Protection and Sustainable Use of the Dinaric Karst Transboundary Aquifer System

MONTENEGO COUNTRY REPORT

October 2012

CONTENT:

Protection and Sustainable Use of the Dinaric Karst Transboundary Aquifer System

Working Group 1

Hydrogeological Report – Draft V.1.

Chapter 1-8

Montenegro

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October 2012

Content

1. Introduction

DIKTAS is an acronym of the GEF-UNDP regional project „Protection and Sustainable Use of the Dinaric Karst Transboundary Aquifer System“. This is one of the first-ever attempts to establish sustainable integrated management principles in transboundary karst aquifers at the magnitude of the Dinaric Karst System. The Inception DIKTAS report stated, „At the global level the project aims at focusing the attention of the international community on the huge but vulnerable water resources contained in karst aquifers (porous carbonate rock formations), which are widespread globally, but poorly understood”.

Partner countries within the framework of the DIKTAS project are Albania, Bosnia and Herzegovina, Croatia and Montenegro as GEF-recipient countries, as well as Greece, Italy and Slovenia as non-recipient countries. In addition a number of international organizations and institutions such as the International Association of Hydrogeologists (IAH) Commission for Karst, GWP-Med, French Geological Survey (BRGM), and the Competence Pool Water (Austria) are actively participating in the DIKTAS project as co-financing partners. The project is being implemented by UNDP and executed by the UNESCO‘s International Hydrological Programme (IHP), an intergovernmental scientific cooperative programme in water research, water resources management, education and capacity-building. The UNESCO‘s regional office for science and culture in Europe, located in Venice, as well as the UNESCO Antenna office in Sarajevo are actively supporting the project implementation.

Project preparatory stage had been covered the years 2008 and 2009. Within preparatory stage of the project two working groups (hereinafter called WG) are established to assist in the preparation of the preliminary Transboundary Diagnostic Analyses (hereinafter called TDA): 1)WG 1 Hydrogeology and 2) WG 2 Legal Policy. Most important events during preparatory stage are: Inception workshop in Podgorica (November 2008), Zagreb workshop (March 2009) and Final Validation Workshop (Venice, October 2009). After signing of the Letters of Commitment by competent national authorities and endorse of the Project document (in November 2009) DIKTAS full size project was prepared to take into enforce.

The Full size project duration is 2011-2014. Beside earlier groups, two new groups are established: WG Environment and Socio-Economics and WG Stakeholder Participation to facilitate

1.1. Project tasks and the role of WG

Karst studies have been a part of the UNESCO Science Sector programmes (International Geoscience Programme, IGCP and International Hydrological Programme, IHP) since last three decades. Since 1972 the UNESCO has coordinated and conducted a Global Study of Karst Aquifers and Water Resources and supported an array of international activities in the field of Karst Hydrogeology and Karst Water Resources Management in the region. Through these activities the UNESCO was instrumental in increasing global understanding of karst hydrogeology and water resources challenges.

The proposed project *Protection and Sustainable Use of the Dinaric Karst Transboundary Aquifer System*, hereinafter called “DIKTAS” Project, as it the above mentioned, is the first ever attempted globally to introduce sustainable integrated management principles in a transboundary karstic freshwater aquifer of the magnitude of the Dinaric Karst System. At the global level the project aims at focusing the attention of the international community on the huge but vulnerable water resources contained in karst aquifers (carbonatic rock formations), which are widespread globally, but poorly understood. The Dinaric Karst Aquifer System, shared by several countries and one of the world’s largest, has been identified as an ideal opportunity for applying new and integrated management approaches to these unique freshwater resources and ecosystems. At the regional level the project’s objectives are to (i) facilitate the equitable and sustainable utilization and management of the transboundary water resources of the Dinaric Karst Aquifer System, and (ii) protect from natural and man-made hazards, including climate change, the unique groundwater dependent ecosystems that characterize the Dinaric Karst region of the Balkan Peninsula (defined in UNDP Project Document).

The DIKTAS project aims at addressing the issue of the sustainable management of karstic groundwater and dependable ecosystems. It focuses on one of the world’s largest karstic geological provinces and aquifer systems: the karst region corresponding to the Dinaric mountain range, which runs from Friuli (NE Italy) through Slovenia, Croatia, Bosnia - Herzegovina, Montenegro and Albania.

The task of the Work Group 1 – Hydrogeology within DIKTAS project is to collect, analyse and process data and information necessary for a complete and reliable Transboundary Diagnostic Analysis (TDA). It is necessary to prepare a report about the current status of knowledge on the assessment of the hydrogeological characteristics of the Dinaric Karst aquifers at the national level including compilation of information available,review of existing relevant text and cartographic documentation on geology, structural geology, hydrogeology, geomorphology, hydrochemistry etc.

Briefly, the WG Hydrogeology will:

- based on all relevant data defined (if it is precisely possible) transboundary aquifers (TBA) between parties
- provide characterisation of TBA, including definition of status of present use of the aquifers
- collect data and analyse existing plans and projects and possible interactions regarding transboundary karst aquifers;
- define qualitative status of groundwaters in the transboundary aquifers
- define main pressure regarding quantity
- analyse and prioritize existing threats to groundwater quality in the the Dinaric Karst including contamination from point and disperse sources and land degradation;

The group will develop the first regional GIS hydrogeological base, with all relevant data regarding groundwater, especially in the area of TBA.

The content of this report (and all national hydrogeological reports) is proposed by the advisor of hydrogeological group professor Zoran Stevanović and adopted by the project management.

1.2. General on karst – term, distribution, importance

The term karst, in addition to its geological meaning, is usually used as a synonym for barren rocky terrains (Milanović, 2005). Classical karst terminology recognizes a karstic region as a region consisting mainly of compact and soluble carbonate rocks in which appear distinctive surficial and subterranean features, caused by solutional erosion. The term can also be applied to any region made up of other soluble rocks: anhydrite, gypsum, salt. In a broader sense, the term is utilized to designate every phase of the karstification process in karstifiable rocks.

Karst is a medium which has traditionally been the subject of hydrogeological research, given the abundant water resources that are stored in it. In many cases karst is the product of climatic and hydrological evolution in carbonate areas in recent periods of geological history. Karst contains key information on recent environmental changes. The action of water has generated a great range of karstic features that are part of our natural heritage and some of them form major tourist attractions (landscapes of natural parks, geosites and show caves, for example). Karst areas often serve as landscapes or as substrates for human activity.

While non-karst geological terrains have been utilized successfully in the construction of large hydro projects including dams and reservoirs and water supply and irrigation projects, karst regions have been considered unsuitable for the development of similar projects. This is due to the complex geological features and unique hydrological characteristics of karst rock formations, consisting mainly of limestone, dolomite, gypsum, and halite. Solubility of these rocks plays a major role in forming the karst terrains with complex geological and hydrogeological characteristics (Milanović, 2005).

However, an increased demand for drinking water, land reclamation, and energy has gradually changed the engineer's attitude toward the use of karst regions. In the past few decades, many water resource projects have been successfully developed in countries with large karst regions, such as Bosnia and Herzegovina, Serbia, Montenegro, Croatia, China, France, Greece, Iran, Italy, Russia, Slovenia, Spain, Turkey, the United States. Nevertheless, the road to those successes has been often paved with failures. For example, many man-made reservoirs in karst regions could not retain water in the quantities necessary for producing expected yields.

Karst is a highly fragile ecosystem and the exploitation of its resources or inappropriate land uses give rise to environmental problems (water pollution, subsidence, flooding, changes in the subterranean environment, etc.).

The first version of the world map of carbonate rocks appeared in Ford & Williams (1989) Karst Geomorphology and Hydrology. A revision was published by Williams & Ford (2006) Zeitschrift für Geomorphologie Suppl-Vol 147, 1-2, and used in Ford & Williams (2007) Karst Hydrogeology and Geomorphology (Wiley). The following figure is map v3.0 revision and it is in greater detail and attempts to differentiate those areas where carbonate rocks are relatively pure and continuous from those where they are abundant but discontinuous or impure. It was prepared by Paul Williams and Yin Ting Fong (figure 1) using a multitude of sources of which the most important are acknowledged in Williams & Ford (2006).

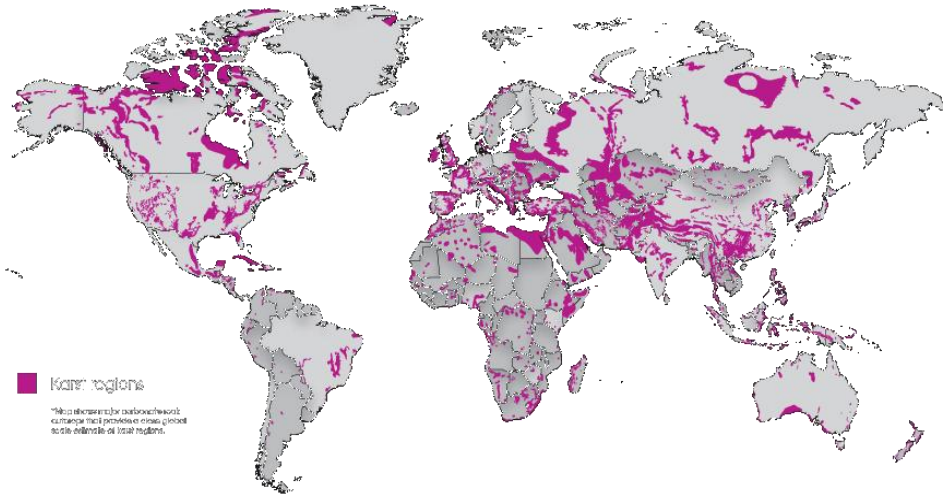


Figure 1: *Karst regions in the world (after Paul Williams and Yin Ting Fong)*

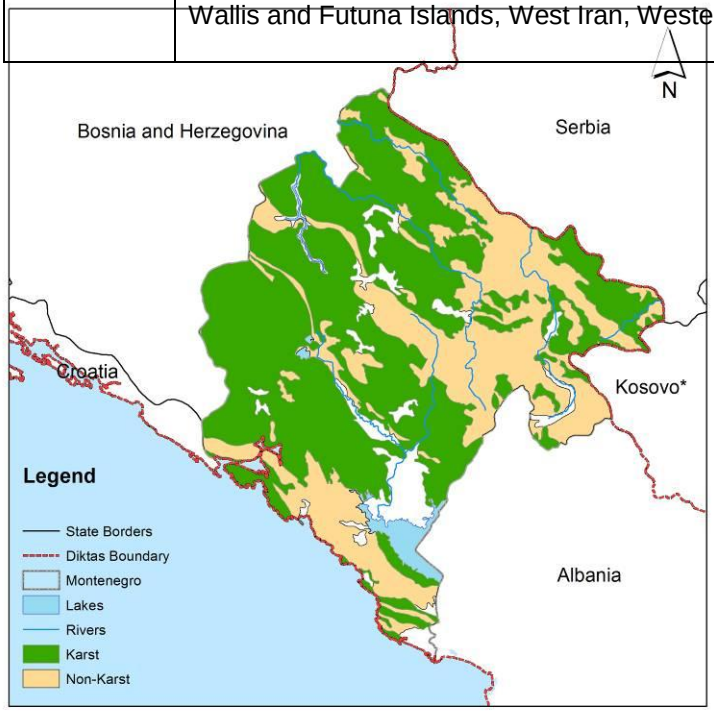
Excluded Antartica, Grenland and Island karst regions in the world cover 133448089 km^2 or 13.2%. In Europe the karst areas cover 6125842 or 21.8% of territory (Table 1).

The Dinaric karst, one of the biggest in Europe, extends from Slovenia via Croatia, Bosnia and Herzegovina, Serbia, Montenegro to Albania.

Table 1: *World Carbonate Outcrop Areas (after Paul Williams and Yin Ting Fong)*

Region	**Countries Included**	**Land Area (km^2)**	**Percentage**
World	Exclude Antarctica, Greenland and Iceland	133448089	13,2
Russia Federation plus	Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Russia, Turkmenistan, Uzbekistan	20649781	19,3
South America	Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Falkland Islands (Malvinas), French Guiana, Guyana, Paraguay, Peru, South Georgia and the South Sandwich Island, Surinam Uruguay, Venezuela	17792882	2,1
Africa	Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Congo the Democratic, Cote D'ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mayotte, Morocco, Mozambique, Namibia, Niger, Nigeria, Reunion, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Western Sahara, Zambia, Zimbabwe	30001574	10,1

North America (exclude Greenland)	Anguilla, Antigua and Barbuda, Bahamas, Barbados, Belize, Bermuda, Canada, Cayman Islands, Costa Rica, Cuba, Dominica, Dominica Republic, El Salvador, Guadeloupe, Guatemala, Haiti, Honduras, Jamaica, Martinique, Mexico, Montserrat, Nicaragua, Panama, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Turks and Caicos Islands, US, Virgin Islands, Virgin Islands (US)	22229293	18,3
East and South East Asia	Brunei Darussalam, Cambodia, China, East Timor, Indonesia (excluding Papua), Japan, Korea (north and south), Lao, Malaysia, Mongolia, Myanmar, Philippines, Singapore, Taiwan, Thailand, Vietnam	15638629	10,8
Middle East and Central Asia	Afghanistan, Bangladesh, Bhutan, Cyprus, India, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Maldives, Nepal, Oman, Pakistan, Palestine, Qatar, Saudi Arabia, Sri Lanka, Syria, Tajikistan, Turkey, United Arab Emirates, Uzbekistan, Yemen	11129677	23,0
Europe (exclude Iceland and Russia)	Albania, Andorra, Austria Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czech, Denmark, Estonia, Faroe Islands, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia, Malta, Moldova, Monaco, Netherlands, Norway, Poland, Portugal, Romania, San Marino, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, UK, Vatican City, Yugoslavia	6125842	21,8
Australasia	American Samoa, Australia, Baker-Howland-Jarvis, Christmas Island, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Micronesia, New Caledonia, New Zealand, Niue, Norfolk Island, Northern Mariana Islands, Palau, New Guinea (Papua New Guinea plus Papua) , Solomon Islands, Tonga, Tuvalu, Vanuatu, Wallis and Futuna Islands, West Iran, Western Samoa.	9611377	6,2



MONTENEGRO - KARST

0 5 10 20 30 40 km

1:1,200,000

Outcrops of karstified rocks are registered on the more than 60% of Montenegrian territory.

Figure 2 *Karst areas in Montenegro*

1.3. Historical review of karst researches

There are chronicles for the year 1410, on the territory of Montenegro, which are related to the floods of Cetinjsko polje, sinkhole and cave Ladnica near Cetinje monastery.

During the First World War, on the territory of Montenegro which was occupied by Austria-Hungary, the speleological surveys of the pothole Duboki do in Negusi have been carried out for the needs of water supplying.

G.Lahner (1916) has carried out the genuine speleologic venture for those times. He descended into the 340 m deep pothole, in which he discovered underground stream connected to the Kotor´s submerged karst springs Gurdić and Škurda.

E.A.Martel (1883), Gesman (1905), Karol Wolf (1910), have explored potholes and pits in the holokarst of Montenegro, in the area between the Boka Kotorska Bay, Cetinje and Nikšić.

E. Tietze (1884) and K. Hassert (1895)have left behind the data of circulation of groundwaters in karst terrain.

There are a numerous data found in documentation, monographs and publications on the hydrogeological characteristics of the karst terrain of Montenegro.

The first and more significant hydrogeological data, which are partly related to these terrains, can be found in the works of J. Cvijić, A. Grund, F. Katzer, from which derive the first understandings of the circulation of groundwater in karst.

J. Cvijić (1883, 1855, 1921, 1926) provides an overview of the hydrological characteristics of karst fields, geomorphological features and glaciation of high mountains of Bosnia, Herzegovina and Montenegro.

Systematic hydrogeological research of karst terrain of Montenegro began after the year 1945, in order to solve a various economic problems, such as:

The use of hydropower potentials of watercourse Zeta, Morača, Piva, Tara, Ćehotina and Lim,

Preparation of hydrological basis for the regulation of waters od Skadar Lake, Bojana and Drim,

Water supply for settlements and industry, irrigation of Zeta and other lowland areas.

Water supply for settlements and industry, irrigation of Zetsko-Bjelopavlicka valley and other lowland regions.

Detailed hydrogeological research of Gornja Zeta began in the 1952, with the preparation of geological datasets for the construction of reservoirs in Niksicko polje.

The results of the hydrogeological study of this region have been synthesized in many works of V. Vlahovic (1952-1962). In particular, this author describes in his work " The hydrogeology of karst region of Niksicko polje", the hydrogeological characteristics of this part of the terrain, the balance of the groundwater of the Gornja Zeta basin, with a special emphasis on the possibility of the surface and deep sinkhole closure. The integral part of this work is the hydrogeological map of Niksicko polje and its immediate rim 1:25.000.

B. Đerković (1959, 1960) and A. Vukovic, M. Komatina (1960) with associates have made, on the basis of hydrogeological researches which were carried out, the first basic hydrogeologic maps 1:25.000 and 1:50.000, for the coastal karst belt.

In the period from 1969-1976, the regional hydrogeological researches for the whole territory of Montenegro were finished, namely: the South Adriatic (S. Ivanovic, N. Mijošić, 1972), the Skadar lake basin (V. Radulovic, 1973), Piva, Tara and Ćehotina (M. Buric, 1976), Lim and Ibar basin (M. Vujasic, 1981).

P. Milanovic (1979) in his book "Karst Hydrogeology and Methods of Research", partly gives attention to the specific hydrogeological phenomena, with examples from the Trebjesnica basin and Niksicko polje.

V. Radulovic (1979) in the book "Hydrogeology of the Skadar Lake basin" provides plenty of data on the hydrogeological characteristics of this part of the karst terrains, hydrological phenomena, directions and velocity of the groundwater flow, water balance, physical and chemical characteristics of the groundwater.

B. Mijatovic (1990) in the monography "Karst", describes geomorphological features of karst and its topography, conditions of circulation and distribution of the groundwater. Basic hydrogeological maps 1: 100,000 with explanatory notes have been made: M. Radulovic (list "Titograd (1982), list "Bar "and" Ulcinj "(1989)," Niksic "(1999), M. Maric list "Kotor" and Budva "(2000), Pljevlja (2004), D. Radojevic list "Ivangrad" (2011) and lists "Zabljak" (2012).

2. Physiography and climate

The next sub-chapters briefly describe main physiography, land use and climate characteristics of Montenegro with emphasize on the area of interest for the DIKTAS project.

2.1. Geographic position and boundaries

Montenegro is basically Adriatic-Mediterranean and Dinaric country, located between 41° 52´ and 43° 32´ northern latitude, and 18° 26´ and 20° 21´ eastern longitude. Additionally, it is opened towards south Adriatic with attractive and 293.500 m long shore.

Area of Montenegro is 13. 812, with 4.800 km^2 of sea (inner sea). Total length of its ground borders is 614 km, 14 km borders with Croatia, 172 km with Albania, 203 km with Serbia and 225 km with Bosnia and Herzegovina. Width of territorial sea is 12 nautical miles (22.224 m), and jaggedness coefficient of 2,8 compared with 3,3 for south Slavic shoreline in general.

FIGURE 3 GEOGRAPHIC POSITION OF MONTENEGRO

Relief is mostly mountainous. Basis of relief is Dinarides mountain system, stretching parallel to coastline. Highest peaks are above 2500 m. Average elevation is 1050 meters above sea level.

Its northern and central part is made of high mountain ridges and plateaus, intersecting deep and narrow river valleys. Relatively spacious plateau expands in its central part, in the area of the Lake of Skadar and Zeta River.

From the administrative point of view, Montenegro is divided into 21 municipalities, out of which Niksic is the largest municipality (2.065 km^2), while Tivat is the smallest (46 km^2).

Municipality of Podgorica (1.441 km^2) has 169.132 inhabitants, or almost one third of total population of Montenegro (27,3% - 2003), which would imply that it (capital Podgorica) became due to its geographical location as well.

Location of Montenegro in southern part Adriatic shoreline, across the Otranto Strait, had special impact on rainfall regime, which has Mediterranean characteristics in this region, and also reaches European maximum values. It is the area of the most intensive hydrologic regime in Europe. That's the reason why Montenegro is one of regions rich in water. Relatively deep river valleys and high plateaus contributed to the concentration of sizeable hydro power potentials. Possibility of water accumulation and its utilization for various purposes, especially for production of electric energy, led to the fact that water represents the major natural wealth this region has, which exploitation can be a ground for further economic development.

2.2. Vegetation and land cover

The dominated land cover class in Montenegro is broad-leaved forest that occupies 26% of the total country territory. Almost 80% of Montenegro is covered by semi-natural and forest areas. Agricultural land occupies 16%, wetlands or water 3.4% and artificial areas only 1% of the national territory.

Figure 4 *Corine land cover map of Montenegro*

Table 2 *CORINE Land Cover classes for the year 2006 (CORINE Land Cover 2006 project in Montenegro, Final report)*

	Code	CLC class	Polygons	Area (ha)	Percentage %
1	111	Continuous Urban Fabric	1	74	0.0051
2	112	Discontinuous Urban Fabric	50	10794	0.7434
3	121	Industrial or Commercial	18	1285	0.0885
4	122	Road and Rail networks	3	88	0.0061
5	123	Sea Ports	1	150	0.0103
6	124	Airports	3	268	0.0185
7	131	Mineral extraction sites	17	1035	0.0713
8	132	Dump	8	473	0.0326
9	133	Construction sites	2	104	0.0072
10	141	Green Urban areas	9	474	0.0327
11	142	Sport and Leisure facilities	9	656	0.0452
12	211	Non-irrigated arable land	9	875	0.0603
13	221	Vineyards	9	2637	0.1816
14	222	Fruit trees and berries plantations	6	311	0.0214
15	223	Olive groves	3	442	0.0305
16	231	Pastures	159	21092	1.4526
17	242	Complex cultivation	89	20378	1.4035

18	243	Land principally occupied by agriculture with areas of natural vegetation	1051	188520	12.9837
19	311	Broad Leaved forest	854	379359	26.1271
20	312	Coniferous forest	289	107699	7.4174
21	313	Mixed forest	447	105632	7.2751
22	321	Natural grassland	650	138619	9.5469
23	322	Moors / heathland	5	229	0.0158
24	323	Sclerophyllous vegetation	34	11819	0.8140
25	324	Transitional woodland shrub	1721	329086	22.6648
26	331	Beaches, dunes, sand	17	2118	0.1459
27	332	Bare rocks	150	15630	1.0765
28	333	Sparsely vegetated	348	63645	4.3834
29	334	Burned areas	2	173	0.0119
30	411	Inland Marshes	30	11474	0.7903
31	421	Salt marshes	1	106	0.0073
32	422	Salines	1	1461	0.1006
33	511	Stream courses	6	874	0.0602
34	512	Water bodies	16	29154	2.0079
35	522	Estuaries	1	42	0.0029
36	523	Sea and ocean	1	5195	0.3578

In Montenegro, 3666 ha or 0.25% of the country territory had changed its land cover class between 2000 and 2006 which represents an increase of the CLC class dynamics when compared to the 2802 ha land cover change (0.2%) during the period 1990-2000.

2.3. Rainfall regime

In order to get a complete picture of the precipitation regime of a region, it is necessary to mention the factors that have direct and indirect impact on the meteorological element and its parameters. Precipitation is one of the most changeable meteorological elements, and its occurrence, intensity and distribution is influenced by numerous factors. Montenegrin territory lies between 41° 30 'and 44° latitude, just in the zone of moderate latitudes. This geographical position gives rise to a four-season appearance with all of its characteristics, and thus different seasonal rainfall regimes. The general picture of the dynamics of air flow over this part of Europe, has also a direct impact on the quantity and distribution of precipitation.

The frequent penetrations of air masses from the Atlantic Ocean, represent an extremely important factor in the precipitation regime in the central and northern areas of the territory of Montenegro. In addition, the western Mediterranean is a unique cyclogenetic area, which has a direct impact on the precipitation regime in Montenegro. The influence of the southwest flow, which also creates enough moisture from the Mediterranean Sea, is particularly large and important during fall and winter in the southern areas.

Direct impact on the precipitation regime is reflected in the orographic uplifting of moist and unstable air from the southwest, which contributes to an increase in the quantity and intensity of precipitation. The general direction of the northwest to the southeast, has as the consequence that

the mountain ranges in the hinterland of the coast, during the prevailing south-westerly flows, provoke the appearance of windward and leeward orographic precipitation. Moreover, such direction of mountain ranges forms a natural barrier for the influence of the Adriatic Sea on the north, and carries the characteristics of continental precipitation regime towards the southern areas of Montenegro.

The average annual precipitation, due to these orographic factors, is very uneven and ranges from about 800 l/m2 in the far north to about 5000 l/m2 in the southwest (the slopes of Orjen). Cyclonic activities in the Mediterranean and moist flows from the south in the winter months and orographic barriers make a significant influence on the ultimate southern, southwestern and southeastern parts of Montenegro to have significantly higher annual precipitation than the northern end parts.

On the slopes of Orjen, in record years, precipitation may reach approximately 7000 l/m^2, as this area is classified as the most rainy area of Europe. Other areas with very high rainfall are Lovćen and Rumija with more than 3500 l/m2 and Prekornica and Žijovo with more than 2500 l/m^2. In the narrow coastal belt, the average annual precipitation ranges from 1300 to 2000 l/m^2.

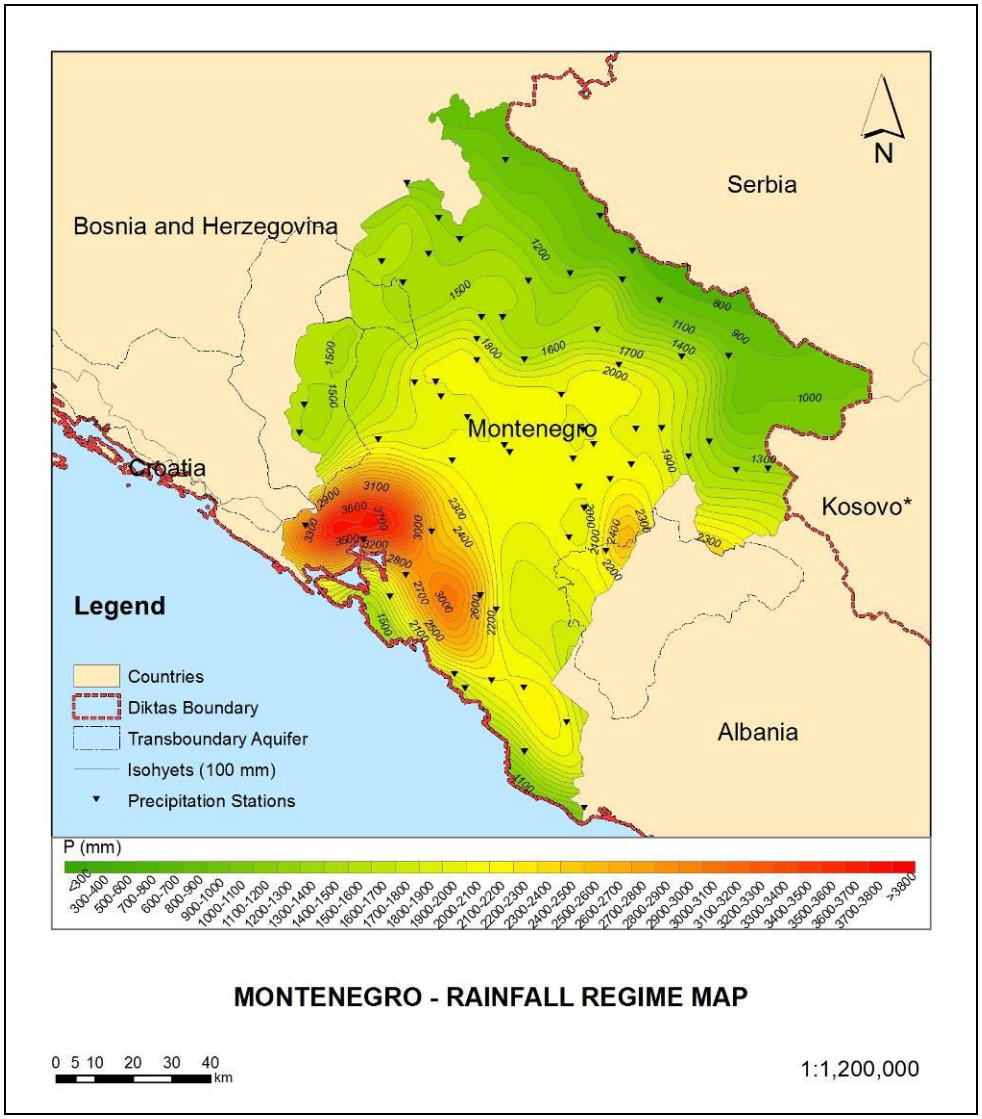


Figure 4 *Reinffall regime map*

According to the precipitation regime, we differ mediterranean and moderate continental regime. The mediterranean regime is characterized by maximum precipitation in November and December, and minimum precipitation in July and August. Moderate continental regime is characterized by frequent precipitation in the second half of the summer, secondary maximum in October and minimum in February.

The coastal belt, as well as the central part of Montenegro, is characterized by the mediterranean and modified mediterranean precipitation regime.

The areas of Lim, Ibar and Ćehotina are characterized by moderate continental climate regime with more frequent precipitation in the first half of the summer and October and with a minimum in February. The greater part of the territory of Piva and Tara basin has a modified mediterranean-type precipitation rate. The medium monthly precipitation for that area has a certain regularity in terms of the amount of fallen atmospheric precipitation during the year. Reported maximum occur during October and March and minimum in July and August. The boundary between the modified Mediterranean precipitation regime and continental precipitation regime extends from the mountains Ljubišnja to the southeast, through Sinjajevina and Bjelasica to Prokletije.

The average annual number of days with precipitation is about 115-130 at the coast, and up to 172 in the north. The wettest months on average are 13-17, and the driest rainy days are 4-10. Number of days with a slightly intensive daily rainfall (over 10 mm) ranges from 25 in (Pljevlja) to 59 in (Kolasin). However, the greatest number of days with heavy precipitation occurs in Cetinje - 74 days.

Spatial distribution of the average annual precipitation, given as map attachment, has been taken from the Water Master Plan and is created on the basis of measurements at 121 rainfall stations, with the unique period from 1949-1991.

In these substrates, the maximum daily precipitation has been statistically analyzed for 22 stations, for different lengths of series (from 20 to 48 years). In the table 1 is given the estimated maximum daily precipitation of a specific probability of occurrence. The table shows that the average maximum daily precipitation ranges from 40 mm /per day in the continental part to more than 250 mm / per day. For the return period of 100 years, the estimated maximum daily precipitation range between 110 mm / per day (continental part) and 480 mm / per day (station near the sea).

Table 1. **Probabilities of maximum daily precipitation (%)**

Station	Period	1%	2%	5%	10%	20%	50%
Bar	49-96	212	191	161	139	116	83
Berane	50-96	110	100	87	76	65	49
Bijelo Polje	51-96	145	127	104	87	70	48
Budva	49-96	237	210	174	146	118	78
Velimlje	70-96	205	184	157	136	114	84
Virpazar	70-96	214	205	192	180	166	138
Grahovo	53-96	351	328	296	270	240	190
Danilovgrad	70-96	250	234	211	192	171	136

Žabljak	54-96	199	180	153	133	111	80
Kolašin	49-96	258	233	198	172	144	105
Kotor	77-96	196	184	167	152	136	108
Krstac	71-96	166	155	140	127	113	91
Nikšić	49-96	264	240	206	180	151	109
Plav	70-96	193	164	127	102	79	56
Pljevlja	49-96	113	100	82	69	57	41
Podgorica	49-96	201	179	151	130	109	82
Rožaj	70-96	200	162	116	85	60	39
Tivat	70-96	187	173	154	139	122	96
Ulcinj	51-96	173	160	142	127	110	83
Herceg Novi-Igalo	49-96	307	277	235	203	168	118
Cetinje	49-96	293	279	259	241	220	182
Crkvice	53-96	485	452	406	368	327	258

Snowfall in Montenegro is analyzed through the duration of snow cover height, which is higher than 30 and 50 cm at 7 sites in the inland of the Republic. The analyses carried out indicate that the snow cover is formed at altitudes above 400 meters above sea level. At altitudes above 600 m, snow cover higher than 30 cm can be expected, and at altitudes above 800 meters above sea level snow cover can be more than 50 cm.

