COASTLINE LENGTHS AND AREAS OF ISLANDS IN THE CROATIAN PART OF THE ADRIATIC SEA DETERMINED FROM THE TOPOGRAPHIC MAPS AT THE SCALE OF 1 : 25 000

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In this paper, modern definition of island established by the IHO has been accepted, and classification of islands, islets, rocks and rocks awash has been proposed according to their areas. The coastline of the Croatian part of the Adriatic Sea was digitized from topographic maps produced at the scale of 1 : 25 000 (TM 25). Topographic maps used for digitization are more precise than the maps that were used in earlier works and consequently the data on the number of islands and their coastline lengths and areas are more precise. Polygons of islands were closed in GIS package AutoCAD Map 2000, and each was given its name. From the obtained database and classification of islands, islets and rocks, in the coastal sea area of the Republic of Croatia 79 islands, 525 islets, and 642 rocks and rocks awash, or a total of 1246 have been recorded. Furthermore, it has been established that on TM 25 the island of Cres has the largest area (405.70 km^2), although in literature so far (including atlases) the island of Krk was most often cited as the largest island in the Adriatic Sea. The island of Pag has the longest coastline length of 302.47 km.

Key words: calculation of surfaces and coastline lengths of islands, categorization of islands

U ovom članku prihvaćena je suvremena definicija otoka utemeljena na preporukama Međunarodne hidrografske organizacije (IHO) i predložena je klasifikacija otoka, otočića, hridi i grebena prema njihovoj površini. Obalna crta hrvatskog dijela Jadranskog mora digitalizirana je sa topografskih karata mjerila 1 : 25 000 (TK 25). Topografska karta korištena za digitalizaciju je preciznija nego karte koje su korištene u ranijim radovima. Stoga je podatak o broju otoka, otočića, hridi i grebena, njihovoj duljini obalne crte i površini precizniji. Poligoni otoka zatvoreni su u GIS paketu AutoCAD Map 2000, a svakom od njih je dodijeljen naziv. Iz dobivene baze podataka i klasifikacije otoka, otočića, hridi i grebena, u obalnom moru Republike Hrvatske zabilježeno je 79 otoka, 525 otočića i 642 hridi i grebena ili ukupno 1246. Nadalje, ustanovljeno da na TK25 otok Cres ima najveću površinu (405,70 km^2), iako je do sada u literaturi otok Krk najčešće navođen (uključujući i atlase) kao najveći otok u Jadranskom moru. Najdulju obalnu crtu ima otok Pag (302,47 km).

Ključne riječi: računanje površine i duljine obalne crte otoka, kategorizacija otoka

Introduction

Croatian part of the Adriatic Sea comprises the coastal sea area from the Bay of Piran (the Dragonja river mouth) in the northwest, to the middle of outer part of the Bay of Kotor in the southeast, excluding the 23,975 km long coastline section near Neum which belongs to the Republic of Bosnia and Herzegovina (RIĐANOVIĆ, BIĆANIĆ, 1993). According to Klemenčić (1992), the land area (without islands) of the Republic of Croatia is 56,609.59 km^2 and the coastal sea area (with islands) about 33,200 km^2. In comparison with the area of the east Adriatic territorial waters, the island area covers a very large area, being divided in several island groups: Western-Istrian islands, Kvarner islands, North-Dalmatian islands, Middle-Dalmatian islands and South-Dalmatian islands (STRAŽIČIĆ, 1987).

Internal waters of the Republic of Croatia comprise ports and bays on the coastline of land and islands, and sea parts between the low water line on the coastline and baseline. Baseline is the line between mean low water along the coast of land and islands, straight baseline closing the entrances to ports and bays, and straight baseline which connects the defined points along the coast of land and islands (POMORSKI ZAKONIK, NN 17/94). Croatian territorial sea spreads from the baseline of internal waters towards the continental shelf boundary up to a distance of 12 M (Fig. 1).

In literature, different data are mentioned about the number of islands, islets, rocks and rocks awash in the Croatian part of the Adriatic Sea. The problem is in the fact that terminology is not standardized and there are no general criteria for island classification, so that the limits between islands, islets, rocks and rocks awash are not clearly defined (STRAŽIČIĆ, 1987). According to "Hydrographic Dictionary", island is a piece of land completely surrounded by water, islet is a small island, rock is the natural occurring material that forms the firm, hard, and solid masses of the ocean floor, rock awash is a rock at chart datum (IHO, 1994).

The purpose of this paper is to present the results of calculations of coastline lengths and areas of islands, islets and rocks in the Croatian part of the Adriatic Sea, according to the categorization suggested by Duplančić Leder et al. (2000 a, b).

Short hystorical review

Many authors based their information about the number of islands in the Adriatic Sea on the paper by Austro-Hungarian naval officer Sobieczky (1911), who offered in his work detailed information on indentation of the eastern coast of the Adriatic Sea. The data were the result of the hydrographic survey campaign carried out in 1873. Hydrographic survey sheets were on scales 1 : 28,800 and 1 : 14,400. In his paper, the islands having area below 0.3 km and the islands inside the isobath of 5 m were not counted. Sobieczky (1911) counted 71 islands, 641 islets, 409 rocks or rocks awash, which is a total of 1121 on the eastern coast of the Adriatic Sea.

