additional questions with regard to collision avoidance and plotting courses in coastal navigation:

- *How close to the coastline do you plot courses in coastal navigation when in transit, when there are no particular hazards to navigation nor sailing restrictions, and when sailing nearer the coast reduces the distance to your destination?*

- a) Within 2 M b) Within 5 M
c) Within 10 M d) Other:

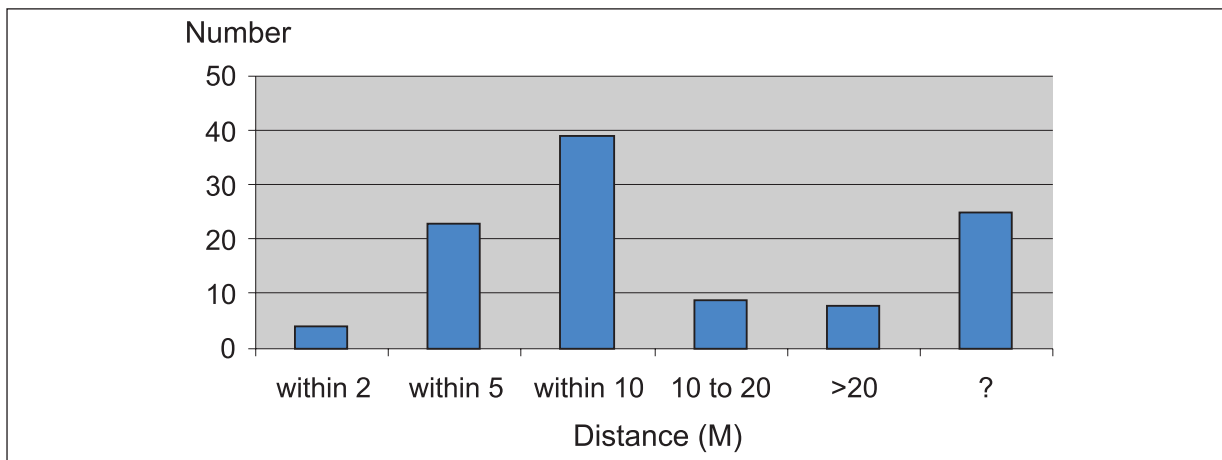
- *In high seas you do not approach other ships⁷ nearer than _____ M, and you keep clear of single hazards to navigation not less than _____ M.*

The following graphs present the answers to the questions:

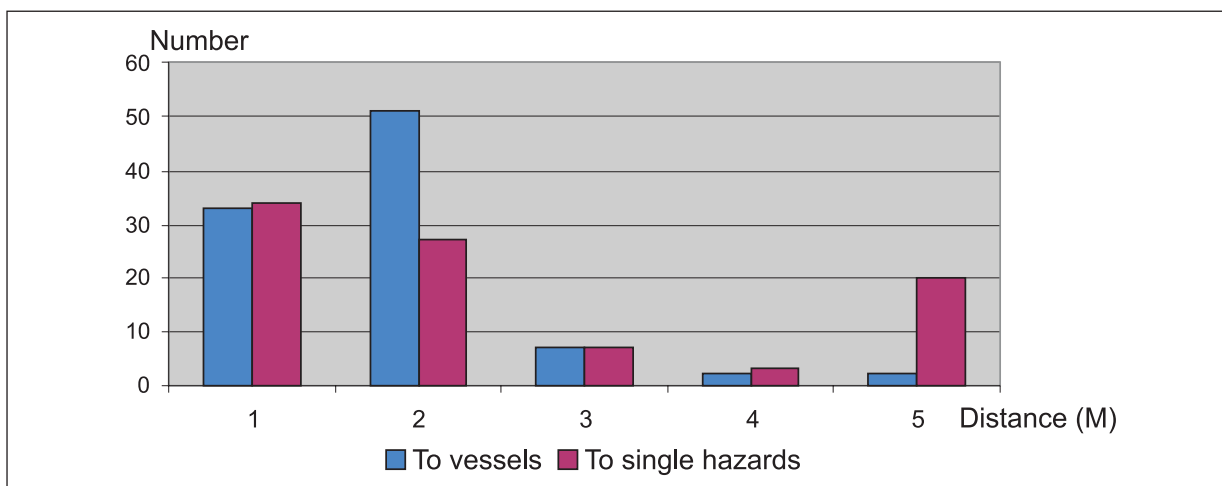
⁷ Veliki trgovački brodovi u međunarodnoj plovidbi, nikako manji od 3 000 BT.

