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MAPPING OF MARSHES AND WETLAND AREAS IN REPUBLIC OF N. MACEDONIA[1]

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Abstract

Wetlands are special ecosystems, besides to natural lakes and artificial reservoirs, have an important role in the functioning of environment. In this case, marshes and wetlands (riparian marsh areas) have been mapped. The aim of paper is to determine the regional distribution and location of wetlands on the territory of the Republic of Macedonia, for providing information to the scientists, experts and wider public with particular emphasis on expanding the scientific research of these hydrologic objects and their protection as important segments in the environment.

Keywords: wetlands, marshes, mapping, regional distribution, Republic of Macedonia

Introduction

Wetlands is an ecosystem, permanently or seasonally flooded with water, where oxygen-free processes predominate (Keddy, P.A. 2010). The primary factor that distinguishes wetlands from other water bodies is the characteristic vegetation represented by aquatic plants, i.e. plants adapted to hydromorphic soils.

According to their characteristics, there are distinguished:

- A swamp is a wetland that is forested and herbaceous rather;
- A marsh is a wetland that is dominated by herbaceous rather than woody plant species.
- A bog or bogland is a wetland that accumulates peat, a deposit of dead plant material -often mosses, and in a majority of cases, sphagnum moss.
- A fen is one of the main types of wetland, the others being grassy marshes, forested swamps, and peaty bogs. Along with bogs, fens are a kind of mire.

Wetlands mainly appear along the larger rivers (dependent on river level) along the shores of lakes, and some wetlands appear as isolated areas (flat lands with or without outflow) with sufficient presence of constant water (Hughes, F.M.R. (ed.). 2003 and Wilcox, D.A, Thomp-

1 Article is part of the results in the frame of project: "Improving the conservation effectiveness of wetlands"/ WetMainAreas, Under TNCP Balkan – Mediterranean 2014 – 2020.

son, T.A., Booth, R.K. and Nicholas, J.R. 2007). In the Republic of Macedonia are recorded wetlands of almost all types (isolated, riparian, and coastal).

Methods

In paper are used geographic and cartographic methods.

The geographical methods have been used with long term field surveys and visit a most of wetlands on the territory of the Republic of Macedonia. Specific geographic measurements and descriptions of wetland sites have been carried out.

Cartographic methods are used to map wetlands, identify wetlands on large scale topographic maps and verify on satellite imagery. The recorded data is used to map wetlands and determine their location and regional distribution.

Results

From the conducted surveys on the territory of the Republic of Macedonia are recorded 31 wetland sites, some of them are isolated areas (depression or flat terrains) as remnants of the geological past or due to tectonic processes, some are anthropogenic and some are coastal wetlands.

The main aim of this paper is the inventory of wetlands. In the table and the text below presents basic geographical and cartographic data of wetlands in the Republic of Macedonia.

Geographic description of marshes (wetland zones) in Republic of Macedonia

In the main body are given short description about geographic location, rectangular UTM coordinates (X,Y), altitude (Z) and area of wetland area, in the table are given more detailed information. (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Karpino 1 is located in northeast part of Republic of Macedonia, north of village Stracin. Centroid coordinates are on, X=581906.74 Y=4670335.43at altitude of 938 m, with area of 0.8ha. (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Karpino 2 is located in northeast part of Republic of Macedonia, north of village Stracin. Centroid coordinates are on X=582356.49 Y=4670905.92 at altitude of 944 m, with area of 0.3ha. (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Arachinovo Marsh is located in Skopje Valley, near village Arachinovo. Marsh centroid coordinates are on X=545384.92, Y=4651111.36, at altitude of 225 m, with area of 56.4ha. (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Katlanovo Marsh is a main wetland hydrological object in the Skopje Plain, North Macedonia. It is located in the lowest, southeastern part of the plain, between the river Vardar on the west and the Pchinja River on the east, with the coordinates X=553115.30 Y=4639053.14 and and elevation of 224 m a.s.l. with area of 198.6 ha. Near this natural feature, on the north side, is the main country motorway (E75) and on the west is flat irrigated part of the Skopje Plain (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Table 1. Cartographic measurements of marshes and wetland areas in Republic of Macedonia

