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Cruise Ships Routing in Central Part of the Adriatic East Coast

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ABSTRACT: Strong expansion of cruise ships traffic and cruising destinations in the Adriatic makes the region ideal for cruise ships routing analysis. The aim of this paper is to detect real cruise ships traffic movement in order to understand how present cruise ships routes are navigationally and environmentally sustainable and safe. Cruise ships characteristic operational demand and navigational routine in relation with regions indented coast line with high level of environmentally preserved areas in landscape of high national value, emphasise importance of real cruise ships routing awareness.
The research is based on one year cruise ships traffic monitoring and routes analysis in the Central Adriatic East coast. The results offer detail insight of cruise ships navigational routines in navigationally less defined area that has not been frequent cruising region before. Cruise ships routes comparison is carried out between North Adriatic region, which is well defined with traffic separation schemes and navigational aids and less defined Central and South Adriatic regions. The results show that principle of cruise ships routing differ from standard maritime practice and that operational demand for attractive cruising and passenger experience bring cruise ships close to shores in various demanding navigational situations. That routing practice does not meet criteria of sustainability as it often present high navigational, safety and environmental risk.

1 INTRODUCTION

The question of cruise routes awareness in costal navigation is important due to the fact that cruise ships spend major part of itineraries in costal navigation, often in environmentally delicate and preserved locations. High passenger demand and increased demand for new cruise ships contributes to cruise industry development and create trend where cruise ships are becoming bigger [3, 15]. That trend makes significant objective for increased awareness of maritime traffic safety in coastal navigation [4].

During last twenty years, the Mediterranean region as well as the Adriatic region record considerable rise in number of ports of calls, currently around 30 cruise ports are in use by cruise lines in the Adriatic Sea [16–18]. The Adriatic Sea for the period from 2015 to 2019 represents the fastest growing region in the Mediterranean with 18.70% growth in cruise calls and 20.90% in total passenger movements [1, 2]. Central and South part of the Adriatic East coast is the fastest growing region inside the Adriatic with 25.75% growth in cruise calls and 46.07% in cruise passenger movement for period from 2015 to 2019 [1, 2]. In addition to notable cruise industry growth, East coast of the Adriatic Sea is the region with great portion of indented coast line with high level of environmentally preserved and natural protected areas with rich biodiversity and high national importance. One of these areas in Croatian part of the Adriatic are three National Parks Brijuni, Kornati and

Mljet and two Natural parks, Lastovo island and archipelago and Telašćica. Taking in consideration above said, cruising routes in coastal navigation in rapidly growing region have to be closely reviewed.

The research will focus on the Central Adriatic region with emphasis to the area of Vis Island and its archipelago. The objective of this research is to detect and analyse current cruise ships routing practices in the Central Adriatic East coast. The focus is to prove that operational demand for attractive cruising and passenger experience, bring cruise ships in navigationally restricted, environmentally protected areas with elevated safety, navigational and environmental risk. Furthermore, that the risk increases in less regulated navigational regions. The aim is also to show how cruise routes differ from standard maritime traffic flow that is defined by Central and Northern Adriatic Separation Scheme.

Current researches and publications related to maritime traffic in the Adriatic Sea are available. Impact of cruise ships routing in coastal navigation from the aspect of sustainability written by Dorigatti, J. 'et al.' [3] analyse current researches in maritime sustainability and discuss operational part of sustainability in cruising industry and its importance. The paper concludes how cruising industry operational practice is important factor of maritime sustainability and has not been enough researched.

Main sailing routes in the Adriatic written by Lušić and Kos [10] and The Adriatic maritime traffic study written by Zec 'et al.' [19] in detail discuss maritime traffic and routes in the Adriatic region. One of the conclusions of these researches' states that maritime traffic flow in Central Adriatic is mostly directed through Central Adriatic separation scheme and that maritime accidents are rare which indicates good maritime traffic coordination. In these researches focus is given on general longitudinal maritime traffic from Otranto strait to Northern Adriatic ports.