According to Rubić (1952), island is a piece of land surrounded by water with the coastline length of over 10 km. Islet has the coastline length between 1.5 and 10 km and rock below 1.5 km. According to this definition, Rubić (1952) counted 69 islands, 558 islets, and 413 rocks, or a total of 1040 in the eastern part of the Adriatic Sea.
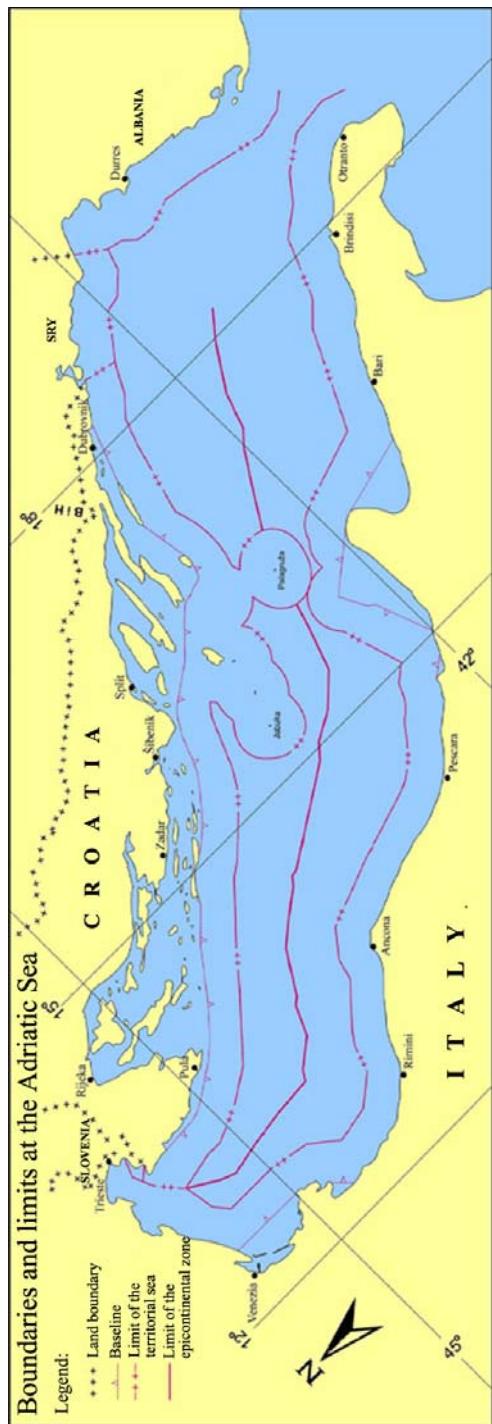
Fig. 1. Map of the maritime territorial boundaries and limits at the Adriatic Sea
Sl. 1. Karta morskih teritorijalnih granica Jadranskog mora

Irić (1955), in the publication of the Hydrographic Institute, systematized earlier results, listed all the islands, islets, rocks and rocks awash, and quoted their dimensions in kilometres and nautical miles. According to Irić, in the Croatian part of the eastern Adriatic there are 66 inhabited islands, 652 uninhabited ones, 389 rocks, and 78 rocks awash, or 1185 in total. In the Montenegrin part of the coastline there are no inhabited islands, 7 uninhabited ones, 37 rocks, and 4 rocks awash, or a total of 48 islands, rocks and rocks awash.

The results of Sobieczky were systematized again by Stražičić (1987), who compared his results with the results of other authors, and counted 60 islands, 653 islets, 438 rocks or rocks awash, or a total of 1151 in the eastern part of the Adriatic Sea.

In 1997 Croatian Ministry of Development and Reconstruction stated the information, not mentioning the authors, according to which in the Croatian part of the Adriatic Sea there are 718 islands, 389 rocks (head above sea level), and 78 rocks awash (head below sea level), or a total of 1185 islands, rocks and rocks awash.

United Nations Convention on the Law of the Sea, Part IV, Article 46 defines the eastern coast of the Adriatic Sea as archipelagic coast (URL 1). This area is a unique location in the Mediterranean area, even in the Earth. Because of that fact it is necessary to categorize islands of this area with special caution. On that basis, Duplančić Leder et al. (2000) proposed the categorisation of islands, islets, rocks and rocks awash as a geographic notion as follows:

- Island is a piece of land completely surrounded by the sea, with the area larger than 1 km^2.
- Islet is a piece of land with the area between 0.01 and 1 km^2.
- Rock or rock awash is a piece of land with the area below 0.01 km^2. The difference between rock and rock awash is that rock is always visible above sea level while rock awash is sometimes submerged below sea level.

Methods

The first step was digitization of the coastline of land and islands covering the Croatian part of the Adriatic Sea on topographic maps at the scale of 1 : 25 000. Topographic maps (edition 1974) were produced by the Military Geographic Institute (VGI) in Belgrade. Transformation of coordinates from the local digitization system in the map projection (5th and 6th zone of Gauss Krüger's projection) was done in ArcInfo 8 software package using Helmert transformation. For this specific purpose, a programme in AutoCAD Map VBA module was made, to project graphic entities of AutoCAD image directly from one projection to another. For easier reference and analysis, the data were then transformed into Gauss Krüger's conformal transverse cylindrical projection, with the central meridian 16° 30' E (FRANČULA, 1981). In order to reduce linear distortions, the linear scale 0.9997 was introduced along the central meridian (TUNJIĆ, LAPAINE, 1998). Maximum linear distortion along the bounding meridian is 40 cm per kilometre; the value of area distortion ranges from -0,06% along the central meridian to 0,08% along the bounding meridian (LAPAINE ET AL., 1993).

Polygons of islands were made in GIS software AutoCAD Map 2000, and the base for designing topology was prepared using Map Cleanup. Each polygon was given its name (Fig. 2), and on this basis the polygon topology was made. Polygon areas *P* on

(Bessel) ellipsoid were calculated using the methods and formulas published by Štemberger (1986, 1992) and Lapaine et al. (1993):

$$P = \frac{1}{2} \sum_{i=1}^{n} (y_{i+1} - y_i)(x_{i+1} + x_i) / p_i \qquad (1)$$

where x_i and y_i are coordinates of the closed polygon points ($x_1 = xn$, $y_1 = yn$), p_i is the factor of correction for each addend because of the projection.

