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Atlas of Environmental Risks and Water Area Quality in Croatian Marinas

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ABSTRACT

The lack of systematic mapping of water quality in the water areas of Croatian marinas hinders visualization and understanding of potential cumulative impact of marinas on the environment. The main goal of the research subject of this paper is forming an atlas of environmental risks and water area quality in Croatian marinas by implementing model of *Marina Environmental Risk Assessment* – MERA. Within the implemented model, input data are concrete and current data obtained through the questionnaire submitted to the management structures of Croatian marinas, which is an additional practical value of model and reasearch results. The implemented methodology and risk model of the impact of Croatian marinas on the environment in this paper provides an insight into the current situation and represents a significant basis for managing environmental risks and the quality of water areas in Croatian marinas.

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1 Introduction

The lack of systematic mapping of water quality in the water areas of Adriatic marinas, encouraged the authors to point out the importance of the environmental risk evaluation issue and the evaluation of water quality in water areas on the available sample, especially in terms of announcement of the construction of new marinas and the enlargement of the existing ones. Without entering into the microbiological quality, this research paper is focused on visual states of water quality in water areas as the primary impression encountered by sailors and local residents. In this paper the basic starting point for environmental risk and quality of water areas research in Croatian marinas is the approach described by Gomez and his colleagues [1, pp. 355-365] when mapping environmental risks and quality in water areas alongside the Spanish coast. When producing so called "atlas" in function of mapping environemntal risks and quality of water areas, mentioned authors use model of *Marina Environmental Risk Assessment* – MERA. The authors use that model to analyze data of general characteristics of marinas, including hydromorphological characteristics, human pressures, environemntal conditions and management. Data of general characteristics of marinas are combined with available level of information of certain locations and generates and ranks the level of environmental risk. The procedure of the investigation of the OECD's model *Pressure – State – Response* [2], according to which is assessed the risk of the impact on environment for 320 marinas alongside the Spanish coast and to visualise issues by elaborating „atlas" of environmental risks and water area quality of water areas of the Iberian peninsula. By enabling spatial overview of the data through the atlas, they create prerequisites for visualizing the regional impact on the marinas and for a better understanding of the potential cumulative impacts of human activities in marinas in reference to environmental risks and water quality in marinas.

2 Methodology of impact of Croatian marinas on environmental and water quality assessments

Aiming at detecting environemental risk of Croatian marinas and water quality, in this research has been used method of *Marina environmental risk assessment* – MERA. For the purposes of this method data of Croatian marinas were collected using the survey method and were systematized and processed in an appropriate manner.

2.1 Basic determinants of *Marina Environmental Risk Assessment (MERA)* methods

The implementation of the MERA approach, in this paper, although of a limited nature, provides an opportunity to identify and compare the impact of Croatian marinas on the environment offering an assessment of the scale of environmental risk and quality of the water areas in Croatian marinas. Similarly, results obtained in the research represent the relevant basis to identify common characteristics of marinas and to develop systematic management strategy appropriate to the scale of the mentioned environmental risks.

Marina environmental risk assessment – MERA integrates three main factors: pressure (Pr), state (St) and response (Rs) Equation: (1)

$$R_i = Pr_i \, x \, St_i + Rs_i \tag{1}$$

Where R_i is a term that describes the environmental risk of marinas on water quality, Pr_i captures the combined environmental Pressures, St_i – provides a measure of the current environmental State (environmental conditions) and Rs_i is the Response to mitigate, adapt to or prevent human-induced negative impacts on the water quality of a (i) marina.

Pressure ("Pr") in Equation (1) is estimated by considering four parameters as the main driving force: intensity of navigation (NV_i), marina operation activities (MA_i), probability of requirement of dredging interventions (DG_i) and external activities (EX_i) (2)

$$Pr_i = NV_i + MA_i + DG_i + EX_i \tag{2}$$

Intesity of navigation (NV_i) is estimated as the density of boats housed by a marina (boats/m^2). This is calculated by dividing the number of berths by the water surface where marina activity takes place. Marina operation activities (MA_i) are assessed by considering presence (1) or absence (0) of main fuel stations and dry docks within the marina boundaries. The structural type of marinas (1: interior; 0,5: dock; 0: anchorage) and the type of substrate when the marina is a harbour (1: mud; 0.7: sand; 0.3: gravel; 0: rocky) are used as surrogates to assess the need for dredging (DG_i). Finally, activities at the periphery of the marinas (EX_i) are valued by identifying primary land usage within a a 1 km buffer distance around the marina (1.0: industrial, mining, urban; 0,5: agricultural; 0: natural or semi-natural). The highest category value will be adopted (worst-case scenario) when assessing the external activity at a marina level.