The absolute maximum height of the snow cover was 209cm in the period of 1961-1990 and was recorded in Zabljak. In this year, this maximum is exceeded because in February, the height of snow cover in Zabljak reached 230 cm. In this town, years are not rare when the maximum height of snow cover exceeds 1 m, and when average number of days, with the snow cover higher than 50 cm, is 76. Kolasin has about 10 of such days and the other analyzed locations have less than 4 of these days.

2.4. Air temperature

The hottest months are July and August, and the coldest is January. Average annual temperatures range from about 15.8 ° C in the coastal areas to only 4.6 ° C in Zabljak, while in the other stations the temperatures are within these limits. Approximate temperature gradient is relatively high and averages about 0.8 ° C per 100 m altitude change. Local conditions may affect the average temperatures, but, in general, the average annual temperature of 0 ° C can be expected for areas above the height of 2000 m above sea level.

On orientation map isotherms (attachment - map of climate zones), the spatial distribution of the average annual temperatures is shown. Declining of air temperatures to the north is caused by the influence of continentality and increased altitude.

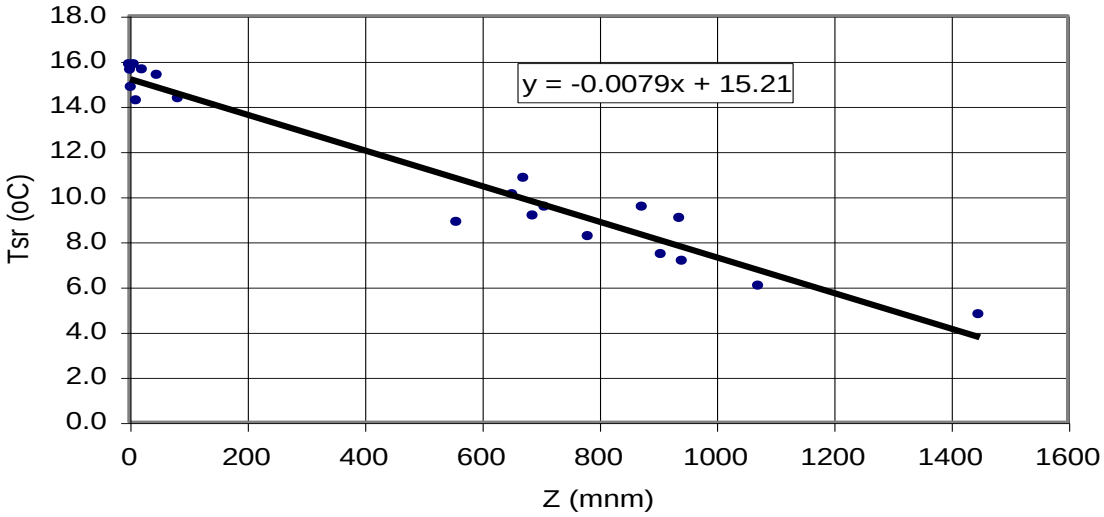


Figure 5 *Interpedence of altitude and average temperature*

Average annual temperatures vary in a quite narrow limits, even for large return periods (for the return period 100 years, about 2 ° C).

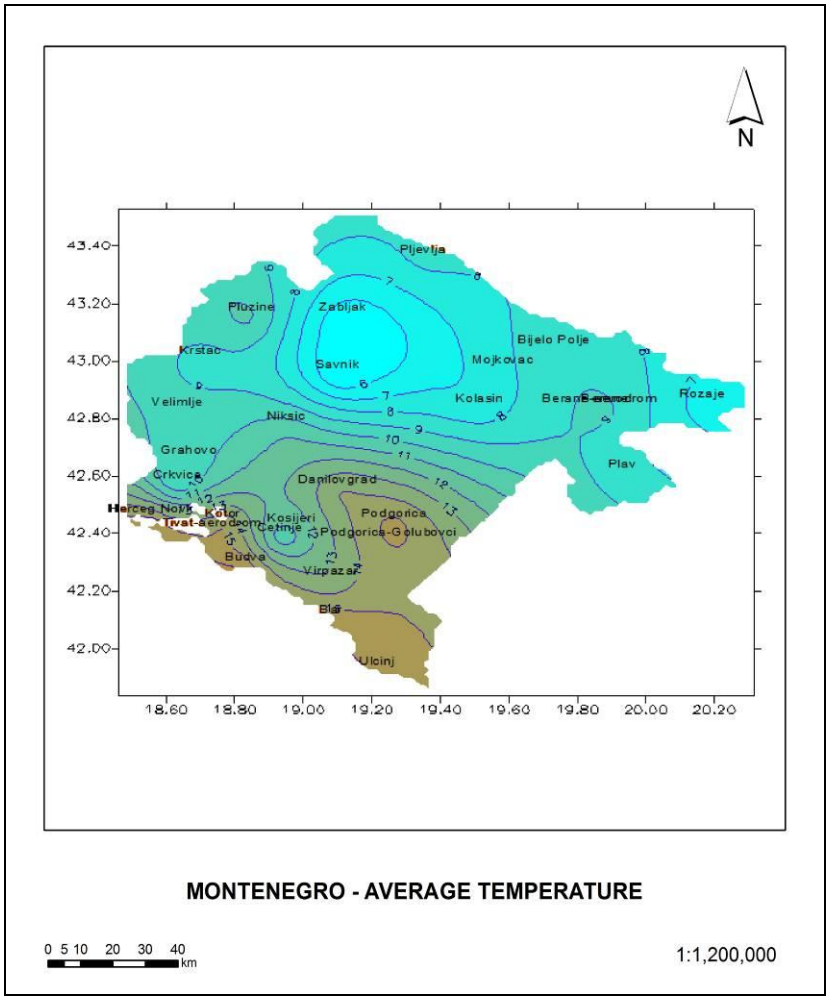


Figure 6 *Reinffall regime map*

Medium minimum, that is, medium maximum monthly air temperatures for the territory of Montenegro fluctuate in considerably wider limits than the average monthly temperatures.

Medium maximum monthly air temperatures are on average about 5oC higher than the monthly average, while the medium minimum monthly temperatures are on average about 5oC lower than the monthly average.

Temperature regime and the climate as a whole, in the northern regions of Montenegro (Black Sea basin), vary depending on the distance from the sea, altitude and diversity of forms of relief. The lowest air temperatures have areas with the highest altitudes on annual average. The hottest part of the northern area of the territory of Montenegro is the Lim valley. In terms of heat in these areas, seasons are clearly distinguished. The summer and winter season are particulary extreme, with a very high absolute air temperature variability.

The hottest month is July and the coldest is January. The lowest medium July temperature has Zabljak (13.9 ° C) and Rožaje (14.8 ° C). Places with lower altitude in this area have a medium July temperature of 15 to 20 ° C (17.4 ° C Pljevlja, Kolasin 15.7 ° C, 18.2 ° C Berane). The average January temperature in these areas is below 0oC and the greatest part cover the isotherms of 2-4-C. The high mountain ranges from the south and southwest, prevent maritime influence of the

Adriatic Sea on the temperature characteristics. In the higher regions of the mountain ranges, the minimum air temperature regime is pronounced. Medium minimum air temperature in January ranges from -9 ° C in Rozaje to -6 C in Berane.

Frost is common in these areas, especially during anticyclone. In some valleys, during sunny winter nights, sometimes air cools to the temperatures below -30 oC. The average annual number of days with frost in the Black Sea basin ranges from 116 days in Berane to 167 in Zabljak. It is interesting that the average annual number of days with frost at the coast ranges from only 4 days in Budva to 9 days in Ulcinj.

Temperature regime in the southern regions of Montenegro (Adriatic basin) also varies depending on the proximity to the sea, altitude and terrain orography. Due to the direct proximity and openness towards the Adriatic Sea, maritime influence is transmitted across the Skadar lake. There is a visible marine air temperature regime in the coastal area and Zetsko- Bjelopavlicka valley, while in areas with higher altitude, this regime is modified in this area by some of the characteristics of continental and alpine climate. This is particularly noticed in areas with altitude around or above 650 m above sea level.

Medium July temperatures at the coast ranges from 23.4 to 24.3 ° C, and in Podgorica it reaches even 26.0 oC. This difference is understandable because in the dry and hot summer period the sea has a cooling effect, what especially contributes to lowering the maximum daily air temperature in the coastal zone. In the winter period, due to the large heat capacity, the sea has the air warming effect, what contributes to minimum daily air temperatures to be particulary high (medium minimum temperature for January in the coastal zone ranges from 3.9 to 4.8 ° C and in Podgorica it reaches 1.4 C). This effect is reflected in the high temperature in January, because it ranges in the coastal zone from 6.9 to 8.3 ° C, and in Podgorica temeprature reaches only 5.0 oC.

The relatively small average number of tropical days indicates that at the coast the sea prevents high daily air temperatures in the summer (days with maximum daily air temperature over 30 ° C). There are between 12 and 32 of these days on the coast during the year and even 66 of such days in Podgorica, while in record years, the number of tropical days may be higher than 100.

On the basis of the medium maximum air temperature in July, it is concluded that the Zetsko-Bjelopavlicka valley is convincingly the hottest part of Montenegro because it reaches even 31.8 oC in Podgorica. On the coast, this value ranges from 27.8 to 29.2 ° C, in Cetinje is 27.1 ° C and in Zabljak it is only 19.4 oC. The absolute maximum of air temperature in Podgorica is even 42 ° C, what also represents the maximum for the entire Montenegro.

2.5. Other climate elements

Evaporation is shortly considered in the following subchapter, as important element of water balance in the karst regions.

As a reliable method for estimation of evaporation, the evaluation of the actual evaporation by Pennman has been used. The evaporation analysis has been performed within the active karst area of the Crnojevića River basin, located in the southern parts of Montenegro (R. Živaljević 2000).

Year	Monthly values of the actual evaporation- corrected Penman for hydrologic moist year E (mm)												E year (mm)
	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	
1987/88	39	15	4	7	19	38	60	51	50	6	22	82	393

A1=79 km2 Qsr =7.03 m3/s, Pgod =3709 mm.

Evapotranspiration generally ranges within the limit of about 400 to about 600 mm per year. Having in mind that the evaporation in karst basins is the most complex component of the hydrological balance, and that it is in many cases defined in an indirect way, and due to the unknown hydrogeological watersheds, it should be considered on the estimation level. The low values of evaporation in the basin of the river Moraca can be partially explained by hydrogeological and pedological characteristics of the terrain and sparse vegetation.

According to the Water Management Plan of Montenegro, on the basis of quite modest fund data about the evaporation from the cup (Class A) for only three stations (Bar, Podgorica and Niksic), and for a relatively short period of measurement, with many incomplete years, the developers state that the annual evaporation is quite similar to the mentioned locations (1200-1300 mm per year). In the warmest months (July-August), evaporation is about 180-230mm and on average about 6 times higher than in winter months. It is expected that the evaporation is lower in the northern parts of Montenegro.

The largest evaporations are from the surface of the Skadar Lake, its immediate surroundings and at the Montenegrin coast. Evaporation from the lakes is estimated at 70% of evaporation from the cup.

3. Hydrology

3.1. Hydrographic network

There are several important water currents on territory of Montenegro which drained towards two directions: towards Black Sea and towards Adriatic. Total size of Black Sea watershed is around 7545 km2. Ibar River is discharging towards Zapadna Morava River, while in direction of Drina Lim, Ćehotina, Tara and Piva are discharged. Total size of Adriatic watershed is around 6267 km2. Morača with its confluents Zeta, Cijevna, Rijeka Crnojevića and Orahovštica are discharging towards Adriatic Sea. All three currents are actually confluence into Skadar Lake, and from there flew with Bojana River towards Adriatic Sea.

Apart from Bojana River, there are several other torrents which confluence to Adriatic Sea, without constant monitoring and measuring of parameters of hydrologic regime.

Basic characteristic of Montenegrin hydrography is the existence of two closely equal watersheds: Balk Sea and Adriatic; Adriatic watershed is attributed with 47.5% of area of Montenegro and 52.5% of Black Sea. Another specific of Montenegro is that highest mountain peaks and wreaths are located within the Black Sea watershed, while the water divide between the Black Sea and Adriatic watershed is south of it. Generally, both watersheds are rich with water, even compared to worldwide standards. However, sizeable portion of Montenegro is made of continental karst, without constant effluents, with numerous sinkholes where water is drained and further efflux underground towards currents or sea.

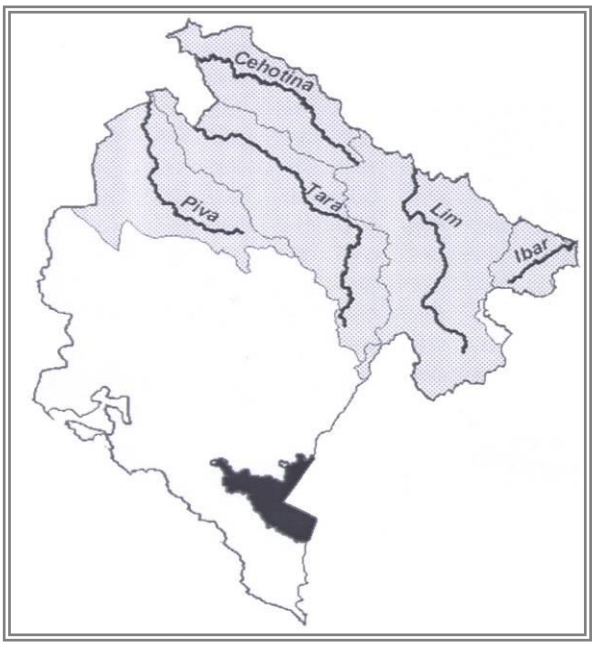


Figure 7 *Black Sea Watershed*

Figure 8 *Adriatic watershed*

Important rivers (major superficial currents) of Black Sea watershed are following rivers Piva, Tara, Ćehotina, Lim as currents from Drina basin and Ibar as a river from Zapadna Morava basin. Important rivers (major superficial currents) of Adriatic watershed are following rivers: Morača, Zeta, Rijeka Crnojevića and Cijevna, all gravitating towards Lake of Skadar from which they overflow to Bojana River and further to Adriatic Sea.

Currents of continental karst drain underground by the means of sinkholes and efflux in watersheds of Adriatic or black sea rivers, or under sea surface. Part of these waters discharge underground to neighbouring territories (Trebišnjica, Konavle).

Very important artificial lakes for hydrography of Montenegro were made at following rivers: Piva, Ćehotina, Zeta (Nikšić field) and Grahovska River (Grahovo). Part of Montenegrin territory was flooded when the artificial lake of hydro power plant „Trebišnjica“ was made.

Natural lakes in Montenegro are relatively numerous and the largest lakes are located in planar terrain of south Montenegro.

Skadar lake was formed in spacious depression is the largest lake in Balkan area. The size of Skadar lake is variable, between less than 400 km^2 at minimal water level, and up to 525 km^2 at maximums registered water level. Volume of Skadar lake for gives sizes is 1.75 and 4.25 km^3 respectively, where we can see that active volume of Skadar lake (value between the lowest and highest water levels) is around 2.5 km^3.

Šasko Lake is the second largest lake in Montenegro, located between Skadar Lake, Bojana River and Adriatic sea.

Crno, Plavsko and Biogradsko Lake are also natural reserves, as typical examples of glacial lakes. Except for Plavsko Lake, all these lakes are located in national parks. Apart from mentioned lakes, there are other smaller lakes of glacial or karst origin.

Section of Adriatic Sea between Montenegro and Italy is 200 km wide and makes part of south Adriatic basin, where the where the greatest depth of Adriatic were recorded – around 1400 m. Total length of coastline of Montenegro is around 300 km. Some 80% of shoreline is rocky, where great depths are recorded immediately next to the shore, while other part of the shore is shallow with sand or gravel bottom. Longest beach is the Velika plaža in Ulcinj. There are numerous spaces (at shoe and at sea) which are suitable for tourism and recreation.

Average ebb and flow amplitude is around 23 cm. Adriatic Sea is relatively warm sea. Dominant direction of winds is parallel with coastline towards northwest. Salinity of south Adriatic sea (38.6 %o) is somewhat lower than the average for Mediterranean Sea (39 %o).

3.2. Stream-flow regime

The average perennial flow is the characteristic of water regime that indicates the overall water level of specified basin area. Average flows are defined for the considered hydrological stations (profiles), based on the observed series and completed data, ie. for a series from 1947-1991. It should be immediately noted that, regardless of the entry and extension of series, the reliability of results is relatively low in stations where the original observations are short, so that these results can be used only as general indicators of water regime.

Numerical parameters of the average perennial values of medium monthly and annual flows for the series from1947-1991 are shown in the table x. Beside average flows per month and for the year, the table nb.x shows the other important parameters of statistical distribution (coefficients of variation and asymmetry Cv and Cs).

Table 5: *Average perennial values of medium monthly and annual flow (m3 /s)*

River	Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Anu	Cv	Cs
Ibar	Rožaje	1,62	2,29	3,04	5,06	5,39	2,41	1,55	1,13	0,91	1,41	2,03	2,65	2,46	0,37	1,47
Ibar	Bać	3,97	5,31	7,30	11,11	11,46	5,92	3,71	2,40	2,17	3,25	4,82	5,93	5,61	0,31	1,10
Lim	Plav	15,09	14,40	15,47	29,94	41,14	28,89	14,41	7,56	7,20	13,63	22,15	21,59	19,29	0,22	0,57
Lim	Andrijevica	24,89	24,25	27,54	50,11	66,96	40,80	19,29	10,3	10,7	19,39	31,37	32,56	29,85	0,26	0,45
Lim	Berane	41,97	44,40	49,84	81,55	95,42	52,84	25,44	14,66	16,31	28,12	46,92	56,60	46,17	0,22	0,28
Lim	Zaton	52,25	54,33	62,19	97,88	112,5	62,98	29,13	16,28	18,55	31,89	55,97	67,05	55,10	0,25	0,20
Lim	BijeloPolje	60,28	63,98	73,56	116,3	129,1	75,34	35,73	20,13	22,1	39,06	67,90	80,46	65,43	0,22	0,55
Ćehotina	Pljevlja	6,76	8,84	10,88	11,56	7,16	5,29	4,01	2,85	3,33	5,05	6,16	8,85	6,73	0,23	0,25
Ćehotina	Gradac	14,50	17,88	21,51	21,45	14,76	10,91	8,06	5,50	6,03	8,86	13,08	17,96	13,37	0,21	0,49
Morača	Crna Poljana	12,11	12,38	13,73	25,18	22,81	9,15	3,44	2,33	3,28	7,43	15,32	18,10	12,11	0,29	0,69
Morača	Trebaljevo	24,96	26,48	29,56	48,64	44,77	20,07	7,91	4,58	6,76	16,28	32,58	37,23	24,99	0,24	0,54
Tara	Bistrica	35,36	35,55	38,90	64,80	62,67	27,55	11,37	7,39	9,55	22,09	43,54	51,66	34,20	0,23	0,45
Tara	Đurđ. Tara	56,32	55,37	62,03	103,5	109,9	62,02	31,89	18,91	20,31	35,32	68,76	79,78	58,66	0,19	0,43
Tara	Š. Polje-	77,11	75,06	85,51	139,4	149,5	85,05	42,10	24,61	26,97	49,87	92,50	104,25	79,36	0,19	0,58
Piva	Š. Polje	73,46	71,16	80,30	125,0	131,5	75,82	33,19	21,00	25,31	52,18	102,06	107,57	74,88	0,20	0,04
Piva	DuškiMost	13,20	13,24	16,26	27,48	27,50	12,66	4,50	3,41	4,48	11,08	23,64	23,26	15,06	0,26	0,29
Morača	Pernica	27,42	27,83	30,46	49,34	57,51	29,27	9,74	6,59	10,44	25,14	46,58	41,63	30,16	0,25	0,99
Morača	Zlatica	79,69	77,03	73,60	90,69	78,41	36,14	9,90	4,61	14,07	43,67	94,88	99,89	58,55	0,26	0,13
Morača	Podgorica	214,94	213,0	203,7	236,1	200,7	103,2	40,86	27,13	50,64	124,19	253,93	274,06	161,90	0,24	0,27
Zeta	Duklov Most	22,44	23,45	24,84	33,13	23,87	9,60	2,26	1,22	4,09	14,38	30,72	31,95	18,50	0,26	0,14
Zeta	Danilovgrad	113,34	110,41	104,77	109,25	79,27	43,28	21,98	15,04	26,35	1,25	122,26	134,69	78,49	0,21	0,07
Cijevna	Trgaj	26,94	28,10	26,80	39,52	41,61	22,93	7,85	4,56	8,15	19,06	36,42	36,34	24,86	0,23	0,15
Rijeka Crnojevića	Brodska Njiva	9.96	8.6	6.84	9.21	3.38	1.63	0.91	0.99	2.83	7.05	13.73	14.08	6.59	0.34	1.0
Orahovštica	Orahovo	5,65	5,37	5,01	4,29	2,55	1,06	0,37	0,23	0,73	2,12	5,32	6,12	3,23	0,25	-0,19

Based on the coefficient of variation, we could globally arrive at conclusion that the temporal variability of discharge in different basins is very different. In this sense, we can conclude:

The most constant average annual flow characterize Cehotina river, where the coefficient of variation is about 0.23. The highest variability is expressed in Ibar river and Rijeka Crnojevica, where Cv is around 0.37, that is 0.34. Variations of monthly flow are even more expressed in the region, and are the largest in the autumn months.

Table 6: *Average annual flow for the typical occurrence probabilities*

River	Station	0,1%	1%	2%	5%	10%	20%	50%	$Q_g(m^3/s)$
Ibar	Rožaje	7,17	5,46	4,93	4,21	3,66	3,08	2,24	2,46
Ibar	Bać	13,81	11,03	10,15	8,94	7,97	6,92	5,30	5,61
Lim	Plav	35,99	30,92	29,25	26,88	24,90	22,66	18,87	19,29
Lim	Andrijevica	59,26	50,58	47,68	43,54	40,06	36,08	29,20	29,85
Lim	Berane	81,73	71,86	68,50	63,60	59,39	54,49	45,67	46,17
Lim	Zaton	100,72	88,50	84,28	78,06	72,68	66,32	54,65	55,10
Lim	BijeloPolje	119,40	103,40	98,14	90,54	84,16	76,87	64,26	65,43
Ćehotina	Pljevlja	11,11	10,13	9,76	9,20	8,69	8,05	6,78	6,73
Ćehotina	Gradac	24,26	21,04	19,97	18,44	17,15	15,68	13,14	13,37
Morača	Crna Poljana	26,59	22,08	20,61	18,53	16,81	14,90	11,70	12,11
Morača	Trebalje-vo	47,98	41,19	38,93	35,69	32,97	29,86	24,48	24,99
Tara	Bistrica	64,81	55,77	52,76	48,45	44,83	40,69	33,53	34,20
Tara	Đurđ. Tara	100,35	88,40	84,38	78,57	73,64	67,95	57,91	58,66
Tara	Š. Polje-	138,61	120,63	114,70	106,27	99,26	91,33	77,87	79,36
Piva	Š. Polje	122,28	110,56	106,38	100,11	94,54	87,79	74,88	74,88
Piva	DuškiMost	28,98	25,12	23,80	21,88	20,24	18,32	14,86	15,06
Morača	Pernica	64,36	52,97	49,34	44,32	40,28	35,88	28,92	30,16
Morača	Zlatica	107,16	94,63	90,23	83,70	77,97	71,12	58,30	58,55
Morača	Podgori-ca	299,37	261,22	248,21	229,26	213,02	194,06	159,95	161,90
Zeta	Duklov Most	34,33	30,25	28,81	26,69	24,82	22,59	18,42	18,50
Zeta	Danilovgrad	132,59	118,64	113,74	106,48	100,10	92,48	78,21	78,49
Cijevna	Trgaj	43,45	38,66	36,98	34,48	32,29	29,67	24,76	24,86
Rijeka Crnojevića	Brodska NJiva								6,15
Orahovštica	Orahovo	5,52	5,01	4,82	4,53	4,26	3,93	3,26	3,23

The condition of average perennial monthly flows can be seen from Table X, where the module values of annual flow are shown Kp = Qp / Qq for several typical occurrence probability (p). Based on these indicators, we can conclude that the monthly water level varies from one watercourse to another watercourse. However, we can draw a general conclusion that most watercourses of Black Sea have the highest water level during April and May, with a secondary maximum in November and December.

On the other hand, the Adriatic basin watercourses at stations closer to the sea show the highest water level in November and December, while at the stations away from the Adriatic coast (Duklov Most Pernica), water level is also the highest in the spring months.

TABLE 7. **MODULE VALUES OF ANNUAL FLOWS FOR TYPICAL OCCURRENCE PROBABILITIES**

River	Station	0.1%	1%	2%	5%	10%	20%	50%	$Q_g(m^3/s)$
Ibar	Rožaje	2,92	2,22	2,00	1,71	1,49	1,25	0,91	2,46
Ibar	Bać	2,46	1,97	1,81	1,59	1,42	1,23	0,94	5,61
Lim	Plav	1,87	1,60	1,52	1,39	1,29	1,18	0,98	19,29
Lim	Andrijevica	1,99	1,69	1,60	1,46	1,34	1,21	0,98	29,85
Lim	Berane	1,77	1,56	1,48	1,38	1,29	1,18	0,99	46,17
Lim	Zaton	1,83	1,61	1,53	1,42	1,32	1,20	0,99	55,10
Lim	BijeloPolje	1,82	1,58	1,50	1,38	1,29	1,17	0,98	65,43
Ćehotina	Pljevlja	1,65	1,50	1,45	1,37	1,29	1,20	1,01	6,73
Ćehotina	Gradac	1,81	1,57	1,49	1,38	1,28	1,17	0,98	13,37
Morača	Crna Poljana	2,20	1,82	1,70	1,53	1,39	1,23	0,97	12,11
Morača	Trebalje-vo	1,92	1,65	1,56	1,43	1,32	1,20	0,98	24,99
Tara	Bistrica	1,89	1,63	1,54	1,42	1,31	1,19	0,98	34,20
Tara	Đurđ. Tara	1,71	1,51	1,44	1,34	1,26	1,16	0,99	58,66
Tara	Š. Polje-	1,75	1,52	1,45	1,34	1,25	1,15	0,98	79,36
Piva	Š. Polje	1,63	1,48	1,42	1,34	1,26	1,17	1,00	74,88
Piva	DuškiMost	1,92	1,67	1,58	1,45	1,34	1,22	0,99	15,06
Morača	Pernica	2,13	1,76	1,64	1,47	1,34	1,19	0,96	30,16
Morača	Zlatica	1,83	1,62	1,54	1,43	1,33	1,21	1,00	58,55
Morača	Podgori-ca	1,85	1,61	1,53	1,42	1,32	1,20	0,99	161,90
Zeta	Duklov Most	1,86	1,64	1,56	1,44	1,34	1,22	1,00	18,50

River	Station	0.1%	1%	2%	5%	10%	20%	50%	$Q_g(m^3/s)$
Zeta	Danilovgrad	1,69	1,51	1,45	1,36	1,28	1,18	1,00	78,49
Cijevna	Trgaj	1,75	1,56	1,49	1,39	1,30	1,19	1,00	24,86
Rijeka Crnojevića	Brodska NJiva	2,17	1,84	1,72	1,56	1,42	1,26	0,98	6,15
Orahovštica	Orahovo	1,71	1,55	1,49	1,40	1,32	1,21	1,01	3,23

3.3. Controlling streamflow – dams and reservoirs

The number of artificial reservoirs in Montenegro is small if compared to hydropower potential. In the Black Sea basin, two reservoirs "Piva" on the Piva river and reservoir "Otilovići" on the Ćehotina river, have been formed so far. In the Adriatic, reservoirs in Nikšićko polje "Krupac," "Salt" and "Vrtac" have been formed until now, on the river Gracanica "Liverovići" and also smaller reservoir "Grahovo" in the Grahovsko polje.

The total capacity of reservoirs amounts slightly more than one billion cubic meters of water. In relation to the total amount of surface water (about 14 x 109 m3/yr), which are formed on the territory of Montenegro, that amounts only about 7% (according S. Hrvavcevic, 2004).

Reservoir "Piva"

”Mratinje” arch dam, by which reservoir with total capacity of 880 million m3 was constructed, was completed in 1978. Useful capacity of reservoir is 790 million m3.

The basin surface of 1758 km2 was determined by project, with medium annual flow of 74.4 m3 / s. Large water in the dam profile $Q_{0,01}$ are calculated to 1900 m3 / s.

The dam is 220 meters high (constructive height), and hydraulic height of the dam is 190 m.

Figure 9 *Reservoir Piva*

Reservoir "Otilovići"

Reservoir and dam "Otilovići" was built in 1980, on the river Ćehotina. By construction of dam, reservoir had the total capacity of 18x106 m3. Its purpose is to provide enough quantity of water for the work of HPP "Pljevlja" as well as for the water supply of the city of Pljevlja.

Reservoirs in Nikšićko polje

Reservoir “Krupac” was created by the construction of the embankment dam ”Krupac” on the river Mostanica, with height of 19.5 meters and length of 1480 and by injection of abyss of Krušačka pothole.

Dam crest elevation is 622 meters above sea level. With the elevation in the reservoir of 620 m above sea level, the capacity of about 42.10 × 106 m3 of reservoir basin is reached. Krupac has a throughput capacity of 12 m3 / s. The water is supplied from the reservoir by the channel “Mostanica” to Zeta channels (see Figure x) for the purpose of the HPP "Perućica".

Figure 10 *Reservoirs in Nikšić field (Google earth)*

Reservoir “Slano” is created by the construction of embankment dam “Slano” (Orlina), with height of 2.21 m and a length of 1630 m and by injection of the southern rim of reservoir in order to isolate the abyss.

The dam is consisted of boulder mound with clay core. Dam crest elevation is 623 meters above sea level. With the elevation of 621 meters above sea level in the reservoir, the capacity of reservoir basin of about 117 x 106 m3 is reached. The spillways are performed using the uncontrolled spillway of type "duck's beak" of capacity of 150 m3 / s. The bottom outlet of the dam “Slano” has a throughput of 51 m3 / s. From the reservoir the water is supplied by the channel “Opačica” to the channel Zeta of the length of 4.3 km, and with throughput capacity 51 m3 / s for the purpose of HPP "Perućica".

By the construction of dam “Vrtac”, approximately 16.5 m high, 2386 m in length, with a dam crest elevation of 616.5 m above sea level, the retention was created which to the elevation of 614.5 meters above sea level has a volume of about 72 × 106 m3.

Spillways are made by head uncontrolled spillway of capacity of 300 m3 / s. Bottom outlet of dam “Vrtac” has throughput of 68 m3 / s. All attempts to seal abyss in the reservoir have not obtained results, so the construction of upstream reservoirs begun for the purpose of HPP "Perućica".

Reservoir “Liverovići”

”Liverovići” dam is a concrete arch dam of 45 m height and the length of 127 m in the crest (together with gravity abutments it amounts 187 m). Dam height from the bottom of the river is about 30 m. The total reservoir volume is 7.8 × 106 m3. Spillways are made by head uncontrolled spillway with capacity of about 38 m3 / s, consisted of 5 spillways. Bottom outlet of the dam “Liverovići” has a throughput of about 80 m3 / s.

The purpose of this dam is to supply water to Zeljezara and was intended for the production of electric power.

Figure 11 *Liverovici reservoir*

Reservoir Grahovo was formed by construction of the same called dam on the Grahovska river about 500 m downstream from of the main springs.

The surface of controlled basin is approximately 1 km2, and the useful reservoir capacity is about 1.1 × 106 m3. The height of the dam is 31 m and the capacity of the dam is about 29 300 m3 of boulder mound, and about 5000 m3 of wall.

Dam crest elevation is 783 meters above sea level, and the elevation of normal deceleration is 782 m above sea level. The surface of the reservoir at the elevation of the maximum deceleration is about 112,000 m2. The length is 171 m.

It is used for land irrigation and water supply for the population and as well as for the alleviation of flood waves.

Hydroelectric power plants

Hydroelectric potential of Niksicko polje is used through HPP “Perućica” of installed flow of 80m3/s and power of 307 MW. The average production is 900 GWh / per year.

Power plant "Piva" has the largest head of 186 m, and the smallest 104 m. Installed power is 3x120 = 360 GWh, with an average annual production of about 750 GWh / per year, of which about 93% of peak power.