⁷ Large merchant ships in international trade, not less than 3000 GT.

Grafikon 6. Udaljenosti povlačenja kursova od obale
? - bez odgovora
Graph 6 Distance off the coast when plotting courses
? – no answer



Grafikon 7. Udaljenosti izbjegavanja brodova i usamljenih opasnosti
Graph 7 Distance when avoiding vessels and single hazards to navigation



* 95 odgovora uzeto u obzir za izbjegavanje brodova, a 91 za izbjegavanje usamljenih opasnosti
* 95 answers regarding avoiding vessels and 91 answers regarding avoiding single hazards were processed

Odgovori na ova pitanja u skladu su s očekivanjem. Najveći broj časnika rute će povlačiti unutar 10 M od obale, izuzetak su časnici koji plove na izrazito velikim brodovima. Na takvim brodovima uobičajene su preporuke, sukladno sustavu upravljanja sigurnosti na brodu, da se rute povlače na dovoljno velikim udaljenostima od obale, npr. većim od 20 M ako to okolnosti dozvoljavaju. Časnici koji plove na takvim brodovima, a koji su sudjelovali u ovom ispitivanju, dobrim dijelom su se odlučili za udaljenosti veće od 10 M od obale, iako je naglašeno da se planiranje odnosi na brod srednje veličine i bez posebno opasnog tereta.

The above two answers were expected. Most of the officers would plot courses within 10 M off the coast. The exceptions include officers on exceptionally large ships. On such vessels, standard guidelines imply that, in compliance with the safety management system, the plotted route distance from the coast is safe enough, e.g. greater than 20 M if the conditions permit so. Participants in the survey, who were employed on board such ships, largely selected distances greater than 10 M off the coast even though it had been pointed out that the passage planning referred to a medium-sized ship conveying no dangerous cargo.

Rezultati u svezi minimalne udaljenosti prolaska od brodova na otvorenom moru kao i izbjegavanje usamljenih opasnosti mogu se svrstati u granice standardnih preporuka.

S obzirom na dobivene rezultate očito je da se u praksi ne može očekivati ujednačeno povlačenje kursova za ona područja gdje ne postoji sustav usmjeravanja plovidbe. To je razumljivo s obzirom na različite brodove, uvjete u kojima plove, ali i postojanje samo općih preporuka kako povlačiti kursove.

4. DODATNE PREPORUKE ZA CRTANJE KURSOVA U OBALNOJ NAVIGACIJI

U cilju izbjegavanja potencijalno opasnih situacija u nasuprotnim kursovima, te općenito izbjegavanja opasnosti, mogu se dopuniti postojeće preporuke za povlačenje kursova u obalnoj navigaciji. Te dopune preporuka temeljit će se na postojećim preporukama, tj. današnjem načinu odlučivanja, ali će isto tako uzeti u obzir i sljedeće: utjecaj manevarskih značajki brodova, pomorsko-pravnu regulativu, vjerojatnost stvarnih i potencijalnih nezgoda, grešku posade, itd. Dodatne preporuke⁸ uključuju sljedeće:

- ne približavati se obali ispod 3 M, ako za to nema posebnog razloga ili ograničenja,
- formirati od obale odgovarajuće zone, a unutar svake zone granične linije za odvajanje nasuprotnih plovidbenih tokova, npr. plovidbene rute uz desne obale formirati u području od 3 M do 5 M, od 10 M do 13 M i od 20 M do 25 M, a uz lijeve obale od 5 M do 10 M, od 13 M do 20 M i iznad 25 M,
- u kanalima ograničene širine (posebno onim od 1 M do 10 M širine) i sa značajnijim nasuprotnim prometom držati se desne strane kanala, ako okolnosti dopuštaju od crte sredine oko 5 do 10% ukupne širine kanala, te
- po potrebi označiti središnju crtu kanala i crtati kružnice sigurnih udaljenosti kod obilazjenja opasnosti.

U navedenim dopunjenim preporukama ključna je podjela područja od obale na tri zone unutar kojih bi se povlačili kursovi.