State ("St" in Equation (1) above) is estimated by cosidering three parameters which directly related to the enviromental conditions: susceptibility (SU_i), ecological value (EV_i) and naturalness (NA_i)

$$St_i = SU_i + EV_i + NA_i \tag{3}$$

Response ("Rs") in Equation (1) is estimated considering two parameters linked to the likely response: adopted environmental measures (AM_i) and adopted environmental instruments (AI_i)

$$Rs_i = AM_i + AI_i \tag{4}$$

Adopted measures (AM_i) are estimated by considering the number of adopted environmental measures undertaken by marina, such as garbage disposal, waste management, bilge management and oil management. Adopted instruments parameter (AI_i) is assessed by computing the number of adopted environmental management procedures relevant to the marina, including Blue Flag (FEE, 2007), ISO14001:2015 , EMAS (Eco-Management and Audit Scheme; Blue Star Marina).

Once all parameters are caluclated, results are normalized by reference to the maximum values across all marinas and discarding outliers for each parameter with values greater than $\bar{x} \pm 3 \cdot SD$.

Finally, risk factors are categorised into four categories with values between 1 and 4 (for Pressure and State factors) or into two categories with values of either 0 or 4 (for Response factor). The percentile system (P25, P50, P75) of the observed values is used to define the criteria among the different categories to favour a dynamic management and continuous improvement. Marinas are classified at: very high-risk($R_i \geq 15$), high-risk ($10 \leq R_i < 15$), moderate-risk ($5 \leq R_i < 10$), low-risk ($1 < R_i < 5$) and very low-risk ($R_i = 1$).

2.2 Data collection for Croatian marinas

According to the data of the Croatian National Tourist Board [3, p. 33], the Republic of Croatia disposes of 85 marinas with capacity of 18.942 berths on the coastline of 73.705 m with total surface of water area of 4.643.877 m^2 of which, according to the data of the Internet portal Charter Croatia [4], for commercial use on the Adriatic coast are destinated 56 marinas with 16.000 sea berths and 8.500 dry dock berths and 30.000 berths in harbour and sports harbours.

All Croatian marinas have official web pages with e-mail addresses and contact of responsible persons. The required data has been collected during July and August 2022 using survey method by correspondence via e-mail for purposes of this research paper. In total were contacted 42 responsible persons in Croatian marinas, i.e. 75% of Croatian marinas for commercial use of which to the survey questionnaire responded 26 contacted persons i.e. 62% of persons. Considering that four survey questionnaires were unusable for processing, 22 survey questionnaires were filled in by responsible persons which represents a relevant sample of 39% of all Adriatic marinas.