Analysis of maritime traffic in central part of the Adriatic written by Lušić, Pušić, Medić [11] analyse sailing routes and structure of maritime traffic. The study is focused on maritime traffic inside Central Adriatic Separation Scheme. The study concludes that the greater part of the longitudinal sailing route extends in the area of sufficient depth and width where there is no significant danger to navigation with exception of danger of collision with the opposite and transverse traffic and danger of grounding in the broader area of Palagruža island. Environmental consideration of the Adriatic East coast is elaborated in the report 'Routing of ships, ships reporting and related matters - Establishment of new recommended Traffic Separation Schemes and other routing measures in the Adriatic Sea' issued by IMO, Sub-Committee on safety of navigation 49th session [6]. In the report emphasis is put on the island Vis, Jabuka, Svetac, Biševo, Sv.Andrija, Palagruža and island of Mljet. The report declares that maritime traffic and incidents are warnings of very serious environmental problems and advice the need for perseverance and protection.

2 CRUISE ROUTES MONITORING AND ASSESSMENT

During last decade east coast of the Adriatic Sea region has experienced strong development of cruising destinations and high growth in cruise calls and passenger movements. Expansion of cruise industry has created new routes that have become standard navigational options for cruise ships. In order to determine and understand cruise routes that are in use today detail analysis of cruise ships traffic movement in Central part of the Adriatic East coast is carried out. The research is performed processing data from 'Evaluation model of sanitary wastewater pollution from cruise ships in the Adriatic Sea' research [14]. All cruise ships movements were monitored on daily basis during one year period (from August 2014 to July 2015) using Marine Traffic software. The research is carried out during busiest five-month period in the Central and South part of the Adriatic East coast on cruise ships over 50 000 GT. Data were selected, analysed, interpolated and chartered in order to determine real cruise ship traffic flow. The research shows that majority of cruise ships have constant seasonal itineraries among scheduled ports with repetitive cruise routes. With that in mind, cruise ships navigational routine doesn't change and obtained results don't become obsolete with time if maritime regulations don't change.

Figure 1. shows cruise ships routes in use in the Central and South part of the Adriatic East coast. The routes are drawn according to real cruise ships movement obtained from the research. Cruise ships routes are marked as black lines. In order to compare cruise ships movement with standard maritime traffic flow through separation schemes, North and Central Adriatic separation scheme is marked by two red squares.

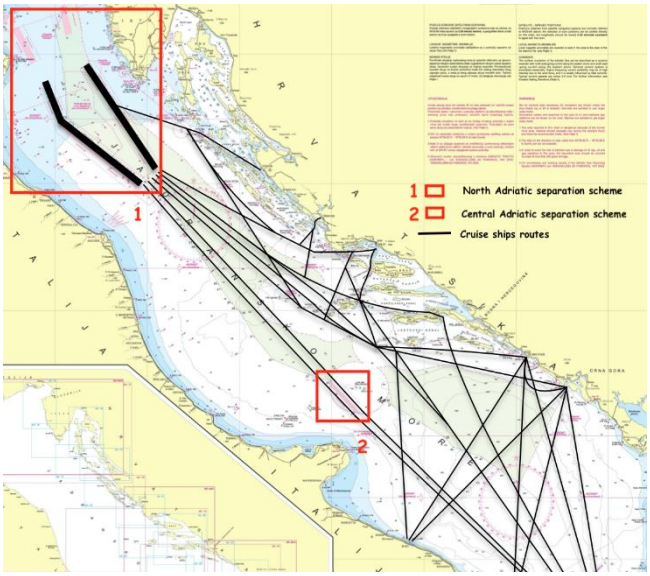

Figure 1. Cruise ships routes in central and south Adriatic east coast
Resource: Ministry of the Sea Transport and Infrastructure Republic of Croatia, chart amended by the author [13]