⁸ Za velike trgovačke brodove u tranzitu (3 000 BT i veći), u normalnim vremenskim uvjetima, ne odnosi se na manevriranje.

The results regarding the minimal distance when keeping clear of other vessels in high seas and avoiding single hazards to navigation can be classified within the limits of the standard guidelines.

The obtained results clearly show that, in practice, one cannot expect uniform course plotting in the areas where there is no traffic regulation system. This is understandable, given the variety of vessels, sailing conditions, and very general recommendations for plotting courses.

4. ADDITIONAL GUIDELINES FOR PLOTTING COURSES IN COASTAL NAVIGATION

The existing guidelines for plotting courses in coastal navigation can be amended with the aim of avoiding potential risks in reciprocal courses and avoiding dangers in general. The amendments of the guidelines would be based on the existing recommendations, i.e. present practice of decision-making, but they would also take into account the influence of ship manoeuvring features, maritime legislation, causation probability, human error, etc. The additional recommendations⁸ include the following:

- distance to the coast should not be less than 3 M unless there is a special reason or constraint,
- create adequate zoning off the coast, each zone featuring boundary lines that separate reciprocal traffic flows, e.g. create sailing routes along starboard coastlines within 3-5 M, 10-13 M and 20-25 M; accordingly, create sailing routes along port coastlines within 5-10 M, 13-20 M and over 25 M,
- keep to starboard in narrow channels, particularly in channels whose width ranges from 1 M to 10 M and/or those with heavy reciprocal ship traffic; keep to starboard of the centre line running 5 to 10% from the centre of the overall channel width, and
- if necessary, mark the channel centre line and draw safe distance circles for avoiding dangers.

⁸ For large merchant ships in transit (approximate 3000 GT and above), in normal weather conditions; does not apply to maneuvering.

Prva zona je na udaljenostima od 3 M do 10 M od obale, s graničnom vrijednošću na 5 M od obale. Osnovni razlog izbora granične linije od 3 M je u dovoljnoj rezervi udaljenosti od obale (opasnosti) kod većine trgovačkih brodova za slučaj u nuždi. Drugi razlog je što je ovo i prva granica koja se nalazi unutar MARPOL 73/78 konvencije. Treći razlog je što većina brodova sukladno postojećim preporukama izbjegava plovidbu od obale i opasnosti na udaljenostima manjim od 3 M. Ne treba zanemariti i nesmetanu mogućnost korištenja obalnih objekata za orijentaciju i pozicioniranje. Da bi se smanjio potencijalni broj mimoilazaka u nasuprotnim kursovima, prva zona dijeli se na područje od 3 M do 5 M od obale, za jedan smjer plovidbe, a za drugi smjer plovidbe na područje od 5 M do početka druge zone.

Druga zona proteže se od 10 M do 20 M od obale, s graničnom linijom odvajanja na 13 M. Razlog uspostave ove zone, odnosno područja povlačenje kursova od 10 M i više od obale proizilazi iz potrebe za dodatnom sigurnošću. Ova zona omogućuje povlačenje kursova izvan područja od 12 M od obale, dakle izvan granica protezanja teritorijalnih mora obalnih država. Također, 12 M od obale je druga granična crta područja za ispuštanje odgovarajuće vrste otpada s brodova sukladno MARPOL 73/78 konvenciji.

Treća zona javlja se iz potrebe da se izuzetno veliki brodovi i brodovi s opasnim teretom što više udalje od obale. Granica područja kretala bi se od 20 M od obale, s graničnom linijom odvajanja nasuprotnih plovidbenih tokova na 25 M od obale. Ova granica proizilazi iz sljedećeg: značajna udaljenost od obale s dovoljno manevarskog prostora, treća granična crta od 25 M unutar MARPOL 73/78 konvencije, obala je još uvijek u vizualnom i radarskom dometu, minimalna opasnosti za ljude i instalacije na obali u slučaju nezgoda brodova, te preporuke nekih broderskih firmi za velike brodove s opasnim teretima upravo savjetuju zapovjednicima povlačenje ruta od obale na udaljenostima većim od 20 M [8], [9].