For Gauss Krüger's projection, with linear scale factor along the central meridian 0,9997, local linear scale in the arbitrarily point is:

$$m = 0,9997(1 + \frac{y^2}{2R^2} + \frac{y^4}{24R^4}) \qquad (2)$$

where $R = 6,377,000$ m is the mean radius of the ellipsoid in the observed point, so that the local area scale for conformal projection is:

$$p = 0,9997^2(1 + \frac{y^2}{R^2} + \frac{y^4}{3R^4}) \qquad (3)$$

Area accuracy estimation m_p can be calculated as:

$$m_P^2 = \frac{1}{8} m_T^2 \sum_{i=1}^{n} (y_{i+1} - y_{i-1})^2 + (x_{i+1} + x_{i-1i})^2 \qquad (4)$$

where m_T is the mean error of each particular point, while coordinates of points are supposed to be uncorrelated and their mean error of abscissa and ordinate to be equal (LAPAINE ET AL., 1994).

Coastline length d can be calculated according formula (5) as the sum of distance d_i between two adjacent points (LAPAINE, 2004):

$$d = \sum_{i=1}^{n} d_i = \sum_{i=1}^{n} \sqrt{(x_{i+1} - x_i)^2 + (y_{i+1} - y_i)^2} \qquad (5)$$

Mean square error m_d of coastline length d:

$$m_d^2 = \frac{1}{2} m_T^2 \sum_{i=1}^{n} \left[\left(\frac{x_i - x_{i-1}}{d_{i-1}} - \frac{x_{i+1} - x_i}{d_i} \right)^2 + \left(\frac{y_i - y_{i-1}}{d_{i-1}} - \frac{y_{i+1} - y_i}{d_i} \right)^2 \right] (6)$$

Area accuracy estimation m_p and mean square error of coastline length m_d will be object of future study, and will be calculated using formulas (4) and (6).

Because of extensive calculations, a programme in AutoCAD Map VBA module was made, which calculates coastline lengths and area with corrections directly from the polygon on AutoCAD image of the Adriatic Sea. Calculated values are entered into the database which is connected with the graphic representation, providing the base for a GIS project of the coastal area within AutoCAD Map (Fig. 2).
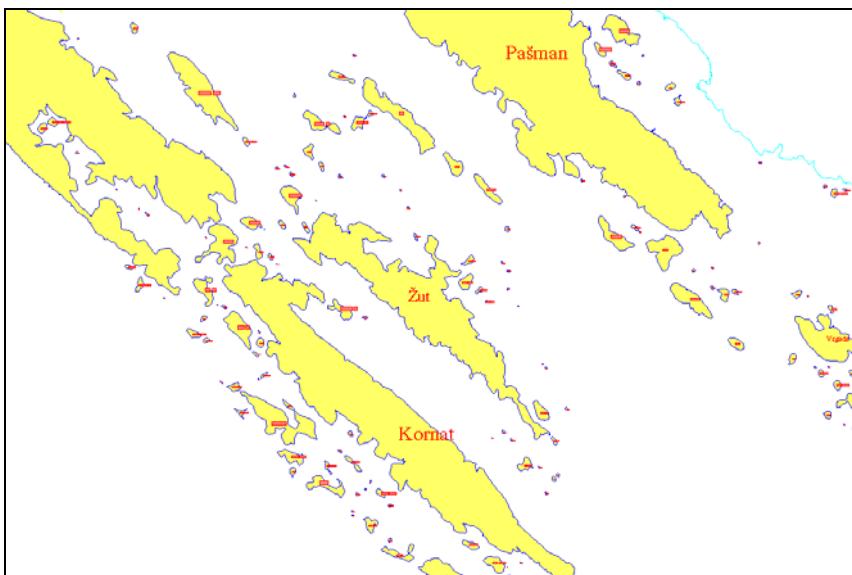
Fig. 2 Part of the North-Dalmatian islands in GIS software AutoCAD Map 2000.
Sl. 2. Dio sjevernodalmatinskih otoka prikazanih u GIS softveru AutoCAD Map 2000.

Results

From the obtained database the number of islands was determined. Categorization and classification of islands, islets, rocks and rocks awash in the Croatian part of the Adriatic Sea was taken from Duplančić Leder et al., (2000a, b) according to their areas. In the Croatian part of the Adriatic Sea 79 islands (Tab. 2), 525 islets (Tab. 3), and 642 rocks and rocks awash were determined, or 1246 in total (Tab. 1).

Table 2 shows coastline lengths and areas of islands in the Croatian part of the Adriatic Sea, while Table 3 gives coastline lengths and areas of islets in the Croatian part of the Adriatic Sea.

Total area of the insular area which belongs to the Republic of Croatia is 3259 km^2, while a total length of the insular coastline is 4398 km. The value of 3259 km^2 for a total area of insular area is close to the value given by other authors [3177 km^2 (RUBIĆ, 1952)] while the value of 4398 km for a total length of the insular coastline is considerably different [4013 km (IRIĆ, 1955); 4058 km (RIĐANOVIĆ, BIĆANIĆ, 1993)].

This fact can probably be explained by different precision of the used maps and methods of geodetic calculation.

Area of islands covers 3195.71 km^2, while area of islets covers 62.41 km^2, totalling 3258.12 km^2. Area of rocks and rocks awash covers 1.44 km^2, which together with the area of islands and islets represents the area of islands, islets and rocks of 3259.57 km^2.