The main sailing route in the Adriatic Sea is longitudinal sailing route in NW - SE direction, it is defined by North Adriatic separation scheme, Central Adriatic separation scheme and the Otranto Strait

(Figure 1). North Adriatic separation scheme branches in the Northwestern and Northeastern direction directing traffic to the biggest ports in the North Adriatic [7]. Due to presence of gas and oil rigs and high traffic concentration the North Adriatic region is well defined with separation scheme and aids to navigation. Central Adriatic region is defined by the Central Adriatic separation scheme, the region is more spacious and unobstructed with less defined traffic corridors [7]. North and Central Adriatic is covered by VTS system. In addition to VTS system every sea craft that operates in accordance with directives of the Resolution of the IMO's Maritime Safety Committee, MSC: 139(76) from December 5, 2002 is obligated to participate in the "Adriatic Reporting System" (ADRIREP). The area is divided into five sectors each of them assigned to competent authority operating on designated VHF channel [5].

The most frequent cruise ships route in the Central Adriatic East coast region is the outer island longitudinal route in the Northwest-Southeast and Southeast-Northwest direction. Depending on cruise ships destination and captains navigational decision there are variety of longitudinal routes that are in use today. Geographical area that will be analysed in this paper is the Central Adriatic outer island region with focus on Vis Island region since the most frequent longitudinal cruise routes pass in vicinity of Vis Island and its archipelago. In addition to that traffic monitoring has shown that area is exposed to higher safety, navigational and environmental risk.

Monitoring of cruise traffic showed that cruise ships on the longitudinal route to the South Adriatic East coast ports or North Adriatic ports do not use Central Adriatic separation scheme. In Northwest-Southeast direction after leaving the North Adriatic separation scheme cruise ships proceed along outer island route on the way to the South Adriatic ports on the East coast. In Southeast-Northwest direction leaving the South Adriatic ports cruise ships proceed on the outer island route until they reach the Northern Adriatic separation scheme (Figure 1). They chose to pass through some geographically restricted, navigationally demanding and environmentally sensitive areas. The challenges that central part of the Adriatic east coast meet are cruise routes that pass close to the shores of environmentally sensitive areas and cruise ships close quarter and crossing situation in navigationally restricted and environmentally sensitive areas.

3 CRUISE SHIPS ROUTING IN CENTRAL ADRIATIC - VIS ISLAND AND ITS ARCHIPELAGO REGION

Island of Vis and its archipelago with Biševo, Svetac, Jabuka and Palagruža islands form the outer island region in the Central Adriatic East coast. According to Figure 2. the region is frequent with longitudinal and transversal cruise ships traffic. Longitudinal routes pass south of Svetac and Biševo islands, between Svetac and Biševo, between Biševo and Vis and north of Vis Island along Vis channel. Transversal routes pass west of Vis island between Biševo and Svetac island and east of Vis between Hvar and Vis islands.

Figure 2. is created according to monitored real cruise ships movement. Black lines are real cruise ships routes in use, red circles present high-risk areas from the aspect of navigational and environmental safety. High risk sectors are in following geographical areas: island of Svetac (1), passage between Svetac and Biševo island (2), Biševo channel (3) and Vis channel - northeast of Vis (4).

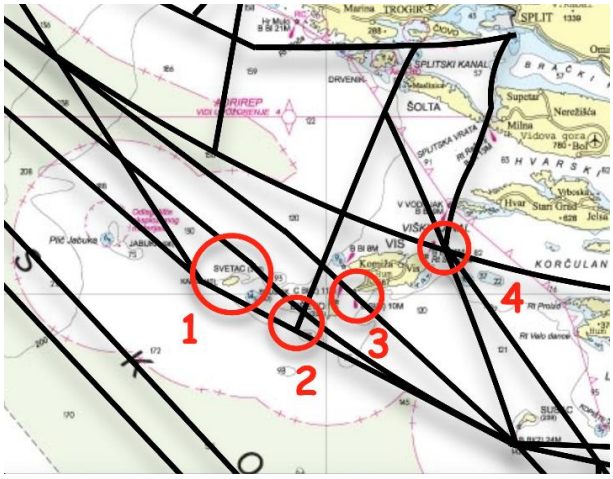

Figure 2. Navigational risk areas - Vis Island and its archipelago
Resource: Marine traffic data, amended by the author [1, 13]
1. Svetac island
2. Passage between Svetac and Biševo Island
3. Biševo channel
4. Vis channel