#	NAME	X	Y	F (ha)	Lb (m)	L (m)	Bmax (m)	Bsr (m)	ALT (m)
1	Katlanovo Marsh	553115.30	4639053.14	198.6	12188	2870	1051	692	222
2	Kundino Marsh	595607.84	4653833.42	1.2	619	224	78	53	751
3	Saramzalino Marsh	580273.81	4625258.51	64.4	12721	1667	1589	386	225
4	Kjoseleri Marsh	577233.73	4624228.03	35.0	4325	1313	420	267	248
5	Dragozhani Marsh	525723.27	4550689.57	3.6	1295	330	253	109	600
6	Krusheani Marsh	529644.88	4573634.43	3.2	1022	364	185	89	595
7	Tulana Marsh	529206.43	4548078.51	14.1	2216	737	375	192	584
8	Bukri Marsh	542414.84	4533407.47	92.9	8748	3327	522	279	573
9	Eleshka Marsh	545197.92	4532711.88	26.8	6242	2454	190	109	576
10	Zhabeni Marsh	534638.75	4533831.74	177.8	5837	2167	1124	820	580
11	Perish Marsh	573529.09	4641888.39	77.8	7334	2878	624	270	340
12	Karatash Marsh	577678.92	4642895.99	99.6	8489	2160	840	461	340
13	Lokva Marsh	576303.03	4643557.78	17.4	2886	1172	252	148	335
14	Gjeran Marsh	577495.73	4646290.41	59.8	7987	3099	385	193	390
15	Vardar Marsh (Udovo-Granica)	625570.21	4566356.74	855.3	62624	27279	797	314	46-70
16	Karpino 1 Marsh	581906.74	4670335.43	0.8	419	172	68	48	938
17	Karpino 2 Marsh	582356.49	4670905.92	0.3	227	85	53	39	944
18	Badar Swamp	556856.88	4636158.92	99.9	6282	2660	633	376	220
19	Belchishko Swamp (Sini Viroj)	485063.72	4573218.66	133.0	8469	2703	1095	492	765
20	Bistrenci Marsh	599946.10	4689592.67	19.5	2164	729	399	267	105
21	Ezerani Marsh	498710.19	4538744.84	294.0	20350	9682	492	304	846
22	Izdeglavje Marsh	485872.33	4575140.01	47.8	5977	999	536	478	794
23	Lukovo Pole Marsh	471779.86	4634536.64	18.3	2516	757	467	241	1735
24	Monospitovo Marsh	648373.57	4584169.13	227.6	12148	4011	976	567	209
25	Nakolec	508384.00	4526339.09	93.3	8315	2865	576	326	846
26	Ostrovo Svamp	478525.54	4529066.89	16.3	2507	728	499	224	698
27	Radolishko Marsh	470784.24	4557335.90	94.3	7247	2860	636	330	693
28	Radozhda Marsh	467408.27	4549193.35	1.9	604.42	239	115	80	987
29	Stenjsko Marsh	492990.01	4531425.56	18.6	1830	593	364	314	850
30	Studenchishko Swamp	483869.88	4549786.81	21.9	2578	658	414	333	692
31	Arachinovo Marsh	545384.92	4651111.36	56,4	3744	1379	621	409	225

Legend: F – area, L_b – coastline length, L – wetland length, B_{max} – wetland maximum width, B_{sr} - wetland average width, ALT - elevation

Source: VGI 1970-1976, Topographical maps, 1:25000, Beograd.
AKN, 2007-2010, Topographical maps, 1:25000, Skopje.
Google earth, Satelit images, 2009-2019.
Author's measurements