Coastline length of islands is 3573 km, while coastline length of islets is 717 km, totalling 4398 km. Coastline length of rocks and rocks awash is 107 km, which together with the coastline length of islands and islets represents the coastline length of islands, islets and rocks of 4398 km.

From the obtained results it follows that the largest islands in the Adriatic Sea are Cres with an area of 405.70 km^2, and Krk with an area of 405.22 km^2. It should be pointed out that in earlier literature, including atlases, Krk was usually cited as the largest island. Only some authors pointed at incorrect calculations of the areas of these two islands (e.g. FRANČULA, 1994; FRANČULA, 2001). Krivičić (1993) hypothesized it might be possible that the two neighbouring islands are identical in area, which would make them unique in the world. The smallest island is Smokvica Vela (Kornati) with an area 1.04 km^2.

The island with the longest coastline of 302.47 km is Pag, being the fifth according to area value. The island with the smallest coastline length of 5.8 km is Vele Orjule. The biggest islet is Badija with an area of 0.97 km^2, while the smallest one is Galicija covering 0.01 km^2.

Tab. 1 Number, coastline length and areas of islands, islets, rocks and rocks awash in the Croatian part of the Adriatic Sea
Tab. 1. Broj, duljina obaalne crte i površina otoka, otočića, grebena i hridi u hrvatskom dijelu Jadranskog mora

	Number	Area (m^2)	Coastline length (m)
Islands	79	3 195 715 335	3 573 816
Islets	525	62 413 694	717 801
Rocks	642	1 441 694	106 822
Total	1 246	3 259 570 887	4 398 440

Tab. 2 Coastline lengths and areas of islands in Croatian part of the Adriatic Sea
Tab. 2. Duljine obalne crte i površine otoka na hrvatskom dijelu Jadranskog mora

Island	Area (m^2)	Coastline length (m)
Cres	405705293	268205
Krk	405218994	219120
Brač	395438030	180613

Island	Area (m²)	Coastline length (m)
Hvar	297376802	270001
Pag	284181553	302474
Korčula	271466109	190735
Dugi Otok	113305339	182109
Mljet	98015857	135185
Vis	89721921	84907
Rab	86115120	121003
Pašman	60110056	70206
Šolta	58176475	79450
V. Lošinj	52573114	76720
Ugljan	51049186	78745
Lastovo	40823785	48969
Kornat	32444557	68787
Čiovo	28127899	46663
Olib	26142083	33340
Molat	22178022	51593
Vir	22075764	31940
M. Lošinj	21792977	44495
Murter	17577982	42605
Unije	16875910	38059
Iž	16513234	35222
Šipan	16223399	29416
Sestrunj	15124115	29345
Žirje	15079719	41758
Žut	14827419	44058
Silba	14270576	26239
Prvić	12756459	23118
Drvenik Veli	11696248	23885
Ist	9734200	23031
Premuda	8665480	25731
Plavnik	8637122	18477
Maun	8502796	23910

Island	Area (m²)	Coastline length (m)
Šćedro	8367461	26135
Zlarin	8047620	20236
Kaprije	7119324	25211
Sv. Grgur	6376875	14528
Biševo	5915335	18147
V. Brijuni	5722615	23415
Ilovik	5508490	14091
Sv. Klement	5275844	29891
Dolin	4611518	18541
Goli O.	4538711	14297
Lopud	4377318	14630
Svetac	4193858	11973
Zverinac	4177872	14274
Sušac	4025460	16380
Škarda	3782313	12322
Susak	3771587	12921
Rava	3633862	15995
Rivanj	3615315	10346
Drvenik Mali	3427341	12024
Kakan	3388666	14284
Zmajan	3300754	12273
Jakljan	3066225	14648
Prežba	2809440	14230
Tijat	2779724	10489
Piškera	2665808	10646
Zeča	2549702	9613
Koločep	2439119	12869
Prvć (Šibenik)	2407033	10634
Vrgada	2315344	9188
Lavdara Vela	2272293	9532
Tun Veli	2210428	8406
Škrda	2052868	7177

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Island	Area (m²)	Coastline length (m)
Levrnaka	1841425	10206
Lavsa	1782429	9338
Sit	1770660	9068
Kurba Vela	1742507	11684
Mrčara	1451178	7798
Arta V.	1279995	5531
V.Srakane	1182335	7441
Katina	1128527	7107
Planik	1091094	6063
M. Brijuni	1074557	8105
V. Orjule	1055181	5895
Smokvica Vela (Kornat)	1045722	6117

Tab. 3 Coastline lengths and areas of islets in Croatian part of the Adriatic Sea
Tab. 2. Duljina obalne crte i površina otočića u hrvatskom dijelu Jadranskog mora

Islet	Area (m²)	Coastline length (m)
Badija	970827	4158
Sv. Petar	956393	5697
Žižanj	927544	4510
Olipa	902754	4987
Škulj	883410	5036
Gangaro	793351	4649
Babac	787240	4599
Koludarc	783666	4888
Tramerka	745407	4263
Kopište	738726	7716
Sv. Marko	705634	3887
Lokrum	693795	5058
Marinkovac	680662	6340
Šilo V.	673686	3828