Table 1 General data of analyzed sample of Croatian marinas, 2022

MARINA	SURFACE IN m²			Part of water area for berths m²	Capacity m²/day (m²*365 days)	Usage of the surface of water area m²/dan	Usage of berths m/day
	Coastal area	Water area	Total				
Umag	44.022	91.293	135.315	41.775	15.247.978	0,38	0,58
Rovinj	16.147	51.433	67.580	22.021	8.037.719	0,12	0,32
Pula	4.647	28.653	33.300	13.728	5.010.846	0,74	0,62
Pomer	9.283	40.912	50.195	18.939	6.912.700	0,52	0,82
Opatija	30.808	82.515	113.323	37.980	13.862.707	0,43	0,83
Cres	35.052	100.876	135.928	46.313	16.904.175	0,40	0,62
S. Draga	15.228	54.345	69.573	26.030	9.500.951	0,33	0,55
Rab	2.609	14.694	17.303	6.856	1.371.188	0,24	0,13
Šimuni	14.027	21.169	35.196	9.738	3.554.213	0,75	0,74
Žut	12.652	31.038	43.690	14.823	2.964.683	0,14	0,13
Piškera	15.222	21.052	36.274	9.680	1.936.026	0,16	0,10
Jezera	15.628	32.460	48.088	15.417	5.627.377	0,64	0,78
Vodice	19.557	53.488	73.045	24.752	9.034.419	0,66	0,89
Skradin	7.097	30.620	37.717	14.083	5.140.463	0,65	0,67
Trogir	8.341	18.159	26.500	8.734	3.187.822	1,25	0,84
Split	15.705	39.667	55.372	18.285	6.674.003	1,07	0,86
Milna	9.222	24.006	33.228	10.948	4.009.151	0,55	0,61
Vrboska	3.583	14.169	17.752	6.517	2.378.737	0,75	0,60
Palmižana	16.127	28.626	44.753	13.378	2.675.644	0,42	0,20
Korčula	7.705	22.365	30.070	10.256	3.743.399	0,36	0,31
Dubrovnik	52.395	71.510	123.905	24.610	8.982.826	1,08	0,70
Slano	7.830	58.449	66.279	27.101	9.892.025	0,36	0,69
Total	362.887	931.499	1.294.386	421.964	146.649.052	Av.val 0,55	Av.val 0,57

Source: Processed by authors according to data collected in the survey questionnaire (2022)

A standarised questionnaire is used to gather information from marina managers and to estimate MERA. The respondents (directors or managers of marinas) were requested to share the following data:

- Pressure data (P)
    - Space occupied by the marina (harbour, dock, anchorage or open space);
    - Water area surface m²,
    - Number of berths,
    - Number of dry docks berths,
    - Number of gas stations (in 1 km around the marina),
- State data (S)
    - Entrance length (in meters),
    - Diameter of manouvre of vessels in the marine,
    - Average tidal range (in meters),
    - Number of protected areas (in 1 km around the marina),
- Response data (O)
    - Adopted environmental measures,
    - Instruments used.

In addition to consulting with marina managers a range of other resources such as local public databases (e.g. governance websites and websites associated with regional tourism and environmental groups) is also consulted. Where possible, data collected is cross-checked using global (https://skipper.adac.de/) and local resources or is specifically sourced from the official web page of each marina.

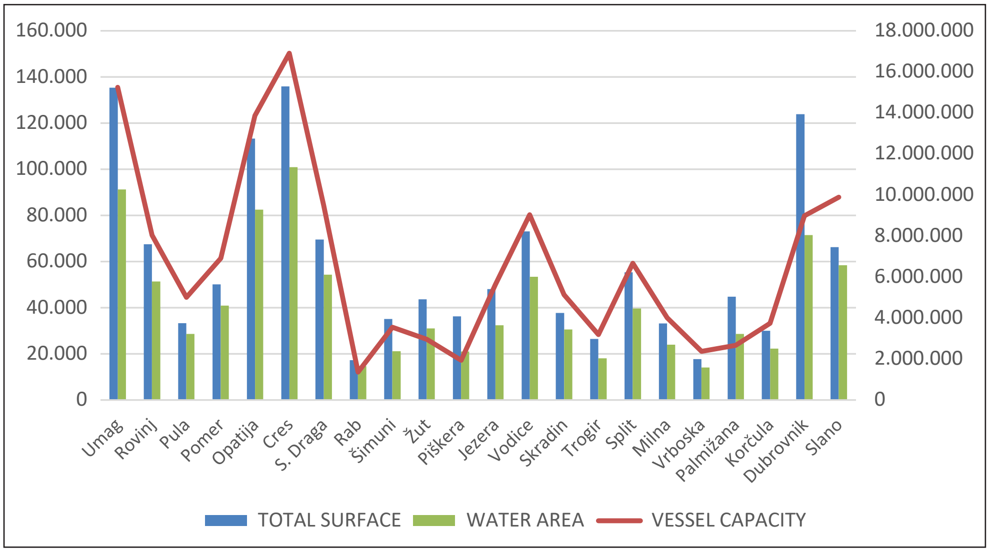
3 Systematization and data processing for Croatian marinas

The collected data were classified within corresponding tables and processed in accordance with the MERA model [5, pp. 1-9], which methodology was briefly explained in the previous chapter.

General data of the analysed sample of Croatian marinas available in HTRS96 system[1] 2022 shown in the Table 1.