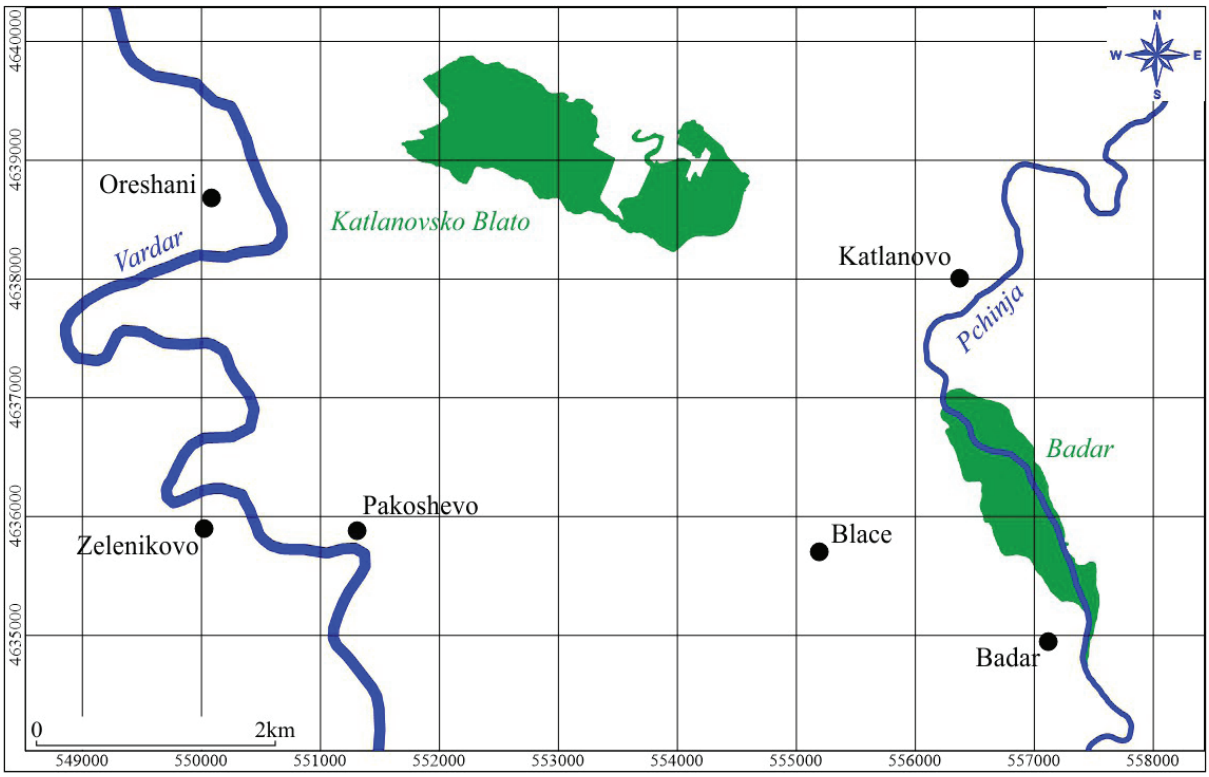

Figure 1. Distribution of marshes in Skopje Valley

Badar swamp is a riparian wet zone along the Pcinja River in the vicinity of the village Badar, upstream of the Badar Gorge. It is located between the highway and r. Pchinja. Its genesis is anthropogenic with the exploitation of sand and gravel. Centroid coordinates are on X=556856.88, Y=4636158.92 at elevation of 220 m, with area of 99.9 ha. (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Karatash marsh is located in Ovche Pole Plain, near city of Sveti Nikole, in catchment area of river Svetinikolska. Centroid coordinates of marsh are on X=577678.92, Y=4642895.99, at altitude of 340 m, with area of 99.6ha. (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Perish marsh is located in the Ovche Pole Plain, near the city of Sveti Nikole in catchment area of river Svetinikolska. Centroid coordinates of marsh are on X=573529.09, Y=4641888.39 at altitude of 340 m, with area of 77.8ha. (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Gjeran marsh is located in the Ovche Pole Plain, near the city of Sveti Nikole in catchment area of river Svetinikolska. Centroid coordinates of marsh are on, X=577495.73, Y=4646290.41 at altitude of 390 m, with area of 59.8ha. (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Lokva Marsh is located in the Ovche Pole Plain, near the Town of Sveti Nikole in the Svetinikolska River catchment. The centroid rectangular coordinates are X=576303.03, Y=4643557.78, with elevation of 335 meters a.s.l. with area of 17.37 ha (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Saramzalino Marsh is located in the southern part of Ovche Pole Plain, near the Town of Sveti Nikole, in the Svetinikolska River catchment. The centroid rectangular coordinates are X =580273.81, Y=4625258.51, with elevation of 225 meters a.s.l. with area of 64.4 ha (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Saramzalino Marsh is located in the southern part of Ovche Pole Plain, near the town of Sveti Nikole in the Svetinikolska River catchment. The centroid rectangular coordinates X=7577233.73, Y=4624228.03, with elevation of 248 meters a.s.l. with area of 35.03 ha (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