S navedenim dodatnim preporukama, opća preporuka prema Pravilima za izbjegavanje sudara "*držati se desne strane kanala*" značajno bi se pojasnila, odnosno, riješilo bi se pitanje različitog tumačenja ovoga pravila kad plovidba nije neposredno uz obalu i u vrlo uskim kanalima. S druge strane sloboda izbora ruta i dalje bi se za-

It is essential that the amended guidelines feature separating coastal waters into three zones for safe course plotting.

The first zone covers the area from 3 M to 10 M off the coast, having boundary value at 5 M off the coast. The basic reason for setting the boundary line at 3 M is the sufficient distance to the coast (dangers) for the majority of merchant ships in case of emergency. Furthermore, this is the first boundary line that is determined by MARPOL 73/78 Convention. The third reason refers to the fact that, in line with the existing guidelines, most ships avoid sailing along coastlines and dangers at a distance less than 3 M. Furthermore, an unobstructed possibility for using shore objects for orientation and positioning should not be ignored. In order to reduce the potential number of head-on meetings, the first zone covers the area ranging from 3 M to 5 M off the coast for one sailing direction, whereas the area ranging from 5 M off the coast to the second zone limit is applicable for the opposite sailing direction.

The second zone ranges from 10 M to 20 M off the coast, with the boundary separation limit at 13 M. This zone, i.e. the area for plotting courses at 10 M and more off the coast, is established for reasons of additional safety. The zone enables plotting courses out of the 12 M range off the coast, hence out of the territorial waters of coastal states. Finally, 12 M off the coast is the second boundary line for releasing certain types of ship waste in compliance with MARPOL 73/78 Convention.

Establishing a third zone is necessary to keep exceptionally large ships and ships conveying dangerous cargo as far off the coast as possible. The area limit would be determined at 20 M off the coast, with a boundary line separating reciprocal traffic flows at 25 M off the coast. The boundary line is determined on the following basis: a great distance to the coast allows for enough manoeuvring space; it is the third boundary line determined by MARPOL 73/78 Convention; the coast is still within visual and radar range; minimal danger to people and shore facilities in case of ship accidents; guidelines of certain shipping companies operating large vessels carrying dangerous cargo recommend their masters to plot courses at distances greater than 20 M off the coast [8], [9].

The above described additional recommendations would considerably clarify the general

držala. Navedene preporuke ne odnose se za područja gdje postoje sustavi usmjeravanja plovidbe ili neke druge ograničavajuće mjere obalnih država.

5. ZAKLJUČAK

Promet brodova svakim je danom sve intenzivniji, sukladno tome gustoća prometa na glavnim plovidbenim pravcima raste kao i opasnost od nezgoda. Analizira li se način kretanja brodova, te sam način planiranja putovanja i izbora ruta od strane zapovjednika brodova i časnika plovidbene straže nedvojbeno je da se nepotrebno stvara izniman broj potencijalnih opasnosti, tj. onih opasnosti koje bi bez odgovarajućih radnji posade broda rezultirale nezgodom. To se posebno odnosi na nasuprotne plovidbene tokove i potencijalne opasnosti od sudara. Rješenje ovoga problema može se postići uspostavom sustava odijeljenog prometa, međutim ovim sustavima ne mogu se pokriti sva područja svijeta, bar ne u skoroj budućnosti. Iz toga razloga, a u kontekstu izbjegavanja potencijalnih opasnosti od brodova koji se približavaju u nasuprotnim kursovima, predlaže se nekoliko dodatnih preporuka kod povlačenja kursova u obalnom području gdje ne postoje posebni sustavi regulacije plovidbe. Temeljeni dio ovih preporuka je definiranje odgovarajućih zona uz obalu, minimalnih udaljenosti približavanja obali, te graničnih linija unutar svake zone kojim bi se odvajali nasuprotni plovidbeni tokovi. Za nadzor držanja unutar odgovarajućih zona, posebno u točkama izmjene kursa, temeljne bi bile kružnice sigurnih (graničnih) udaljenosti.

ZAHVALA

Autori se zahvaljuju na podršci znanstvenoga projekta "Istraživanje korelacije maritimno transportnih elemenata u pomorskom prometu" (112-1121722-3066) kojega financira Ministarstvo znanosti, obrazovanja i Športa Republike Hrvatske.

recommendation of "keeping to the starboard side of the channel" integrated in the International Regulations for Preventing Collision at Sea. The additional recommendations would eliminate the variety of interpretations of this rule when not sailing in very narrow passages and when not sailing inshore. On the other hand, the freedom of selecting routes would be maintained. The suggested recommendations do not refer to areas featuring routing systems or some other sailing regulation forms.