From the data in Table 1 it is evident that for the analyzed Croatian marinas the total area of marinas is 1.298.679 m² of which land area 381.283 m², and water area 917.396 m². If it is taken into account the distribution of wa-

[1] System HTRS96/TM, projection coordinate system of the Republic of Croatia for the area of the Land registry and detailed state (Croatian, trasl.note) topographic maps, the Universal Transverse Mercator coordinate system with the central meridian 16°30' and linear scale on the central meridian 0,9999 defined in accordance with HTRS96, official use starting from January 1 2010.



Graph 1 Relation between the total surface, the water area surface and the capacity of receiving vessels in Croatian marinas, 2022

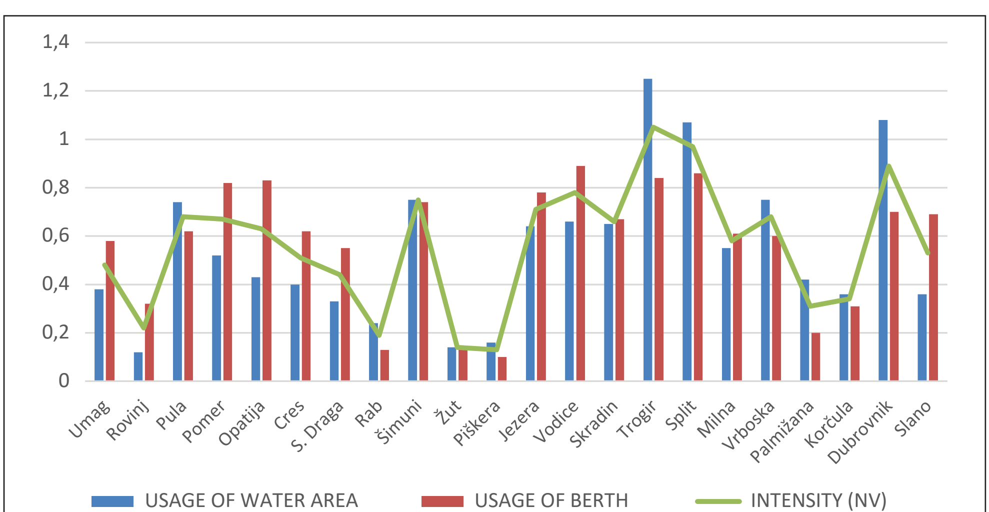
Source: Processed by authors according to data collected in the survey questionnaire (2022)

ter areas according to the function, i.e. that 46% of the total marinas surface is used for berths, the total capacity of marinas is 422.002 m^2. The obtained water area surface is multiplied by 365 days in the year when the specified area is available (except for Rab, Žut, Piškera and Palmižana which as seasonal marinas have availabilty of 200 days), which leads to the available surface capacity/day for the analyzed marinas which is a total of 146.649.053 m^2/d.

Graph 1 shows the relation between the total surface, the water area surface and the annual capacity of receiving vessels (secondary axis of the graph) for the analyzed Croatian marinas.

From the graph above the logical conclusion is subject to questioning that implies how larger total area and thus a larger water area imply a larger annual capacity which is also the rule for the northern Adriatic marinas. However, this does not apply to the southern Croatian marinas and especially to the southernmost Croatian marinas that are not car destinations (at least they were not until the Pelješki bridge was open fror traffic).

Besides the mentioned parameters, Croatian marinas use in their reports data of daily usage of water surface (m^2/day) and daily usage of berths per day (m/day). These coefficients express quality management of marina in financial aspect but also the density of traffic in marina which can be used also in the environmental aspect. The coefficients mentioned in the analyzed marinas are shown in the following graph.