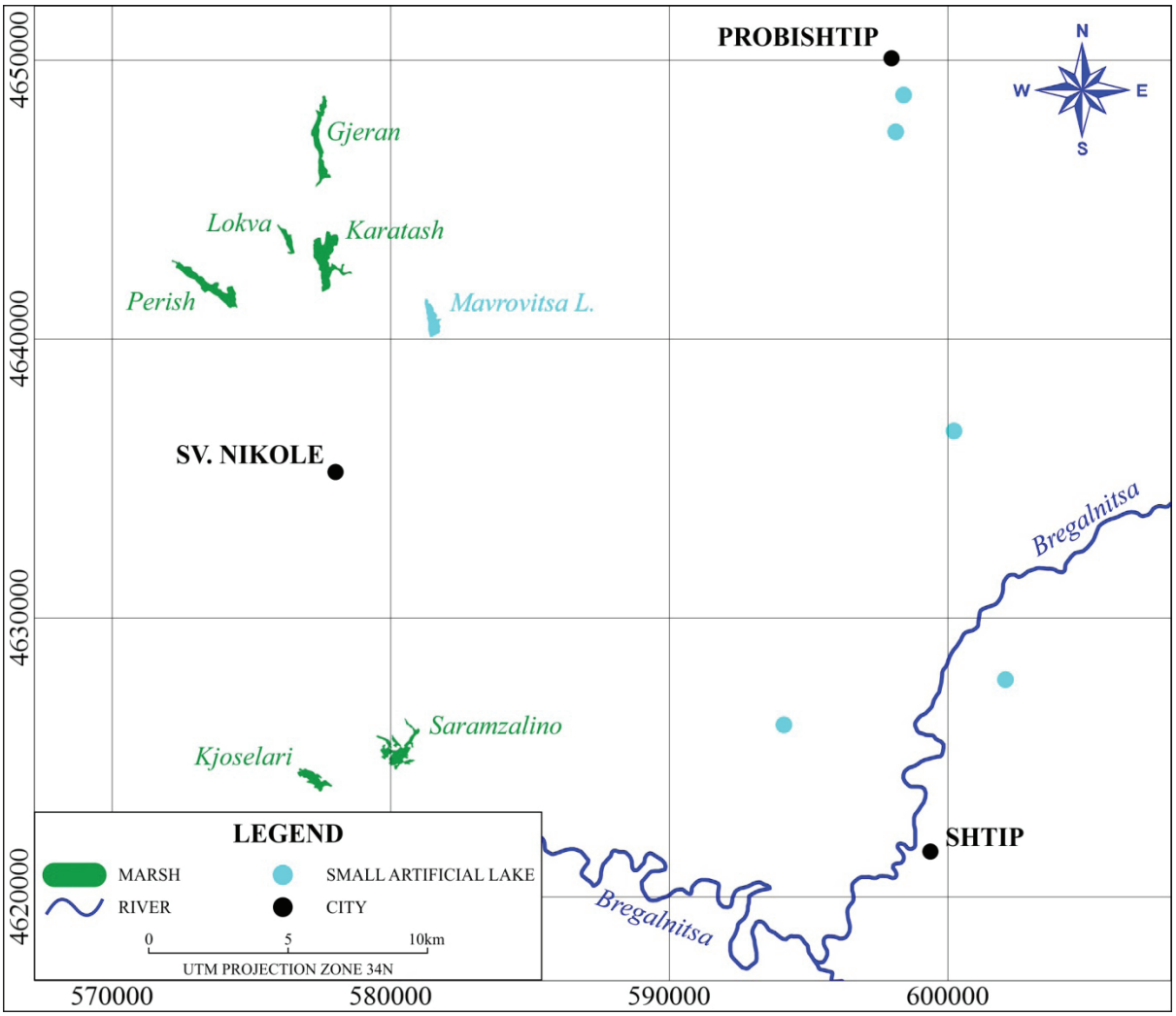

Figure 2. Distribution of marshes and small artificial lakes in Ovche Pole

Kundino Marsh is located in the eastern part of the North Macedonia, in the wider catchment area of the Zletovica River, in the southwestern part of the Osogovo Mountain Range, on the Plavica Mountain Branch, in the area of the village of Kundino, Municipality of Probishtip. It is situated 1 km northeast of the village of Kundino, from the town of Probishtip in a straight line it is 2 km away, and from the regional road Priobishtip-Kratovo it is 1.5 km away. Centroid coordinate of marsh are at X=595607.84 X=4653833.42 at altitude of 751 m and area of 1.2 ha (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Monospitovo bog is located in flat area of Stumica Valley between villages of Monospitovo from north, Bansko from south and Koleshino from east. Centroid of bog is at X=648373.57, Y=4584169.13 at altitude 209m, with area 227.6ha. This is largest bog in Macedonia. It features a diverse fauna and flora with rare and relict plant communities. (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

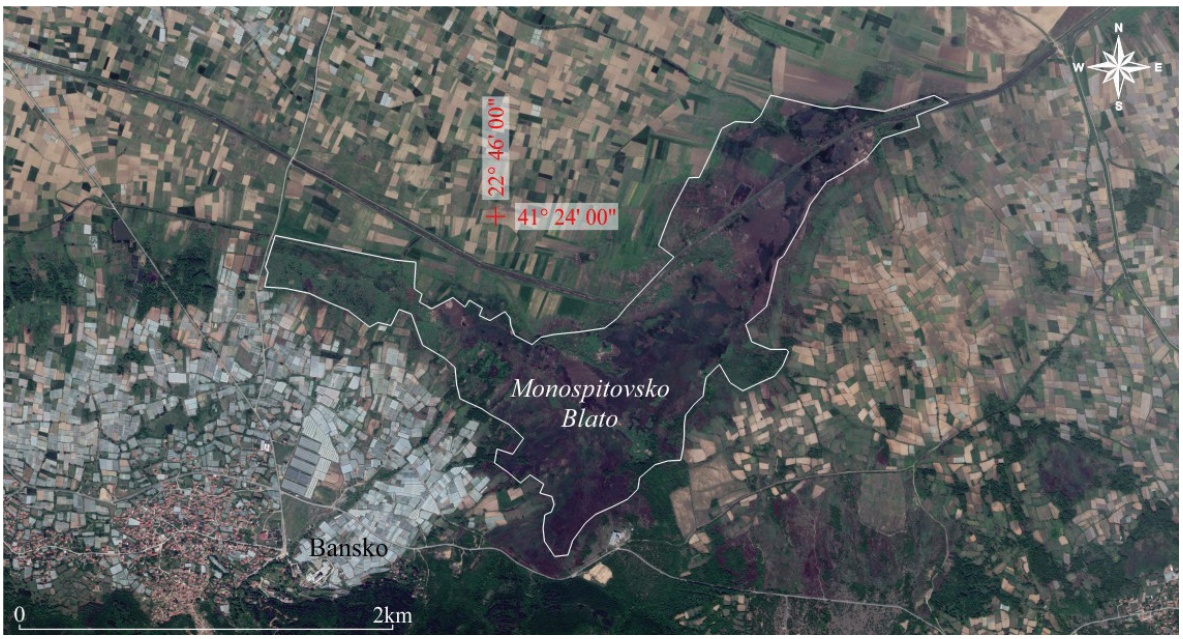

Figure 3. Geographical location of Monospitovo Bog
Source: "Strumica Valley" 41^0 23' 00'' N and 22^0 48' 00'' E. Google Earth. November 11, 2019