There are three small hydro power plants: HPP “Mušovića river” near Kolasin with installed capacity of 1.5 MW, HP “Slap Zete” with installed capacity of 1.5 MW and HP “Zeta” of capacity 5 MW.

4. Geological pattern

4.1. Paleogeography of the Dinaric region

The Dinarides as a mountain system have not been clearly spatially defined yet regarding to surrounding systems. In the framework of the classic but abandoned geosynclinal concept Kober (1911) separated “two branches” within the Alpine-Himalaya belt and the Dinarides, together with the Apennines, the Southern Alps and the Helenides included in “the southern branch” and the Eastern Alps and the Carpatians into “the northern branch”.

The continuation of the Dinarides toward the Alps is not clearly defined. As a matter of fact that the External Dinarides, e.g. the Adriatic-Dinaridic carbonate platform paleogeographically continue in the Southern Alps some geologist their structure boundary anyway put along the Southalpine Front (Carrulli et al., 1991; Placer, 1988).

Recently, in the Alps/Dinaride adjoining area is separated by the transitional zone named the Mid-Trans-Danubian Zone (Fulop et al., 1987), Zagorje-Mid-Trans-Danubian Zone (Pamić and Tomljenović, 1998) or the Sava Zone (Hass et al., 2000). The zone is composed of mixed blocks from both the Alps and the Dinarides and it is the result of the Tertiary (the Oligocene-Miocene) lateral extension tectonics (Kazmer and Kovacs, 1985; Ratschbacher et al., 1991).

The relation between the Dinarides and the Hellenides is clearer. This is shown in the fact that all paleogeographic and structural units of the Internal Dinarides continue south-eastward into the Helenides (under different names) suggesting that they must originate from one and the same oceanic domain, i.e. the Dinaridic-Hellenidic Tethys (Pamić, 2002) or the Vardar Ocean (Decourt, 1972; Stampfli, 2000).

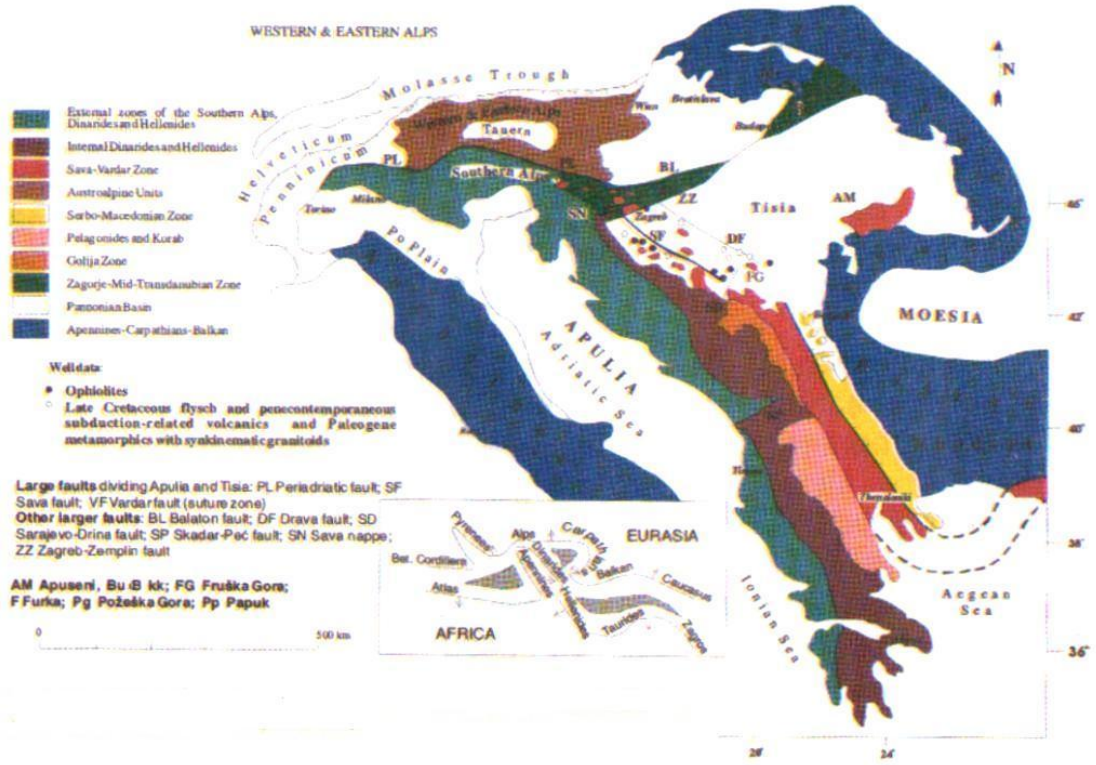


Figure 12 *Tectonic scheme of the Alps, Dinarides, Helenide and Pannonian basin; simplified according to Dimitrijević (1999)*

The southwestern boundary between the External Dinarides and the Adriatic Microplate is covered by the Adriatic Sea. The Adriatic-Ionian Zone is positioned between them as a foredeep zone. It does not outcrop along the Adriatic shore but southeastward of Skadar-Peć fault and represents the most external zone of the Hellenides (Figure 12).

Geologically speaking, territory of Montenegro represents southeast sections of outer and inner Dinarides, which are, just like other parts of these macrotectonic units, of complex structure. Terrain is made of igneous, sedimentary and metamorphic rocks of Paleozoic, Mesozoic and Tertiary age. More than 60 % of Montenegrin territory (more than 8287 km^2), is made of carbonate sediments. Tectonic movement from lower Paleozoic until present day, rock masses folded and broke. Numerous anticlines and synclines were more or less deformed with faulting process. Present tectonical structure of Montenegro is made of four major geotectonical units:

- *Adriatic-Ionian zone (paraautohton)* whose section that belong to Montenegro is entitled Adriatic system of folds*;*
- *Pindos- Cukali zone*- section of Montenegrin territory entitled *Budva- bar zone;*
- *High karst zone;*
- *Durmitor overthrust.*

Initial relief of Montenegro, formed with tectonical movements is modified in long-term geological time, from the end of Lower Cretaceous up to now, with intensive marine, fluvial, glacial, karstic and other exogenous processes.

Present relief is mountainous with absolute elevation of more than 2500 m above sea level, except for the narrow coastal area. Major section of relief is typically karstic (mostly holokarst) type with

numerous and diverse karst phenomena: karst plateaus, polje, sinkhole, karst depressions, swallow holes, caves, pits and other forms.

Terrain of Montenegro is made of igneous, sedimentary and metamorphic rocks. Its age ranges between Devon to present days. Numerous lithological members occur in several known lithostratigraphical units of southeast Dinarides within four major geotectonical units.

Adriatic system of folds is the terminal tectonical unit of outer Dinarides in Montenegro. This system of folds continues from southeast, from Albania territory further northwest making the hinterland of Ulcinj, all the way to Bar field where it goes under sea.

Numerous lithostratigraphic formations are making this tectonical unit in Montenegro, from Lower Triassic to Paleocene. It is represented by sedimentary rocks of Triassic, Jurassic, Cretaceous and Paleocene and igneous rocks of Middle Triassic.

Rock masses of this geotectonical unit are highly urban and intersected with numerous fractures, including not only reserve faults but overthrust nappe. Complex lithological-facial structure and distinct folding and ruptures making Budva-bar zone makes these terrains very complex.

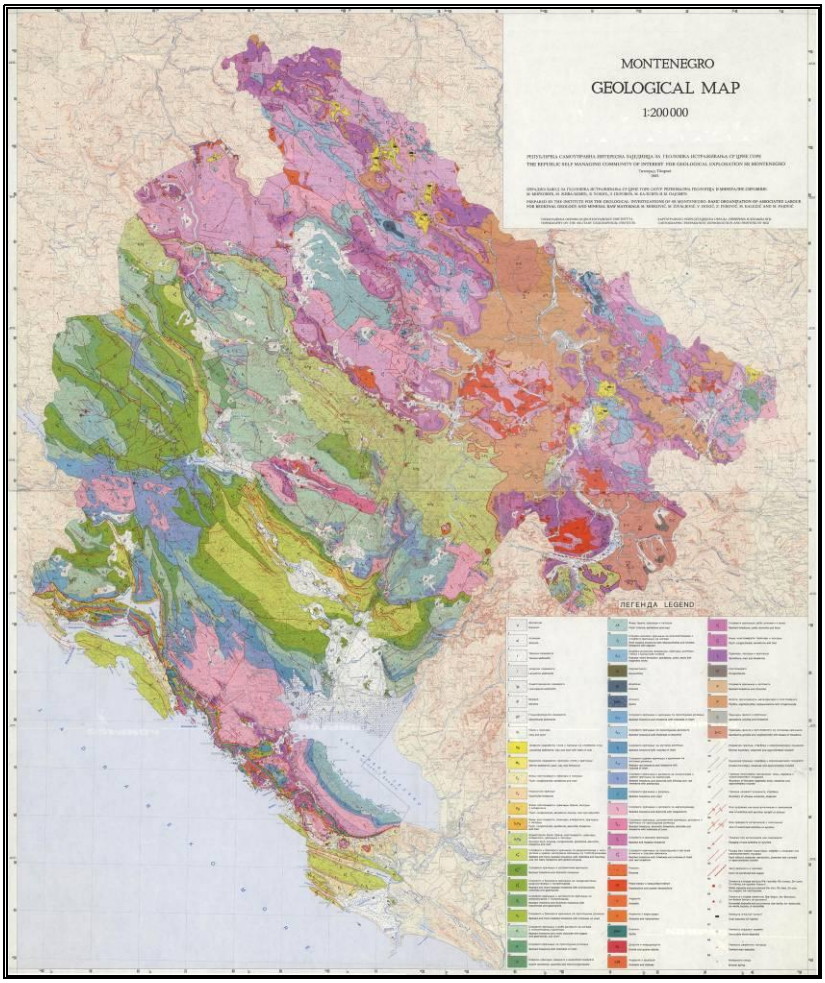


FIGURE 13 *GEOLOGICAL MAP*

High karst zone is spread to more than 6,000 km^2 or more than 40% of Montenegrin territory. It is known geotectonical unit of southeast Dinarides which is overhtrusted from north and northeast towards south and southeast over Budva-bar zone.

Zone of high karst in Montenegro is mostly made of sedimentary rocks of lower Paleozoic, Triassic, Jurassic, Cretaceous and Paleocene, while neogene and Quaternary sediments are also present. Igneous rocks of Middle Triassic are significantly less present.

Durmitor overthrust include north and northeast Montenegro, with its size of over 5000 km^2. It is spacious overhrust of southeast Dinarides which is overhtrusted from northeast towards southwest over Durmitor flysch i.e. synclines of Kučka overhtrust nappe of High karst zone.

4.2. Tectonic

The terrains of Montenegro belong to the southeastern Dinarides, whose complex tectonic structure was a subject of numerous researchers. There are many disputes over the characters of the main dislocations among scientists: some scientists give a high significance to covers in the structural material of Dinarides, while the others are of the opinion that the overthrust structures with horizontal movements of more than 50 or even 100 miles are not in question, but that these are overthrust nappe, with falling plane dislocations above 45o. But despite these differences, almost all scientists agree that there are four geotectonic units in Montenegro, which are commonly known as: Parautochthone, Budva -Cukali-zone, Visoki krs and Durmitor tectonic units (see fig.14).

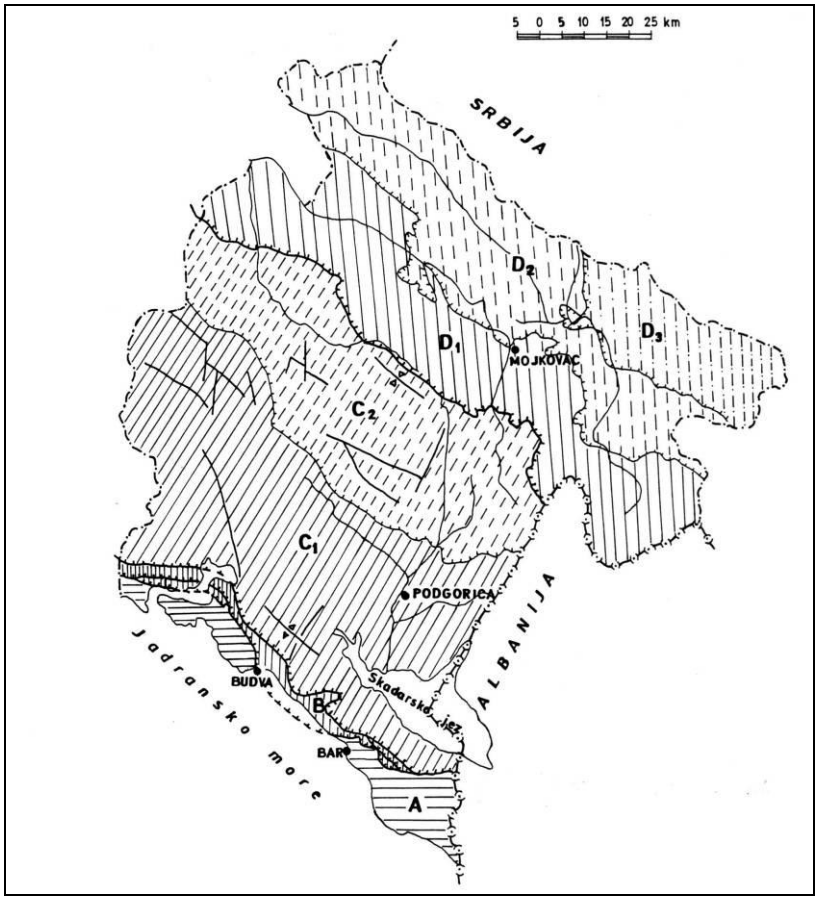


Figure 14 *Generalized tectonic map of Montenegro (A- Paraauhton, B- Budva Cukali zone, C- Visoki krš, D-Durmitor tectonik unit, C1- Starocrnogorska t.u., C2- Kučka t.u., D1- Sinjajevina, Durmitor, Komovi t.u., D2- Ćehotina t.u., D3- Limska t.u.)*

Parautochthone

Geotectonic unit Parautochthone is also known in the literature as: Adriatic, Adriatic - Ionian, Southern Adriatic, Dalmatia zone and etc. It includes the outermost parts of the coast of Montenegro: Kobila, Lustica and Grbalj, with immediate hinterland and Ulcinj area between the rivers Bojana and Bar. This unit has on the surface a relatively simple structure. In fact, its basic structural feature in the area of Ulcinj creates regional, almost parallel system of folds, which were by exploratory oil drilling determined to represent the inverted structures and reversely broken structures. Among them are the anticlines: Volujica - Sasko Lake, Možura-Brivska gora, anticline of Bijela Gora. These structural forms are built from carbonate sediments of the Upper Cretaceous with anhydrites, and by drilling the Lower Cretaceous anhydrites are proved. Syncline separate these anticline forms, and are built from the Eocene flysch sediments.

In the area of Luštice and Grbalj, Senonian carbonate and mostly Eocene flysch sediments have general decline towards the Northeast, with mild and moderate declining angles. Geophysical testing has demonstrated that the Parautochthone southwest (offshore Montenegro) is slipped on the Ionian geotectonic zone.

Budva- Cukali zone

Budva-Cukali zone includes a narrow strip of the Montenegrin coastal region which extends from Sutorine in the northwest to slopes of Orjen, Lovcen, Sozina and Rumija – and almost vanishes on the border with Albania, and then it appears again on the east from Shkoder over a wide Cukali area.

By litofacial and structural characteristics, this structural zone is significantly different from the adjacent-Paraautochtone on the southwest and the Visoki krs on the northeast. Geotectonic units of the Visoki krs are thrusted over the Budva –Cukali zone, and this zone is thrusted over Parautochthone.

Budva-Cukali zone represents a trench structure between the two platforms, which according to some estimations was 40 to 100 km wide. By Alpine orogeny, by the end of the Paleogene (primarily in the Oligocene), this geologic units were pressed in the system of isoclinal folds, of the total thickness of 3 to 7 km, with frequent shearing and overthrusting. So area of this tectonic zone has suffered extremely overthrusting structure with southwest vergence and axial planes and overthrust, whose angle ranges from 40 to 60^{o}.

General spreading of structures is Dinaric, with some smaller or bigger variations in the area of Crmnice and Bar. The intensity of the variations increases from northwest to southeast. Thus, in the northwestern part of the structure, two monoclinal fold belts of Mesozoic and Paleogene sediments are developed, separated by reverse dislocation which vanishes from Sutorine over Veriga and Vrmac in the east of Kotor. In the northeastern area, there is no plicative forms, while in the southwest are formed overturned synclines and anticlines with SW vergence. In the terrain around Budva, sediments were collected in the several parallel inverted structure, mutually separated by local overthrusts. Further, to the southeast, in the folded and ripped structural

shapes, the three overturned anticlines are distinguished: Sustaša, Rađena and Turčina. Along the southwestern wings, these are ripped and thrusted over the Paleogene flysch sediments.

Visoki krš

This unit includes the central and southern part of Montenegro. Coming from the northeast direction it is thrusted over the Budva –Cukali zone, and in the area of Rumija - over Paraautochtone. Within the Visoki krs, two structural units are developed, which Z. Besic (1948) named Starocrnogorska and Kučka kraljušt, or unit. These names were adopted in the medical and scientific geological literature.

The Starocrnogorska structural unit is characterized by the presence of complex and folded forms, such as: Starocrnogorski anticlinorium, sinclinorium of Orjena and Bijela Gora, anticline Ledenica, Crmnice, Trešnjevo, Grahovo, Zaljute and Njegoš, sinclinorium Zeta and anticline Dečić. Almost all of these structural forms are separated from the adjacent by reverse dislocations of general direction NW-SE, or by diagonal faults of gravitational type. Another important feature of this unit is the presence of numerous regional and local faults of different orientations which are easily recognized and noticed on photoes of the entire region. Based on the total tectonic-structural setting, it can be rightly concluded that the terrains of this unit during the geological evolution were exposed to the intense tectonic processes, which practically, regionally considering, led to the current morphological structure of this and neighboring regions. The sinclinorium of Zeta continues from Skadar Lake through Bjelopavlici over Niksic and klanac Duga in the northwest direction of Lebršnik. From Lake Skadar to Niksic, the northeastern part of this structure is characterized by often reversed shear and Božaj, Dečić, Medun, Doljan, Martinići, Povija overthrusts and etc., and in the southwestern part, isoclines folds are common, which have also been developed in the areas of Budos, Bijele poljane i mountain Njegoš.

Kučka tectonic unit includes terrains of Žijovo, Kuče, Prekornica, Maganik, Lola, Vojnik, Golija, Treskavce and Lebršnik. In structural terms, this unit essentially represents a complex overturned anticline carbonate structure, with thick layers of flysch Durmitor on its northeast part – which are limited on the north-east by the regional dislocation of Durmitor overthrust. The south side of the structure is also reverse dislocation which is thrusted over the Starocrnogorska structural unit. Structural features of Kučka unit greatly depend on its lithological composition. Its carbonate part is characterized by anticline: Dobrelice, Komarnica and Treskavac, Nikšićka zupa, Mrtvica, Moraca and Žijovo and also synclines: Golija, Rubez, Prekornica, Seoca, Lebršnik and etc. Anticline of Nikšićka zupa has a very complex tectonic structure, especially in its inverted southwest part. The deep oil drilling research in Niksicka zupa provided such information on tectonic relations in this structure, which is not possible to correlate logically with the surface geology data. The regional “scissors” type dislocation in the Niksicka zupa from Liverovićko lake to the mountain Kamenik has character of overthrust nappe, and from Liverovići to Niksic - fault with decline in northeast. The characteristical overthrust nappe are Ledenica, Golija, Goranska, Studeno and other of local interest.

Durmitor tectonic units

This structural-tectonic unit belongs the northern and north-eastern parts of Montenegro. It includes the area of mountain ranges Volujak, Piva mountain, Durmitor Ljubisnja, Kovac Mountain,

Sinjavina, Lisa mountains, Bjelasica, Komovi, Visitor, Čakor, Sjekirica and Hajla. On the southwest side it is thrusted over the Durmitor flysch of Kučka tectonic units, whose overthrust route extends from the southwestern slopes of Volujak (in the northwest of Montenegro) through Plužine, southwestern slopes of Durmitor, Boan, Crkvina and southwestern slopes of Komovi, and then gradually bends along the river Vrmoša and Grncar, where suddenly turns to the south in the territory of Albania.

According to geological data, the overthursting plain of Durmitor unit is relatively steep, stretching from Volujak to Durmitor, and from there to the southeast the amplitude of overthrusting increases, as evidenced by tectonic patches of Planinica and Karimani and tetonic holes of flysch sediments in the river Trokuska near Andrijevica, in the area of Salevic village and etc. The internal structure of Durmitor unit is very complex. In this area the presence of tectonic patches and holes is certainly proved, what confirms the opinions of one part of researchers on the presence of horizontal limestones and tectonic shear in the Internal Dinarides. The best known tectonic patches are Planinica, Korimana, Karaula – Trojan, Kukića bora, Planinice near Mateševo and tectonic patches on the mountain Bjelasica. All these tectonic patches, except Bjelasica, are thrusted over the Durmitor flysch, which was also detected in the tectonic windows (below the Paleozoic sediments) in the river Trokusit spring area near Plav, and near Andrijevica within the river Svinjaca basin near Kolasin.

5. Geomorphology and karstification

5.1. Karstification process

Karstification is an aggregate of geological processes either naturally or artificially in the earth's crust and on its surface due to chemical, physic-chemical, dissolution and erosion under diverse geological and climatic conditions through time. It is expressed through the formation of openings, the destruction and alterations of the structure of the rocks, and through the creation of a particular type of a groundwater circulation and characteristic regime of drainage network and of characteristic regional topography. The degree to which the rocks have been karstified varies greatly from place to place depending on how much the fissure in the rock have been enlarged by the solution action of acidified rain water and the extent to which the underground drainage system has become organised and integrated into efficient conduits for the collection, transport and ultimately discharge of recharge waters. In some karst areas the karstified rocks can be overlain with non-carbonate strata or unconsolidated deposits and this is termed a covered or mantled karst. Old karstic landforms, surface or underground, which have been filled by subsequent deposits, often have no surface expression and do not function hydrogeologically (or has lost its mass transport function). These are called paleokarsts. Paleokarst may be reactivated if environmental conditions change (F. Assaad and F.E. La Moreaux, 2004).

Intensity and deph of karstification process depend on many factors. The most important are (after V. Dragišić, 1998):

- presence of the soluble rocks
- fissuring, permeability and porosity of rocks in which atmosphere and surface water circulate
- geological-structural setting and contemporary climate factors which accelerate or slow-down karstification process
- crust movements which determined acceleration or slow-down karstification process.

Most intensive karstification processes happens in fissures of crust of disintegration and zone of faults. Solution effect of groundwater depends also on content of carbon acid in groundwater. The karstfication process can be simply described by formula:

$$CaCO_3 + H_2O + CO_2 \Leftrightarrow Ca_2^{++}\ 2(HCO_3)^-$$

Montenegrin terrains which are consisted of carbonate rocks are characterized by relief that is very suitable for the development of karst process. By tectonic movements of positive signs during the Paleogene, Neogene and later during Quaternary, the high mountain ridges (Durmitor, Ljubisnja, Volujak, Sinjajevina Komova, Orjen, Lovcen, Rumija and etc.) were formed of old karst plateau which are arranged in multiple levels and among mountain depression (Zeta valley - Nikšićko polje).

Particularly important role in the development of karst process have had the old karst plateau intersected by deep canyons of Piva, Komarnica, Susica and Tara.

In karst terrains of Montenegro, the density and size of surface and underground karst forms, the karstification depth and karst process development dynamics are different.

The karstification depth ranges from a few meters to over 2000 meters. For example, the continuing depth of karstification, per vertical profile in the flat limestone plateau of Klikovača is 5-

10m. In the area of Cetinje field it is limited by the level of flysch sediments on 200m, in Njeguši area 340 m (Duboki do), in the Durmitor area over 800 m (Vjetrena brda, 880m depth). Deep drillholes in the Niksicka zupa indicated the karstified limestones in the range of 1900-2236 m, and on the slopes of Možuren (near Ulcinj) in the range of 3136 to 3247 m.

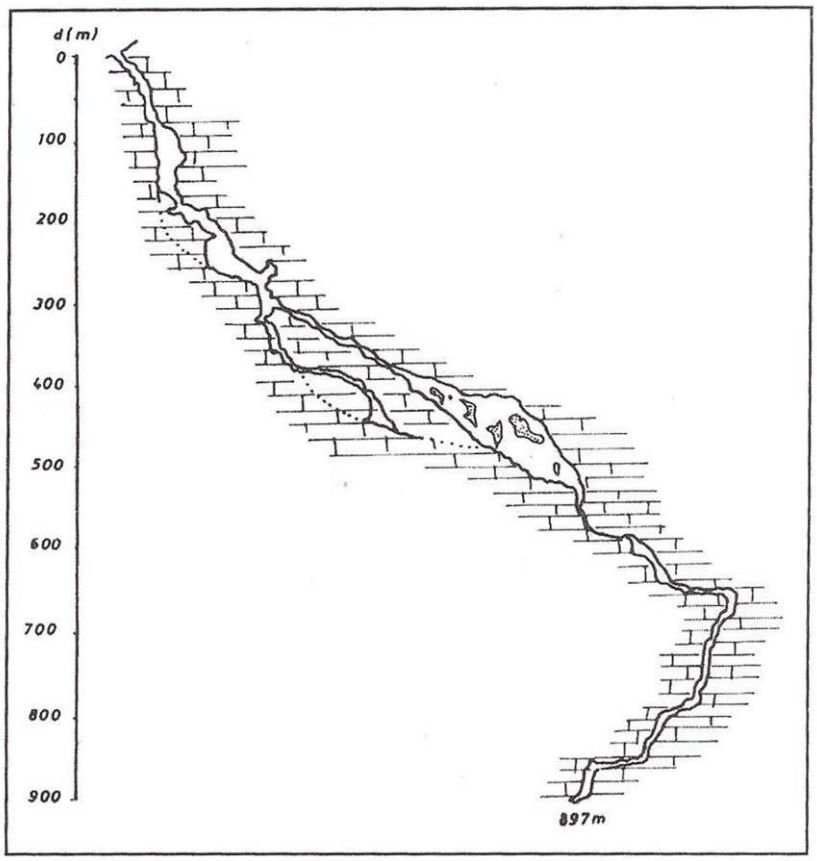


FIGURE 15 *PIT ON VJETERNIK HILLS (SPELEOLOGICAL SECTION OF THE CLIMBER ASSOCIATION BELGRADE, 1991)*

5.2. Karstic features

The terrains of Montenegro are made of carbonate rocks are characterized by numerous surface and underground karst forms among which are the most characteristic: cracks, gorges, dry valleys, sinkholes, caves and potholes.

5.2.1. Surface karstic features

Surface micro-features - karren runnels, mostly <1 m deep, produced by dissolutional fretting of bare rock (Bögli, 1960), including grykes, cutters and inherited subsoil rundkarren, and ranging in size up to pinnacles 2-30 m high in pinnacle karst (Waltham, 1995);

Surface macro-features - dry valleys, dolines, poljes, cones and towers, all landforms on the kilometre scale that are elements within different types of karst (Ford and Williams, 1989).

Poljes - a large, flat-floored depression within karst limestone, whose long axis develops in parallel with major structural trends and can become several kilometres long.

Most karst plains in Montenegro (Niksicko, Cetinjsko, Grahovsko) are of polygenetic origin and are generally predisposed by tectonics and later shaped by erosion processes. Niksicko polje is the largest karst plain in Montenegro whose elevations range from 660 m in the northwest to 600 m in its southeastern part, in direction where it is gradually expanding. Its surface is about 65 km2. It is flooded by the Quaternary glaciofluvial and limnoglacial deposit, with an average thickness of 15-20m.

Sinkholes - can be classified into several groups:

• sinkholes formed along the rift zones (sinkholes along Budoški faults in Niksicko polje, along the faults at the edge of Cetinjsko and Grahovsko polje)

• Sinkholes by contact of permeable and impermeable rocks (in Bare Bojovića - Nikšićka zupa, sinkholes Uganjska vrela - springs near Cetinje),

• sinkholes along the riverbed of permanent and seasonal watercourse (the monastery Duga and Kolovrat in the riverbed of Moraca)

• sinkholes that open in paleorelief beneath the Quaternary deposit (Brezna, Nozdra, the southern part of Niksicko polje, Obzovica)

5.2.2. Caves and potholes

Potholes - the deepest examined pothole in the terrains of Montenegro is the pothole on Vjeterna hills, (southern slopes of Durmitor) formed in carbonate rocks of Durmitor flysch. The tested depth of the pothole in which the occurrence of groundwater was registered on many levels is 897m. The other tested potholes in the area of Durmitor with the greatest depths are: Todor's cave (316m), Skala (128m), Boljska pothole (164m), Pecaklina potholes in Dubrovsko (186), Sniježna pothole (101) and so on.

In Niksicko polje and its southern edge, over 30 speleological objects were tested. The most important potholes and sinkholes are Golubnjača, Ajdarov sinkhole, Vukalova potholes, Opačica, Misor, Slivski sinkhole and etc.

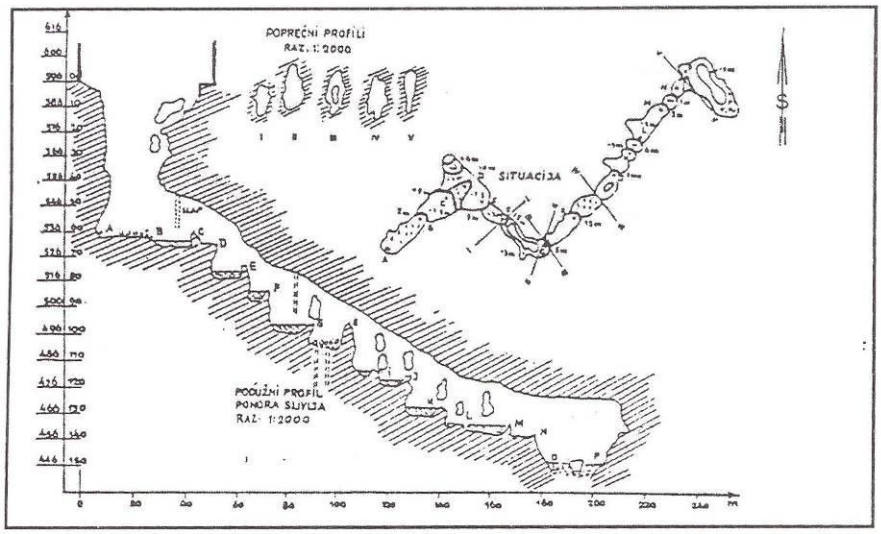


FIGURE 16 *PONOR SLIVLJE (ACCORDING TO J. PETROVIC)*

Potholes with water are very important from the point of water supply of smaller settlements in karst parts of terrain. Thus, for example, Oraska water is used for the needs of Danilovgrad. *Caves* - cavities typically metres or tens of metres across formed within the rock by its dissolution, and left empty or filled with sediment (Ford and Williams, 1989).

Caves - the longest surveyed caves are caves above Vrazji firovi near Bijelo Polje (10,550 m), Bratuška cave in Lješanska nahija (530m), Macja cave in Zatrijebač (255), the cave with water Socnora in Kuci (235 m), the cave Studenula in Garc (228) and Magara near Podgorica (168m), Vidrovanska cave in Gornje polje near Niksic (600 m), Studena cave in Mokro near Savnik (678), Zelenovirska cave in Durmitor (830m) and so on.

In limestones of coastal belt, a certain number of caves with water is formed, with inlet above and directly below sea level, while some of them are on the higher elevations in contact with the flysch sediments.

Such are Risanska cave and Sopot, whose waters are salt during dry periods of year. Opacica and caves in Presjeca have constant spring flow and connected to water supply system of Herceg - Novi.

FIGURE 17 *SOPOT CAVE IN HYDROLOGICAL MAX AND MIN (V. DUBLJEVIĆ, 2001)*

6. Aquifer systems

Procured types of the aquifers:

- Karst-fissure aquifer, permeability good,
- Karstic-fissure, permeability moderate,
- Fissure,
- Intergranular, permeability good,
- Intergranular, permeability moderate,
- Aquitard.