3.1 *Svetac island*

The Island of Svetac stands about 12.7 M west of the island of Vis [5]. Cruise ships routes pass frequently shores of Svetac island in northwesterly and southeasterly courses. On southeasterly courses from the North Adriatic ports to the South Adriatic East coast cruise ships don't use Central Adriatic Separation Scheme. They proceed along east coast outer island route, passing south or north of the Svetac island (Figure 3).

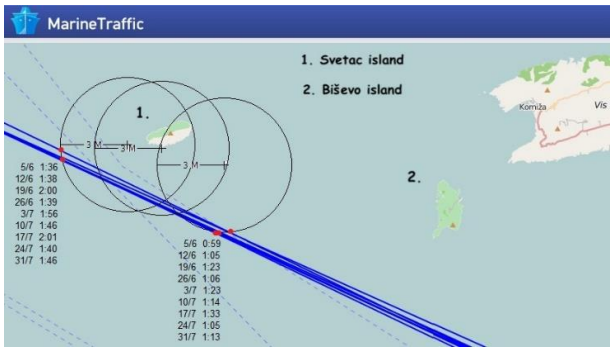

Figure 3. The example of cruise routes passing shores of Svetac island - Central Adriatic
Resource: Marine Traffic, amended by the author [12]

Figure 3. shows real cruise traffic movement around the Svetac island region. For the purpose of presentation movement of one cruise ship in period of time is selected and presented (Figure 3). Blue line represents actual cruise route taken by a cruise ship. Black circles have 3 M diameter and represent

environmental reference to the International Convention for the Prevention of Pollution from Ships, Anex IV (MARPOL) [8]. Traffic monitoring showed that 76 cruise ships passed inside 3 M from shores of Svetac island with average retention period of 16.1 minutes. 155 cruise ships pass on 3 M to 6 M distance and 47 cruise ships kept 6 M and more from the island shores. Traffic monitoring showed that 6 times in 90 minutes period two cruise ships meet inside 3 M from island shores. In one occasion 3 cruise ships met in 90 minutes period inside 3 M from the island shore.

Navigational risk occurs when cruise routes pass close to the shores of the Svetac island and when cruise ships meet in head on or overtaking situation close to the island shores. Head on and crossing situation close to the island shores puts cruise ships in northwesterly courses in particularly demanding navigational situation, since shallows and shore are in immediate vicinity on ships starboard side [9]. In addition to cruise ships traffic, the area around the Svetac island is a fishing ground with a dense presence of fishing boats depending of fishing season.

Taking above mentioned in consideration, passing near the shores of the Svetac island presents navigational risks of grounding, collision and environmental risk.

3.2 *Passage between Svetac and Biševo island*

Passage between Svetac and Biševo island is part of longitudinal and transversal corridor cruise ships use. Longitudinal southeasterly routes proceed to South Adriatic east coast destinations while northwesterly routes head to North and Central Adriatic ports. Transversal routes in northerly and southerly directions connect port of Split with southern Adriatic destinations and Italian coast.