Bistrenci marsh is riparian wetland zone near river Vardar in vicinity of village Bistrenci in Tikvesh Valley, between city of Negotino and Demir Kapija. Marsh centroid is X=599946.10 Y=4689592.67, at altitude of 105 m, with area 19.5 ha (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Vardar Swamp is riparian wetland zone near river Vardar in Gevgelija – Valandovo Valley. It spread along river Vardar from village of Udovo to Macedonian-Greece state border. Swamp centroid coordinates are X=625570.21 Y=4566356.74, at altitude between 46-70 m, with area of 855.3 ha (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Zhabeni Marsh is located in Southern Pelagonia Basin, eastern from Baba Mountain. The whole area is rich with underground phreatic but especially with artesian water. The rectangular coordinates centroid according to the UTM projection are X=534638.75, Y=4532711.88, and elevation of 580 meters a.s.l. with area of 177.8 ha (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Bukri Marsh is located in the southern part of Pelagonia Basin, Bitola Plain, when the Crna River makes large left curve and change its course from South to NE. The location is between village Sredo Egri on the west and Bach on the east. The rectangular coordinates according to the marsh centroid are X=542414.84, Y=4533407.47, with an elevation of 573 m a.s.l. with area of 92.9 ha (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Eleshka Marsh is located in Southern Pelagonia Basin, on the confluence point between the Eleshka River and Crna River. The rectangular coordinates centroid according to the UTM projection are X=545197.92, Y=4532711.88, and elevation of 576 meters a.s.l. with area of 26.76 ha (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