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Islet	Area (m^2)	Coastline length (m)
Proizd	632042	4908
Češvinica	619091	4706
Stipanska	618785	3377
Murvenjak	609582	4709
Lunga (Kornat)	608995	4375
M.Srakane	605481	3918
Košara	579686	4076
Obonjan	550390	3786
Radelj	540362	3420
Zečevo (Pag)	536319	3692
Kobrava	520811	5453
Kručica	474289	3208
Arkanđel	474010	3352
Kurba M.	423344	3857
Saplun	414592	3224
Glamoč	412582	3076
Mana	409123	4590
Oruda	405646	3018
Zvirinovik	404778	4211
Krknata	391674	3444
Orud	389820	2650
Arta M.	389019	2967
Logorun	386956	4023
Aba D.	385622	3740
Knežak	358459	2361
Oključ	357829	3803
Krapanj	356141	3620
Maslinovik	351201	2739
Mišjak Veli	348666	2658
Tetovišnjak V.	348028	2147
Kasela	345016	3541
Lupac	336302	2239

Islet	Area (m^2)	Coastline length (m)
M. Orjule	335780	4226
Gangarol	332103	3210
Ošljak	331553	2406
Trstenik (Cres)	330186	4413
Mišjak Mali	320389	2454
Šćitna	317853	2563
V. Budikovac	316748	3460
Kameni Žakan	315101	2791
Drvenik (Zlarin)	309460	2434
Ravni Žakan	299299	2970
Dobri O.	297313	2791
Ruda	295908	2369
Stomorina	294692	3165
Luški O.	293825	3101
Gustac	292721	2242
Palagruža	285539	3681
Gustac (Kornat)	284227	2306
Vrnik	281558	2300
Borovnik (Kornat)	279177	2914
Trstenik (Hvar)	278423	2535
Sv. Fumija	276183	2696
Svršata V.	268810	3104
Ravnik	266605	2737
Mažirina	265775	2075
Dolfin	259702	2025
Rašip V.	258330	3816
Vodnjak V.	252666	2682
Tajan (Pelješac)	250990	2230
Oblik (Zlarin)	249077	1991
Gominjak	244090	3000
Žutska Aba	238687	2025
Borovnjak V.	234007	1809

Islet	Area (m²)	Coastline length (m)
Moračnik	233801	2727
Balkun	233738	1740
Pomeštak	233577	2671
Planjak	232221	1972
Zminjak	229086	2498
G. Aba	225315	2037
Tmara	214851	2297
Ošjak	212933	1961
Sestrica Vela	211744	1718
Kozjak	209506	1771
Jerolim	207144	2368
Veli Pržnjak	204325	2258
Veli O.	202038	1995
Utra	201809	1757
Morovnik	201323	1824
Gustac (Žut)	198264	1784
Mrkan	196909	3262
Krasnica (Vanga)	193806	2695
Veruda	192214	1881
Bršćak	189434	2074
Vinik V.	188560	1666
V. Sestrica	187520	1854
Ceja	183396	1643
V. Brušnjak	181802	1593
Bratin	174703	1949
Smokvica Vela	173243	2004
Obun	170717	1658
V. Školj (Ugljan)	170203	1571
V. Dajna	170099	1847
Fenera	169954	1704
Borovac 1 (Hvar)	167533	1882
Balabra V.	167342	2225

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Islet	Area (m²)	Coastline length (m)
Brušnjak (Sit)	165422	1987
Veli Školj (Molunat)	164647	1834
Lutrošnjak(Strošnjak)	163511	1474
Sestrica Mala	162974	1472
Sridnjak	159658	1872
Rašip M.	158216	1890
Tramerčica	157825	1493
Krbela Vela	156141	2169
Majsan	152773	1736
Komornik	151537	1590
Panitula V.	150697	2447
V. Sikavac	147828	1761
Crveni Otok (Sv. Andrija)	144164	2002
Idula	142409	1405
Bavljenac	140265	1431
Sridnji O.	140189	1800
Južni greben	138859	2174
Jaz	136964	1568
Vrhovnjak	136946	2065
Maman	136466	2135
Zapadni greben	135655	2074
M. Sikavac	135629	1761
Garmenjak Veli	133076	1348
Galešnjak	132475	1545
Vlašnik	126866	1516
Sv. Jerolim	125962	1554
Bodulaš	124559	1424
Sv. Nikola	124281	2105
Sv. Katarina	124193	1825
V. Kotula	123703	1582
Dražemanski V.	123431	1394
Uljanik	123233	1969

Islet	Area (m²)	Coastline length (m)
Tun Mali	122572	1613
Skala V.	122387	1586
Dubovac	120146	1310
Koritnjak	119504	1535
Vodenjak (Ist)	116704	1835
Klobučar	115787	1425
Muntan	115304	1507
Rakitan	115179	1330
Zečevo (Hvar)	113288	1539
Sv. Juraj	112408	1733
Otok (Trogir - stari grad)	112114	1389
Tajan (Jakljan)	110834	1405
Dugo	110408	1502
Frašker	110136	1671
Borovnjak M.	106809	1213
Buč Veli	106623	1489
Ravan	106153	1653
Sr. Sestrica (Rivanj)	104837	1627
Sv. Ivan	102663	1722
Čavlin	101789	1249
Lucmarinjak	101231	1251
Planikovac	100836	1259
Mrtovnjak (Kurba Vela)	100193	1244
Crkvina	99836	1502
Crklica	99249	1321
Sestrica V. (Kornat)	97760	1378
Sutvara	97674	1299
Krknjaš Veli	96961	1321
M. Pržnjak	96610	1120
Brguljski O.	96332	1156
Maškin	95785	1327
Tegina	95464	1146