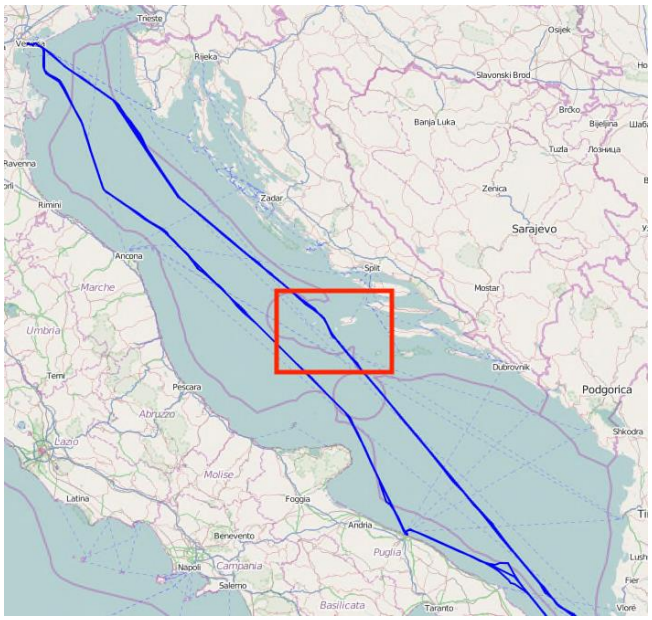

Figure 4.1. Overview of cruise route passing from Mediterranean regions to Northern Adriatic ports
Resource: Marine Traffic application, amended by the author [12]

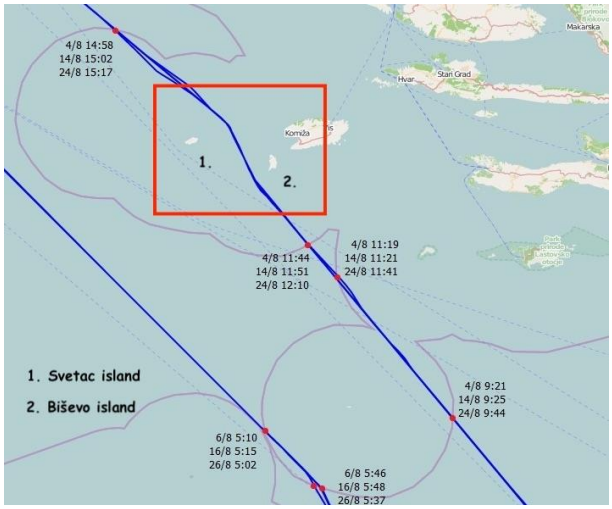

Figure 4.2 Fragment of Figure 4.1. Cruise route passage between Biševo and Svetac island on the international route from the Mediterranean region to North Adriatic (Italy)
Resource: Marine Traffic application, amended by the author [12]

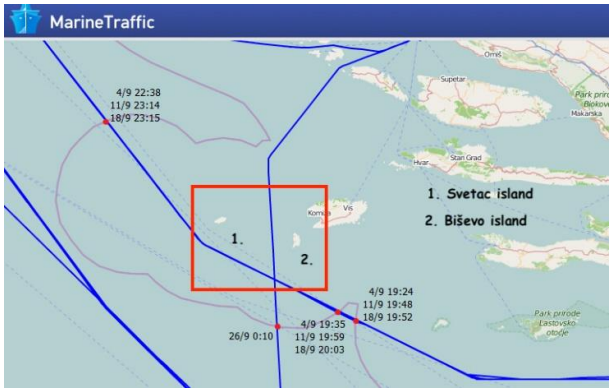

Figure 4.3 Overview of transversal and longitudinal routes in Biševo and Svetac island region
Resource: Marine Traffic, amended by the author [12]

Figures 4.1 - 4.3 show longitudinal and transversal cruise ships routes in the Central Adriatic region around Biševo and Svetac islands. Blue line represents real cruise ship route, light blue line is 12 M limit, dates and times indicate when a ship left and entered 12 M area and red square emphasise points of interest. For the purpose of presentation movement of two cruise ship is selected and presented. First ship (Figure 4.1 and Figure 4.2), second ship (Figure 4.3).