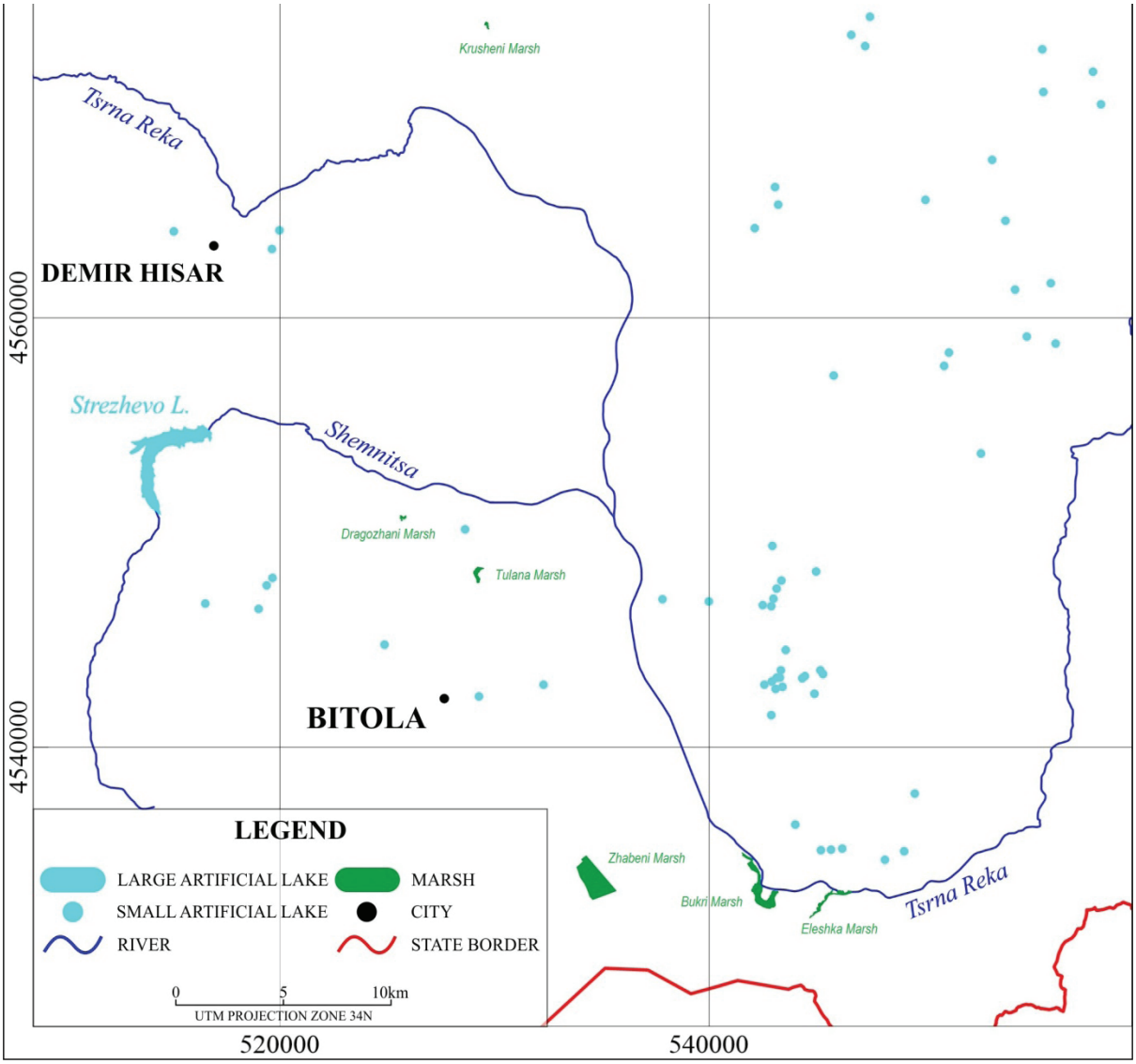

Figure 4. Distribution of marshes and artificial lakes in Pelagonija Valley

Tulana Marsh is situated 3 km north of Bitola. It is located between the international road M5 to the west and the old Bitola-Prilep road to the east. The rectangular coordinates centroid according to the UTM projection are X=529206.43, Y=4548078.51, at altitude 584 a.s.l. It covers an area of 14.3 ha, which is among the largest lakes in the Municipality of Bitola (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Dragozhani Marsh is located on the western frame of Palagonija Basin, on the regional road Bitola-Demir Hisar. This marsh is situated below the Snegovo-Oblakovo Massive in the Shemnica River watershed. The rectangular coordinates of the marsh centroid are X=525723.27, Y=4550689.57 and elevation, 600 meters a.s.l. with area of 3.6 ha (VGI

1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Krusheani Marsh is located in the northern part of Pelagonia Basin (largest plain in North Macedonia), exactly in the western part of the Prilep Plain. The rectangular coordinates of the marsh centroid are X=529644.88, Y=4573634.43 and the altitude above the sea level is 595 m. This is the lowest part of the Prilep Plain, where the river Blato is canalized from the ancient stream which was strongly meandered before the big ameliorative action in 1950's. It covers an area of 3.2 ha (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Nakolec is a coastal marsh on the east coastline of Prespa Lake in the vicinity of the village Nakolec. The marsh centroid is with coordinates, X=508384.00, Y=4526339.09 at 846 m asl. It covers an area of 93.3 ha.

Ezerani marsh covers the northern coastal parts of Prespa Lake. It is located between the villages of Sir Han and Asamati. The marsh centroid coordinates are X=498710.19, Y=4538744.84 at 846 m asl. It covers an area of 294 ha (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements). The marsh is close to lake aquatory. The shallow parts are overgrown with reeds and a variety of marsh vegetation. At higher water levels of the lake marsh is flooded. Various species of flora and fauna are present, the most significant is the presence of many species of birds. (Markoski, B.; Jovanovski, M.; Milevski, I.; Matevski, V.; Melovski, Lj.; Hristovski, S. (2016)).

Regulations on the Implementation of Measures for the Protection of the Strict Natural Reserve "Ezerani" on Prespa Lake (29/97); Declaring the Ornithological Reserve "Ezerani" as a Strict Natural Reserve (37/96);

"Ezerani" - protected area is on the list of the most important ornithological areas in Europe (IBAImportant Bird Area) and, from 1995 on the list of the Ramsar Convention as one of the most important wetlands in Europe (Ramsar Site - Lake Prespa).

Stenje Marsh is located near to the village of Stenje close to western coast of Prespa Lake. Marsh coordinates are X=492990.01, Y=4531425.56, at 850 a.s.l. with area of 18.62 ha (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Radolishko Marsh is located in Struga Field, southwestern of city of Struga, in vicinity of village Radolishta. Marsh coordinates are X=470784.24, Y=4557335.90 at 693 a.s.l., with area of 94.3 ha (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Radzhda Marsh is located in vicinity of village Radozhda, western of Ohrid Lake, near to state border pass Kjafasan. Marsh coordinates are X=7467408.27 Y=4549193.35 at 987 a.s.l., with area of 1.9 ha (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Studenchishta swamp is located between channel from Studenchishta springs (Biljanini Izvori) and bad of river Racha, near Ohrid Lake coast. Swamp coordinates are X=7483869.88, Y=4549786.81 at 692 a.s.l., with area of 21.93 ha (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements). Studenchishta Swamp is the last glacial relict remnant of marsh vegetation in Macedonia. Very important site with old, relict, tertiary marsh vegetation but almost completely destroyed.

Ostrovo swamp with Ostrovo Lake is located near to monastery St. Naum Ohridski at southeastern cost of Ohrid Lake. Swamp centroid is with coordinates X=478525.54,

Y=4529066.89, at 698 a.l.s., with area of 16.3 ha (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