Graph 2 Review of daily usage of water area, berths and sailing intensity in Croatian marinas, 2022

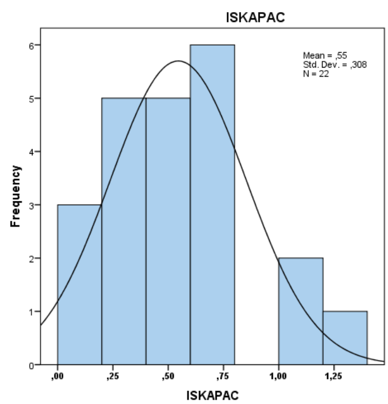
Source: Processed by authors according to data collected in the survey questionnaire (2022)

Table 2 Descriptive data of the usage of the water area, berths and of the intesity of maneuver in Croatian marinas, 2022

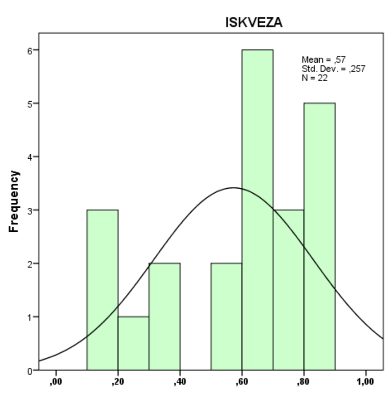
	N	Min.	Max.	Average value	Stand. Dev.	Variance	Distortion	Kurtosis
Usage of water area m^2/day	22	0,12	1,25	0,5455	0,30803	0,095	0,737	0,081
Usage of berth m/day	22	0,10	0,89	0,5723	0,25698	0,066	-0,735	-0,750
Intensity of maneuvers/day	22	0,13	1,05	0,5609	0,26088	0,068	-0,078	-0,653

Source: Processed by authors according to data collected in the survey questionnaire (2022) implementing programme SPSS 24

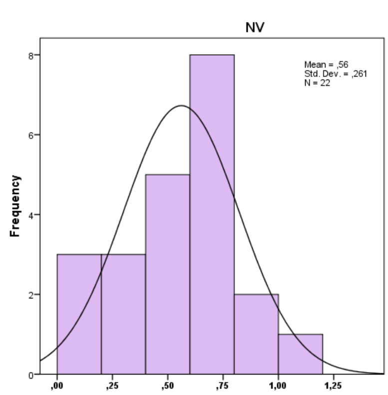
Usage of the water area m^2/day



Usage of the berth m/day



Intensity of maneuvers n/day



Graph 3 Histograms of the usage of water area, berths and intensity of maneuvers in the analyzed Croatian marinas 2022

Source: Processed by authors according to data collected in the survey questionnaire (2022) implementing programme SPSS 24

In order to objectively interpret the data from Table 1 and Table 2 it is necessary to underline that the average data are reported per one day. However, marinas serve as the place for wintering, out of the season months, when all berths are generally occupied and the intensity of the navigation is minimal. Also during the season the intensity of maneuvers is maximum and the berths are generally vacant since vessels are on the sea outside marinas. Therefore is necessary to consider data from the descriptive statistics of the following table.

The following histograms show trends of usage of the parameters of water area, berths and intensity of maneuvers in the analyzed Croatian marinas.

The presented histograms of the usage of water areas, berths and intensity of maneuvers in the analyzed sample of Croatian marinas clearly depict normal distribution pursuant to geographical distribution of marinas (North Adriatic, Central Adriatic, South Adriatic and islands) and the high seasonality of Croatian nautical tourism.

In the following Table 3 are systematized special data for the analyzed Croatian marinas relevant for the MERA calculation.

All analyzed Croatian marinas from the sample according to their structure pertain to the category ''harbour'' and in the MERA calculation they have value 1. Other foreseen categories are dock, anchorage and open marinas. Since Croatian marinas are not situated in estuaries with alluvium of sand and silt there are not foreseen dredging works. However, there is a difference in the bottom of the water area which is mostly stonish and has vote zero (0) and gravel (vote 0,3) and sand (vote 0,7). Type of water in the water area has initial value of 0 since all respondents assess the quality of their water area as clean and clear. Therefore, in the further research that data is ignored in the calculation. Marinas located in the proteted areas or 1 km away from the protected area obtain vote one (1), while the others have vote zero (0).