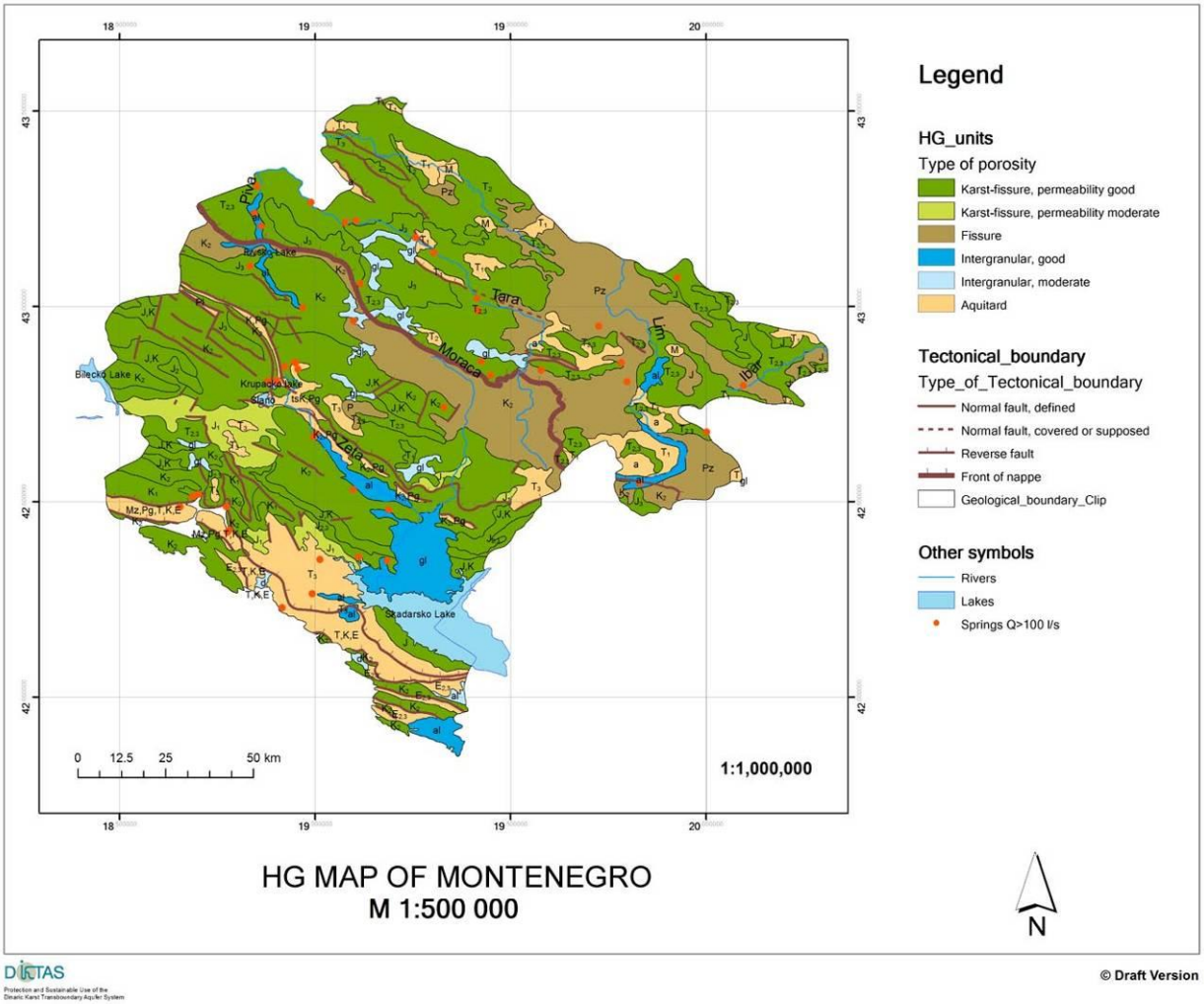


FIGURE 18 *HYDROGEOLOGICAL MAP OF MONTENEGRO 1:500.000*

6.1 Aquifers classification and distribution

Granular aquifer is present in Zeta valley, Orahovacko field, Niksic field, section of Lim, Ćehotina, Tara and Morača river valleys. The most important aquifer was developed in Zeta valley where reserves of groundwater were estimated at 13m^3/s.

Rock masses of fissure-cavernous porosity are the most common and, having in mind the volume of accumulations of groundwater formed in them, also the most significant water-bearing environment in Montenegro. Apart from its significant spreading, these mediums are of great thickness of several thousands of meters. Significant porosity of these water-bearing mediums is a result of intensive karst processes which greatly increased dimensions of syngenetic and tectonic fissure porosity.

Karstification of carbonate rocks in Montenegrin territory occurred in several instances, which is indicated by karst forms in the floors of specific bauxite deposits. Regarding their continuity the karst processes were longest lasting at the carbonate rocks of Durmitor nappe, and shortest in the area of Adriatic system of thrusts.

Depth of karstification of carbonate rock masses varies doyens of meters (Klikovača plateau), up to over 800 m in the area of Durmitor massif and other karst terrain.

Karst aquifers exist in all carbonate rock masses from the Adriatic shoreline to the northeast border of Montenegro. With the exception of narrow coastal area, Skadar Lake depression, Bjelopavlici valley and river valleys or canyons in northern Montenegro, free levels of groundwater are regionally located at greater depths, several hundreds of meters below the ground surface. Belo the fresh water neogene sediments containing coal in Pljevlja and Maočinski basin, unconfined karst aquifers have subartesian or artesian level.

In order to simplify presentation of basic characteristics of major deposits of aquifer water at specific hydrogeological units, we separated following regions in territory of Montenegro:

- Littoral karst (Paraautohton, Cukali zone)
- Polje, platueaus, and high mountains (High karst and sections of Durmitor tectonical unit),
- Karst of inner Dinarides (tectonical unit: Lim, Rožaje and Ćehotina).

Review of major deposits of aquifer water shall be given at separated hydrogeological units, which to some degree match the previously separated getectonical units.

7. Groundwater basins

As it mentioned in the previous chapter the main hydrogeological regions in the territory of Montenegor are:

- Littoral karst (Paraautohton, Cukali zone)
- Polje, platueaus, and high mountains (High karst and sections of Durmitor tectonical unit),
- Karst of inner Dinarides (tectonical unit: Lim, Rožaje and Ćehotina).

Littoral karst

Deposit Možura and Brivska gora

Anticline structure of Možura (elevation 622 m) and Brivska gora (elevation 178 m) are made of Upper Triassic sediments. The most dominant area in this structure is collective area of Gač aquifer, which is discharged through Gač spring. Discharge of Gač spring is occasionally conditioned with impermeable flysch sediment of Eocene age. Well, with depth of 29 m, is made at the location of discharge. Minimal yield of the well is Q= 30 l/s and it is used for water-supplying Ulcinj.

Deposit Morinj

It is including karst space, made of carbonate complexes, rocks of Zukali zone between Mojdež and Morinj Bay, as well as parts of Orjen massif, and therefore the total size is 110 km^2. Deposit is edged southward and northwards with impermeable flysch sediments, while is partly opened in Mojdež towards Orhen massif. It is being discharged through Morinj spring, with yield varying between 0.6 m^3/s in hydrological minimum to several dozen m^3/s in hydrological maximum. These springs are salinated in zone of discharge through alluvial sediments, which are making contact with eroded sediments of flysch and limestone.

Deposit Vrmac

Area of Vrmac is made of Jurassic and Cretaceous carbonate rocks within which the karst type of aquifer was developed, discharging through Plavda spring (Qmin= 20 l/s), and submerged springs between Stoliv and Prčanj and partly through spring in tunnel underneath Trojice (Qmin= 20-30 l/s).

Polje, plateaus, and high mountains (High karst and sections of Durmitor tectonical unit),

Deposit of Orjen massif, Lovćen, Ivanova korita and Njeguši

It includes spacious karst area of Boka bay catchment area, made of karstified Triassic, Jurassic and Cretaceous rocks. Discharge zones are concentrated through series of brackish springs and submerged springs, and the springs with highest yield are: Škurda, Gurdić, springs from Vrmac tunnel, Plavda, Šišićki springs, Orahovačka ljuta, Orahovački springs, Risanska cave, Sopot submerged springs and Morinjski springs.

Škurda is a hydrogeological phenomenon which is functioning as spring-karstic spring, brackish spring and swallow hole. It is diffused karst aquifer, used in Kotor water-supplying system discharging at the point of contact of flysch and limestone of zone Dobrota-Škaljari.

Yield of this spring varies between 0.1 m^3/s in hydrological minimum to over 30 m^3/s in hydrological maximum. In dry period, when Gurdić acts as swallow hole, Škurda spring is occasionally salinated.

Gurdić is a hydrogeological phenomenon which is functioning throughout a year as brackish spring, submerged spring and swallow hole. It is being discharged at sea level or underneath sea level from dept of 15 m. Water of this spring, which catchment area lies in mountainous Lovćen massif is constantly salinated. During hydrological maximum this spring is effusing over 10 m^3/s.

Bracki spring discharges in the area of Orahovac at contact of sediments of flysch and limestone, at the sea level and underneath sea level. The contact is masked with detritus and sizeable boulders. The yield of this spring which catchment area lies in mountainous Lovćen massif and Njeguši field is variable between 0.10 and 170 m^3/s.

Deposit of aquifer water of catchment of Crnojevića RIver

It includes karst area of Cetinsko field and Dobrsko village made of limestone and dolomite of Triassic, Jurassic and Cretaceous age, in total size of 120 km^2. Karst type of aquifer, developed within carbonate rocks is discharged through Crnojevića River spring (Qmin= 380 l/s).

Deposits of aquifer water of catchment area of Podgorski springs

It includes upstream section of Orahovštica catchment area, made of limestone and dolomite, with size of 27 km^2. Coloring water from Obzovica swallow hole, we determined connection with Podgorska springs, with nominal yield Qmin= 200 l/s, and average yield Qsr= 1,7 m^3/s. It is important spring of quality fresh water used for water-supplying Budva and Cetinje.

Deposit of Starocrnogorska plateau

In includes are between the catchment areas of Boka Bay, Crnojevića River and Nikšičko field.

Karst aquifer is formed in karstificated Jurassic and Cretaceous limestone, and discharged through series of temporal and constant springs, estavels and submerged springs at west banks of Bjelopavlići and Zeta valleys and in northwest rim of Skadar lake such as: Svinjačka and Milojevićka springs, Dobrik, Smrdan, temporal springs Sušice and estavels alongside its river basin, Vučji studenci, estavel around Matice, Golač, submerged springs at west rim of Malo blato, Karuč etc.

Size of catchment area of Karuč and Sinjac springs is over 210 km^2.

Sinjačka submerged springs *(Krakala, Šujica, Crno oko, Biotsko oko, Bolje sestre, Bobovine etc.)* are drained through Biševina River, only drainage of Malo blato, with minimal yield of 6.5 m^3/s.

Deposit of Prekornica massif

At northeast rim of Bjelopavlići valley from Glava Zete to junction of Zeta to Morača, we registered series of karst springs with high yield *(Dobropoljski springs, Sušica spring in Mijokusovići, Viška springs, Tamnik, Podgajska sinkhole, Lakića sinkhole, Vujića sinkhole, Brajovića sinkhole, Žarića sinkhole, Vukovića sinkhole, Straganičko oko etc.).*

Catchment area of these springs is located northeast of Bjelopavlići valley in Prekornica massif, mostly made of kartsified Mesozoic limestone of Cretaceous age.

Mareza spring is located west of Podgorica, at contact of quaternary sediments and limestone of Velje brdo, which is used for water-supplying of Podgorica, with minimal registered yield during hydrological minimum of Qmin= 2,0 m^3/s.

Deposits of aquifer water of catchment area of Morača upstream from junction of Zeta

It includes spacious area mostly made of carbonate rocks of Triassic, Jurassic and Cretaceous age. Karst aquifer present within the area is being discharged through series of temporal and constant springs in Morača river basin and basin of its affluents. The springs with highest yield are Bijeli nerini in Mrtvica canyon (Qmin= 0,5-1,0 m^3/s), Svetigora near Morača monastery, spring in the base of Vjetrina Lanjevik, springs near Piletiča houses, Smokovac, Kaluđer etc.

Deposits of aquifer water of mountain massif of Vojnik, Studena and Golija

It includes area made of Triassic, Jurassic and cretaceous limestone and dolomite within which is formed Karst aquifer with catchment area of 300 km^2. It is very important since it replenished the springs with highest yield in north rim of Nikšić field used for water-supplying of Nikšić and adjacent settlements. Disharge zones are concentrated at north rim of Gornje polje, through several constant springs with total yield during hydrological minimum is over 1.0 m^3/s *(Vukova springs Qmin= 330 l/s, Gornja Vidrovanska springs Qmin= 200 l/s, Donja Vidrovanska springs Qmin= 150 l/s, Rastovačka springs Qmin= 100-200 l/s, Gornjopoljski vir etc.). Vidrovanska springs are used for water-supplying of Nikšić.*

Deposits of mountainous area of Rudine, Zla gora and Njegoš

It occupies spacious karst area mostly made of Cretaceous limestone. They are represented as massive, banked and low karstified. There is no superficial drainage from this holokarst terrain. Even temporal springs are rare in this area. Depth of karstification is over 800 m. All water that sink into inner limestone masses are being drained underground.

Zone of discharge of karst water are concentrated at north and northeast rim of Krupačko an Slano Lakes *(Krupačko oko Qmin= 130 l/s, Zminac and Žabica Qmin= 100 l/s, Kusidska springs, Slansko oko, Manito oko, springs Stružice and Krbanje Qsr= 6,50 m^3/s),* and at springs of Donja Zeta with total minimal yield is Qmin= 3 m^3/s.

Deposits of aquifer water of Nikšićko field and Budoš

This section of terrain is made of limestone, dolomitic limestone and dolomite of Triassic, Jurassic and Cretaceous age. Zones of discharge are concentrated in middle part of Nikšićko field, upstream of flysch zone of Cretaceous-Paleocene age. *(springs Poklonci and Blaca Qmin= 300-400 l/s, Studenačka springs Qmin= 50 l/s, spring Mrkošnice, Oboštničko Qmin= 100 l/s, Glava Zete Qmin=2,0-3,0 m^3/s.). Poklonci springs are included in water-supplying of Nikšić.*

Deposits of aquifer water in Piva catchment area

It includes spacious mountain massifs of Maglić, Volujak, Golija, Vojnik, Lola and Piva made of carbonate sediments. Zones of discharge are concentrated at series of springs, while the most of them were sunk with Piva accumulation lake. That is the case of Dube springs, Bezujski mlini, Sinjac (Qmin = 500-1.000 l/s, Rastioci (Qmin = 100 l/s), Vrutak (Qmin = 100 l/s), Medjedjak (Qmin = 500 l/s), Nozdruć (Qmin = 500 l/s), Jakšića spring and Vrioca (Qmin = 100 l/s), Kaluđerovo spring, Čokova springs Qmin = 100 l/s etc.).

Deposits of aquifer water in Tara catchment area

It includes spacious mountain massifs of Durmitor, Sinjajevina, part of Piva Mountain, part of Bjelasica, parts of Rastovo and Ljubišnja. Karst aquifer present within the carbonate rocks is being discharged through series of temporal and constant springs in Tara canyon and canyons o its affluents.

There are a large number of springs of small yield (up to 1 l/s) at catchment area of Gornja Tara, mostly made of low-permeable and impermeable flysch sediments.

Bistrica spring is located in catchment area of Pčinja River, precisely in its source area below Vučje. It is contact spring being drained at contact of Paleozoic and Low Triassic flysch complex and Triassic and Upper Triassic limestone (Qmin = 100-1000 l/s).The most known and the spring with highest yield in catchment area of Plašnica is Vojkovića spring (Qmin – 1000 l/s).

Between Bistrica and Ljutica is a number of springs alongside the Tara river basin where the most known springs are spring above Đavolje laži and Bjelovac spring (Qmin = 1000 l/s).

Ljutica spring is effused from left side of Tara River upstream of Đurđevića Tara Bridge directly from Middle Triassic limestone Qmin = 1000 l/s.

7.1. Regional groundwater direction

Genraly, groundwaters in the territory of Montenegor flow in two directions:

- to the south in the Adriatic sea basin and
- to the north in the Black sea basin .

Generally, direction of the spring water movement in the Adriatic Sea basin is mainly the NW, NW-SE and NE-SW. The exceptions are the northern slopes of Rumija and Gluhi Do which drain submarine springs around the rim of Skadar Lake, that is, submarine karst springs along the rim of Crmnica plain, where the direction of source water movement is S-N.

The reverse case is with the karst terrains of the Black Sea basin, where the most common direction of the source water is S-N.

However, the other trends and directions of movement of source water are often discovered (from north to south and from east to west), what is caused by deep canyons of Piva, Tara and Ćehotina. It was registrated that water from one sinkhole, which is on the watershed, are circulating in two opposite directions, towards the Adriatic basin and the Black Sea basin.
The rupture structures have the important role for the direction of groundwater in karst, along which the process of karstification is intensified (by M. Radulovic, 2000). There are numerous examples where striking faults represent the main drains of source water:

• Cetinje fault has predisposed the development of Cetinje cave system or directs spring water from the plain basin to the Crnojevica river,

• Gornjopoljski fault, which extends from northwest to southeast, generally directs the ground water from the area of Srijeda toward *estavela* Gornjopoljski Vir,

• Fault in the hinterland of Boka Kotorks Bay, the direction of NW-SE, directs groundwater from the area of Grahovo towards Risanska Cave.

7.2. Tracing tests results

The greatest number of tests for marking of groundwater by sodium fluorescein is derived in karst terrains of the Skadar Lake, and over the sinkhole in Niksicko and Cetinjsko polje, where quantitative designation of markers were carried out.

Tests were mainly carried out within the framework of regional hydrogeological researches, during the preparation of the Basic hydrogeologic maps and within the detailed study of the need to create reservoirs in karst areas.

Since in the karst terrains of Montenegro has been conducted over 100 tracing tests, the following table provides an overview of the most important established connections of regional character between sinkhole and karst springs, with the fictive speed source water movement:

Table 8 *Tracing tests in Montenegro*

Br.	LOCATION	Date of tracing test	Location of apperace of tracer	Date of apperace	Altitude dif	Distance (m)	Fiction speed (cm/s)
1.	Swallow hole in Sozina	16.12.1971	Izvor pod Kapom	20.12.1971	600	3000	0.82
2.	Swallow hole- cave in B. Polje	23.09.1969	M.oko,V.oko Okruglica	06.11.1969	592.5	3500-4000	0.09-0.11
3.	Tunnel Sozina	19.10.1960	Izvor Brca-Sutomore	23.10.1960	23	3000	0.92
4.	Obzovica	07.01.1970	Podgorska vrela	08.01.1970	657	6965	13.82
5.	Ugnji	16.10.1969	Crnojevića Rijeka	19.09.1969	640	6990	2.75
6.	Cetinjski swallow hole	15.03.1934	Crnojevića rijeka	17.03.1934	598	7000	4.05
7.	Ivanova korita-Lovćen	21.10.1960	Gurdić-Kotor	23.10.1960	1205	7100	4.70
8.	Erakovića swallow hole - Njeguši	31.10.1956	Gurdić-Škurda	02.11.1956	845	4870	4.04
9.	Orulina – Čevo	31.03.1970	Oraška jama	03.04.1970	805	13750	5.34
10.	Trešnjevo	15.02.1973	Orahovačka Ljuta	17.02.1973	755	16700	11.04
11.	Bobotovo groblje-Gacko	29.05.1964	Sinjac-Piva	03.07.1964	286	15950	0.52
12.	Dobra voda-Čarađe	04.02.1975	Sinjac-Piva Fatničko Polje	13.03.1975 04.04.1975	276 380	16000-26500	0.68 0.63
13.	Krnovska glavica	02.10.1975	Bijela	21.10.1975	485	3500	3.74
14.	Bare Cigovića	29.10.1970	Glava Zete, Perućica	16.11.1970	1210	21100	1.37
15.	Luke Bojovića	05.06.1967	Izvor Bistrice	23.06.1967	770	14150	0.91

16.	Bare Bojovića	06.06.1968	Dinjak-Bjelopavlići	01.07.1968	1447	23650	1.10
17.	Dugačko lake-Žijovo	28.05.1974	Vrela-kanjon M.rij.	03.06.1974	1380	17400	3.20
18.	Miločanskj swallow hole	27.03.1956	Poklonci I Blaca	27.03.1956	7.5-8.9	1030-1435	4.24-6.01
19.	Ponor u Vidrovans. reci	19.08.1939	Izvori Zoja I Rasovac	20.08.1939	6	285	0.37
20.	Ponor Krupačka jama	27.03.1956	Klačinska vrela	02.08.1958	8	4600	1.52
21.	Ponor u Studenačkim gl.	07.09.1953	Izv. Đurđevac i Vuki	29.07.1958	7.7	550	4.36
22.	Ponor u Studenačkim gl.	21.06.1954	Izv Studenački mlini	21.06.1954	22.2	140	3.1
23.	Nikš. polje Ađarov pon.	07.07.1958	Gl.Zete Obošn.oko	13.07.1958	544.7	14630	2.80
24.	Nikš. polje Klačanski pon	28.07.1964	Gl.Zete Obošn.oko	17.08.1964	544.7	14500	0.83
25.	Nikš. polje Ponor Orline	07.08.1959	Gl.Zete Obošn.oko	14.08.1959	546.3	12500	2.04
26.	Nikš.polje Mihaljin pon.	22.06.1958	Gl.Zete Obošn.oko	28.06.1958	545.7	14450	2.79
27.	Nikš.polje Pon.Široka ul.	10.06.1957	Gl.Zete Obošn.oko	15.06.1957	546.7	13350	3.11
28.	Swallow hole-pit Zavrh	18.08.1939	Poklonci I Blaca	20.08.1939	6.6-8.2	1480-1745	0.89-1.05
29.	Slanski swallow hole	28.07.1956	Glava Zete, Oboš.oko	03.08.1959	540.5	15300	2.81
30.	Slivski swallow hole	29.10.1939	Glava Zete,Perućica	02.12.1939	218	5000	0.02
31.	Swallow hole Misor	05.08.1961	Gl.Zete, Oboš.oko	18.08.1961	545	9880	7.73
32.	Liverovići swallow hole	03.011958	Gl.Zete,Perućica	04.01.1958	352	8750	10.68
33.	Trepački swallow hole	28.04.1992	Svinjička vrela	13.06.1992	890	29000	0.72
34.	Manastirs. mlin-Morača	18.07.1973	Piletića izvor	22.07.1973	20	5550	1.64
35.	Dinoša-Cijevna	16.09.1965	Mileš.Krvenica Vitoja	17.02.1965	33-80	2755-8500	2.05-3.07
36.	Begova lokva	15.05.1961	Bezdan-Pljevlja	15.05.1961	500	4000	31.74
37.	Žabljački ponor	08.07.1963	Bijela Vrela	10.07.1963	840	10000	5.78
38.	Malo Crno jezero	05.09.1963	Dubrovska Vrela	13.09.1963	750	18000	2.58
39.	Trnovačko jezero	21.07.1971	Đokova vrela	23.07.1971	1047	11300	7.86
40.	Studenica-Jabuka	16.05.1974	Tvrdaš	20.05.1974	300	7300	2.30

41.	Ljubovija-Previja	23.05.1974	Tvrdaš	27.05.1974	290	8100	2.52
42.	Bare Žugića	12.11.1975	Ljutica	19.11.1975	780	10600	1.80
43.	Ledenica-Pljevlja	09.11.1974	Bezdan-Breznica	13.11.1974	340	3400	1.09
44.	Mokri do-Smiljevica	07.11.1979	Zagorska rijeka	09.11.1979	465	2900	1.64
45.	Sušica-Korita	16.09.1978	Bistričko Vrelo	08.09.1978	370	5200	0.26

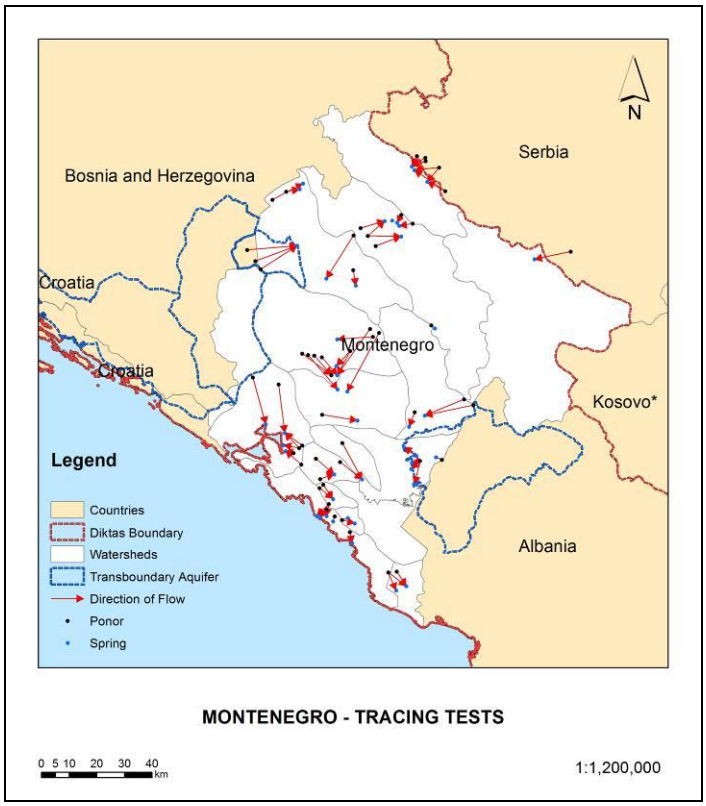


Figure 19 *Tracing tests in Montenegro*

7.3. Groundwater bodies

Preliminary characterisation of GW bodies is not performet for Montenegro. It is reason why the next part of paper paer will deal mostly with transboundary aquifers, defined as important for the project.

Legend:

F – area of the balance unit

F_o – open area of the balance unit

F_z – covered area of the balance unit

Figure 20: *Transboundary aquifers*

Table 9 *TBA Bilećko Lake*

General data about balance area		
ID	**6**	
Test area	**TBA Bilećko Lake**	
River Basin	Trebišnjica	
F (km^2) - 1652 km^2	F_o (km^2) = 1354 km^2	F_z (km^2) = 298 km^2

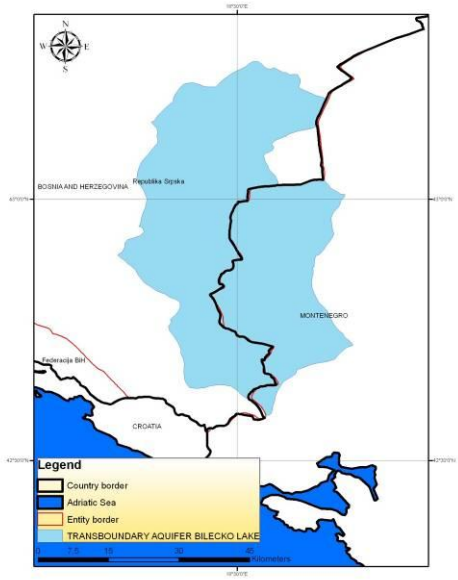
Sketch


Table 10: *TBA Piva*

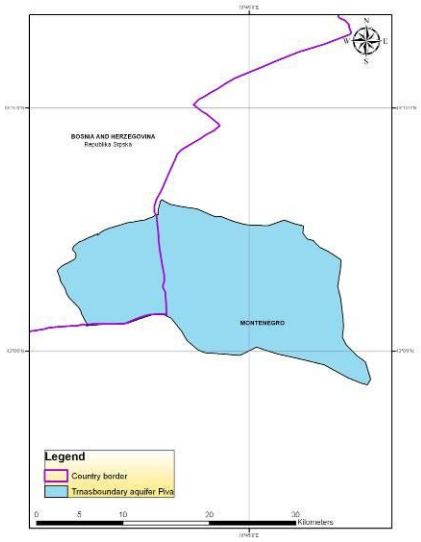
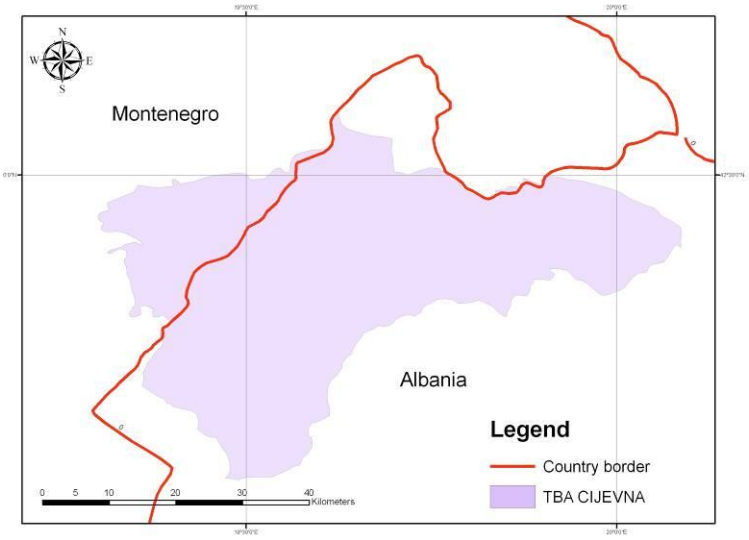
General data about balance area		
ID	**7**	
Test area	**TBA PIVA (Bosna and Hercegovina- Montenegro)**	
River Basin	Trebišnjica	
F (km^2) - 312 km^2	F_o (km^2) = 265 km^2	F_z (km^2) = 47 km^2
Sketch: 		

Table 11: *TBA Cijevna/Cemi*

General data about balance area		
ID	**6**	
Test area	**TBA Cijevna/Cemi (Albania-Montenegro)**	
River Basin	Trebišnjica	
F (km^2) - 1570 km^2	F_o (km^2) = karst 239 km^2 in Montenegro	F_z (km^2) = nonkrast 11 km^2 in Montenegro
Sketch		

8. Karst aquifer characterization

8.1. Aquifer permeability and porosity

The researches showed that regional permeability in the Dinarides is very big (K_f 10^{-1} cm/s) up to 150-200 m. After this depth it rapidly decreases and hardly reaches 10^{-3} cm/s.

Porosity of karstified rocks is usually 0.2-4 %. But in the rare cases (zones) exceed even 10% (just up gradient of the spring zone of the Trebišnjica river).

According to G. Castany, the registered world-wide values are from 0.2 to 34 %.

Torbarov analysed recession curve of Trebišnjica and concluded that effective porosity of aquifer is 1.2-1.5%.

Milanović calculated the values of effective porosity for the aquifer of Ombla spring 1.4-3.5%. Vlahović calculated the value of effective porosity 0.79% after analysing fluctuation of groundwater level in 76 observation boreholes in the upper part of the Zeta basin (Montenegro). This value represents the average porosity of a large region. Within the same region, zones with much greater porosity were detected. For example, the porosity of the tectonically disintegrated limestone ridge Budoš-Kunak was found to amount to 6.07%.

8.2. Aquifer recharge

The conditions of feeding of aquifer (by M. Radulovic, 2000) depend on the hydrometeorological circumstances of areas, vegetation, lithofacial composition, tectonic structure of the terrain, geo-morphological features, the degree of karstification, branchiness of hydrographic network and hydrogeological characteristics of the terrain.

Hydrometeorogical conditions are very favorable, almost on the entire area, especially in the central and the southern Montenegro. This is reflected in the amount of annual precipitation, whose medium perennial average usually ranges from 2000-4000 mm.

Tight aquifers are fed by precipitation on the entire surface, by surface watercourses, artificial and natural lakes as well as waters of karst aquifers.

Karst aquifers are fed by water infiltration from atmospheric deposition. In very scarce and bare terrains of exposed bare karst, with the numerous surface and underground karst forms, the size of infiltration can amount up to 100% of the precipitation.

Some watercourses play the important role in feeding of karst aquifers. For example, the watercourse Zeta has a significant contribution to the feeding of karst aquifer in paleorelief of Niksicko polje. Moraca watercouse feeds compact aquifers of Zeta valley and karst aquifer, which is discharged through springs at its rim. The watercourse of Vruca river feeds karst aquifer of spring Kajnak, and temporary watercourse Brdele feeds karst aquifers Gača etc..