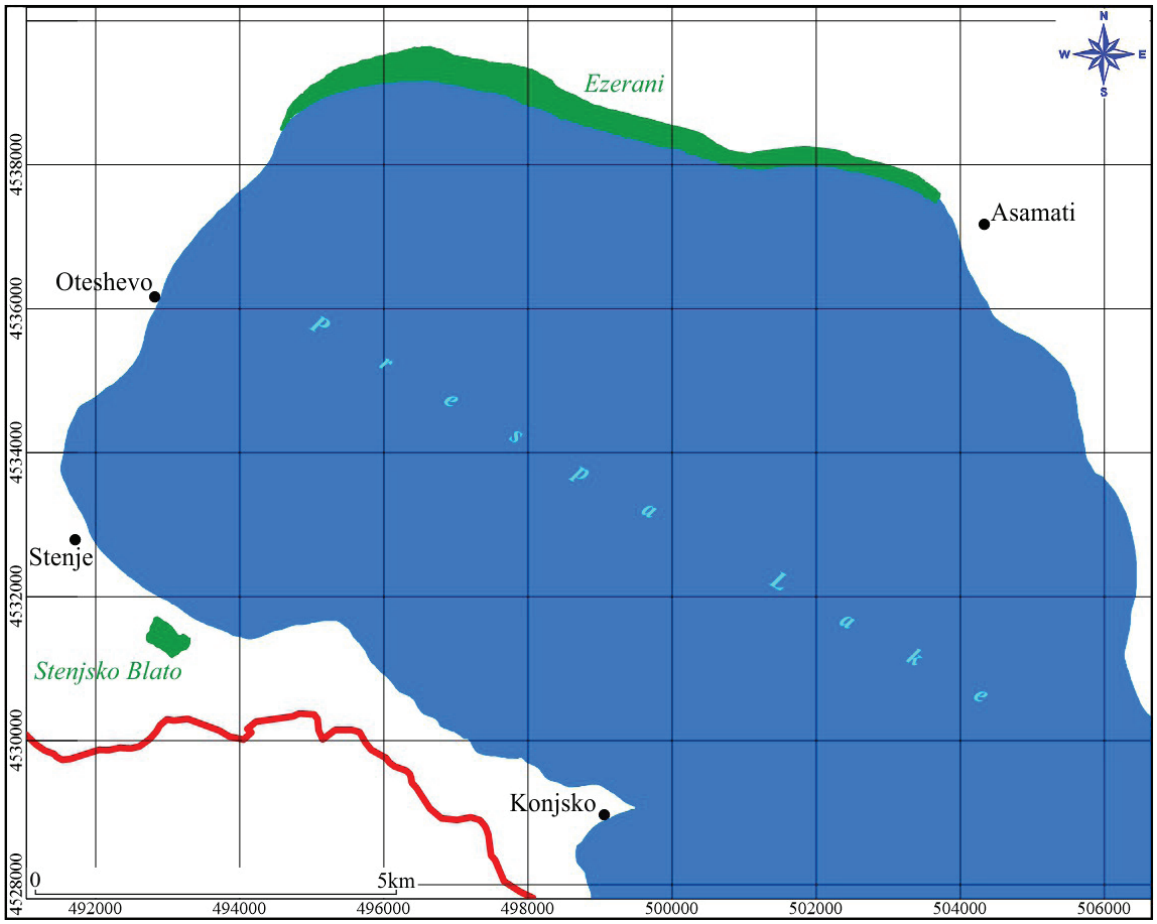

Figure 5. Distribution of marshes in Prespa Valley

Belchishko Swamp (Sini Viroj) is located in southwest part of Republic of Macedonia, actually in Dolna Debarca region, near gorge of river Sateska, between villages Belchishta and Novo selo, 20 km northern form city of Ohrid. Swamp centroid coordinates are X=485063.72, Y=4573218.66, at altitude of 765 m a.s.l., with area of 133 ha (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements)

Izdeglavje Marsh is located close to village of Izdeglavje in Sredna Debarca microregion, near to Ohrid-Struga region. The centroid rectangular coordinates are X=485872.33, Y=4575140.01, with elevation of 794 m a.s.l., with area of 47.8 ha (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Lukovo Pole Marsh is located in upstream catchment area of river Radika, at northwestern part of Republic of Macedonia. Marsh centroid coordinates are X=471779.86, Y=4634536.64, at 1735 a.s.l., with area of 18.25 ha (VGI 1970-1976; AKN, 2007-2010; Google earth; Author's measurements).

Figure 6. Distribution of marshes in Ohrid Valley

Figure 7. Insert from Studenchishte Swamp near Ohrid (Foto: Sl. Hristovski)