The responses represent accepting the climate crisis risk. The more answers are comprehensive within the scope of marina management, the more developed is the awarness of the need to undertake measures and activities for environmental protection, prevention of any pollution and decarbonization within the framework of one's capabilities and competences. Independently of readyness of the marina management and personel to participate actively in answers the latter ones cannot be and may not be arbitrary and spontaneous but behind them must stand

Table 3 Relevant data for the analyzed Croatian marinas, 2022

MARINA	Quality of water area		Protected area	Structure ST	PRESSURE			STATE		
	Water	Bottom			NV	MA	EX	SU	EV	NA
Umag	Sea	0	0	Harbour	0,48	0	1	0	0	0,5
Rovinj	Sea	0	0	Harbour	0,22	1	1	0	0	0,5
Pula	Sea	0	0	Harbour	0,68	0	1	0	0	0,5
Pomer	Sea	0	0	Harbour	0,67	0	0	0	0	0,5
Opatija	Sea	0,3	0	Harbour	0,63	1	1	0	0	0,5
Cres	Sea	0	0	Harbour	0,51	0	1	0	0	0,5
S. Draga	Sea	0,3	0	Harbour	0,44	0	0	0	0	0,5
Rab	Sea	0	0	Harbour	0,19	0	1	0	0	0,5
Šimuni	Sea	0,3	0	Harbour	0,75	0	0	0	0	0,5
Žut	Sea	0	1	Harbour	0,14	0	0	0	1	0,5
Piškera	Sea	0	1	Harbour	0,13	0	0	0	1	0,5
Jezera	Sea	0	0	Harbour	0,71	0	0	0	0	0,5
Vodice	Sea	0	0	Harbour	0,78	0	0	0	0	0,5
Skradin	Fresh	0,7	1	Harbour	0,66	0	0	0	1	0,5
Trogir	Sea	0	0	Harbour	1,05	0	1	0	0	0,5
Split	Sea	0,3	0	Harbour	0,97	1	1	0	0	0,5
Milna	Sea	0	0	Harbour	0,58	0	0	0	0	0,5
Vrboska	Sea	0	0	Harbour	0,68	0	0	0	0	0,5
Palmižana	Sea	0	0	Harbour	0,31	0	0	0	0	0,5
Korčula	Sea	0	0	Harbour	0,34	0	1	0	0	0,5
Dubrovnik	Brackish	0,3	0	Harbour	0,89	1	1	0	0	0,5
Slano	Sea	0,3	0	Harbour	0,53	0	0	0	0	0,5

Source: Processed by authors according to data collected in the survey questionnaire (2022)

profession and science expressed through certain certifictaes. Once obtained certificate it is subject to constant control and evaluation pursuant to new scientific achievments.

MERA assesses the adopted measures (AM) and adpoted instruments (AI) as shown in the following tables.

From Table 4 it is evident that in all analyzed marinas are organized waste collection and waste management which includes sorting (paper, glass, metal, textile, plastic and organic) as also sorting of collected waste. For the bilge water collection is required corresponding equipment (pumps, tubes, neutralizing agents) which has not been established in the marinas far away from the land. Similar situation is also with oil collection (from the kitchen, machine room, wellness…).

Instruments are tools that certain marinas have as simbol of commitment to preserve the environment by doing the right thing.

From Table 5 that shows answers of instruments which managment board of marinas have at their disposal one can conclude that all marinas have Green Flag certificate (100%), Blue Flag have 18 marinas (82%), ISO 1400 has been successfully implemented in 19 marinas (86%), while EMAS own all surveyed marinas (100%).

Table 4 Response of adopted measures (AM) of the environmental protection for certain marinas in 2022

MARINA	WASTE DISPOSAL	WASTE MANAGEMENT-SORTING	BILGE WATER MANAGEMENT	OIL MANAGEMENT	VOTE OF ADOPTED MEASURES- AM*
Umag	Yes	Yes	Yes	Yes	0
Rovinj	Yes	Yes	Yes	Yes	0
Pula	Yes	Yes	Yes	Yes	0
Pomer	Yes	Yes	Yes	Yes	0
Opatija	Yes	Yes	Yes	Yes	0
Cres	Yes	Yes	Yes	Yes	0
S. Draga	Yes	Yes	No	No	2
Rab	Yes	Yes	No	No	2
Šimuni	Yes	Yes	Yes	No	1
Žut	Yes	Yes	No	No	2
Piškera	Yes	Yes	No	No	2
Jezera	Yes	Yes	Yes	Yes	0
Vodice	Yes	Yes	Yes	Yes	0
Skradin	Yes	Yes	No	No	2
Trogir	Yes	Yes	Yes	Yes	0
Split	Yes	Yes	Yes	Yes	0
Milna	Yes	Yes	Yes	No	1
Vrboska	Yes	Yes	No	No	2
Palmižana	Yes	Yes	Yes	Yes	0
Korčula	Yes	Yes	Yes	Yes	0
Dubrovnik	Yes	Yes	Yes	Yes	0
Slano	Yes	Yes	Yes	Yes	0