A significant contribution to formation of karst water aquifers have natural and artificial lakes. For example, Crno Lake has a significant contribution to feeding of the karst aquifer of Drobnjačka lake and mountain Piva, that is, Dubrovsko and Bijela springs. Reservoirs Slano and Vrtac have a certain contribution to feeding of karst aquifer of Budos, that is, Glava Zete and Oboštnica. Biogradsko lake is important for feeding of karst aquifers of Jezerštica springs, and Liverovićko lake is important for feeding of Perucica springs.

8.3. Aquifer discharge

Karst springs or emergences are very scattered within karst regions. The majority of important springs are located along the perimeter of the erosion base, that is, at the outer boundary of karst poljes, river valleys, and the seacoast. A common characteristic of these springs, whether permanent or temporary, is the direct dependence of their discharge on precipitation. In general, the capacity and hydrogeological character of karst springs depend on a number of factors such as

catchment area, retardation capacity of the aquifer, total effective porosity, geological composition, and other similar factors (Milanović, 2005).

Dominant roles are played by the surface catchment area and relative, active volume of the aquifer.

The main types of drainage of source water in karst terrains of Montenegro are leakages through numerous submerged karst springs and also through underground leakage i.e. replenishemnt of compact aquifers.

Highlighting areas are concentrated mainly along the local erosion base, that is, on the rims of karst plains and karst depressions (Niksicko polje, Zetsko –Bjelopavlicka valley and Skadar Lake and Bilećko lake) along canyons and the main erosion base in the coastal belt. The gravitational springs are mainly present, with a large slope in the leakeage zone (by M. Radulovic, 2000).

Table 12 *Most important springs with basic data*

NO. SPRING NAME	AQUIFER NAME	MINIMUM YEALD*(L/S)*	SPRING UTILISATION
I.ADRIATIK SEE BASIN			
1. Vidrovanska vrela	Vojnik	350	water supply of Nikšić
2. Vidrovan wells (B_1, B_2) Nikšić	Vojnik	60	
3. Vukova vrela	Vojnik	200	not tapped
4. Gornjepoljski vir	Golija	400	not tapped
5. Rastovačka vrela	Studena	200	not tapped
6. Glibavačka vrela	Tović	10	not tapped
7. Uzduv	Tović	10	not tapped
8. Poklonci Nikšić	Golija	300	
9. Blaca	Golija	100	submerged by Krupac reservoir

10.Krupačko oko Krupac	Zla Gora	130	sub.
11.Žabica Krupac	Zla Gora	50	sub.
12.Zminac Krupac	Zla Gora	50	sub.
13.Ćetkovi izvori Krupac	Jakalj	5	sub.
14.Izvori u Slanom Slano	Njegoš i Rudine	450	sub.
15.Izvori Lukavice Nikšćka	Žurim	10	Župa
16.Morakovska vrela Nikšćka	Prekornica	10	Župa
17.Crni Oštak, Žurovica Nikšćka	Seoca	10	Župa
18. “Trebjesa” Nikšić wells brewery“Trebjesa” Nikšić	Nikšić fiel	100	
19.Studenačka vrela	Studenačke glavice	50	Studenci
20.Glava Zete i Obošničko oko tapped	Nikš.field, Budoš	3200	not
21.Bašina voda	Ostroške grede	10	Povija
22.Dobropoljski springs tapped	Prekornica, Župa	1000	not
23.Milojevića vrela, Svinjačka vrela, Danilovgrad Dobrik i Smrdan	Garč and Starocrnog.platou	>200	20 l/s for
24.Slatinski springs Danilovgrad	Prekornica	10	
25.Žarića pit Danilovgrad	Prekornica	50	
26.Oraška pit Danilovgrad	Starocrnog. platou	150	

27.Orlujina	Starocrnog. platou	1	Čevo
28.Iverak	Prekornica	5	Piperi
29.Viška vrela, Tamnik, Lalevića spring	karst edge		
Moravica, Bijeli Studenciettc. tapped	Bjelopavlićka platou	10	not
30.Izvori obodom Bjelop. ravnice	karst edge		
(Vrela, Živa voda, i dr.) innaproprijate tapped	Bjelopavlićka platou	20	
31.Studenci i Bubuljin tapped	Velje i Malo brdo	5	not
32.Other spring in river bad of D. Zete	Starocrnog.platou		
(Šabovo oko, Grgurovo oko e.tc) tapped	and Prekornica	500	not
33.Mareza and Danilovgrad	Prekornica		Podgorica
	Velje brdo	2000	1100 l/s
34.Kraljičino oko, Vriješko vrelo	Bataljonska		
Blizanci tapped	komun	50	not
35.Vučji studenci	Markovina i		
	Starocrnog.zaravan	30	Komani
36.Ribnička vrela tapped	Kuči i korito Cijevne	10	not
37.Izvor pod Vjetrinom tapped	Bijele stijene	10	not
38.Bijeli Nerini tapped	Maganik (sliv Mrtvice)	500	not
39. Other springs in river bad of	Kamenik, Broćnik		
Morače and Male rijeke tapped	Žijovo	1000	not
40.Svetigora – Manastir Morača Manast.Morača	Gornja Morača	30	

41.Straganičko oko	between Zeta i Morača	10	Drezga
42. Vitoje i Podhuma	Dečić i sliv Cijevne	10	Podhum
43.Podgorska vrela Cetinje,Budva	Orahovštice	200	
44.Obzovica	Ljubotinj	1	Cetinje
45.Uganjska vrela	Konak	5	Cetinje
46.Velje oko	Sozina	50	Bar
47.Malo oko i Okruglica well tapped	Sozina	10	not
48.Karučke vrulje tapped	Starocrnog.platou	2300	not
49. Sinjačke vrulje (Malo blato) tapped	Starocrnog.platou	6500	not
50.Vrelo Crnojevića rijeke tapped	Cetinjsko field	380	not
51.Raduško oko tapped	Rumija	60	not
52. Sač	Možura	2	Ulcinj
53. Gač	Možura	30	Ulcinj
54. Donja Klezna	Šasko brdo i Čok	15	Ulcinj
55. Mide	Rumija	10	Ulcinj
56. Kaliman	Rumija	5	Ulcinj
57. Brajša	Rumija	5	Ulcinj
58. Brca	Sozina	40	Bar
59. Kajnak	Rumija	40	Bar
60. Zaljevo	Lisinj	16	Bar
61.Sustaši	Rumija	2	Bar
62.Turčini I i II	Mikulići-Đerinac	11	Bar
63.Spring in Čanju	Veligrad	5	Bar

64. Wells in Čanju	Srednje brdo	12	Čanj
65.Reževića rijeka	Paštrovska planina	55	Budva
66.Smokovijenac	Paštrovska planina	5	Budva
67.Zagradac	Zagrad	40	Budva
68.Sopot	Bijelo Polje	7	Budva
69.Lončar	Bijelo Polje	2	Budva
70.Piratac	Cukali zona	3	Budva
71.Vrelo below Piramida	Brajići and Hum	5	Budva
73.Loznica	Brajići and Hum	3	Budva
74.Topliš	Lovćen	15	Tivat
75.Plavda	Lovćen i Vrmac	20	Tivat
76.Češljari	Vrmac	3	Tivat
77.Vrmac	Lovćen i Vrmac	20	Kotor
78.Gornjogrbaljski springs	Lovćen	17	Kotor
79.Škurda	Lovćen i Njeguši	40	Kotor
80.Orahovački springs	Lovćen i Njeguši	110	Kotor
81.Risanska spila Risan	Grahovsko polje	4	Kotor-
82.Morinj springs tapped	Mokrine	600	not
83.Opačica Novi	Glavice i Lazine	80	Herceg
84.Lovac Novi	Mojdež	10	Herceg
85.Other sprins in Boka Bay submerged	Orjen and Lovćen	>2000	
86. Zaslapnica	Mirotinjske grede	35	Zaslap

87. Rečevina tapped	Mirotinjske grede	20	not
88. Šavnik tapped	Nudolske river	50	not
89.Trebišnjica springs Bilećko reservoir	Banjani	> 1000	sub.
II. BLACK SEE BASIN			
1. Springs in river bad of Gornje Tare tapped	Širokar	> 200	not
2. Izvori Bistrice u slivu Pčinje tapped	Vučje	200	not
3. Mušovića vrela	Bjelasica	170	Kolašin
4. Vojkovića vrela tapped	Sinjajevina	100	not
5. Springs in river bad of Plašnice tapped (Migalivica, Ropušica, Plašnice, Đev. vrela)	Sinjajevina	> 100	not for table water
6. Ravnjak water	Sinjajevina	1150	for table
7. Bjelovac tapped	Sinjajevina	1500	not
8. Ćorbudžak tapped	Sinjajevina	100	not
9. Ljutica tapped	Sinjajevina	2000	not
10.Mušova vrela tapped	Kosanica	100	not
11.Bijela vrela tapped	Njegovudja	100	not
12.Sige tapped	Pivska planina	100	not

13.Kućišta tapped	Pivska planina	1500	not
14.Kaludjerovača tapped	Pivska planina	1500	not
15.Sige Bailovića tapped	Pivska planina	100	not
16.Nozdruć i Vukovića vrelo tapped	Pivska planina	100	not
17.Bukovička vrela tapped	Durmitor	200	not
18.Boanska vrela tapped	Sinjajevina	50	not
19.Grabovice i Komarnice springs tapped	Ivica i Durmitor	> 200	not
20.Šavnička glava	Sinjajevina	100	Šavnik
21.Krnovska vrela tapped	Krnovska glavica	10	not
22.Oko Bijele tapped	Ostrvica	80	not
23.Duški spring reservoir	Pivska planina	200	sub..Piva
24.Dubrovska vrela reservoir	Pivska planina	> 500	sub..Piva
25.Vrela Dube reservoir	Brezna	500	sub..Piva
26.Bezujski mlini sub..Piva reservoir	Pivska planina	500	
27.Nozdruć sub..Piva reservoir	Pivska planina	500	
28.Jakšića vrelo sub..Piva reservoir	Pivska planina	100	
29.Medjedjak sub..Piva reservoir	Pivska planina	500	

30.Rastioci sub..Piva reservoir	Pivska planina	200	
31.Sutulija	Bioč	50	Plužine
32.Pivsko oko – Sinjac sub..Piva reservoir 33.Čokova vrela not tapped	Golija-Čaradje Pivska planina	1000	100
34.Kaludjerova vrela tapped	Pivska planina	100	not
35. Other springs in river bad of Pive submerged by Krupac reservoir sub..Piva reservoir	Pivska planina	> 2000	
36. Springs in river bad of Maočnice tapped (Manito vrelo, Vlaovska vrela)	Bujaci, Krupice	150	not
37.Springs in Matarugama tapped	Mataruga	30	not
38. Springs in river bad of Ćehotine (between Kozička river i Durutovića) tapped	Katabun, Mataruge Otilovići	200	not
39.Potpeć springs (Zmajevac, Mandovac, Vrelo etc) Pljevlja	Ćehotina Pljevaljski basen	35	
40.Breznica Pljevlja	Pljevaljski basen	30	
41.Joguštica Pljevlja	Pljevaljski basen	5	
42.Tvrdaš tapped	Pljevljakski basen	65	not
43.Vrioci and Porosom spring Gradac	Gradac	1	
44.Šumansko vrelo tapped	Vezišnica	10	not

45.Springs in Bjeloševina tapped	Bjeloševina	100	not
46. Other springs in river bad of Ćehotine (between Pljevalja i Gradca)	Krće, Plješevina Brvenica, Potoci	600	not tapped
47. .Alipašini spring	Prokletije	2000	not tapped
48. Bajrovića spring Gusinje	Prokletije	20	
49 . Springs in river bad of Đurička and Jasenička river	Prokletije	50	Plav
50 .Izvori Veličke rijeke tapped	Mokra planina	> 1000	not
51 .Murinski izvori Murino	Visitora	50	
52 .Krkori Andrijevica	Kutsko field	100	
53. Other springs in river bad of Lima, izmedju Plava i Andrijevice tapped	Visitor, Željetin Sjekirica	> 100	not
54 .Vinicko vrelo tapped	Berane river bed	> 100	not
55. Dapsića vrelo Berane	Berane river bed	20	
56. Manastirsko vrelo Berane	Berane river bed	80	
57.Merića vrelo Berane	Bjelasica	100	
58. Other springs in river bad of Lim between Andrijevice i Berana tapped	Berane river bed	2000	not
59.Bistrica spring Bijelo Polje	Bjelasica	300	

60.Bistričko vrelo – Đalovića klisura tapped	Korita	300	not
61. Other springs in river bad of Lim betweenBerana i Bijelog Polja tapped	Kurilo, Bjelasica Mušnica	> 1000	not
62.Vrelo Ibra Rožaje	Hajla i Žljeb	100	
63.Vrelo Grlje Rožaje	Hajla i Žljeb	5	
64. Other springs in river bad of Ibar tapped	Hajla i Žljeb	> 100	not

8.4. Springflow and GW regime

Regime of karst aquifers on the territory of Montenegro is insufficiently and unevenly studied. Systematic long-term monitoring of individual elements of the regime has been performed only for certain karst areas (Niksicko polje, Cetinjsko polje), as well as for a certain number of capped karst springs, which are connected to water supply systems for larger settlements.

The karst aquifer regime (by M. Radulovic, 2000) is caused by a number of factors, out of which are the most important: litofacial composition, tectonic structure, the degree of karstification, vegetation, surface flows, hydrometeorogical conditions and others.

In the coastal belt in the hinterland of Bar and Ulcinj, the abundance regime of numerous karst springs has been monitored, usually at higher elevations in the terrain and at the contact of flysch and limestone. Maximum abundance of these springs is related to the late fall and early winter months, and the minimum for the summer months, mostly August and September. The relationship between the minimum and maximum quantity Qmin: Qmax ranges within the limits from 1:40 to 1:200.

On the basis of data on changes in abundance and observations of groundwater level fluctuations in the numerous piezometers of Niksicko polje and its direct rim, it is clear that the minimums associated with summer and autumn months September and October and maximums for November and December, that is, spring months.

Ratio between the minimum and maximum quantity Qmin: Qmax varies in large limits and often exceed 1:120.

It is specific and should be pointed out that the recorded minimum water flow of Gornja Zeta, which is formed from strong karst springs in the northwest of the Niksicko polje, at the gauging station "Duklo", amounts 09 m3/sa and the maximum amounts even 214 m3 / s.

Similar is the case of karstic aquifers in paleorelief of Cetinjsko polje, which is concentrately discharged through springs of Crnojevica River.

The minimum flow of the Crnojevica river during the year 1988, was registered in August and September, and it amounted Qmin = 0.383 m3/s and maximum in December Qmax = 188 m3 / s. The ratio between the minimum and maximum quantity Qmin: Qmax is over 1:490.

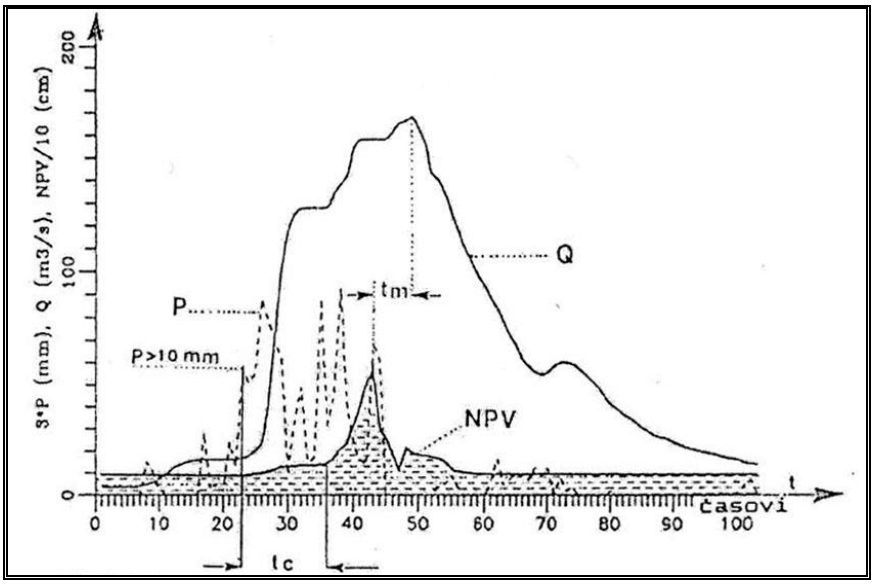


FIGURE 21 *REGIME OF OSCILATION OF LEVEL OF KARST AQUIFERS IN CETINJE FIELD RELATION TO THE REGIME OF PRECIPITATION (R. ŽIVALJEVIĆ, 1992)*

8.5. Groundwater quality

With regard to certain peculiarities, in hemism of groundwater in karst of Montenegro, caused primarily by litofacial composition of terrain, the presentation of basic chemical composition of karst source water will be given according to certain hydrogeological units (according to M. Radulovic, 2000):
Coastal karst. Source water in the coastal karst, in some parts of the terrain are directly influenced by the sea. Such is the case with the Boka Kotorska Bay, the part of Barsko and Ulcinjsko polje. In these anion zones, the Cl content is dominant and then follows the content of Mg ions.

Kurl formula, with characteristic chemical composition for source water of coastal belt, according to data of regional hydrogeological researches (S. Ivanovic, 1972), has the following form:

$M_{0,563-30,950}\ Cl_{36-97}\ HCO^{3}_{0,2-45}\ SO^{4}_{1-19}$ t 12°C

$Na{+}K_{5-99}Mg_{0,1-68}Ca_{0,1-58}$

Mineralization is usually within the range of 500-1000 mg / l, that is, in the Boka Kotorska Bay it is more than 20,000 mg / l.

Karst plains, plateaus and high mountains (the Skadar Lake basin, Piva basin, Tara and Ćehotina). With regard to this as a typical karst, it is clear that the chemical composition of the source water completely reflects the chemical composition of water-bearing environment, through which water circulates. All these are generally clear water, without taste and odor.

Source water temperature in the Skadar Lake basin ranges within the limit of 15-18 ° C and in Tara and Ćehotina basin it ranges from 1-18 ° C.

The maximum temperature of water within this karst unit and in Montenegro as a whole, has Ilidža thermal source, which in July 1973, reached 26.3 ° C.

Anionic composition of the analyzed water (in the Skadar Lake and Tara and Ćehotina basin), clearly indicates that these are predominantly hydrocarbonate water, with HCO_3 regularly greater than 70 eq / l and with low-sulfate content.

Cationic composition of these waters indicates the group of calcium water, where the concentration of Ca usually varies in the range of 70-90% eq / l. The content of magnesium rarely dominates the content of calcium. These are springs, whose staging area is related to the terrains which are composed of dolomite. Ions of alkali metals have the lowest content.

pH value of the analyzed water of karst aquifers mostly varies from 6.8 to 8.5, that is, they belong to neutral and slightly alkaline waters.

The total mineralization of these waters is predominantly within the limits of 200-600 mg / l.

General hardness mostly varies in the range of 4-25 ° dH, that is, according to classification of Klute, these waters belongs to soft, hard and moderately hard water.

Kurl formula, of a characteristic chemical composition, has the following form:

$M_{0,200}\,CO^{2}_{0,01}$ $HCO^{3}_{83}\,Cl_{36\text{-}97}$ t 12°C

$Na{+}K_{5\text{-}99}Mg_{0,1\text{-}68}Ca_{0,1\text{-}58}$

Karst of inner Dinarides (Lim and Ibar basin). The tested water of karst aquifer types in this region are of similar chemical composition as those in the previous unit of Dinaric karst, where from the content of cations dominates the Ca content and from anion content dominates HCO_3.
These are clear source water with the temperature of 5 -15 ° C.

One of the characteristic of this unit, by which it is distinguished from others, is that it is a region where the mineral water occurs.

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Protection and Sustainable Use of the Dinaric Karst Transboundary Aquifer System

Montenegrin report on “Environment and Socio -Economic aspects”

November 2012

Prepared by: Novak Čađenović

United Nations Educational, Scientific and Cultural Organization

International Hydrological Programme of UNESCO

Information note:

This report has been provided under framework of Montenegrin NC–ESE for the project: Protection and Sustainable Use of the Dinaric Karst Transboundary Aquifer System in November 2012. http://www.diktas.iwlearn.orrg

Front cover photo: Road in village Delaj, upper canyon of river Cijevna, Montenegro © Novak Cadjenovic.

Abbreviations:

DIKTAS - Protection and Sustainable Use of the Dinaric Karst Transboundary Aquifer UNESCO IHP – United Nations Scientific and Cultural Organization – International Hydrological Programme
NEU- National Execution Units
ToR- Terms of Reference
PCU -Project Coordination Unit
NC-ESE -National Consultant for Environmental and Scoio –Economic aspects
WG-ESE -Working Group for Environment and Socio-Economics TBA – Transboundary area
TDA – Transboundary diagnostic analyses
DIKTAS GIS -Integral Geographical Informational System for DIKTAS area

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BACKGROUND

ABOUT DIKTAS PROJECT

The project Protection and Sustainable Use of the Dinaric Karst Transboundary Aquifer System (DIKTAS Project), is the first ever attempted globally to introduce sustainable integrated management principles in a transboundary karstic freshwater aquifer of the magnitude of the Dinaric Karst System. Project is financed by the GEF (Global Environmental Facility) and contributions from the beneficiary countries (Croatia, Bosnia and Herzegovina, Montenegro and Albania). Implementing Agency is UNDP and executing agency is UNESCO-IHP. After a preparatory phase (2008-2009) full size project has started with implementation on July 2010 and it is foreseen to be implemented in course of four years.

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Fig. 1: DIKTAS project area (green) include whole territory of Montenegro (yellow) and large portion of territories of Albania, Bosnia and Herzegovina and Croatia

At the global level, the project aims at focusing the attention of the international community on the huge but vulnerable water resources contained in karst aquifers (carbonatic rock formations), which are widespread globally, but poorly understood. The Dinaric Karst Aquifer System, shared by named countries and one of the world's

largest, has been identified as an ideal opportunity for applying new and integrated management approaches to these unique freshwater resources and ecosystems.

At the regional level the project's objectives are to (i) facilitate the equitable and sustainable utilisation and management of the transboundary water resources of the Dinaric Karst Aquifer System, and (ii) protect from natural and man-made hazards, including climate change, the unique groundwater dependent ecosystems that characterize the Dinaric Karst region of the Balkan Peninsula. These objectives, which aim to contribute to sustainable development of the region, are expected to be achieved through a concerted multi-country effort involving improvement in scientific understanding, the building of political consensus around key reforms and new policies, the enhanced coordination among countries, donors, projects and agencies.

WORKING GROUP FOR ENVIRONMENT AND SOCIO-ECONOMICS

At the beginning of implementation phase of the full-size project, Project Coordination Unit (PCU) has been established in Trebinje, Bosnia and Herzegovina and afterwards four (in each partner country) National Execution Units (NEU) has been established. NEU is comprised of the National focal point and 4 national experts (legal and policy, stakeholder's involvement, hydrogeology and environment and socio-economic aspects).

National Consultants for Environmental and Socio –Economic aspects (NC-ESE) are conducting DIKTAS regional environmental and socio-economical assessment together with other national and international consultants organized in the DIKTAS Working Group Environment and Socio-Economics.

DIKTAS regional environmental and socio-economical assessment will take in consideration both natural conditions as well as anthropogenic impact (such as population and economic activities). The assessment will result in a number of thematic regional maps showing (combination of) various environmental and socio-economic parameters. Data on (point, line, distributed) sources of pollution, population distribution, ecosystems, existing and planned infrastructure and human activities (reservoirs, tunnels, industry, waste disposal facilities, agricultural activities) and similar, will be collected, processed and presented in the framework of this activity. Both, environmental and socio-economical assessment will have a regional character and will be limited to possible impact on Dinaric karst groundwaters, and in particular to transboundary impact. In order to harmonize collection of data and national reports from NC-ESE Working Group for Environment and Socio-Economics has been established- WG ESE (among 3 others).

PREFACE

This report has been prepared by Montenegrin expert for Environment and Socio-Economics (based on the ToR for NC-ESE) as a National contribution to the DIKTAS regional Environmental and Socio-economical assessment (as part of TDA). All guidelines and agreements (made during the meetings of the WG ESE in 2011-2012 as well as joint WG's meetings) have been taken into account in this report.

First meeting of the WG ESE has been held 31.03.2011 where NC-ESE has agreed joint work plan, methodology and deliverables (updated and agreed in four joint WG meetings that fallowed mentioned initial meeting). This report follows agreed methodology of work.

In general, each NC-ESE is required to gather specific national data necessary for national and regional Environment and Socio-Economic analyses. (List of topics for data collection can be found in Annex I of this Report). Each data-set should be recorded in series (suitable for deriving trends) and with spatial coordinate reference (for later advanced analyses of the impacts). All data are then feed to the PCU in Trebinje, where integral GIS system of the DIKTAS area (DIKTAS GIS) has been created.

Analyses has been done on the data collected on two different scales: national, and on the (more detailed) level of trans-boundary areas of special concern and **presented in this report as part A and B, while data collection has been documented mainly as the Annexes of this Report.**

By analyzing of country collected data, DIKTAS Environment and Socio-Economic overview at national level has been created **(part A of this report).**

Beside the insight on the Environment and Socio-economic aspects at the country level, this national analyses contributed also to the identification of "narrow areas of concern" or Trans-boundary areas of special concern (TBA) and identified data gaps (and solutions to overcome them) in order to crate comprehensive national data set and conduct respective analyses on more detailed scale.

TBA has been identified in 2012 as a result of joint work of WG-ESE and WG for Hydrogeology of the DIKTAS project.

For Montenegro, four TBA areas has been identified as follows: TBA Piva (Montenegro –Bosnia and Herzegovina), TBA Bilecko Lake (Montenegro –Bosnia and Herzegovina), and TBA Cijevna (Montenegro -Albania).

Additionally, TBA area Skadar lake has been identified as well for Montenegro (shared between Montenegro and Albania), but the national experts decided not to focus on this area in order to avoid overlapping due to the ongoing implementation of bilateral GEF project : Lake Skadar/Shkodra Integrated Ecosystem Management with total budget of near 5 mil USD in the area. Therefore outputs of this project should be directly used in the regional TBA analyses.

Targeted data collection and Environment and Socio-Economic analyses has been done specifically for all three TBA areas in Montenegro, and summary is presented as **part B of this report**

Fig. 2: TBA areas in Montenegro

Next steps of the WG ESE will include (according to the Annual Work Plan 2011) identification and prioritization of transboundary problems, and assessment of their impacts and underlying causes (causal chain analysis) in order to finalize regional Trans-boundary Diagnostic Analyses.

Due to the specific requirements for data collection from TBA areas (all of them are remote and scarcely populated) field visit to each TBA area has been conducted during the period August-September 2012. Field visits where necessary in order to fulfill identified data gaps for TBA areas. This activity caused slight delay in reference to the work plan timetable agreed in 2011.

PART A: ENVIRONMENT AND SOCIO-ECONOMIC OVERVIEW AT THE NATIONAL LEVEL

GENERAL INFORMATION

Montenegro is situated at the central Mediterranean in the South East Europe .Total land area is 13.812 km^2 and number of inhabitants is around 620 000.

Fig. 3: Position of Montenegro in Europe

Population in country	620,145 (SOURCE: MONSTAT, CENSUS 2003)
Area	13,812 km 2
Position	41°52'-43°42' latitude 18°26'-20°22' longitude
Length of border	614 km
Coast line	293 km
Length of beaches	73 km
Climate	Mediterranean
Average temperatures of air	27.4 C° (summer) 13.4 C° (winter)
Maximum sea temperature	27.1 C°
Average number of sunny days	240
Capital City	Podgorica
Old Royal Capital City	Cetinje
Time Zone	GMT +1

Fig.4: Basic info for Montenegro

Montenegro is the country of natural rarities divided into three differentiated geographic regions (seaside, central region and high mountains at the north). There are three climate zones: moderate continental in the inland part, Alpine in the highlands and Adriatic-Mediterranean along the coastline with many warm and sunny days where an average temperature in January never drops below 7°C and is around 25°C in July.

The length of the coastline is 293,5km of which 52km are beaches. Montenegro's coastline includes long, sandy beaches, deep blue sea and dramatic mountain backdrop. The north of Montenegro is the area of high limestone mountains. From the tablelands and plateaus of 1,700 m in altitude, rise vast mountain ranges and ridges of over 2,000 m (Durmitor, Bjelasica, Komovi, Visitor).

The rivers Piva, Tara, Moraca, Cehotina and their tributaries have cut deep narrow steep-sided channels in the limestone - the canyons. In its size, the canyon of the Tara is the second largest in the world.

Lake Skadar, the fertile Zeta plain with the Zeta River valley, and the Niksic field, comprise the third geographic region of Montenegro. This is lowland and the only plain area in Montenegro.

Montenegrin economy is mostly service based in transition process to the market economy with significant dependence on foreign direct investments. GDP for 2010 has been estimated to the 4.1 billion USD and GNI per capita to the 6,740 USD[1]. More than two thirds of economy of Montenegro relays on Services and much less on Industry and Agriculture. Tourism is one of the main income sources for country.

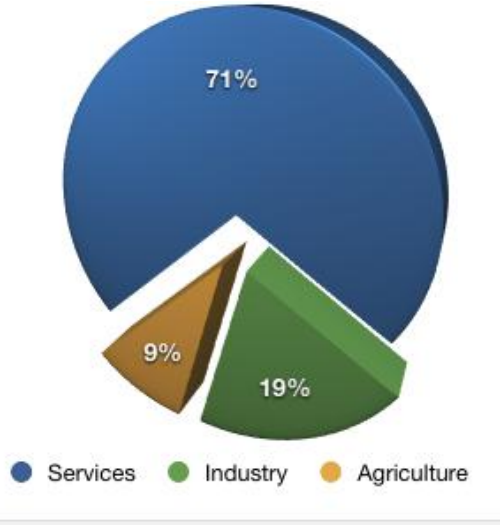

Fig.5: Structure of Montenegrin economy (2010 in % of GDP)

Having in mind that over two-thirds of the territory of Montenegro belongs to the karst of south-eastern Dinarides and that more than 90 % of the population in Montenegro consumes and depends on drinking water from the karst region, total territory of Montenegro was identified as a relevant for the data collection and analyses.

It is important to note that this review is using data on the 17 specific categories collected for the DIKTAS GIS system. Dataset contain three types of data format: numerical, textual and where available GIS shape-files. *Data sheets can be found in Annex II of this report.*

ADMINISTRATIVE SETUP

Montenegro is territorially organized into municipalities, defined by Constitution as the basic form of self-government. Territorial organization is regulated by the Law on the Division of the Socialist Republic of Montenegro, while the conditions and procedures for the formation, abolition and modification of local government units are defined by the Law on Local Self-Government. In that respect Montenegro has 21 municipalities and two urban municipalities (city municipalities of Golubovci and Tuzi) as subdivisions of Podgorica municipality. Based on the WG agreement city municipalities will be treated as integral part of the respective Podgorica municipality. Montenegro has in total 1308 settlements.

In establishing a municipality, the starting-point is historical development and tradition, whether a municipality represents a geographically and economically integrated entity for the local people, which is reflected in the integration of urban areas, the number of inhabitants (population size), the organization of the services of immediate interests for local people, gravitation towards the center, the developmental and ecological conditions of the area and other questions important for the citizens of a certain area and for the realization of their mutual interests and needs.

[1] Source: World Bank 2012

Comparatively, most of the municipalities in Montenegro are proportionally large compared to the local communities in West-European countries; thus certain municipalities and especially the capitals of European countries may also be the second-level units. Territorially, the area of local communities ranges from 46 square km. in Tivat to 2,065 square km. in Niksic.

Fig. 6: Territorial organization of Montenegro

Municipalities are the only legally recognized territorial units in Montenegro. Sometimes, division of Montenegro to south (or coastal), central and north part occur. This division is based on geographical features and thus not officially recognized territorial division in Montenegro. In this geographical division municipalities of Ulcinj, Bar, Budva, Kotor, Tivat and Herceg-Novi would make south part, Podgorica, Niksic, Cetinje and Danilovgrad central part and the territory of the rest of the municipalities would be counted as the northern part of Montenegro. There is notable difference in economic development of south and central part of the country from its north part.

Therefore, municipalities were taken as the basic territorial unit for collection of data, regional comparisons and analysis on the national and regional level in the DIKTAS project area.