Islet	Area (m^2)	Coastline length (m)
Obručan V.	94996	1304
V. Laganj	94954	1633
Bisaga (Kornat)	94167	1825
Tajnik	93913	1344
Grujica	93264	1210
Garmenjak V.	92863	1432
Svilan	92579	1168
Prišnjak Veli	90514	1460
Dužac V.	90291	1370
D. Školj	90284	1110
Petrovac	90063	1623
Mrtovnjak (Dugi otok)	89797	1098
Ljutac	89536	1249
Fulija	88203	1231
Školjić (Vir)	87906	1665
Murtar	87860	1399
Bisaga (Murter)	87079	1619
Šipnata	84880	1143
Burnji Školj (G. Školj)	84437	1067
Mežanj	82890	1151
Srednji greben	82160	1324
Tomešnjak (Gaćinov Školj)	81570	1197
Ćutin Veli	81047	1684
Mišjak	80639	1243
Glavat (Mljet)	80574	1491
Vodenjak (Kornat)	80529	1047
Tovarnjak (Molat)	80132	1548
Planičić	79785	1476
Mrtonjak	79184	1080
Kluda	78407	1231
Kotež	78212	1239
Ražanac V. (Istočni Školj)	77183	1525

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Islet	Area (m^2)	Coastline length (m)
Skrižanj V.	76873	1429
Tovarnjak (Žut)	75628	1315
Smokvenjak	74998	1000
Oblik (Vrgada)	73900	1015
Kamešnjak M.	73626	1108
Grbavac	73305	1095
Tetovišnjak M.	72703	1212
Košljun	72426	1083
Kamešnjak V.	72407	1311
Prčevac	71909	987
Glurović	71430	1011
V. Osir	70203	964
Pločica	70031	1941
Veli Planatak	69229	1004
V. Paržanj	68276	1171
Levan	67955	1160
Koversada	67477	990
Maslinjak (Kornat)	66678	1022
Dvainka	66184	1344
Planac	65912	1010
Daksa	65880	1398
V. Sestrica (Rovinj)	65693	966
Dužac (Tetovišnjak V.)	65052	1421
Prišnjak (Murter)	64941	1009
Golac (Dugi Otok)	63870	1038
Bobara	63854	1254
Rudula	62859	1002
Kozina	62744	1040
Gaz	62511	1128
Sv. Katarina (Šašman)	62314	1227
Polebrnjak	61788	946
Lovorikovac	61338	1077

Islet	Area (m²)	Coastline length (m)
D. Vlašnik	60791	1014
Smokvica	60188	909
Galun	60172	1278
Vinik M.	59848	904
V. Školj (Mljet)	59646	892
V. Školj (Grgetov rt)	59600	909
Maslinjak (Ist)	59590	959
Vrsar	58919	946
Garmenjak	58487	873
Obljak (Molat)	58345	872
Sušica	58153	1237
Kraljak	57872	949
Jančar	57824	969
Gira	56259	895
Lukovnik	55997	931
Zečevo (Krk)	55681	936
Magarčić	55406	882
M.Plavnik	55042	1074
Andrija	54935	996
V. Školj (Pašman)	54900	877
Šilo	53928	903
Lavdara Mala	53806	912
Škrovada	53338	1240
Kraljevac	52851	1012
Pinizelić	52171	1041
Brskvenjak	52060	905
Balun	51963	921
O. Greben	51690	1482
Mrtovac (Mrtvac)	51679	1483
Galija	51534	849
Kosor	50773	1244
Lukovac (Mag)	50416	1113

Islet	Area (m²)	Coastline length (m)
Hrbošnjak (Murter)	50200	844
Palacol	50167	1096
Pusti O.	49889	1160
Brusnik	49455	1097
Maslinovac (Pelješac)	49390	824
Garmenjak Mali	49192	839
Lukar	48977	925
Borovnik (Murter)	48637	860
Zabodaski	48592	810
Kamenjak (Premuda)	48354	933
Galičak	48124	907
Hr. Masarine	47455	1708
Komorica	47206	852
Sr. Vlašnik	46468	919
Krbela Mala	46428	1087
Bisage	46382	864
Bisače	46042	1067
Kormati 2	45724	1366
Ražanac M. (Zap. Školj)	45547	978
Prduša Vela	45411	1245
Kosmač V.	44724	803
Borovac 1 (Mljet)	44399	895
Obljak (M.Brijuni)	44133	778
Kormati 1	43840	1156
Visoki	43297	868
Samograd	42983	850
Prišnjak M.	42117	920
Maslinjak 1 (Murter)	41914	754
Krava	41885	755
G. Vlašnik	41723	985
Plešćina (Plešćenica)	41608	1258
Veli Školj (Mljet)	41508	1261

Islet	Area (m^2)	Coastline length (m)
Host	41375	910
M. Brušnjak	40867	805
Gubavac (Korčula)	40856	972
Plitki Kukuljar (Vodnjak)	40294	769
Ravna Sika	40248	742
Otočić	40248	742
Arženjak V.	40165	821
Gojak	40103	834
Obrovanj	40002	751
Tresorka	39953	771
Otoci Salamun 2	39881	773
Tukošćak	39834	758
Paržanj	39529	804
Grmej	38916	723
Kudica	38460	706
Skala M.	38352	849
Supetar	38137	946
Prećski Školj	37876	810
Črnikovac	37764	791
Lukovac (Hvar)	37578	777
Šip	37337	1113
V. Kneža	37235	745
Otočac	37053	717
Bisaga V. (Žut)	37032	834
Kosmerka	36870	787
Grunj	36677	960
Ovrata	36429	1181
Sv. Andrija	36259	1214
Pod Kopište	35835	813
Sparušnjak	35294	705
Arženjak M.	35204	793
V. Paranak	34463	702