*Scale: adopted all measures = 0; unadopted all measures = 4

Source: processed by authors according to data collected in the survey questionnaire (2022)

Table 5 Response of adopted environmental instruments (AI) for the analyzed marinas 2022

MARINA	GREEN FLAG	BLUE FLAG	ISO 14001	EMAS	VOTE OF ADOPTED INSTRUMENTS – AI*
Umag	Yes	Yes	Yes	Yes	0
Rovinj	Yes	Yes	Yes	Yes	0
Pula	Yes	No	Yes	Yes	1
Pomer	Yes	Yes	Yes	Yes	0
Opatija	Yes	Yes	Yes	Yes	0
Cres	Yes	Yes	Yes	Yes	0
S. Draga	Yes	Yes	No	Yes	1
Rab	Yes	Yes	Yes	Yes	0
Šimuni	Yes	No	No	Yes	2
Žut	Yes	Yes	Yes	Yes	0
Piškera	Yes	Yes	Yes	Yes	0
Jezera	Yes	No	Yes	Yes	1
Vodice	Yes	Yes	Yes	Yes	0
Skradin	Yes	Yes	Yes	Yes	0
Trogir	Yes	Yes	Yes	Yes	0
Split	Yes	Yes	Yes	Yes	0
Milna	Yes	Yes	Yes	Yes	0
Vrboska	Yes	No	Yes	Yes	1
Palmižana	Yes	Yes	No	Yes	1
Korčula	Yes	Yes	Yes	Yes	0
Dubrovnik	Yes	Yes	Yes	Yes	0
Slano	Yes	Yes	Yes	Yes	0

*Scale: adopted all measures = 0; unadopted all measures = 4

Source: Processed by authors according to data collected in the survey questionnaire (2022)

4 Results of research and discussion

The water quality risk assessment in water areas according to the model MERA is based on empirical research [1]; [5] according to which has been formed the sacle of quality factors vote (Table 6) and the scale of risk assessment (Table 7). The percentile system makes it possible to identify risks beyond the average values.

In Table 6 is shown the evaluation of quality factors in the water areas of Croatian marinas.

In Table 7 are shown the results of the water quality risk assessment in marinas 2022 according to the model MERA.

According to the MERA model risk assessment of the water quality in the water areas of Croatian marinas is between 0,835 (negligible risk) to 4,49 (low risk) The average

Table 6 Scale of votes of water quality factors in the water areas of Croatian marinas 2022

FACTOR	CATEGORY	CRITERIA	GLOBAL TRESHOLDS
Pressure	VL – very low (1) L- low (2) M – medium (3) H – high (4)	Pri ≤ P25 P25 < Pri ≤ P50 P50 < Pri ≤ P75 Pri > P75	Pri ≤ 1.5 1.5 < Pri ≤ 2.2 2.2 < Pri ≤ 2.7 Pri > 2.7
State	VL – very low (1) L- low (2) M – medium (3) H – high (4)	Sti ≤ P25 P25 < Sti ≤ P50 P 50 < Sti ≤ P75 Sti > P75	Sti ≤ 0.5 0.5 < Sti ≤ 0.8 0.8 < Sti ≤ 1.2 Sti > 1.2
Response	Optimal (0) Insufficient (4)	Rsi ≥ P50 Rsi < P50	Rsi ≥ 0.75 Rsi < 0.75

Source: Valdor P., A global atlas of the environmental risk of marinas on water quality, 2019, pag. 7.