POPULATION

Total population number in municipalities according to the last census (2011) is 620.029 inhabitants. Demographically, the differences in the number of inhabitants of local communities are indicative, from 2,070 in Šavnik to 185,937 in Podgorica (census 2011).

Fig.7: Population by Municipalities in Montenegro (census 2011)

	Ukupno *Total*	U / *In* %
CRNA GORA / MONTENEGRO	620029	100.00
Andrijevica	5071	0.82
Bar	42048	6.78
Berane	33970	5.48
BijeloPolje	46051	7.43
Budva	19218	3.10
Cetinje	16657	2.69
Danilovgrad	18472	2.98
Herceg Novi	30864	4.98
Kolašin	8380	1.35
Kotor	22601	3.65
Mojkovac	8622	1.39
Nikšić	72443	11.68
Plav	13108	2.11
Pljevlja	30786	4.97
Plužine	3246	0.52
Podgorica	185937	29.99
Rožaje	22964	3.70
Šavnik	2070	0.33
Tivat	14031	2.26
Ulcinj	19921	3.21
Žabljak	3569	0.58

There is constant growth of population in more economically developed municipalities and constant decrease of population in

most remote and undeveloped municipalities (such as: Adrijevica, Savnik, Zabljak and Plužine). Retrospectively, population density varies very much.

Trends for population number per municipalities for years (1948, 1953, 1961, 1981, 1991, 2003 and 2011) are provided in Table 1 of Annex II.

Main sources of income for population in municipalities are public sector, agriculture and manufacturing. *Details regarding sources of income is given, in the form of the active employed population in municipalities per categories (18 categories), in Table 3 of Annex II.*

SELECTED INFRASTRUCTURE DATA

The categories of roads in Montenegro are: Main roads (Magistralni putevi) , Regional roads (Regionalni putevi) , Local roads (Lokalni putevi) and Motorways (Autoputevi). Currently there are no roads in category Motorways but there are plans to build Bar -Boljare motorway and one part of the Adriatic–Ionian motorway.

Main roads in Montenegro are:

- M2 (Debeli Brijeg/Croatia - Petrovac - Podgorica - Kolašin - Berane - Rožaje - border with Serbia)
- M18 (Border with Albania - Božaj - Tuzi - Podgorica - Danilovgrad - Nikšić - Plužine -Šćepan Polje - border with Bosnia & Herzegovina)
- M21 (Bijelo Polje - border with Serbia)
- M2.4 (Petrovac - Sutomore - Bar - Krute - Ulcinj - Sukobin - border with Albania).

Energy is produced by two hydropower plants (Prucica and Piva) and one termo- power plant Pljevlja . Small hydropower plant contributes only 0.23 % to the total energy production.

Name of the dam and accumulation	storage volume (m2)	coordinates	System of HE
Krupac	42,1 x 106	42.786173,18.892466	Perucica
Slano	111,2 x 106	42.751499,18.883292	Perucica
Vrtac	71,9 x 106	42.734491,18.931834	Perucica
Mratinje	880 x 10^3x10^3	43.272511,18.842216	Piva
System in Grahovskom field	1 000 000	42.668916,18.630826	none, used for irrigation
Otilovici	18 000 000	43.303468,19.401211	Thermo Power Plant Pljevlja

Fig. 8: Details on existing hydropower infrastructure (dams and accumulation).

TOURISM

The direct contribution of Travel & Tourism to Montenegrin GDP in 2011 was EUR249.3 mil (7.5% of GDP). This is forecast to rise by 16.8% to EUR 29 mil. in 2012.This primarily reflects the economic activity generated by industries such as hotels, travel agents, airlines and other passenger transportation services (excluding commuter services). But it also includes, for example, the activities of the restaurant and leisure industries directly supported by tourists.

The direct contribution of Travel & Tourism to GDP is expected to grow by 11.8% to EUR890.4mil (17.8% of GDP) by 2022.
Induced income impacts was EUR510.6 mil in 2011 (15.4% of GDP) and is expected to grow by 14.9% to EUR586.5mn (17.3% of GDP) in 2012. It is forecast to rise by 12.4% pa to EUR1,893.3 mil. by 2022 (37.9% of GDP)[2].

Notably coastal region is of primary interest to tourists in Montenegro. Only coastal municipalities are affected by the very large number of tourists (Budva, Herceg Novi, Bar, Ulcinj, Tivat and Kotor) while northern part of Country has less touristic attractiveness due to the lack of infrastructure (Kolasin and Zabljak are the only winter touristic centers).

Extensive number of tourists, especially in municipalities where during high touristic season number of tourists are higher than number of inhabitants, is significant indicator of waste water/ solid waste pollution and infrastructure pressure.

Data for areas of Montenegro of special interest has been collected for longer time series (2007-2011) in order to document trends. Data sheet with number of nights spent per municipalities for 2010 and part of 2011 as well as longer time series for municipalities Podgodica, Šavnik and Niksic (2007-2011) has been collected and presented in Table 2 of Annex II.

AGRICULTURE

Agricultural area in Montenegro occupies 38% of the total surface area (2009). The total agricultural land is of 516,404 ha or about 0.84 ha per capita. According to this indicator Montenegro is amongst the top countries in Europe. Larger agricultural area per capita in the EU only can be found in Ireland (1.10 ha), while the average (EU-25) is 0.36 ha (2003). Nevertheless, agricultural area is quite heterogeneous. This is the consequence of the topography and geological composition that predetermines the dominance of low production value soil. Arable land, orchards and vineyards occupy only 58,262 ha or 12% of total agricultural area.

Most cultivable land is used for pastures (324,501 ha) and meadows (126,931 ha) with a smaller area in orchards and vineyards (16,285 ha). This is well above the respective share in all other European countries, with highest shares to be found in Ireland (73%),

[2] According to: Tourism & Travel, Economic Impact 2012 Montenegro, World Travel & Tourism Council, 2012

Great Britain and Slovenia (about 60%). The share of pastures and natural meadows in the EU 25 amounts
to about 33%. Statistical data sources show almost no change in total agricultural area in Montenegro (e.g. 1996: 517.6; 2004: 518.0 in 000ha).

Agriculture is by far the largest activity of the rural population - more than 60 000 households obtain their income partly or entirely from agriculture. The agricultural production is structured by traditional vegetable markets and small privately-owned family farms, of which the average size is estimated to be less than 5 ha of agricultural land.

Table with Agricultural Land by categories of exploitation/Land by way of exploitation/Number of livestock, poultry and beehives in Ha per municipalities has been provided in Table 4 of Annex II.

Use of Plant health products on the state level is modes and given as follows:

PLANT HEALTH PRODUCTS for 2009 (in t/year.)

Fungicides	69
Herbicides	10
Insecticides	10
TOTAL	89

INDUSTRIES

The period of 1954 - 1984 was the period when some significant industrial facilities for the production of special steel, aluminum, aluminum oxide, bauxite, coal and sea salt were constructed in Montenegro in addition to the facilities of wood processing, metal processing, leather and textile industry, electric industry, chemical industry, processing of agricultural products, etc. A decline in economic development in the 90's of the previous century resulted in very unfavorable conditions for industrial production which inevitably brought about a change in the direction of economic development of Montenegro.

The current principles of development of Montenegro are based on sustainable valorisation of natural resources in the area of tourism, agriculture, forestry, wood processing and similar in addition to the utilization of modern business and technological methods and introduction of cleaner and new technologies, in order to create the required preconditions for a sustainable development of Montenegro.

Accordingly this raises an important issue of how to manage the waste generated in the previous period by large industrial systems, such as the Aluminum Plant of Podgorica, Ironworks of Niksic and Thermal Power Plant of Pljevlja in addition to the waste generated by small and medium-sized enterprises that can contribute to the un favored ecological state of the underground-water.

Most important industrial polluters has been identified as “5 industrial pollution hotspots in Montenegro” and they are : Alumnnium plant Podgorica (hazardous waste

dumpsite and red mud pond), Maljevac -Thermal Power Plant of Pljevlja, Adriatic shipyard Bijela, Steel plant in Niksic and Gradac flotation tailings pond. Government of Montenegro in cooperation with the World Bank is preparing the Management and Clean-Up project (IWMCP) with the objectives to remediate mentioned industrial pollution locations. Total investment is estimated to be near 70 mil USD.

The data set on most important industrial polluters has been provided as Table 5 in Annex II including all registered industries/polluters in municipalities Podgorica, Niksic and Šavnik from the official business cadaster from Chamber of economy of Montenegro (www.pkcg.org) as those municipalities are belonging to the identified transboundary aquifer areas.

WASTE DISPOSAL, WASTEWATER TREATMENT AND WATER USE

All municipalities have their own system of collection of household waste (usually public companies which are run by Municipality) but the proper waste deposition is a major issue in Montenegro.

Montenegro have only two operational landfills according to the EU criteria (one for Municipality Podgorica and one for Municipalities Bar and Ulcinj). Other Municipalities have their own dumpsites (which are not fulfilling national or EU standards for waste landfill). There is no waste management on those dump sites except occasional operations of compression and burning (*list of dumpsites and waste landfills provided in Table 5 of Annex II*). In addition, there is no disposal location or treatment facility for hazardous or industrial waste on the national level.

Due to this, waste deposition has been identified as one of the threats for groundwater pollution.

It is very hard to estimate the quantities of waste currently generated in Montenegro. The main reason for a shortage of data on qualitative and quantitative analysis of waste lies in an absence of valid records. The quantities of generated waste differ significantly from those of collected, treated and disposed waste. No accurate information on waste quantities is available as well as locations and quantities of the damp sites.

Observed by regions, the Strategic Master Plan for Waste Management (208-2012) considered the following daily quantities of generated waste per capita:

· Mountain (Northern) Region 0,6 kg/per capita/day;
· Central Region 0,8 kg/per capita/day;
· Coastal (south) Region 0,9 kg/per capita/day.

The quantity of waste generated as a result of tourist services varies depending on the season of the year and the region where it is generated and is directly related to the number of overnight stays. This type of waste is mainly generated during a specific period of a year. According to the Strategic Master Plan, each tourist generates 1,5 kg/tourist/day.

There are many waste dump spots spread thought all country and created spontaneously by local inhabitants. Those micro locations are not related to the municipalities or industry/business sector but have localized impact to the water protection. Those small sites will be elaborated in relation to the karst groundwater dependent ecosystems in part B of this report.

Regarding water-waste treatment 61 % of total population has no connection to the any sewage system and only two municipalities have more than 50 % of inhabitants connected to the sewage system (Budva and Cetinje). This indicates that individual septic tanks are widely used *(please see Table 7 from Annex II for details*) and that wastewater represent another treat to the quality of underground water.

Only sewage system in Podgorica municipality has a waste water treatment plant (coordinates: x 42.434474, y 19.234721 party in function) while others discharge non treated waste water directly to the recipient.

It can be seen that use of water in Montenegro is very high and can be compared with biggest users of water in the World such as USA (270 l/day/Inh.) and it is almost twice much than average in western Europe (150 l/day/inh.). This could be due to the current poor condition of water-supply system (losses) and generally low prices of water in Montenegro .

Most of the water is used as a drinking water, much less as industrial water . It is important to delineate that registered irrigation systems are used on only 2730 ha (Grahovsko polje for 400 ha, DP Boka from Tivat for 20ha and Plantaze for 2310 ha) and the rest is individual (household) irrigation.

Since there is very limited area irrigated by the registered irrigation systems in Montenegro, we can assume that majority of irrigation is done in not organized and traditional manner (estimation is on 3% of the total arable land) (please see Table 8 from Annex II for details on categories of water use).

In Municipality of Podgorica for tap water price is 0, 40 eur/m3 and waste water price is 0,12 eur/m3

SURFACE WATER QUALITY

Collecting of the surface water quality data is of the high importance for future analyses of the possible treats for the underground water systems. In order to be able to compare different national classifications on the regional scale (for the Regional environment and socio-economic analyses) and based on the WG2 agreement classification into 5 categories (inline with EU framework directive) was adopted .

In that regard, reclassification of the national water quality data to match requirements of the EU framework Directive has been done. **According to the that data, inland waters in Montenegro has satisfactory water quality and all of them belongs to the categories average or good** (*please see Table 9: Classification and categorization of surface water bodies with coordinates of the monitoring stations in Annex II for more* details).

PROTECTED AREAS AND GROUNDWATER DEPENDANT ECOSYSTEMS

In Montenegro 53 objects are under protection. Pursuant to the national legislation, 124 929 ha or 9.04 % of the territory is protected, while 237.899 ha or 17.22% is under protection pursuant to the obligations from the taken over relevant international treaties. Altogether, on both grounds, the protected areas of nature cover 20.76% of the state territory, with some territories being protected on both grounds (e.g. NP Skadar Lake as a national park and a wetland area pursuant to RAMSAR Convention, NP Durmitor as a national park of nature and UNESCO world heritage site).

In the context of protected areas system reform and increase of area under protection, of importance is the implementation of the project ''Establishing the EMERALD network in Montenegro", which identified 32 locations of the international importance for protection. None of the identified categories on the national level does not include specifically groundwater dependent ecosystems.

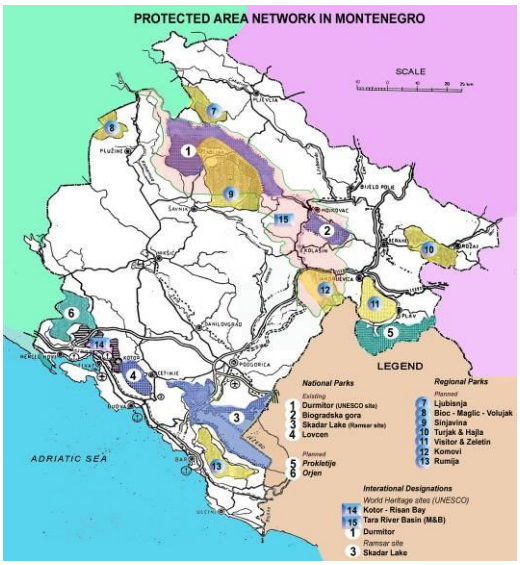

Fig. 9: Network of protected areas in Montenegro

Groundwater dependent ecosystems (GDE) are a diverse and important component of biological diversity. The term GDE takes into account ecosystems that use groundwater as part of survival, and can potentially include wetlands, vegetation, mound springs, river base flows, cave ecosystems, playa lakes and saline discharges, springs, mangroves, river pools, billabongs and hanging swamps.

We are of the opinion that two-way approach should be used for identifying ground water dependent ecosystems (i) identification of the protected areas/categories that are already recognized in the national/regional framework as a biologically dependent on the groundwater (such as protected inland salines, caves and wetlands) and (ii) identification and mapping of the areas that are not widely recognized as a groundwater dependent features/systems using the GIS software and data collected within WGs (such as : system of springs, aquifer and cave ecosystems, river base flows).

Since a key driver for controlling the significance of the groundwater to any ecosystem is hydrological settings, extensive collaboration and data exchange with the WG on hydrology is expected in order to verify proposed sites and find new ones.

Thus, based on (i) we have identified 8 potential ground water dependant ecosystems (Malimrmoljak iz Velike osečenice, Vodov Potok potrjnica, Orijen sa bijelom gorom, Cijevna, Golija,Lukavica sa velikim and malim zurimom, Humsko Blato, Mala Rijeka*)* without being able to clearly mark boundaries and coordinates. Next step of the assignment will identify in details ground water dependent ecosystems

in close collaboration with HG WG trough (ii) and exact boundaries of the already identified GDE.

In addition we have identified 56 most attractive (from the hydrogeological and touristic point of view) caves as *described in Table 10 in Annex II of this report.*

PART B: ENVIRONMENT AND SOCIO-ECONOMIC OVERVIEW AT THE TBA LEVEL

GENERAL INFORMATION

In general, all three TBA areas in Montenegro (Cijevna, Piva and Bilecko Lake) are characterized by the fact that no industries or mid-sized commercial activities exist in any of them. All areas are remote and scarcely populated with un-favored demographic condition and low economy and personal income rate. All three areas are characterized by the severe scarcity of the drinking water and absence of water supply or sewage systems. Waste collection is also unorganized. Due to those conditions, migration and de-population of the all TBA areas is notable and have a stable trend in last 50 years.

It is not likely that any of TBA area is suffering from the significant pollution from waste or wastewater. Individual septic tanks exists as a potential treat but not to be consider as an major one, since TBA areas are very scarcely populated. Main limiting factor for development of TBA areas is seen as a lack of drinking water that can serve everyday needs and be used to add to the household economy by improving traditional agriculture and animal husbandry. Traditional agriculture and animal husbandry in TDA is very modest but those households obtain their income entirely or partly from those activities.

Only by providing secure source and quantities of drinking water, negative demographic and economic trends in those areas can be mitigated or reversed.

In this chapter, detailed assessment of each TBA area in Montenegro is given.

TBA BILECKO LAKE

SOCIO ECONOMICS ASPECTS

TBA Bilecko Lake is located in the north-west of Municipality of Niksic. It is stretching from settlements Velimlje , Grahovo and border of TBA Piva to the state border between Montenegro and Bosnia and Herzegovina. Total area of this TBA in Montenegro is 591.5 km2 (or 28,6 % of Municipality of Niksic). One part of the state border is crossing Bilecko Lake, artificial 18 km long reservoir with surface area (max) of 32 km^2. The Lake is used for purpose of electric power production as well as for drinking water supply.

Fig. 10: Position of TBA Bilecko Lake

Total population of TBA Bilecko Lake is 2293 inhabitants dispersed in 30 settlements. The biggest settlement in TBA has less than 200 inhabitants and settlements (over 100 inhabitants) are Velimlje, Grahovac, Pilatovci,

Klenak, Tupan, Petrovici, Gornje Polje, Vilusi, Dubocke and Nudo (*see Table 1 and 2 of Annex III for details).* Density of population in TBA area is 4 inhabitants per 1 square km. while density of population in Municipality of Niksic is 36 inhabitants per 1 square km**.** This clearly indicates that TBA area is very scarcely populated.

One of the main problems perceived from the population in this area is related to the lack of infrastructure. Settlements in TBA area are very remote from administrative centres in country and the nearest settlement (Velimlje) is 32 km far away for Niksic city. This represents severe difficulty for providing quality services needed for everyday living (health care, education, administration). Since this area has been always on the periphery as transboundary area, major investments has always bypassed this area. This is reflected trough major water scarcity and high unemployment rate in the area as well.

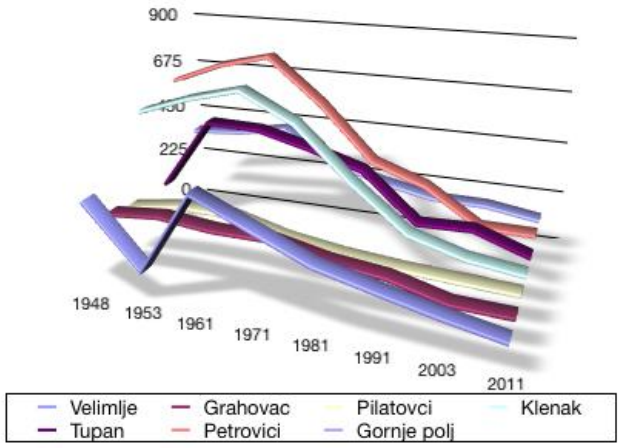

Fig. 11: De-population of the TBA area in last 60 years

In short period of time after Second World War this area receives most of it's development. At that time, settlement Velimlje was administrative center of special administrative unit Banjani. After 1960, process of migration (that followed proces of intensive industrialization) towards larger administrative centres has began and continued until present day. This process strongly contributed to the depopulation and under-development of this ara.

Average age of the inhabitants in TBA is 44,4 years which indicated demographically extremely old population (e.g in settlement Klenak 48 % of total population is older than 60 years- *details in Table 3 of Annex III*). Near half of TBA population has no income or is incapable of working (29,9 % of population is capable of working, and 23 % of population is not capable of working but have some incomes such as pension, social welfare, rent incomes, etc.).

Fig. 12: Velimlje. Once important administrative center of the TBA region, today, is not attractive for life

Today, most of the income of the population in TBA is coming from is animal husbandry and traditional agriculture. Additional sources of income are mainly social welfare.

According to the 2003 data (CoRINE) 30 % of the TBA Bilecko Lake area in Montenegro is agricultural land. Pastures covers 8.6% od TBA area while land principally occupied by agriculture covers 30,7 % of the total TBA area. 30 % of the area is classified as forests.

Fig. 13: Pasture patterns in the landscape of TBA area (left) and traditional cattle barns (right)

Cattling is usually main source of income for households in TBA while traditional agriculture is usually contributing as additional sources of income. Most households combine both activities in order to diversify risk for household economy due to the possible bad weather or natural conditions during season. There is no processing industry or organized purchase for their household products.

Grahovsko field (located just at the east border of TBA) provide good condition for agriculture production on the larger scale because of the Mediterranean influence and availability of water for irrigation from artificial Grahovsko lake.

In general TBA area Bilecko Lake is very scarce with water. There is no water supply system in any of the settlements. Drinking water supply is individual with the help of mobile water tanks (from city of Niksic), individual rain collection systems (Bistjerne) and water wells.

Social issue is high drinking water price, if the water is transported and delivered by the mobile water tanks. Usually trucks with water need to travel more than 80 km in both directions (from/to Niksic city) to deliver the water, This is reflected in the final water price. Current price of one mobile tank (9m^3) is 150 euro and Municipality of Niksic covers 70 % of the costs while rest is left to be covered by the individual households.

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Fig. 14: Water scarcity: trough for cattle, Bistijerna, mobile water tank and another Bistjerna along the road in Pocekovici -all in TBA area.

Some of the water is used for small scale irrigation of the household agricultural parcels (where sufficient quantity of water for basic needs exists) and there is no industry developed in the TBA.

Total domestic water use per day in TBA area has been estimated (based on the number of inhabitants and level of agriculture) to the Total 0.00335 m3/s.

There are no functioning irrigation systems in TBA. However, Grahovsko field (located just at the east border of TBA) has been used for agriculture production on the larger scale since whole field (4.4 sq. km) has enough water for constant irrigation. Water is provided from artificial lake „ Grahovsko lake“made on the Grahovska River. Irrigation system exists but it is not in working condition.

Very important fact about water use from TBA Bilecko Lake is actual use of water from Bilecko Lake **for drinking water supply for coastal City of Herceg Novi (Montenegro)** and producing **of Hydropower for entity of Republika Spska in Bosnia and Herzegovina** (HE trebinje I and HE Trebinje II , HE Dubrovnik) **and Croatia** (HE

Namely, Bilecko Lake is artificial lake created by the construction of arc dam (height 123 m) in 1968 on the Trebisnjica River in Bosnia and Herzegovina. Artificial reservoir that was created (Bilecko Lake) flooded part of Bosnia and Herzegovina territory and some part of Montenegrin territory. From the Bilecko Lake water is firstly used by the HE Trebinje I (nominal power 3x60 MW) and then derived by HE Trebinje II to the 15 km long (6 m wide) hydraulic tunnel to the Plat in Croatia (system Trebisnjica-Plat). In Plat, water is used by Hydro Power Plant Dubrovnik (nominal power 2X108 MW) and then transfered (to be used as drinking water) to the City of Herceg Novi in Montenegrin coast through 32 km long steel water pipes (system Plat- Herceg Novi, constructed in 1980). Around 70 % of drinking water for over 35 000 inhabitants of Herceg Novi is supplied from the Bilecko Lake (around 350 l/s) while rest is supplied from the underground accumulation Opacica in Zelenika on Montenegrin territory.

The current price that Municipality of Herceg Novi is paying to the communal company of Konavle in Croatia for water transfer via system Plat-Herceg Novi is fixed to amount of 25 000 euro/month (according to the billateral agreement from 2011).

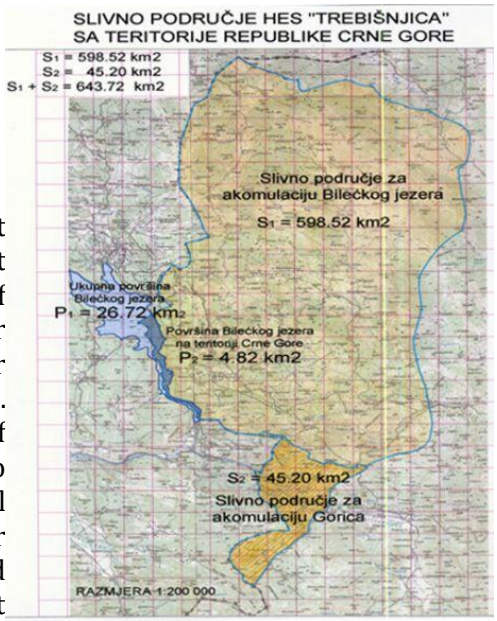

Fig. 15: Potential watershed area of Bilecko Lake in Montenegro.

High water transfer price, and fact that Municipality of Herceg Novi is left without drinking water supply occasionally (eg. in case of maintenance works in system of Hydro Power Plants of Trenisnjica) bring the questions of fair use of the system built in ex-Yugoslavia. According to the some sources, 40 % of watershed of the Bilecko Lake belong to Montenegro and Montenegro has claimed several times rights to benefit from Hydro Power Producing from Trebisnjica System (and claimed potential loss of thousands of bil. EUR in that regard according to some authors[3]) based on that fact. Since the negotiations (through work of sub-commission for hydropotential of watershed Trebisnjica of "Montenegrin–Croatian Commission for management of water of mutual interest" and billateral meetings with representatives of Repuiblica Srpska entity and Bosna and Herzegovina) did not give any results in that regard,

[3] Boška Bogetića UDIO CRNE GORE U HIDROPOTENCIJALU HES "TREBIŠNJICA"

Montenegro has developed plans for construction of new HE Boka in Risan, Boka-Kotorska Bay in order to utilise water from Bilecko Lake for own hydropower production and water supply. Those plans are not operational yet.

SOURCES OF GROUNDWATER POLLUTION PER SECTOR

Due to the non-existence of sewage system and wastewater treatment households (total 937) individual septic tanks represent diffuse pollution source for underground water. There is no study developed to estimate individual or cumulative potential of pollution from those sources in TBA area.

There is no Industries in TBA area. Small business sector is not developed and there is no companies registered in the Montenegrin Chambre of Commerce within the TBA area. We have identified only two local micro-stores (along the road Petrovici- Debeli Brijeg crossing border) and one petrol/gas station (Hellenic petroleum) in Ubli.

There is no extensive agriculture and only one family owned company for primary processing of the meet is registered in Miljanici. This is basically butchery with no technology for food processing at the spot, but there is plan to introduce some technology for further processing in the future. Estimation on number of cattle (370), pigs (43) and sheeps/goats (829) in TBA area has been done in order to evaluate quantity of organic pollution. Use of non-organic fertilizers and pesticides is limited, due to the small individual parcels and non-intensive agriculture.

Fig. 16: Potential pollution site: abandoned precise tool factory facilities in Grahovo.

It is important to note that, in the past, two notable industries (Precise metal industry –branch of Tool factory from Trebinje ih Grahovo and Montex, export–import and producing factory with branches in Petrovići, Vraćenovići, Velimlje and Vilusi) have been pillars of economic development of the region.Now they are closed.

It is possible that, on the location of Precise metal industry in Grahovo, some of the abandoned materials used for metal processing is stored/dumped without attendance and thus, represent direct potential threat to the environment.

SOLID WASTE AND WASTEWATER TREATMENT

There is no solid waste and wastewater management or treatment in the TBA area. Household wastewater is usually collected in individual septic tanks without any treatment. Garbage is disposed randomly, sometimes in the karstic caves.

ENVIRONMENT

In the TBA there are no protected areas. However, on the border of the TBA area (in place Grahovo) there is natural monument „ Arboretum“ under state protection as an feature of national importance . The locality has been protected since 2000 as a unique horticultural area with 127 species of trees.

Nerby, in Locality Velika Osecina, habitat of the endemic amphibian Triturus vulgaris has been registered. This rare species has been registered in other karstic water pits along the Montenegro (eg. Kovacevica water pit).

Fig. 17: Habitat of *Triturus Vulgaris* in Velika Osecina is clearly marked by the by Municipality of Niksic, since population is severely endangered.

At the location of the Brocanas there another edemic species of plant is registered -Acer intermedium.

In addition, souther parts of the TBA area belong (with the small part) to the Mt. Orijen sa Bijelom Gorom which has been foreseen as a potential site for protection (Regional park) by the Municipalities of Herceg Novi and Niksic.

Nature values of the Mt Rumija (according to the EMERALD database[4]) are community of Bosnian pine Pinus heldreichii and other rare vegetation species, such as: Asperula baldacci local endemic species of Rumija mountain massif, Wettsteinii's bellflower (Edraianthus wettsteinii) -Montenegrin-Albanian endemic species, (Gymnospermium scipetarum) -Montenegrin-Albanian endemic species, Minuartia velenovsky- Balkan endemic species, Grisebachian's tulip (Tulipa grisebachiana) - Balkan endemic species, Ramonda serbica - Balkan endemic species. Rumija is located in Adriatic bird's

[4] The Emerald Network is an ecological network made up of "areas of special conservation interest", which was launched by the Council of Europe as part of its work under the Bern Convention. It is to be set up in each Contracting Party or observer state to the Convention.

migration corridor and represents a link between Delta of River Bojana and Skadar Lake, the most important bird eco-systems in the state. S. Neumayer is a typical representative of karst Rumija region. This area colonizes 64 bird species of the Habitats Directive, from which 51 are migratory species.

By Spatial plan for Montenegro until 2020 this area is planned to be a Regional Nature Park.

Altogether eight types of habitats from Resolution 4 and seventy-six species form Resolution 6 of the Barn Convention exist in this area:

Habitats	**Habitat type**
Dense perennial grasslands and Middle European stepps	34.3
Mediterranean xeric grasslands	34.5
Beech forests	41.1
Oak-hornbeam forests	41.2
High oro-Mediterranean pine forests	42.7
Thermophilous and supra-Mediterranean oak woods	41.7
Mixed thermophilous forests	41.8
Caves	65

There are plenty of caves in the TBA area but detailed research (hydrological nature or touristic) has not been done (List provided in table 10 of Annex II).

TBA PIVA

SOCIO ECONOMICS ASPECTS

TBA Piva in is the smallest TBA area covering (in Montenegro) only 205 km2. It is located in northwest Montenegro framed by the border of the TBA „Bilecko Lake“, Montenegrin - Bosnia and Herzegovina state border and road M 18 (Niksic – Foca). TBA area „Piva“ belongs to the Municipalities of Pluzine and Niksic.

Fig. 18: Position of TBA Piva

TBA area is very scarcely populated. Total population of the TBA „Plva“ is only 124 inhabitants in 5 settlements. Average density of population is 3 inhabitant per sq. km. This ratio is even lower than Municipality of Pluzine ratio (5 inhabitants per 1 sq. km.). Current population in TBA area is just 1/8 of population registered in 1953 indicating strong process of depopulation. The main reasons are water and agricultural land scarcity.

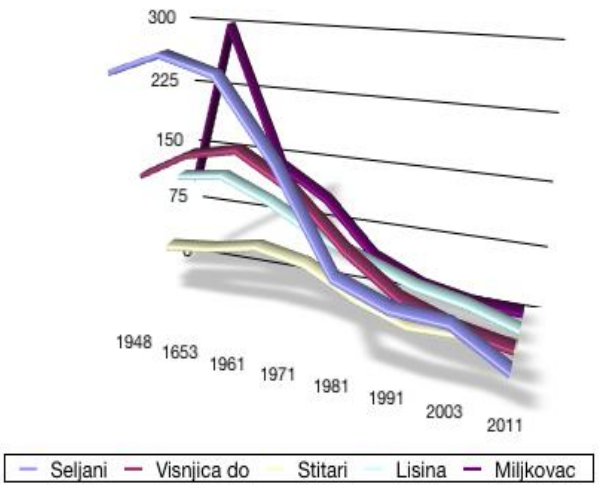

Fig. 19: De-population of the TBA area in last 60 years

Fig.20: „Moonlike“ holokarst in TBA Piva, remote and scarcely populated area (landscape photo and googlemaps image)

Average age of the inhabitants in the TBA is 48.2, years which indicated demographically extremely old population. Near half of TBA population is not capable of working.
Most of the income of the population in TBA is coming from household farming and traditional agriculture. Additional sources of income are social welfare (pension).
According to the 2003 data (CoRINE) only 3 % of the TBA „Piva“ in Montenegro is agricultural land. There are practically no pastures. Near 46 % of the area is classified as Forests.