Islet	Area (m²)	Coastline length (m)
Borovnik (Sit)	33751	725
Samunćel	33740	665
M. Sestrica (Rivanj)	33732	733
Košarica (Maslinjak)	33722	775
Kamenar	33563	797
Krknjaš Mali	33281	716
Galovac(Školji})	33259	736
Pučenjak	33224	670
Goljak	33100	686
Artina	32540	797
Runjava Kotula	32382	714
Mrtovnjak (Maćin Školj)	32242	712
Katarina	31883	817
Garmenjak M.	31353	703
Obljak (Korčula)	31307	645
Panitula M.	31194	789
Abica	30875	719
Lukovnjak	30297	640
Artica	30205	634
Stambedar	29945	714
Lunga	29923	826
Mišnjak (Rab)	29829	799
Školjić V.	29826	675
Karantunić	28894	639
Kristović	28747	768
Buć M.	28709	703
Sestrica M. (Kornat)	28692	627
Figarola	28522	751
M. Paranak	28516	613
Smokvica Mala	28230	658
Galičnjak	28034	651
Strižnjak	27838	613

Islet	Area (m²)	Coastline length (m)
Žavinac V.	27721	675
Mačaknar	27720	669
V. Maslinjak	27565	722
Otoci Lukavci 1	27387	651
Purara	27380	850
Dražemanski M.	26908	607
M. Palagruža	26510	887
Piščena V.	26093	767
Dužac M.	25738	896
M. Budikovac	25565	622
Prduša Mala	25499	580
Rutnjak	25179	669
Fraškerić	25169	610
Bikarijica	25163	580
Mičnjak (Šipan)	25143	640
Gubavac V.	24800	573
Visoki Kukuljar (Babuljak)	24722	583
Pohlib	24674	600
Otoci Salamun 1	24587	590
Fenoliga	24581	614
Maslinovac (Dugi Otok)	24545	568
Kosmeč	24107	567
Gušteranski	24050	589
Mimonjak	23971	554
Ričul	22946	550
Golubinjak V.	22681	781
Jabuka	22585	715
Merara	22478	577
Sturag	22473	615
Tovarnjak (Prišnjak)	22229	691
Lirica	22223	674
Trumbuja	21830	531

Islet	Area (m^2)	Coastline length (m)
Rasparašnjak	21828	558
Borovac (Hvar)	21666	736
Mišnjak (Ugljan)	21663	556
V. Lagan (Lagnići)	21640	689
M. Sestrica (Rovinj)	21601	567
Prišnjak	21600	691
Šailovac	21569	648
Gojca	21471	549
V. Dajnica	21355	536
Vlaka	21316	560
Šilo M. (Crnikovac)	21227	632
Kamenjak 1 (Korčula)	21187	547
Lukovac (Mljet)	21117	541
Maslinjak (Žut)	20656	657
Oštrica	20648	544
V. Školj (Pelješac)	20478	598
Vešar	20258	523
Tajan V.	20127	699
Pulari	19383	522
Knežačić	19068	542
Hrbošnjak (Žirje)	18966	517
Makarac	18854	575
Galijola	18819	768
Premanturski Školjić	18734	524
Lisac	18481	539
Glavat (Lastovo)	18430	542
Sovljak	18370	493
Blitvenica	18303	567
Vrtlac (Žirje)	18216	531
Sokol	18215	535
Stupa	18206	944
V. Barjak	18116	582

Islet	Area (m²)	Coastline length (m)
Trimulić V.	18046	504
Školjić (Iž)	17815	513
Zaklopatica	17699	631
Hr. Kurjak	17496	552
Otoci Lukavci 2	17441	483
Visovac	17376	478
Bisaga V. (Pašman)	17119	497
Duga	17076	500
Hr. Pregaznik	16771	548
Sv. Marija	16740	484
Pokonji Dol	16697	466
Lukovac Sr.	16611	526
Mišnjak (Unije)	16596	464
Fržital	16560	681
Divna	16437	484
Stupa V.	16411	504
Otočić 1 (Divulje)	16356	648
Dragunara	16167	520
Saskinja	16161	485
Rončić	16077	523
Dupinić V.	16075	464
Sedlo	15850	584
Gospin Školj	15773	527
Čerigul	15717	450
Maslinovac (Mljet)	15664	488
Lukvenjak	15597	487
Muljica V.	15508	511
Šekovac	15502	499
Maslinjak (Murter)	15353	501
Puh	14986	508
Svršata M.	14954	471
Krpeljina	14658	569

Islet	Area (m²)	Coastline length (m)
Gališnik	14612	446
Rogačić	14444	435
Pomerski Školjić	14407	442
M. Kneža	14404	446
Skrižanj M.	14075	463
Supin	13912	456
Veseljuh	13893	533
Brnjestrovac	13793	471
M. Dolfin	13751	469
Hr. Podmrčaru	13514	484
Mali Planatak	13452	464
Hr. Mali Goli (Goli O.)	13410	593
M. Paržanj	13403	448
Dužac (Ist)	13369	493
Kamenjak (Korčula)	13340	439
Sestrice 2 (Ist)	13331	425
Ula (Artica M.)	13313	427
Čavatul	13287	423
Mrduja	13116	417
Rutvenjak V.	12841	448
Vrtlić (Kurba Vela)	12765	424
Gusti Školj	12673	404
Sustipanac	12556	473
Školjić M.	12457	424
Koromašna	12305	471
Sv. Justina	12253	442
Vješala	12180	657
M. Kotula	12107	434
Kamenjak (Ist)	11998	485
Hr. Hripa	11973	645
Sridnjak (Rab)	11938	477
Tužbina	11909	445