Table 7 Water quality risk assessment in the water areas of Croatian marinas according to the model MERA 2022

MARINE	PRESSURE (Pr) ST+NV+MA+EX	STATE (St) SU+EV+NA	RESPONSE (Rs) AM+AI	RISK (Ri) Pr · St +Rs
Umag	2,48	0,5	0	1,24
Rovinj	3,22	0,5	0	1,61
Pula	2,68	0,5	1	2,34
Pomer	1,67	0,5	0	0,835
Opatija	3,63	0,5	0	1,815
Cres	2,51	0,5	0	1,255
S. Draga	1,44	0,5	3	3,72
Rab	2,19	0,5	2	3,095
Šimuni	1,75	0,5	3	3,875
Žut	1,14	1,5	2	3,71
Piškera	1,13	1,5	2	3,695
Jezera	1,71	0,5	1	1,855
Vodice	1,78	0,5	0	0,89
Skradin	1,66	1,5	2	4,49
Trogir	3,05	0,5	0	1,525
Split	3,97	0,5	0	1,985
Milna	1,58	0,5	1	1,79
Vrboska	1,68	0,5	3	3,84
Palmižana	1,31	0,5	1	1,655
Korčula	2,34	0,5	0	1,17
Dubrovnik	3,89	0,5	0	1,945
Slano	1,53	0,5	0	0,765
Average	2,1973	0,6364	0,9545	2,2318
Stand. Dev.	0,87708	0,35125	1,13294	1,16547
Percentil P25	1,5675	0,5	0	1,2513
P50	1,7650	0,5	0,5	1,1835
P75	2,7725	0,5	2,0	3,6988

Source: Processed by authors according to data collected in the survey questionnaire (2022)

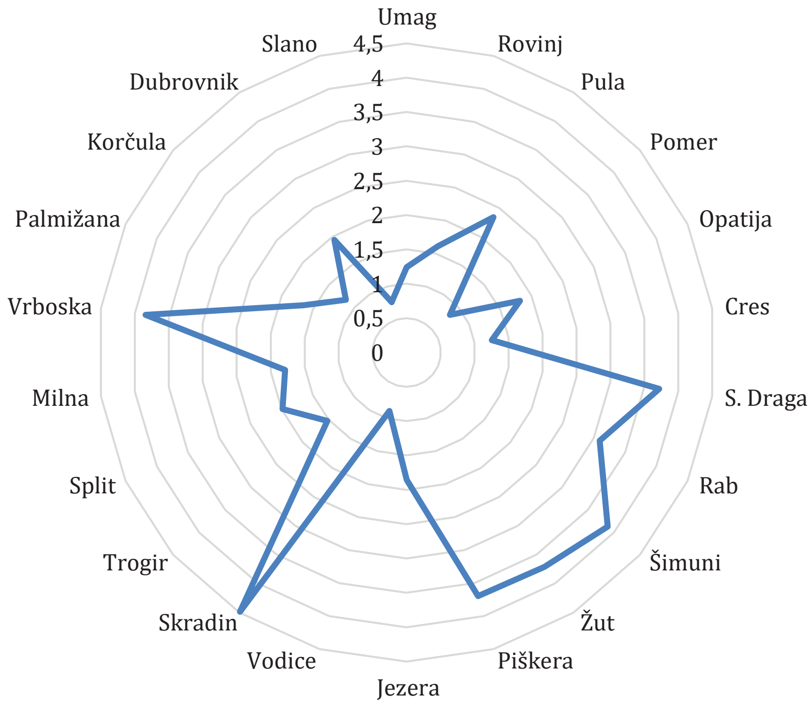


Figure 1 Assessed risk and water quality in water areas of Croatian marinas according to the MERA model

Source: Processed by authors according to data collected in the survey questionnaire (2022)

value of risk is 2,23 which is valued as *low risk.* Division according to the percentiles does not excess the values of the low risk. The radar chart shown in Figure 1 clearly presents the water quality in the water areas of the observed marinas from north to south in a clockwise direction.

Croatian nautical tourism is a seasonable tourism which does not imply that the marinas are empty or closed. On the contrary, they serve as winter camps with significant activities (repairs and corrections) and very often are used for accomodation of their owners, friends and family. However, the intensity of the maneuvering is minimal and also is the risk of maritime accidents out of the main season time. That period of ''resting'' is sufficient for the natural regeneration of damaged flora and fauna in water areas which despite desires of the owners to prolongue the season is extremly convenient for the environment. Climate change predicts longer warm seasons that would be favourable to the boaters and on such way would prolongue the season but probably will increase the pressure and deteriorate the situation which will require additional research and answers.

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