There are no industries, and main sources of income are forestry and cattling.

WATER DEMAND AND WATER USE

Area that is covered by the borders of TBA „Piva“ is in scarcity of water. Inhabitants use mainly individual collection of rainfalls as source of drinking water since there is no water supply system developed.

Total domestic water use per day in TBA area in country has been estimated (based on the number of inhabitants and level of agriculture) to the Total**: 0.00017 m³/s.**

SOURCES OF GROUNDWATER POLLUTION PER SECTOR

Due to the nonexistence of sewage system and wastewater treatment, household's individual septic tanks represent potential pollution source for underground water. Due to the low number of households, this pollution is not likely to be significant. There are no industries or any kind of commercial (except forestry) activity in TBA area.

SOLID WASTE AND WASTEWATER TREATMENT

There is no solid waste and wastewater management or treatment in the TBA area. Household wastewaters are usually collected in individual septic tanks without any treatment. Household garbage is disposed randomly but not in big quantities.

ENVIRONMENT

TBA area is preserved due to the lack of any pollution source. Montenegrin part of the TDA partly merge with proposed Emerald site „Golija i Ledenice.
According to the EMERALD database, Golija and Ledenice are located at the north-west part of Montenegro and they are mostly built up of calcite and dolomite. They border mountains Vojnik and Pivska planina from east, and mountain Njegos from west.
Quite steep mountain slopes and central alighted parts are areas where representative Norway spruce and mixed beech forests grow. Golija also represents a habitat of a huge number of rare and endemic protected species that witnesses the presence of 10 nationally protected plant species. It is especially important to mention preserved populations of *Eryngium palmatum* (Balkan endemic species) for the first time described by Josifa Pančić, then Silver fir (*Abies alba)*, Heledreich's maple *Acer heldreichii* (Balcan endemic species), *Campanula scheuchzeri*, *etc.* Among them, living space find very rare species of insects from class of beetles (*Coleoptera*): *Buprestis splendens*, *Stephanopachys substriatus* and many other.

Relatively not endangered by humans, Golia and Ledenice enable survival not only to above mentioned rare and endangered species, but uphold the survival to greater number of other species of our flora and fauna.

Altogether four habitat types form Resolution 4 and eighteen species from Resolution 6 of the Bern Convention exist in this area.

Habitats	**Habitat type:**
Beech forests	41.1

Mixed thermophilous forests	41.8
Montenegrian spruce forests	42.243
Western Balkanic black pine forests	42.62

The area has a variety of karstic features, which are not investigated in detailed (*some of them presented in Table 10 of Annex II*).

TBA CIJEVNA

SOCIO-ECONOMICS ASPECT

Cijevna river is entering Montenegrin territory as sa strong mountain river south of the Miždrakut hill with deep karst canyon (17 km length) until village Dinosa. After village Dinosa, rivers slows down forming small canyon in conglomerate which is entering Cemovsko field with characteristic of a plain river and finally entering Moraca river thru small Cijevna river delta. Total leigh of the Cijevna River in Montenegro is 26 km.

Fig. 21: Position of TBA Cijevna

Area of concern for this report (Tranboundary area of Cijevna river – TBA Cijevna river) covers only upper part of Cijevna river canyon and surrounding areas with 24 settlements. The location of the TBA „Cijevna" is 5 km north-east from Podgorica.

TBA Cijevna is situated along the valley of the River Cijevna along with the Montenegrin - Albanian state border. Total coverage of area in Montenegro is 235,54 sq.km and respective population is 1475 inhabitants. Montenegrin part is (as two others TBA as well) scarcely populated with no extensive industries and with poor infrastructure. In total 24 small settlements has been registered to be within the borders of TDA Cijevna and all of them administratively belong to the Municipality of Podgorica. Main settlements are Krševo, Medun, Skorać, Fundina i Omerbožovići (over 100 inhabitants). Three elementary schools exist in the area (*table 6 of the Annex III).*

Despite constant population growth of the Municipality od Podgorica (population growth index 396 as of 2003/1948) settlements in the TBA Cijevna have high rate of depopulation (near 10 % per year). In two settlements (Radovce and Benakaj), according to the 2011 census, not a single inhabitant has been registered. This migration is mainly directed from the TBA area (higher part of the Cijevna river) to the lower part ie. toward administrative centers (Podgorica and Tuzi).

Population in TBA has average age of 39 (population is on the border between demographically old to demographically very old) and near 30 % of population is capable of working. Over 50% of population in TBA is not capable of working but have some kind of income.

Main sources of income for the TBA Cijevna population are small scale (traditional) agriculture and social welfare or employment in the industries/administration which is situated outside TBA (in Podgorica, Tuzi).

Agriculture is limited with the scarce agricultural areas available and the maintain climate. According to the 2003 data (CoRINE) pastures cover only 2.03% od TBA area while land principally occupied by agriculture covers only 10,4 % of the total TBA area. Most of the area is classified as forests (41,4 %).

Fig. 22: TBA Cijevna traditional agriculture and cattling

Cattling is usually main source of income for households in TBA that is sometimes combined with the incomes from traditional agriculture or occasionally collection of medicinal herbs. One of the limitations for extensive agriculture is non existence of the organized purchase of raw products

During the summer, cattle are migrated from the canyon to the higher parts of the TBA, particularly on the locations with springs and well developed meadows.

Fig. 23: Bikers on the Katun "Korita" in Cijevna TBA

Those temporarily settlements are called „Katun“and they are common features for mountains area of Montenegro. Some of them has become very attractive to the specific toursits categories (adventures, hiking and biking, weekend tourism) mainly due to the pristine scenery and domestic food. In TBA Cijevna, Katun „Korita“ with the vicinity of Rikavacko Lake is visited by modest number of tourist, yet enough to support few traditional restaurants with few rooms available on the sight.

WATER DEMAND AND WATER USE

There was no drinking water supply systems in the TBA Cijevna (some drinking water supply network exist in villages Gornji i Donji Miljes and Diniša- but outside the TBA Area) until 2012 year. New water supply system has been developed for area of Kuci. This water supply system is comprised of 2.5 km long water supply pipeline from reservoar on mountain Bioc (capacity 600 m3) to elementary school in Kuci, but without secondary network developed yet.

Due to this fact, water individually used from : water wells, direct water supply from Cijevna river and mobile water tanks where first two solutions are not possible.

Fig. 24: Various ways of collecting the water in TBA area Cijevna river

Most of the water is used for small scale irrigation of the household agricultural parcels.

Total domestic water use per day in TBA area in country has been estimated (based on the number of inhabitants and agriculture) to the Total **0.00284 m3/s**

POTENTIAL SOURCES OF GROUNDWATER POLLUTION

Quality of the water of Cijevna River is very good, since Cijevna origin from the very high and mountainous area of Prokletije which is scarcely populated and with no industries. In the past, as well as today, raw water from the Cijevna River has been used as drinking water without any (pre) treatment.

Hidrometeorological institute of Montenegro monitor the quality of the Cjevna river water on two locations (Trgaja and Prije ušća). Monitoring station Trgaja is just on the border of TBA area , where river slows down and enters the Cemovsko field.

According to those measurements, quality of the water in the upstream of Cijevna river belongs to A1, S, I category which is the highest quality category in national legislation (correspond to the category „good" from EU framework directive).

However, occasionally (especially after spring rainy season) elevated level of HPK and phosphates has been registered on Trgaja monitoring station as well as elevated level of PAH, phenols and pesticides. This pollution is probably related to the untreated hazardous waste dump site of Alumina factory in Podgorica and pesticides and fertilizers runoff from large agricultural properties of Company 13 Jul Podgorica. Both of the polluters are outside the TBA.

In the TBA no industries has been registered. Only one small industry and one small service has been registered (meet processing farm „Korac" and car mechanic shop near Medun). One extensive animal husbandry (more than 20 heads of cattle) has been registered at Katun Korita.

Since this area has low population and is with no extensive agriculture, we can assume that only wastewater and solid waste produced from the households can be considered as potential polluters of underground water.

It is worth noting that illegal sand gravel extraction, that takes places along the Cijevna river in lower part of the TBA area, is contributing to disturbance and pollution of the river as well.

SOLID WASTE AND WASTEWATER TREATMENT

Waste management in TBA area is complex due to the diversity of the terrain and scarse population. Waste collection system exists only in settlements Fundina and Medun and it is in principle represented with few garbage collection containers. Garbage is regularly collected and transferred to the Municipality of Podgorica landfill. Other parts of the TBA does not have any system of collection of waste which results in creation of dump sites along the TBA as well as piles of debris along the Cijevna River canyon.

Fig. 25: Garbage collection containers in Medun

There is no wastewater treatment or sewage system developed in the TBA area. Household wastewater is collected by individual septic tanks, which are in some occasions in vicinity of Cijevna River. There is no study on number and influence of the individual septic tanks to the (underground) water pollution, but we can assume that they can be direct source of pollution for underground waters.

ENVIRONMENT

Canyon of the Cijevna river has been identified as a important site for the nature protection. Despite the fact that Cijevna River is not legally protected, area has been recognized as one of the 32 Emerald sites in Montenegro (number16: Cijevna River Canyon), one of the Important areas for plant Conservation (IUCN Important Plant Areas -IPA programme) and the site of international importance for bird habitation (IBA).

Within the Canyon, as a special attraction stands out the presence of hard-leaf and evergreen vegetation of Holm oak habitats, that represents its inmost breach into the land in the ex-Yugoslavia territory, as well as preserved population of Serbian phoenix flower (*Ramonda serbica)* the Balkan endemic species, Dalmatian hyacinth *Hyacinthella dalmatica*, the Dinaric endemic species, Dalmatian cranesbill *(Geranium dalmaticum)*, Dalmatian orchid *(*Orchis provincialis*)*, European holly *(Ilex aquifolium), Narcissus angustifolius* etc.

Except for the splendid plant life, in the Canyon can be find populations of wolf (*Canis lupus*), as well as 4 endangered species of fish: marble trout (*Salmo marmoratus*), *Leuciscus souffia*, Mediterranean Barbel (*Barbus meridionalis)* and White Bleak (*Alburnus albidus).* Up to now, more than 110 species of birds have been registered in the Canyon. This is an area of the international importance for bird habitation (IBA).

Fig. 26:
Upper part of Canyon of the Cijevna River near village Delaj

Altogether seven habitat types from Resolution 4 and thirty-six species from Resolution 6 of the Bern Convention exist in this area.

Habitats	**Habitat type:**
Beech forests	41.1
Thermophilous and supra-Mediterranean oak woods	41.7
Mixed thermophilous forests	41.8
High oro-Mediterranean pine forests	42.7
Riparian willow formations	44.1
Southern riparian galleries and thickets	44.8
Temperate broad-leaved evergreen forests	45

List of plant and fish species potentially important for protection in TBA Cijevna region is given in *Table 7 of Annex III.* Many of the caves have been registered, but none of them has been explored in details (*Table 10 of Annex II).*

Generally speaking, environment in the upper canyon of Cijevna river is well preserved.

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ANNEX I : DEFINITION OF DATA REQUIRED (WITHIN THE BOUNDARIES OF THE DINARIC KARST AS DEFINED BY THE HYDROGEOLOGY GROUP) FOR EACH COUNTRY

Demographic data

- Number of people per administrative unit (to the lowest level possible)
- Demographical trends
- Migration
- Number of tourists/visitors (for hot spots only)

Land Use and sources of income

- Land use (shp file)
- Sources of income per sector (agriculture, fishery, industry, tourism…)
- Agricultural data (crops being grown, fertilizers, pesticides…)

Infrastructure and potential sources of pollution

- Roads
- Wastewater treatment plants
- Sanitary landfills/dumpsites
- Industries (specify potential pollutants)
- Mining sites (specify potential pollutants)
- Military sites

Protected areas

- All types (national parks, biosphere reserves, nature parks, etc – shp file)
- List of species (including endemic species, endangered species)
- Groundwater dependant ecosystems
- Karstic caves

ANNEX II: DATA SHEETS COLLECTED FOR DIKTAS GIS - MONTENEGRO

ANNEX III : SPECIFIC DATA ON TBA AREAS IN MONTENEGRO

Table1: Population changes in TBA Bilecko Lake in setllments over years

	1948	1953	1961	1971	1981	1991	2003	2011
Velimlje	383	129	472	368	268	210	156	109
Grahovac	269	289	265	264	214	188	125	117
Pilatovci	240	273	267	206	172	152	139	128
Klenak	607	682	737	624	411	226	160	130
Tupan	534	539	532	475	408	209	216	135
Petrovici	668	754	807	624	394	314	165	163
Gornje Polje	392	407	447	313	248	207	202	168
Vilusi	318	477	396	283	231	216	213	171
Dubocke	491	548	672	603	441	289	283	194
Nudo	267	264	264	238	206	201	238	199

Table 2: Households number (2003) in TBA Bilecko Lake

setllment	**number of households**
Gornje Crkvice	27
Vrbica	2
Dolovi	5
Jabuke	11
Zagora	13
Ubli	19
Vidne	15
Balosave	16
Prigradina	19
Pocekovici	15
Kovaci	12
Zaslap	20
Donje Crkvice	29
Miljanici	21
Rijecani	17
Spila	17
Macavare	34
Somina	25
Koravlica	9
Broćanac Nikšićki	35
Velimlje	47

Grahovac	38	
Pilatovci	37	
Klenak	60	
Tupan	62	
Petrovici	57	
Gornje Polje	74	
Vilusi	71	
Dubocke	194	78
Nudo	199	52

Table 3: Average age of population in TBA Bilecko Lake (2003)

Settlement	Average age
Velimlje	43.8
Grahovac	48.1
Pilatovci	43.4
Klenak	54.1
Tupan	41.9
Petrovici	43.9
Gornje Polje	40.4
Vilusi	43
Dubocke	45.8
Nudo	39.2

Table 4: Population changes in TBA Piva in setllments over years

	1948	1953	1961	1971	1981	1991	2003	2011
Seljani	276	296	281	204	99	77	74	38
Višnjića do	160	188	199	167	111	69	49	38
Stitari	63	69	80	69	39	19	21	17
Lisina	133	140	117	86	65	45	34	16
Miljkovac	118	300	147	113	53	28	17	15

Table 5: Average age of population in TBA Piva (2003)

Settlement	Average age
Seljani	42.2

Višnjića do	53
Stitari	43.4
Lisina	43.5
Miljkovac	59.2

Table 6: Population in settlments in TBA Cijevna

Radovce	0	Lovka	43
Benkaj	0	Gurec	46
Nikmaras	10	Nabon	46
Rudine	10	Seliste	47
Sjenice	22	Helimica	51
Delaj	23	Koci	54
Stijepovo	24	Pikalj	54
Budza	25	Vrbica	93
Arza	29	Medun	100
Ducici	34	Omerbzovici	133
Spinja	39	Skrac	137
Krsevo	164	Fundina	273
		Total	**1457**

Table 7: List of plant and fish species potentially important for protection in TBA Cijevna region

Plants

Centaurea incompta Vis.
Cerastium dinaricum G.Beck & Szysz.
Cymbalaria ebelii (Cufod.) Speta
Gentiana levicalyx Rohlena
Gentiana lutea L. ssp. symphyandra (Murb.) Hayek
Geum bulgaricum Panc
Hyacinthella dalmatica (Baker) Chouard
Narcissus augustifolius Curt.
Minuartia velenovsky Rohlena
Pinus heldreichii H.Christ var. heldreichii)
Ramonda serbica Pancic
Silene macrantha (Pancic) Neumayer
Senecio thapsoides DC. subsp visianianus (Papaf. ex Vis.) Vandas
Valeriana pancicii Halácsy & Bald.
Viola orphanidis Boiss. subsp. nicolai (Pant.) Valentine

Fish species

Fam Salmonidae

Salmo farioides- potocna pastrmka

Salmo dentex- strun

Salmo marmoratus – glavatica – gornji tok, u kanjonu

Alburnoides bipenctatus- ukljevica

Alburnus alburnus alborela – ukljeva

Fam Cyprinidae

Barbus peloponnsius rebeli – potocna mrena

Carassius auratus gibelio- srebrni karas – samo u donjem toku, introdukovan

Gobio gobio-mrenica

Leuciscus souffia montenegrinus – mekis

Leuciscus cephalus albus –klijen

Phoxinellus stimphalicus montenegrinus –endemicna vrsta

Pseudorasbora parva - introdukovana

Ritilus basak ohridanus- bijeli brcak

Ritilus prespensis vukovic-zuti brcak

Scardinius erithrophthalmus scardafa-ljolja – u donjem toku, blizu usca

Fam Cobitidae

Cobitis tenia ohridana - vijun

Orthrias barbatulus sturanyi – brkica

Fam Percidae

Perca fluviatilis Linnaeus – grgec – donji tok, malobrojna (introdukovana)

Fam Blenidae

Salaria (Blenius) fluiatilis - rijecna singularica

Fam Gobidae

Knipowitschia (Podogobius) panizzai – glavoc vodenjak

Fam Anguillidae

Anguilla anguilla- jegulja –do karaule

Fam Poecilidae

Gambusia affinis – gambuzija (introdukovana)

Protection and Sustainable Use of the Dinaric Karst Transboundary Aquifer System

Montenegro Report

WG4, Stakeholder Analysis

November 2012

INTRODUCTION

STAKEHOLDERS ANALYSIS IN THE FRAMEWORK OF THE DIKTAS PROJECT

Within this background, a Stakeholders Analysis (SA) at transboundary level was prepared to produce the necessary information to be used:

(i) for the revision and adaptation of the preliminary SPPS by means of identifying the Stakeholders at national and transboundary levels and analysing their characteristics and positions.

(ii) in support of the preparation of the TDA by identifying the issues and problems with regard to the management of the Dinaric Arc aquifer system as these are perceived by the stakeholders in the Project beneficiary countries, as well as their causes.

(iii) in support of the preparation of the Shared Vision; information regarding the EXPECTATIONS AND ASPIRATIONS OF STAKEHOLDERS PERTAINING TO THE FUTURE OF THE TRANSBOUNDARY KARST AQUIFERS MANAGEMENT can be taken into consideration while the draft document Shared Vision is prepared.

The first step in the process for the preparation of the Stakeholders Analysis was the identification of the different actors that could influence/affect or be influenced/affected by the Project, as well as the management of the karst aquifers in the Dinaric Arc area.

In this respect the Project identified:

1. Stakeholders from the Project countries at the following levels: (i) Transboundary; (ii) National, and –where appropriate- entity (iii) Regional and (iii) Local.

   With regard to the regional and local stakeholders, the efforts for their identification were focused on the specific transboundary areas, overlapping the transboundary aquifers, where the preparation of the TDA focused on.

   Shared by Albania and Montenegro: Cijevna.

   a) Shared by Bosnia and Herzegovina and Croatia: Una; Krka; Cetina; Neretva right side; Neretva left side.
   b) Shared by Bosnia and Herzegovina and Montenegro: Piva; Trebisnjica.

2. Stakeholders at the international levels.

The list of stakeholders is a “dynamic” one; it will be revisited in the course of the Project to reflect eventual changes in the institutional and managerial settings and

frameworks at all levels as these may affect the accomplishment of the Project's objectives.

METHODOLOGY

The basic methods for gathering and processing information for this stakeholder analysis include:

- Expert opinion and Expert knowledge (provided by the International and Country experts);
- Web-based survey;
- Workshops;
- Structured interviews.

Information collected from interviewees and workshop participants represent their perceptions and views, and have been used as such in conjunction with background research and expert knowledge.

ANALYSIS PARAMETERS

The analysis elaborates on the following parameters regarding the stakeholders:

i. "Primary" and "Secondary" stakeholders.

As Primary stakeholders we define those actors that ultimately affect or are affected by the DIKTAS, either positively or negatively. Secondary stakeholders are the intermediaries in the DIKTAS.

ii. Importance

Importance denotes how critical the stakeholder is to the success of the DIKTAS project and indicates the priority that should be given to satisfying the stakeholders' needs and interests.

iii. Interest

Interest can be manifold. It could be that the stakeholders are personally affected in regard to their social and economic personal well-being (e.g. physical health, leisure, costs for services such as sewage treatment, provision of drinking water, cultural values etc.); it could also regard the business of the stakeholder (e.g. agriculture, fisheries, industries, navigation etc.); it could be that the stakeholder is advocating superior interests of the society such as environmental protection or social justice.

iv. Attitude

The level that stakeholders would be supportive or not towards the DIKTAS Project.

v. Influence

The influence of the stakeholders derives by the synergistic combination of different resources available to the stakeholder, the available level and the ability to mobilise these resources in favour or against the DIKTAS Project implementation as well as the implementation of the project's suggestions in relation to the management of the shared karst aquifers. Such resources may be knowledge, financial, technical and human resources, juridical power and the ability to mould public opinion (e.g. an organisation with a strong public relations

department and good connections to the media or an organisation with a big number of members who support the goals of the organisation).

vi. Knowledge

The levels of knowledge and the degree of information that stakeholders have on topics such as the karst aquifers management, the activities undertaken by the DIKTAS, the EU Water Framework Directive, etc.

vii. Opinions/perceptions

The opinions and perception of the stakeholders in relation to the:

- implementation of the DIKTAS and the establishment of a transboundary consultative body.
- significant issues related to the management of karst aquifers, their probable causes, impacts, and proposed solutions.

STEPS FOR THE COLLECTION AND ANALYSIS OF INFORMATION

The steps for preparing the Stakeholders Analysis are presented below; a number of coordination meetings between the GWP-Med team and the National Experts were used for the preparation and implementation of the respective actions. Information about the resources used in each step is given in brackets.

(i). Actions to secure -at the highest possible level- that the National Experts implement the methods chosen for the acquisition and preliminary analysis of information in a harmonized way.

(ii). Identification of stakeholders at the transboundary level and preliminary analysis of their characteristics.

- Elaboration of criteria for the identification of stakeholders of transboundary significance (GWP-Med team);
- Compilation of a list of stakeholders for each of the countries of focus and preliminary analysis of their characteristics (National Experts).

(iii). On-line survey for information collection.

- Preparation of questionnaires / on-line survey (GWP-Med team);
- Translation of questionnaires / on-line surveys in national languages of the Project countries (National Experts);
- Publication of the links to the on-line surveys in the DIKTAS website and e-mail notification of all identified stakeholders.

(iv). National Consultation Meetings with selected stakeholders in order to: (a) elaborate on initial information acquired regarding stakeholder identification and analysis, and; (b) to acquire new information regarding the significant issues related to the karst aquifers' management to be fed in the preparation of Transboundary Diagnostic Analysis (GWP-Med team and National Experts).

(v). Processing and analysis of National Consultation Meetings results.

(vi). Semi-structured Interviews with selected stakeholders.

- Preparation of questionnaires / interview script (GWP-Med team with input by the National Experts);

- Selection of the stakeholders to be interviewed (National Experts with assistance by the GWP-Med team);
- Interview of selected stakeholders (National Experts);

(vii). Preparation of the stakeholder analysis report using the results of the on-line surveys, the National Consultation Meetings and the selected stakeholder Interviews (GWP-Med team).

MONTENEGRO

MONTENEGRO ON-LINE SURVEY RESULTS

Nine respondents participated in the survey and six answered most or all of the questions. All of the respondents are involved in Projects relevant to water management, and they represent stakeholders from River Basin District Agencies (2), Tourism Agencies/Boards (2), State Owned Utilities (2), Ministries (1), Land and Water Use Associations (1) and Research Institutes (1).

Table 1 On-line survey participants

Nature of Organisation	
Ministry or other high level governmental authority	1
Entity / Regional or Local Government body/Authority (entity, region, county, municipality etc.)	0
Protected Area Authority	0
River Basin District Agency	2
State Organisation	0
State owned utility	2
Research institute	1
Land and Water Use Associations / Cooperatives (Farmers'/Livestock Breeding/Fishermen/Water Boards)	1
Public Enterprise (Forest and Water Management)	0

Private sector (land owners, navigation, industry) including Chambers	0
Tourism Agency/Board	2
NGO	0
Civil society	0
Local community	0
International and Regional Institution or Organisation	0
Donor country and development agency	0
International Commission/Committee/Organisation	0
Media	0
Religious Institution	0

All of the respondents wish to get involved in the management of groundwater in the Dinaric Karst Area, and would like to be kept informed about the project. There appears to be a preference to electronic means of communication and face to face engagement. Monthly bulk e-mail communication mainly, followed by monthly internet updates in the DIKTAS website and personalised e-mails are the most preferred means of receiving information. Additionally, some of the respondents find monthly information meetings useful.

Table 2 Preferred means of information and frequency

Would you prefer to be informed by... (choose all that apply)						
Answer Options	**every month**	**every 3 months**	**every 4 months**	**on outstanding occasions**	**never**	**Responses**
Information provided on DIKTAS website	3	0	0	0	0	3
Bulk e-mails	5	0	0	0	0	5

Newsletter	2	0	1	1	0	4
Publications (brochures, leaflets)	1	0	1	0	1	3
Personalised e-mails	3	0	0	0	1	4
Information meetings (conferences, workshops, lectures)	3	0	0	2	0	5

Table 3 Preferred means of consultation

Would you like to be consulted by ... (choose all that apply)	
Answer Options	**Responses**
participating in consultation meetings	4
providing feedback in electronic or other form	5
participating in on-line surveys	3

Most of the respondents wish to contribute information to the Project team and to be consulted and/or contribute to the project implementation. Participation through the internet and in face to face meetings are the two most preferable means. The resources which most of the respondents are able to mobilize in order to participate to ground water management are, in decreasing order, **Expertise and Information** followed by **Human resources** and in a lesser degree **Financial Resources.** Half of the respondents consider their contribution to the improvement of groundwater management as valuable; no one believes they have nothing to offer. Most attribute the value of their contribution to their professional experience, their position and responsibilities in policy making, or the nature of the organisation they represent (NGO).

Podgorica National Consultation Meeting Results – Stakeholders Map and Evaluation

The participants of the National Consultation Meeting elaborated upon a preliminary list of stakeholders and produced a stakeholders' map that included hundred and nine (109) significant stakeholders at transboundary level: forty-seven (47)

stakeholders as actors of high influence and high interest, nineteen (19) stakeholders of high interest and low influence, twenty-six (26) stakeholders of low interest and high influence and seventeen (17) stakeholders of low interest and low influence. These are presented in the tables 48, 49, 50 and 51 below. The slightly lower number of stakeholders in comparison to the Bosnia and Herzegovina and Croatia is attributed to the fact that the transboundary areas of interest are smaller in extent than in the other two countries. Agriculture and the tourism sector are represented only centrally by the relative ministries; the project should put effort to identify related primary stakeholders as well. Other points of interest are the opinion of participants for the level of influence of most of the NGOs, which is considered to be rather low, and the inclusion of many media organisations in the stakeholders.

Category 1 – High interest/ high influence

Thirty-eight (38) of the stakeholders under this category have been evaluated as having high importance, eight (8) having medium importance and one having low importance. With three exceptions all high importance stakeholders have a positive attitude towards the DIKTAS project. Compared to the following categories (see below) stakeholders in this group present the highest rate of supporting attitude, with forty-one supporting stakeholders, one neutral, two opposing and three whose attitude cannot be estimated. The participants have no clear idea with regard to the attitude of two stakeholders towards the project.

Regarding the three stakeholders that are thought to be opposing, special efforts should be made to gain their support since in addition to their high interest and influence they are also thought to be of high importance actors. The first is Podgorica Municipality which is affected and affects water resources in a multitude of ways, and the second is the Steel Plant Niksic. Another stakeholder from the private sector the KAP-Aluminium Processing Plant, one of the largest industries of the country, is thought to have a neutral attitude. Pollution issues have been attributed to this stakeholder, especially from stakeholders in Albania. As it could turn to an opponent during the course of the project, this stakeholder should be approached in order to gain its support; in this regard it should be kept dully informed and consulted.

The category includes international institutions, central and local authorities related to water management, a number of municipalities, research institutes, private sector stakeholders, national parks and NGOs. The Hydropower sector is also represented here and it is thought to be supportive of the project aims and objectives. The project should put effort on informing stakeholders under this category and actively engaging them in the public participation process and project activities, aiming to gain and maintain their support.

Table 4 Category 1 – High interest/ high influence

Montenegro - Stakeholders	Importance	Attitude
World Bank	HIGH	SUPPORTER
EU Delegation in Montenegro	HIGH	SUPPORTER

REC	HIGH	SUPPORTER
Kreditanstalt für Wiederaufbau, KfW - Reconstruction Credit Institute	HIGH	SUPPORTER
EBRD	HIGH	SUPPORTER
GIZ	HIGH	SUPPORTER
Ministry of Agriculture and Rural Development	HIGH	SUPPORTER
Ministry of Sustainable Development and Tourism	HIGH	SUPPORTER
Nature Protection Institute	HIGH	SUPPORTER
Hydro-meteorological Institute	HIGH	SUPPORTER
Department for Sustainable Development Council Support	HIGH	SUPPORTER
Water Administration	HIGH	SUPPORTER
Geological Survey of Montenegro	HIGH	SUPPORTER
Montenegro Seismological Observatory	HIGH	SUPPORTER
Hydrographic Department within Hydrometeorological institute	HIGH	SUPPORTER
Environmental Protection Agency	HIGH	SUPPORTER
Ulcinj Municipality	HIGH	SUPPORTER
Herceg Novi Municipality	HIGH	SUPPORTER
Public Enterprise National Parks of Montenegro	HIGH	SUPPORTER
National Park Skadarsko Jezero	HIGH	SUPPORTER
PROCON- National Project Implementation Unit	HIGH	SUPPORTER
VODACOM - Coordination Company for Water and Waste Water	HIGH	SUPPORTER

Services		
CETI- Centre for Ecotoxicological Research	HIGH	SUPPORTER
Biotechnical Faculty	HIGH	SUPPORTER
Speleological Society of Niksic	HIGH	SUPPORTER
Public Enterprise Regional Water Supply System	HIGH	SUPPORTER
Public Enterprise Water Supply and Sewerage	HIGH	SUPPORTER
HYDROPOWER Enterprise of Montenegro, EPCG	HIGH	SUPPORTER
Niksic Municipality	HIGH	SUPPORTER
NGO Eco Movement	HIGH	SUPPORTER
NGO The Greens of Montenegro	HIGH	SUPPORTER
Montenegrin Academy of Arts and Sciences	HIGH	SUPPORTER
GEOPROJECT d.o.o. Podgorica	HIGH	SUPPORTER
Gradevinski Fakultet	HIGH	SUPPORTER
KAP-Aluminium Processing Plant	HIGH	NEUTRAL
Steel Plant Niksic	HIGH	OPPONENT
Podgorica Municipality	HIGH	OPPONENT
EIB	HIGH	
Forestry Administration	MEDIUM	SUPPORTER
National Park Lovćen	MEDIUM	SUPPORTER
National Park Biogradska Gora	MEDIUM	SUPPORTER

National Park Durmitor	MEDIUM	SUPPORTER
NGO Ekoforum	MEDIUM	SUPPORTER
NGO The Greens	MEDIUM	SUPPORTER
Natural Sciences Faculty (Biology Department)	MEDIUM	SUPPORTER
NGO FORS Montenegro	MEDIUM	
National Council for Waters	LOW	

Category 2- High interest/ low influence

The nineteen (19) stakeholders under this category present a mixed picture regarding their level of importance as this was assessed by the NCM participants. Nine (9) stakeholders are estimated to be of high importance, four (4) of medium and five (5) of low importance. There is one stakeholder for which no estimation can be made. Regarding their attitude, the majority is estimated to be supportive (11) or neutral (3) towards the project objectives and activities, while two (2) stakeholders are perceived to be opponents to the project. For one stakeholder no safe estimation can be made, while the two newspapers are perceived as neutral since they are media.

Most of the NGOs are placed in this category by the NCM participants and although they are attributed low influence in their majority, they are considered to be positive towards the project and its objectives. These stakeholders should be kept informed and engaged in networking for the promotion of the project objectives. Their high interest may be translated to motivation and they may be involved in general public activities such as awareness raising. The two opposing stakeholders, estimated to have high importance, the Association of Rafters of Montenegro and the NGO Expeditio should be approached in order to gain their support, given their high interest to the subject.