5. CONCLUSION

Ship traffic is becoming increasingly intensive. Accordingly, traffic density on major waterways increases as does the risk of accidents. The analyses of the ship movement behaviour, and the ways the captains and officers of the navigation watch make passage planning and select sailing routes, clearly show that these activities lead to an unnecessary high number of potential risks, i.e. the risks that could result in accidents in case of not undertaking adequate avoiding actions. This particularly refers to reciprocal traffic flows and potential collision risks. The problem can be eliminated by introducing traffic separation systems. However, such systems cannot be applied to all areas in the world, at least not in the foreseeable future. Therefore, within the context of avoiding potential risks in meeting situations when ships move in reciprocal courses, certain amendments to the existing guidelines can be suggested, referring to plotting courses in coastal waters which have no particular sailing regulation systems. The essential part of these recommendations is defining adequate zones along the coast, minimal distances when approaching the coast and boundary limits within each zone, aimed at separating reciprocal ship traffic flows. Circles indicating safe (boundary) distances would be essential for monitoring the ship position within appropriate zones, in particular at course altering points.

ACKNOWLEDGMENTS

The authors acknowledge the support of the research project "Research into the correlations of maritime-transport elements in marine traffic" (112-1121722-3066) funded by the Ministry of Science, Education and Sports of the Republic of Croatia.

LITERATURA / REFERENCES

- [1] Benković, F., /et al./, Terestrička i elektronska navigacija, Split, Hidrografski institut Ratne mornarice, Split, 1986.
- [2] Bowditch, N., The American practical navigator, Maryland, DMAHTC, 2002.
- [3] Coolen, E., Nicholls's concise guide to navigation, 10th ed., Vol. 1, Glasgow, Brown's, Son & Ferguson, 1987.
- [4] Coolen, E., Nicholls's concise guide to the navigation examinations, 12th ed., Vol. 2, Glasgow, Brown's, Son & Ferguson, 1995.
- [5] Lušić, Z., Prilog istraživanja utjecaja sigurnosti i ekonomičnosti na optimizaciju pomorskog putovanja, doktorska disertacija, Rijeka, Z. Lušić, 2010.
- [6] Simović, A., Terestrička navigacija, Zagreb, Školska knjiga, 2001.
- [7] Hansen, P. F., ISESO Project 7 and 8 - Basic modelling principles and validation of software for prediction of frequencies, ISESO – Information technology for enhanced safety and efficiency in ship design, Denmark, 2000.
- [8] OSG Safety management manuals-shipboard organization and responsibilities, 2001.
- [9] SMS Manual, NYK Shipmanagement-responsibilities and duties (Deck officers), 2001.

INTERNET

- [10] http://www.esa.int/esaEO/SEMBDI0OWUF_index_1.html#subhead2 (European Space Agency), srpanj 2010.
- [11] http://www.gerwick.com/PDF/ship_tracks.pdf (Gluver, H., D. Olsen, Survey of ship tracks in Fehmarn Belt, ICCGS 2001 2nd International Conference on Collision and Grounding of ships survey of ship tracks in Fehmarn Belt), svibanj 2008.
- [12] <http://www.ens.dk> (Anholt offshore wind farm, analysis of risks to ship traffic, Denmark, 2009.), srpanj 2010.
- [13] <http://www.marinetraffic.com/ais/> (Pomorski promet-AIS), srpanj 2010.
- [14] http://www.ramboll-wind.com/PDF/Referencer/Ship_collision_Risk_Rødsand.pdf (Christiansen, C. F., L. W. Andersen, P. H. Pedersen, Ship collision risk for an offshore wind farm), svibanj 2008.
- [15] http://www.slc.ca.gov/division_pages/DEPM/DEPM_Programs_and_Reports/BHP_Deep_Water_Port/FinalEIR/Volume%20III/Appendix%20C1/C1f_Appendix_F.pdf (Cabrillo Port LNG Deepwater-Independent Risk Assessment, Appendix F-Marine Traffic and ship collision modeling to the independent risk analysis (Appendix C1), 2006.), svibanj 2008.