During research period 43 cruise ships passed between Svetac and Biševo island, 21 cruise ship pass inside 3 M from Biševo island with average retention period of 19.23 minutes, 51 cruise ships pass on 3 M to 6 M distance from Biševo island and 6 cruise ships kept 6 M and more from Biševo island. Monitoring has shown that 5 times in 90 minutes period, two cruise ships meet inside 3 M from Biševo island shores.

Traffic monitoring has shown cases where cruise ships from the Mediterranean regions, passing from the Otranto strait to North Adriatic ports, avoid Central Adriatic Separation Scheme and proceed between Svetac and Biševo island on the way to the North Adriatic Separation Scheme (Figure 4.1, Figure 4.2).

Navigational risks for cruise ships traffic that pass between Svetac and Biševo islands are: cruise routes that pass close to the island shores, head on and overtaking situation close to the island shores, crossing of longitudinal and transversal routes in restricted coastal areas and presence of water-crafts, sailing boats and fishing boats inside the passage as the area is traditional fishing region and nautical touristic destination.

General comparison between traffic flow in the North Adriatic which is well defined with traffic separation schemes and navigational aids and traffic flow in the Central and South Adriatic, as less defined maritime zone has been made. It has shown that cruise ships routes oscillate from standard traffic flow which is defined by longitudinal corridor that pass through the North and Central Adriatic Separation Scheme (Figure 1, Figure 4.1 and Figure 4.2). The research has shown that all doubtful navigational decisions have been carried out in navigationally less defined Central and South Adriatic region.

3.3 *Biševo channel*

Biševo channel leads between the SW extremity of Vis Island and Biševo island. The channel is 2.2 M wide; it is navigationally restricted for passage less than 300 m from the shore with recommended daily passage [5]. In addition to that the region is popular touristic, nautical and fisherman destination with dense seasonal watercraft, sailing and fishing boat traffic, which makes navigation of large cruise ships serious safety and environmental risk.

Figure 5. shows Central Adriatic region with Vis, Biševo and Svetac islands. Blue line represents actual cruise route taken by two cruise ships in period of time and red square emphasise point of interest. Black circles have 3 M diameter and indicate environmental reference to the International Convention for the Prevention of Pollution from Ships, Anex IV (MARPOL) and safety navigational reference to distance cruise traffic pass from the island shores [8]. Dates and time indicate when a ship entered and left 3 M area. Data collected has showed that selected routes are not isolated case nor made by coincidence but have become standard navigational choice for monitored cruise ships in period of time.

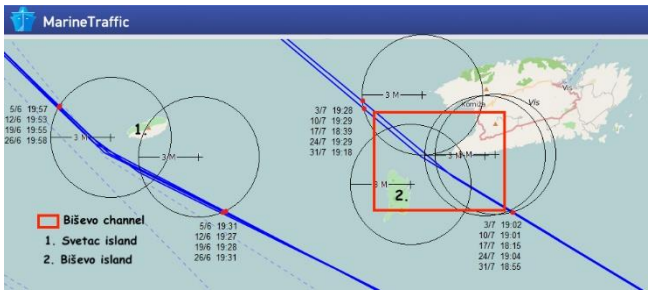

Figure 5. The example of cruise routes in use passing Biševo channel Resource Marine Traffic, amended by the author [14]

Cruise ships routes through Biševo channel are not usual, however despite of restrictions, cruise ships passage in Biševo channel was detected. During monitoring period, a cruise ship passed through Biševo channel 5 times with average retention period 25.2 minutes inside 3 M from shore. The passage was carried out by identical cruise ship, that shows that the route has become standard navigational routine for monitored cruise ship. Observed cruise route put cruise ship in immediate grounding and collision danger (Figure 5) [9].

3.4 *Vis channel*

Vis channel is situated between island of Hvar and Vis in the Central Adriatic. It is located in intersection of longitudinal and transversal routes. Longitudinal inland cruising route connects the Northern and Central Adriatic region with the Southern Adriatic ports. Transversal route connects Split with South Adriatic coast and Italy.