Islet	Area (m^2)	Coastline length (m)
Babina guzica	11848	413
M. Laganj	11786	566
Hr. Sv. Anton	11621	438
Mlin	11591	424
Lučnjak	11548	412
Žavinac M.	11544	390
Gubeša	11536	392
Smokvica Mala (Kornat)	11420	524
Mumonja	11411	429
Hrid Šestakovac 1	11244	450
Kamenica	11210	398
Sestrica V. (Pelješac)	11183	388
Rašipić	11133	400
Školjić (Murter)	11104	386
Golić	11051	434
Pijavica	11037	607
Božikovac	10942	393
Hr. Mišar	10878	442
O. Života	10854	390
Ošljak V.	10834	376
M. Dajnica	10567	383
M. Lagan(Lagnići)	10417	372
Dupinić M.	10409	379
Srednjak (Pelješac)	10400	374
Mali O.	10380	392
Tatišnjak	10304	382
Dingački Školj	10268	472
Hr. Stolac 1	10265	448
Galicija	10198	524

Conclusions

Eastern coast of the Adriatic Sea is one of the best indented coasts and belongs to the so-called archipelagic coast. The number of islands in Croatian part of the Adriatic Sea, as determined in this paper, is greater than it was published earlier in literature:

- According to the proposed classification of islands (Duplančić Leder et al., 2000a), in the coastal sea area of the Republic of Croatia 79 islands, 525 islets, and 642 rocks and rocks awash have been recorded, or a total of 1246 on topographic maps produced at the scale of 1 : 25 000 (TM25).

 - Total area of the insular area which belongs to the Republic of Croatia is 3259 km^2, while a total length of the insular coastline is 4398 km.

 - The largest island in the Adriatic Sea determined from the topographic maps produced at the scale of 1 : 25 000 (TM25) is Cres with an area of 405.70 km^2 and the smallest island is Smokvica Vela (Kornati) with an area 1.04 km^2.

 - The island with the longest coastline of 302.47 km on TM25 is Pag, while the smallest coastline length of 5.89 km belongs to Vele Orjule.

 - The biggest islet on TM25 is Badija with an area of 0.97 km^2, while the smallest one is Galicija covering 0.01 km^2.

This paper represents the beginning of a systematic analysis of the Croatian insular area, which should encourage scientists and economists, providing them with guidelines for carrying on their studies in this field. The authors propose that determining of coastline lengths and areas of islands, islets and rocks according to the set criteria should be done from larger scale charts, e.g. 1 : 5000, which is an extensive and demanding task.

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SAŽETAK

Tea Duplančić Leder, Tin Ujević, Mendi Čala: Duljine obalne crte i površine otoka na hrvatskom dijelu Jadranskog mora određene sa topografskih kartata mjerila 1 : 25 000

Istočna obala Jadranskog mora jedinstveno je područje na Sredozemlju, možda i na svijetu, po svojoj razvedenoj obali. Ta obala, prema konvenciji o pravu mora Ujedinjenih naroda (dio IV, članak 46), pripada takozvanim arhipelaškim morima. U ovom članku prihvaćena je suvremena definicija otoka (prema Duplančić Leder i dr., 2000) utemeljena na preporukama Međunarodne hidrografske organizacije (International Hydrographic Organization). Otok je definiran kao dio kopna potpuno okružen morem. Prihvaćena je klasifikacija otoka, otočića, hridi i grebena prema njihovoj površini, predložena od istih autora. Otok je dio kopna okružen morem površine preko 1 km^2, otočić je kopno površine od 0,01 do 1 km^2, dok je površina hridi i grebena manja od 0,01 km^2.

Obalna crta hrvatskog dijela Jadranskog mora digitalizirana je sa topografskih karata mjerila 1:25 000. Topografske karte koje se koriste kao podloge, te metode rada i alati korišteni u ovom radu bolje su i preciznije od dosada korištenih. Stoga se broj otoka na Jadranu, a naročito njihove površine i opsezi mogu smatrati preciznijim od podataka do sada korištenima u literaturi.

Koordinate dobivene digitalizacijom topografskih karata transformirane su iz sustava digitalizatora u 5 i 6 zonu Gauss Kr⌉gerove projekcije. Radi bolje preglednosti i lakšeg računanja podaci su prebačeni u jedinstveni projekcijski sustav: konformnu poprečnu cilindričnu projekciju sa središnjim meridijanom 16° 30' E i linearnim mjerilom na središnjem meridijanu m=0,9997, uvedenom radi smanjivanja deformacije. Procjena točnosti površina i duljina obalne crte, prema navedenim formulama, biti će predmet budućih istraživanja.

U okviru GIS programskog paketa AutoCAD Map 2000 zatvoreni su poligoni otoka, i svakom od njih dodijeljen je naziv, koji služi kao centroid poligona. Pomoću centroida poligona kreirana je topologija. U AutoCAD programu je napisan podprogram koji računa površine i opsege otoka, otočića i hridi, te ih sprema u Microsoft Acess bazu podataka.

Iz dobivene baze podataka i klasifikacije otoka, otočića, hridi i grebena, u obalnom moru Republike Hrvatske na TK25 zabilježeno je 79 otoka, 525 otočića i 642 hridi i grebena ili ukupno 1246. Nadalje, ustanovljeno da otok Cres ima najveću površinu (405,70 km^2), iako je do sada u literaturi otok Krk najčešće navođen (uključujući i atlase) kao najveći otok u Jadranskom moru. Najdulju obalnu crtu ima otok Pag (302,47 km).

Ukupna površina otočnog dijela Jadranskog mora je 3 259 km^2, a ukupna duljina obalne crte je 4 398 km.

Rad predstavlja početak sustavne analize cjelokupnog hrvatskog otočnog područja, koji će potstaknuti znanstvenike za njihov daljnji rad i studije na ovom polju.