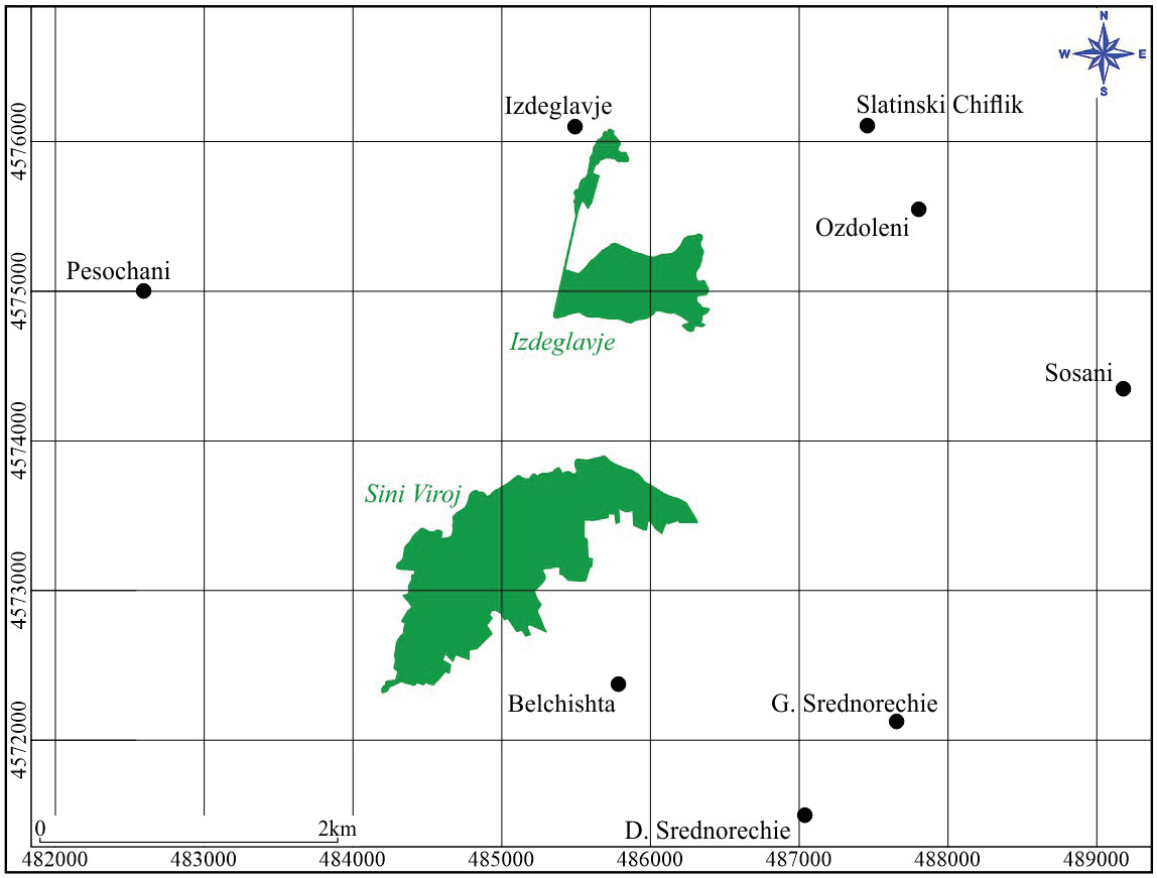

Figure 8. Distribution of marshes in Debarca Valley

Discussion

In Republic of Macedonia there are recorded this types of wetlands: isolated, near river beds and near lake coasts.

Genesis of isolated wetlands are bound up with geological and tectonic processes and morphometric characteristics of relief. Mostly of them are defined as left-over of Pleistocene lakes in valleys (flat areas or field depressions). Most of wetlands in Republic of Macedonia are isolated. Most characteristic wetlands according to area and biodiversity are: in Skopje Valley (Arachinovo Marsh, Katlanovo Marsh), Strumica Valley (Monospitovo Swamp), Pelagonija Valley (Zhabeni Marsh, Bukri Marsh, Krusheani Marsh, Tulana Marsh, Dragozhani Marsh, Eleshka Marsh) and region Debarca (Belchishko Swamp, Izdeglavje Marsh) (Markoski, B.; Jovanovski, M.; Milevski, I.; Matevski, V.; Melovski, Lj.; Hristovski, S. (2016)).

Riverbed wetlands are recorded near bigger rivers in plain areas. In Republic of Macedonia most characteristic wetlands are Bistrenci and Vardar near riverbed of Vardar, Bukri near river Crna and Eleshko near Eleshka River.

Lake coastline wetlands in Republic of Macedonia are recorded near Ohrid Lake (Radolishko Marsh, Studenchishta Swamp, Ostrovo Swamp) and Prespa Lake (Nakolec Marsh, Ezerani Marsh).

Until the 60s of the 20th century on the territory of the Republic of Macedonia there were around 86000 ha of wetlands (MASA, 2009), but with the land meliorations in the 60s and 70s of the 20th century the wetlands are significantly reduced. Today, there are 31 wetlands with a total area of about 2900 ha. The number of wetlands is larger than 31, but the sites are with insignificant areas, generally less than 0.1 ha and they do not represent ecosystems with significance and impact on global ecosystems.

Some of wetlands are anthropogenic changed, so some parts of them are fish pounds (pound Bel Kamen at Zhabeni Swamp, pound Novoselani at municipality of Dolneni). According to anthropogenic impact (gravel and sand explorations) near riverbeds there are wetland structures like Badar Swamp near river Pchinja in Skopje Valley.

Conclusion

In a territory of Republic of Macedonia from field researches, topographic maps and satellite imageries is made inventory of wetland areas. In the past (until 60s and 60s years from 20th century) at territory of Republic of Macedonia there were numerus wetlands (around 86000 ha), but with melioration processes their number are significant reduced (MASA, 2009). From inventory there are recorded 31 wetlands, with total area of 2900 ha.

Wetland areas generally are distributed at flat zones of valleys, near riverbeds and near lake costal areas.

As important ecosystem part, some of wetlands are under protection, in some of them are remarked some anthropogenic degradations.

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