Main navigational risk is crossing of transversal and longitudinal route and head on situation in restricted area of Vis channel. Longitudinal inland cruise traffic during research period was not constant, on the other hand transversal traffic is frequent. With cruise traffic there is a frequent ferry and catamaran connection from Vis and Lastovo islands to Split and vice versa. In addition to that the area of Vis channel is very touristy popular with developed nautical tourism and dense leisure craft traffic.

Taking above in consideration navigation in Vis channel has to be carried out with caution because risk of collision and grounding is elevated [9].

Figure 6. show longitudinal and transversal cruise ships routes in the Central Adriatic region around Vis channel. Blue line represents real cruise ship route, light blue line is 12 M limit, dates and times indicate when a ship left and entered 12 M area.

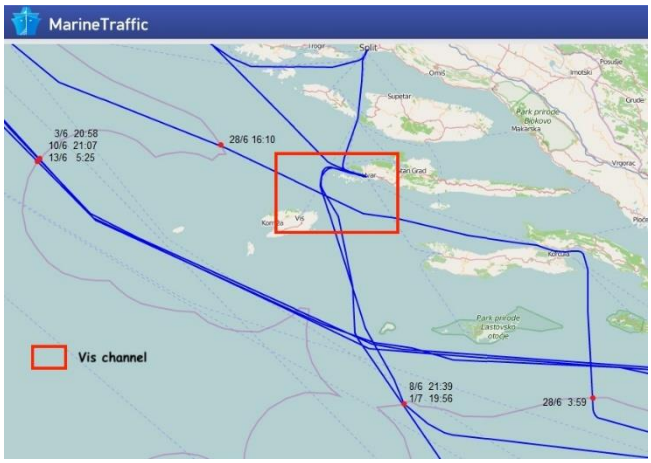

Figure 6. The example of cruise routes in use passing Vis channel.
Resource: Marine Traffic, amended by the author [12]

4 CONCLUSION

The research has shown various situation cruise ships encounter during their operation. In order to meet operational schedule and offer unique passenger experience cruise ships have chosen routes that are navigationally challenging. Navigational decisions

taken by some cruise ships, in order to meet operational demands were unpredicted and performed often in unusual maritime manner.

Route monitoring has shown that cruise routes are repetitive, they become usual navigational practice as majority of cruise ships have standard seasonal itineraries. With that in mind, irrespective of monitoring period, cruise ships routing practice does not change if maritime regulations don't change.

Research proved that cruise ships in order to comply with operational demand, in less defined navigational regions, plan routes that present navigational, safety and environmental hazard. Cruise ships traffic analysis showed that cruise ships have been choosing high risk navigational routes deliberately and that selected routes are not exemption nor taken by coincidence. On the contrary, the routes have become repetitive practice and standard navigational routine.

Comparison between traffic flow in the North Adriatic, which is well defined with traffic separation schemes and navigational aids and traffic flow in the Central and South Adriatic, as less defined maritime zone, has proven that cruise ships routes oscillate from standard traffic flow. Cruise traffic overview has confirmed that cruise ships on the way to the South Adriatic East coast ports do not use Central Adriatic Separation Scheme. In addition to that the research has shown that the most doubtful navigational decisions have been carried out in theCentral and South Adriatic region.

The study has brought to the attention how well-defined traffic schemes and efficient traffic coordination are of high importance for regulated and safe maritime traffic. With that in mind, it is of high importance that cruise traffic expansion is well controlled and equally complemented with investment, implementation and development of routing systems, efficient traffic control and maritime regulation. With aim to create and maintain efficient cruising operation with high level of navigational safety, environmental preservation and natural protection.

Monitoring of cruise routes has brought to the attention lack of regulation and coordination in new, developing and expanding cruising regions. The research has shown that cruise industry is unique when it comes to passage planning in costal navigation. Operational requirements for cruise itineraries and route planning differ from maritime industry standards. Which certainly leave a room for detail analysis of cruise ships routing in costal navigation in one of future researches.

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