Table 5 Category 2– High interest/ low influence

Montenegro - Stakeholders	Importance	Attitude
PAP/RAC UNEP/MAP	HIGH	SUPPORTER
NGO Society of Friends of Durmitor and Tara	HIGH	SUPPORTER
NGO The Green Step	HIGH	SUPPORTER
NGO Eco Bjelasica	HIGH	SUPPORTER

NGO Euromost	HIGH	SUPPORTER
Suza Bottling Company/Water Group D.O.O.	HIGH	NEUTRAL
Montenegrin Fishermen Association	HIGH	NEUTRAL
Association of Rafters of Montenegro	HIGH	OPPONENT
NGO Expeditio	HIGH	OPPONENT
Diva Bottling Company/Eco Per Investor	MEDIUM	SUPPORTER
NGO Centre for Ecology and Environmental Management	MEDIUM	SUPPORTER
NGO Young Ecologists Society Niksic	MEDIUM	SUPPORTER
SAVEZ IZVI DACA CG	MEDIUM	SUPPORTER
NGO Ozon	LOW	SUPPORTER
NGO Geo Eco Montenegro	LOW	SUPPORTER
ADRICOSM project (funded by Italy)	LOW	NEUTRAL
Dnevna Novina daily	LOW	
Pobjeda daily	LOW	
Montenegrin Farmers Association		

Category 3 – Low interest/ high influence

The second largest category is this of low interest and high influence, including twenty-six (26) stakeholders. The picture with regard to the level of importance attributed to the stakeholders under this category is again a mixed one. Almost half of the stakeholders, fourteen (14), are of high importance, six (6) of medium and six (6) of low importance.

One stakeholder neither support nor oppose the project and its objectives. The exact position towards the project cannot be determined for two (2) stakeholders. This gains special significance due to the high influence of the stakeholders; the project should try to inform its actions with their needs and concerns. The category includes a number of media, which should be perceived as neutral and which can influence

public opinion or can promote the project objectives and activities; therefore communication efforts should include them.

Table 6 Category 3 – Low interest/ high influence

Montenegro - Stakeholders	Importance	Attitude
UNDP	HIGH	SUPPORTER
Marine Biology Institute	HIGH	SUPPORTER
Ministry of Finance	HIGH	SUPPORTER
Coalition of Municipalities	HIGH	SUPPORTER
Public Enterprise Morsko Dobro	HIGH	SUPPORTER
NGO Green Home	HIGH	SUPPORTER
NGO Breznica	HIGH	SUPPORTER
Chamber of Commerce	HIGH	OPPONENT
Ministry of Economy	HIGH	
IN TV	HIGH	
Portalanalitika	HIGH	
MINA Agency	HIGH	
TV Budva	HIGH	
Civil Engineering Faculty	HIGH	
USAID	MEDIUM	SUPPORTER
Real Estate Administration	MEDIUM	SUPPORTER
Cetinje Municipality	MEDIUM	SUPPORTER

NGO Network of environmental NGOS G8PLUS	MEDIUM	SUPPORTER
National TV- RTCG	MEDIUM	
Radio CG	MEDIUM	
Aqua Bianca Bottling Company/Aqua Bianca D.O.O.	LOW	NEUTRAL
Bar Municipality	LOW	
Montena TV	LOW	
Elmag TV	LOW	
TV Vijesti	LOW	
Vijesti daily	LOW	

Category 4 – Low interest/ low influence

Category 4 includes seventeen (17) stakeholders. Six (6) stakeholders are supportive and one neutral; the rest are stakeholders of not known attitude. These stakeholders need to be informed of the project developments through general information activities of the project. Four media stakeholders are included in this category and they are perceived as neutral. Attention should be given into informing the ministries and other high level organisations included in this category. One point of interest is the inclusion in this category of the National Tourism Organisation given the importance of the tourism sector in the country.

Table 7 Category 4 – Low interest/ low influence

Montenegro - Stakeholders	Importance	Attitude
Public Health Institute	HIGH	SUPPORTER
Ministry of Health	HIGH	SUPPORTER
National Park Prokletije	HIGH	SUPPORTER
RTCG 2	HIGH	

ATLAS TV	HIGH	
Ministry of Culture	MEDIUM	SUPPORTER
NGO Natura	MEDIUM	SUPPORTER
Cafedelmonetenrgo portal	MEDIUM	
Ministry of Internal Affairs	MEDIUM	
National Tourism Organisation	MEDIUM	
Union of Entrepreneurs	MEDIUM	
Metallurgical Faculty	MEDIUM	
Aqua Monta Bottling Company/Atlas Company	LOW	SUPPORTER
ADA (Austrian Development Agency)	LOW	NEUTRAL
Antena M radio	LOW	
Dan daily	LOW	
TV Niksic	LOW	

Results from interviews

23 organizations and institutions were interviewed in Montenegro between 24 of April and 28 of June 2012.

Level of knowledge

Seventeen (17) out of the twenty-three (23) stakeholders interviewed were familiar with the WFD's objectives. The same number of respondents (17 out of 23) feel they are not sufficiently informed about issues related to groundwater management. The source of information regarding water-management issues most commonly mentioned is the workplace of the interviewees. The media and the internet are the next most popular source of information and especially the websites and publications of the Waters Directorate and that of the Agency for Environmental Protection. The third most often mentioned source of information is the national or EU relevant legislation. Finally, stakeholders are relying on water-management relevant institutions and organisations, including the Ministry of Agriculture and Rural Development, the Ministry of Sustainable Development and Tourism, the

Hydrometeorological Institute and their publications for their information, as well as on workshops organised in the framework of various projects and training initiatives.

Eighteen (18) out of the twenty-three (23) interviewees are aware of the DIKTAS project, an indication of the general interest in the subject of karst aquifers and groundwater management. The vast majority (22) of stakeholders wish to be kept informed about the project and its activities; fifteen (15) of the key stakeholders interviewed wish to participate to the implementation of the project. The preferred means of information are monthly electronic newsletters and regularly project brochures, while relevant workshops every three months or so come as a close second. A well maintained website, providing monthly updates on the project developments and other news is the next preferred source of information, together with regular Information meetings.

Regarding the content of information, the proposed "news from the DIKTAS" is on top of the list of information, followed by "Best practices and guidelines". "Karst aquifer management issues", "Water management policy and practical issues" were all chosen by thirteen (13) respondents, although only a little over half (12) are interested in information on how to participate in the project activities.

Table 8 Information Content

Information Content	Responses
News about the DIKTAS project	18
Karst aquifer management issues	13
Water management policy issues	13
Water management practical issues	13
Best practices and guidelines	15
How to participate in the DIKTAS activities	12

Desired Capacity and willingness of the Stakeholder to contribute and desired level of participation to the DIKTAS Project.

With regard to the improvement of the management of Transboundary Karst Aquifers through enhanced cooperation[5] fifteen (15) interviewees are strongly and seven (7) somewhat supportive, whereas one stakeholder is not inclined either way. **Human**

[5] The stakeholders were asked to choose among the following options: strongly support it, somewhat support it, do not support nor oppose it, somewhat oppose it, strongly oppose it.

resources are mainly mentioned by the respondents as the means mostly available and easy to be mobilized towards influencing decisions related to the management of the Transboundary Karst Aquifers, followed by **expertise and information**. The least available and the most difficult resource to mobilise are **financial resources**.

Table 9 Resources available to stakeholders and ability to mobilise them

Which resources are available to your organization/institution/authority and how easily can these be mobilized to influence decisions related to the management of the Transboundary Karst Aquifers?								
Resource	Not easily	Easily	Very easily	A	B	C	D	E
Financial resources	15	2		12	1	2	2	1
Expertise / Information	5	11	3	1	7	1	7	3
Political power / Lobbying	10	4	2	6	3	2	3	2
Human resources	3	13	3	0	5	3	11	1
Other (please specify)								

(A) VERY LITTLE (B) LITTLE (C) SOME (D) ENOUGH (E) A LOT

Table 10 Stakeholders' opinion on improved management of Transboundary Karst Aquifers through enhanced cooperation

Which of these categories best describes your opinion about the improved management of Transboundary Karst Aquifers through enhanced cooperation for?	
a. I strongly support it	15
b. I somewhat support it	7
c. I do not support nor oppose it	1
d. I somewhat oppose it	0
e. I strongly oppose it	0

Expectations from participating in the DIKTAS implementation

The majority of the interviewed stakeholders (15) wish to participate in the DIKTAS project implementation. When asked to indicate the most preferred form of participation in the DIKTAS activities, they showed an equal preference to **contributing information** related to their domain/business to be **consulted on the preparation of the TDA and SAP**. Fewer wish to be involved and contribute to the project activities.

Table 11 Preferred form of participation in the DIKTAS' activities

What is the preferred form of participation in the DIKTAS' activities?	Responses
Contribute information related to my domain/business to be used through DIKTAS for the sustainable management of the transboundary karst aquifers	11
Consulted on the preparation of the document that analyse the aquifers systems state / on the transboundary problems and issues. **Consulted** regarding the identification of policy, legal and institutional reforms and investments needed to address the problems?	11
Involved in and contribute in the implementation of the project activities	8

Accordingly, on the subject of the stakeholders participation in the management of the transboundary karst aquifers, most responses (11) refer to **information about the decisions and measures**, and on an equal level (11) to **consultation on the proposed decisions and measures**, especially at a national level. Most respondents list **Economic cost** as the main constraint keeping them from participating in the management of the transboundary karst aquifers, followed by **Work load** and to a lesser degree **Lack of training/education**.

Table 12 Preferred form of participation in transboundary karst aquifers management

What is the preferred form of participation in the management of the transboundary karst aquifers?	Responses	International/ transboundary	National	Regional	Local
Informed about decisions and measures	11	4	10	7	3
Consulted on proposed decisions and measures	11	2	10	5	2
Involved into decision making	8	2	7	5	3

Involved into implementation of decisions	5	2	4	3	2

Table 13 Constraints to participation in the management of the transboundary Karst Aquifers

What constraints exist, that would hinder your participation in the management of the transboundary Karst Aquifers?	Responses
Economic cost (fees/taxes implied by measures, travel, equipment etc)	17
Work load (limited human resources)	14
Working with other stakeholders	0
Access to information	4
Lack of training/ education	7
Other (please specify)	0

The form of support stakeholders regarded most valuable in order to meaningfully participate in the management of the transboundary aquifers was **financial support**, and **opportunities for information exchange** with other stakeholders. Support in **training, education and/or more human resources** are also considered necessary. This gives an additional value to the efforts of DIKTAS to engage stakeholders, and the important role the project could play in the wider field of groundwater management in the area.

Table 14 Support to participation in the management of the transboundary Karst Aquifers

What kind of support would you need to overcome these constraints and participate/ be involved?	Not Important	A bit important	Quite important	Important	Very important
Financial support	0	1	7	6	5
Training/Education and/or more human resources	0	0	5	5	4
Opportunities for information exchange with other stakeholders	0	0	2	4	7

(e.g. conferences, meetings)					
Legal advice	1	0	3	3	0
Access to information	0	0	2	3	5

Expectations and aspirations for the future of the transboundary Karst Aquifers management

Six interviewed key stakeholders mentioned the acquisition of information and data regarding the resource as their main expectation from their participation in the DIKTAS project. Contributing information and expertise and being consulted on the decision making process and on the potentially agreed measures were among the expectations expressed. Additionally, one stakeholder views the project as an opportunity to mobilise financial support in the activities relative to karst aquifers' management.

All interviewees advocate a sustainable model of development as well as green economy. Most propose: enhanced protection measures for the karst groundwater depending ecosystems; solutions to problems such as pollution and waste management; improvements in the management and efficiency of water use and; raising awareness of the population. A little less than half of the responses specifically mention sustainable agriculture as the main economic activity for the areas related to the Dinaric karst aquifers; others mention tourism in this regard. There are also few stakeholders referring to industry/manufacturing and in the use of water resources for energy production.

As for their hopes for changes in the future regarding the management of the Transboundary Karst Aquifers, improved cooperation and communication, and the development of new or the implementation of existing legislation and regulations are most commonly reported. More research and technical innovative technology to tackle problems are also mentioned quite often, followed by the exchange of information and awareness raising.

The key stakeholders interviewed are all very positive in contributing in order to see these changes taking place. The majority is willing to provide human resources and exchange information and expertise; these are resources that stakeholders are saying they have enough. Their commitment to cooperation and communication, and for many, to participation to the project and the development of measures, even legislation and regulations, is also stated.

Most key stakeholders interviewed expect protection of groundwater and surface waters to be improved as a result of the DIKTAS project and its activities. They also see the systematic collection of data and expertise as an outcome of the project that will contribute to improved sustainable management of the karst aquifers. Some of

the interviewees also foresee better monitoring of the resource and raising of awareness of the public regarding the issues related to karst aquifers.

The opportunities for cooperation and networking arising from the project summarize the next most preferred outcome expected by the interviewees.

CONCLUSIONS FOR MONTENEGRO

Many primary stakeholders / users of the resource are identified and included in the analysis, such as municipalities, public enterprises, the industry and numerous NGOs ("representing" the environment). Agriculture and tourism related primary stakeholders at regional or local level are underrepresented. The respective Ministries are included and considered to have significant influence, whereas organisations such as the Montenegrin Farmers Association and National Tourism Organisation are considered not to have significant influence. More effort in informing and engaging these sectors is required. Despite the existence of many environmental NGOs - most are estimated to have high interests- the majority are characterised as of low influence. The majority of the identified stakeholders are supportive towards DIKTAS and other similar initiatives.

Extra attention is required while approaching the private sector and more particular the industries when aiming at their engagement, since they are believed to have a neutral or negative attitude towards the project aims and objectives. In addition they have been criticised for their contribution to the environmental problems of the water bodies and groundwater in the area; related criticism has come also from the Albanian stakeholders. The project should inform and consult with them on matters of their interest, raise their awareness regarding the value of groundwater resources and keep them informed on the project developments. Once gaining their support, it would be advisable to involve them even further in the project.

The project should consult with the stakeholders who, although not influential, have high interests in groundwater management, and gain their support. This is also recommended since this category of stakeholders includes a number of NGOs and Farmers Associations, groups which can become very vocal if they feel their interests are undermined. Furthermore, a large number of Media are identified as stakeholders, some of which are attributed with high influence; the DIKTAS should take that under consideration when implementing project promotion activities.

The need for intensive communication activities on a regular basis is stipulated by all consulted stakeholders. Interviewed key stakeholders, although well informed of the project, are very interested to be frequently informed through many different media; electronic media and face to face meetings being most favoured. Regarding the electronic media, key stakeholders prefer monthly electronic newsletters with the project developments and news, and appreciate a well maintained website and regular bulk e-mails. Stakeholders would also like to take part in regular Information

meetings. It is indicative that information and scientific data are some of the outcomes they are expecting from the DIKTAS project.

Most of the key stakeholders are interested in contributing information and being consulted on the decisions and measures proposed regarding transboundary aquifers management. Similarly they are willing to exchange information and be consulted on the preparation of the TDA and the SAP in the framework of the DIKTAS, especially at national level. On both cases though, stakeholders are reluctant to get involved in the implementation of decisions and project activities. This is one point the project should take under consideration and intensify the communication activities in order to gain the stakeholders trust and active support.

According to the stakeholders, the project should aim to facilitate cooperation at different levels and especially at transboundary level. Financial support, opportunities for information exchange and training would encourage and assist meaningful participation. Furthermore, key stakeholders are keen in contributing human resources and information and expertise.

PERCEIVED SIGNIFICANT ISSUES IN MONTENEGRO

Lack of scientific information and comprehensive knowledge of the karst aquifers is considered to be the most prevailing issue together with the overall improvement of water resources management.

Regarding pollution surface and groundwater pollution is the main issue indicated. The prevailing pollution problems according to the stakeholders are nitrate and phosphate, organic and toxic substances pollution.

Unsustainable/insufficient municipal waste water management is primarily indicated as a cause of these problems, followed by unsustainable/insufficient municipal solid waste management.

ISSUES

A. DATA AND INFORMATION

Lack of information regarding the characteristics, state, and use of the karst aquifers are indicated as causes of a range of issues. It is thought to be an impediment to the cooperation between stakeholders and a major obstacle in the development of appropriate management plans and legislation for the effective protection of the resource. The introduction of systematic monitoring, the promotion of information exchange between stakeholders at national and transboundary levels and the further research on the resource, are proposed. Furthermore, data acquisition and in depth information about the resource is one of the expectations of the stakeholders from the DIKTAS project.

B. ENHANCED WATER MANAGEMENT

Water management is rated as an important issue. The funds for the development and implementation of management plans are considered to be lacking at the moment. Unsustainable/insufficient water management including lack of management plans, legislation and regulations, and lack of information and cooperation is indicated to lead to unsustainable exploitation of the resource. The resulting degradation of the resource being an impediment to the development of the area is reported. Another important aspect mentioned as missing is stakeholders and public participation; it leads to failure to use local and traditional knowledge.

C. POLLUTION

Waste water pollution

Unsustainable/insufficient waste water –primarily municipal- management is thought to have a sever effect primarily on surface waters but also on groundwater, causing bacteriological, organic, nitrate, phosphate and toxic substances pollution. Industry is also viewed as a significant source of pollution, and, to a lesser degree, tourism related activities.

Pollution from solid waste

Unsustainable waste management is believed to impact more groundwater than surface waters, causing toxic substances pollution.

D. GROUNDWATER OVER-ABSTRACTION

Groundwater over-abstraction is mostly an issue arising in conversations with interviewed stakeholders; over-abstraction for irrigation is thought to be causing the decline of groundwater levels.

E. COOPERATION

Further to the lack of exchange of data and information, already referred at, the issue of cooperation is linked to the lack of common initiatives for the management and the protection of the resource.

F. LAWS AND REGULATIONS - LEGISLATION

Inadequate legislation –more in particular in relation to protective measures- and failure to harmonise legislation with international conventions and EU regulations are pointed out as important. Additional related issues include insufficient implementation of laws and inability of local government to provide solutions.

HOT SPOTS

Several issues have been indicated by stakeholders to manifest in a number of areas:

- Water use from the aquifers in **Trebisnjica** by Montenegro and Bosnia and Herzegovina.

- Concentration of industrial polluters in **Trebisnjica**.
- Water pollution in **Cetinjsko polje** has an impact on the quality of waters that leaves the Obod pit (note: this is no transboundary problem).
- In **Zeta** there is abstraction of large amounts of water for irrigation. Pollution from industrial and municipal waste is also reported. Monitoring is thought to be very insufficient.
- Pollution is cited as an issue in the **Cijevna River.**
- **Bilećko Lake** is reported to be affected by water uses in the area.

A.1. MONTENEGRO

PERCEIVED SIGNIFICANT ISSUES IN MONTENEGRO PER METHOD USED.

RESULTS FROM ON-LINE SURVEY

Eight respondents answered the on-line survey (information regarding the nature/competences of organizations/ institutions participated in the on-line survey are given in Table 45).

The most familiar pressures for the online survey respondents in Montenegro, are the **Unsustainable / Insufficient waste water management** and the **Changes in the hydromorphology of watercourse**s, followed by the **Unsustainable / Insufficient management of solid waste** and **Transportation**. These pressures collect most of the responses; however, with the exception of 'Mining and quarrying', stakeholders are familiar with all of the pressures. This may be explained by the nature of the respondents, most of whom represent stakeholders closely linked with the resource.

The picture is similar in the question regarding problems in water management. Most respondents are aware of almost all of the problems. The problem of **Groundwater Pollution from agriculture** collects most responses, followed by **Surface water Pollution from municipal** and **industrial wastewater**, **Sea water intrusion in groundwater**, and **Eutrophication/Nutrification**.

Table 15 Water management related pressures chosen by the stakeholders

Answer Options	Responses
Hydromorphological changes (e.g. regulation of waterways, construction of dams, diversion of rivers)	4
Unsustainable Agriculture	2

Unsustainable Forestry	1
Mining and quarrying	0
Manufacturing / Industry	1
Illegal discharges from industries	2
Unsustainable / Insufficient waste water management (e.g. lack of sewerage untreated/insufficiently treated urban wastewater)	4
Unsustainable / Insufficient waste management (e.g. controlled and un-controlled dump sites)	3
Transportation (road, pipelines)	3
Storage (including tailing dams for mining and industrial wastes)	2
Industrial accidents	2
Groundwater abstraction	2
Tourism	2
Climate variability	2

Table 16 Water management related issues/problems chosen by the stakeholders

Answer Options	Responses
Surface water Pollution from municipal wastewater (e.g. BOD, COD, nitrogen, phosphorus)	3
Groundwater Pollution from municipal wastewater (e.g. BOD, COD, nitrogen, phosphorus)	2
Surface water Pollution from agriculture (e.g. nitrogen, phosphorus, pesticides)	2
Groundwater Pollution from agriculture (e.g. nitrogen, phosphorus, pesticides)	5
Surface water Pollution from industrial wastewater (BOD, COD, heavy metals, hydrocarbons)	3

Groundwater Pollution from industrial wastewater (BOD, COD, heavy metals, hydrocarbons)	1
Viruses and bacteria from lack/inefficiency of wastewater treatment facilities	0
Decline of groundwater levels (or piezometric levels), reduced baseflow and springflow of groundwaters	1
Sea water intrusion in groundwater	3
Salt water upconing	0
Salinization	2
Land subsidence	1
Flooding	2
Scarcity and droughts	1
Eutrophication/Nutrification	3
Loss of biodiversity in surface waters and water-related ecosystems	1

RESULTS FROM PODGORICA NATIONAL CONSULTATION MEETING

The groundwater management related issues in the transboundary karst aquifers of interest shared between Montenegro on the one hand, and Bosnia Herzegovina and Albania on the other, were identified by the participants and grouped in five (5) clusters; the clusters were ranked according to their perceived importance as follows:

1. Water management
2. Data availability
3. Cooperation
4. Laws and regulations
5. Pollution

The issues under each cluster are presented in order of importance following the prioritisation made by the NCM participants.

- ### WATER MANAGEMENT

Diverse issues are brought together under the cluster Water Management: the generic absence of management plans; the more specific issue of transboundary

importance related to the unsustainable use of water of the Bilecko Lake, situated on the borders between Montenegro and Bosnia and Herzegovina; the unsustainable management of the reservoirs in the Albanian side that leads to floods. In regard to the latter, it is worth mentioning that stakeholders have linked floods they think are caused due to unsustainable water management of the Albanian side, with effects on the shared karst groundwater between Montenegro and Albania.

Table 17 Water Management

Causes	Issues	Impacts
Lack of funds	Lack of funds for the management plans (after systematic research) Nonexistent plans for management Hydro potential – regime of water supply	Inefficient use of resources Pollution Financial loss
Lack of scientific cooperation	Overmanagement and overexploitation of the waters of Bilecko lake	Financial loss
One side management (lack of cooperation)	Montenegro and Albania – inadequate use of accumulations which is a cause of floods in Montenegro	Financial loss
Nonexistent bilateral agreement	Lack of adequate management of the caves which are a possible source of ground waters	Potential not valorized (ecological, tourism)
Bad management	Solving a one state problem that affects other state	Environment impact and financial loss

NOTE: THIS TABLE IS A TRANSCRIPTION OF THE TABLE PREPARED BY THE STAKEHOLDERS DURING THE NCM; THE CONTENT HAS BEEN TRANSLATED FROM THE NATIONAL LANGUAGE.

The following list is an effort to codify the issues under this cluster; the discussion during the NCM has assisted in this regard:

1. Absence of management plans;

2. Over-exploitation of the waters of Bilecko lake;

3. Unsustainable use of water accumulations (reservoirs) in Albania, causing floods;

4. Absence of management of caves as potential sources of groundwater and tourist attraction;

5. Lack of cooperation between countries.

Inadequate management and **lack of bilateral cooperation** in this regard as well as **insufficient funding** are among the causes indicated. The impacts are felt across a range of domains from **insufficient use and the degradation by pollution** of the water resources, to **financial loss** and the **impediment on using the resource for the development of the area**.

- DATA AVAILABILITY

Participants have ranked second the group of issues related to the data and information availability and acquisition regarding the karst aquifers. Participants think that lack of relevant information inhibits the effective management and protection of the aquifers. It is also an impediment to the harmonisation of national legislation with EU legislation, in view of the perspective of Montenegro joining the EU. Apart from the actual insufficiency of systematic monitoring and research, stakeholders attribute the problems to lack of awareness and political will and the lack of a national strategy and legislation that would create the framework for better information acquisition.

The issues are presented in descending order following the related prioritisation done by the participants:

1. Lack of water resources cadastre

2. Lack of polluters cadastre

3. Monitoring

4. Geological research (lack of).

Table 18 Data Availability

Causes	Issues	Impacts
Lack of awareness and political will regarding management of karstic aquifers	Nonexistent cadastre regarding waters (amount of water in the karst aquifiers etc)	Lack of possibility for the adequate management
Nonexistent national strategies Incomplete laws and regulations	Nonexistent cadastre of polluters Monitoring Geological research	Pollution Lack of possibility for data

		exchange
Research and monitoring that are not systematic enough		Lack of possibility for approximation of the national legislative with the EU legislative

NOTE: THIS TABLE IS A TRANSCRIPTION OF THE TABLE PREPARED BY THE STAKEHOLDERS DURING THE NCM; THE CONTENT HAS BEEN TRANSLATED FROM THE NATIONAL LANGUAGE.

- COOPERATION

Having already mentioned cooperation-related issues in the two previous clusters, participants here group different aspects of cooperation at the transboundary and national levels that they think are missing, hence they stress their importance.

As pointed out in the two previous clusters, lack of cooperation and coordination results in restricted information exchange. Apart from data exchange, the failure to incorporate local and traditional knowledge into water management is also mentioned. The absence of initiatives and projects regarding the management and protection of the resource further restricts the opportunities for cooperation between different stakeholders. The result is water management issues which remain unsolved and new knowledge which remains unexploited. Therefore, cooperation between all national and transboundary authorities, NGOs and other stakeholders becomes a challenge and a prerequisite for sustainable water management.

The list below codifies the issues under this cluster based on the discussion during the NCM:

1. Lack of cooperation among state institutions;

2. Lack of sufficient international cooperation

3. Insufficient cooperation in the field of data and information exchange

4. Failure in the implementation of international agreements

5. Stakeholders involvement.

Table 19 Cooperation

Causes	Issues	Impacts
Cooperation of all the state structures	Lack of information	Actions that are not timely
Lack of international cooperation	Lack of initiative	Lack of solving issues

Data exchange problem	Lack of projects Lack of implementation of the international agreements	Lack of useful new knowledge
Cooperation with NGOs Awareness raising on the protection of ground waters	Lack of inclusion and information amongst citizens	Lack of use of traditional knowledge

NOTE: THIS TABLE IS A TRANSCRIPTION OF THE TABLE PREPARED BY THE STAKEHOLDERS DURING THE NCM; THE CONTENT HAS BEEN TRANSLATED FROM THE NATIONAL LANGUAGE.

- LAWS AND REGULATIONS

Participants have chosen to include in this cluster issues that constitute the underlying causes of problems related to karst aquifers management.

The issues included in Table 86 have been codified based on the discussion during the NCM as well as on the causes/impacts analysis, and presented below:

1. Lack of adequate legislation and failure to transpose Directives that would fill in the gaps;

2. Insufficient implementation of National and International legislation;

3. Insufficient information and inclusion of interested institutions and the public;

4. Inefficiency of local government in providing solutions.

With regard to the last issue this is attributed to the **insufficient organization of the local governments** and the lack of adequate financial resources that limit their capacity. Overall, it is felt that not all available capacities are used, **decisions reached through the existing framework may be easily challenged**, and that this ultimately leads to bad management of the resource.

Table 20 Laws and regulations

Causes	Issues	Impacts
Lack of adequate laws	Transposition of directives Implementation	Bad management

Inadequate implementation of the conventions (Espo, Helsinki)	Insufficient information and inclusion of the interested institutions and of the public in general	Decisions reached are under the question mark
Decentralization and strengthening of the capacities (financial resources of the local governments)	Lack of interest of the local government for involvement into these problems	Lack of capacities

NOTE: THIS TABLE IS A TRANSCRIPTION OF THE TABLE PREPARED BY THE STAKEHOLDERS DURING THE NCM; THE CONTENT HAS BEEN TRANSLATED FROM THE NATIONAL LANGUAGE.

- POLLUTION

Here the participants bring up mainly the issue of pollution control management, giving weight to the acquisition of information and data, a theme recurrent in most of the previous clusters of issues. Transboundary pollution of the shared karst aquifers due to waste -originating from the neighbouring countries, Albania and Bosnia and Herzegovina- is an issue of concern potentially exacerbated by the floods.

The list below codifies the issues under this cluster based on the discussion during the NCM:

1. Determination of potential polluters;

2. Identification of pesticide and fertiliser pollution hot spots;

3. Exchange of information with Albania regarding the solid waste related polluters;

4. Understanding transboundary -between Montenegro and Albania- pollution transport patterns;
5. Domestic wastewater pollution linked with illegal constructions.

The quality of waters is declining and the impacts are felt on the ecosystems but also on economic sectors such as tourism.

Table 21 Pollution

Causes	Issues	Impacts
	How to determine potential polluters?	
Waste water pollution/		Quality of waters worsening/

Pesticide and fertilizer pollution/ Waste pollution (Albania and BiH)/ Insufficient regulation of waters of Bojana)/ Underground pollution of the Karstic fields/ Lack of information amongst citizens/	Recognize hot spotsof the greatest polluters/ How to gain polluters cadastre form the Albania territory/ How to determine a degree of pollution in Montenegro and Albania/	Impact on flora and fauna/ Impact on tourism/ Floods in Montenegro that bring pollution/ Erosion of land/Fertility of land/
Illegal construction/ Not connected to the sewage system/	Pollution	

NOTE: THIS TABLE IS A TRANSCRIPTION OF THE TABLE PREPARED BY THE STAKEHOLDERS DURING THE NCM; THE CONTENT HAS BEEN TRANSLATED FROM THE NATIONAL LANGUAGE.

RESULTS FROM INTERVIEWS

In responding to the question regarding the most significant issue affecting the transboundary karst aquifers, key stakeholders mentioned **lack of knowledge, data and information** regarding the **characteristics of the aquifers**, their **condition** and the **use of the resource**. The **irrational of inefficient exploitation of the resource** is also mentioned very often; over-abstraction of groundwater for irrigation is one of the issues highlighted in this regard.

Groundwater and surface **Pollution** is the third most commonly cited issue; related aspects brought up are **lack of information** and **lack of protection measures**. The main source is believed to be **Unsustainable / insufficient municipal waste water management**. Other sources indicated are **Unsustainable tourism development** and **Urbanisation**, but also **Manufacturing/ industry** and **Mining. Lack of awareness** is also cited as an important issue.

Other issues mentioned in conversation with the interviewees include

- Cooperation,

- Urbanisation,
- Financial resources and
- Climate variability

What are the impacts, how are they expressed, how do they manifest?

The impacts from the significant issues manifest in the **degradation of groundwater quality and depended ecosystems**, and ultimately to the quality of life of citizens.

How this issue/problem could be addressed in your opinion – what needs to be done in order to avoid or address the problem?

Most of the interviewees refer to the need for sustainable management of the resource, focusing on comprehensive quality management as a proposed way to address the issues. Additional proposals include further research regarding the characteristics of the problems affecting karst aquifers, and the establishment of systematic monitoring.

Protection and Sustainable Use of the Dinaric Karst Transboundary Aquifer System

REPORT FOR 2012

WG Legal and institutional framework and policy

Maja Raicevic, Montenegro

November 2012

1. INSTITUTIONAL FRAMEWORK

Water management is one of the most important segments of the environment under the responsibility of the Ministry of Agriculture and Rural Development, which defines the policy and prepares laws through its internal organizational unit and these are subsequently implemented and enforced by the Directorate for Water.

The Regulation on Organization and Manner of Work of the Public Administration ("Official Journal of MNE", no. 5/12) delegated responsibilities related to waters to the Government authorities as it follows:

Ministry of Agriculture and Rural Development is responsible for administrative affairs related to: water management development policy; system solutions for ensuring and using of water, water-bearing soil and water springs for irrigation purposes, protection of water from pollution, regulation of water and water courses and protection from harmful effects of water; system and other incentives for improvements in this field.

Directorate for Water is responsible for affairs related to: ensuring and implementing measures and works relating to regulation of water and water courses, protection from harmful effects of water and protection of water from pollution; ensuring exploitation of water, material from water courses, water bearing soil and water structures owned by the state, through concessions, lease, etc., and drafting of related documents; management of water structures for protection from harmful effects of water; management of investors' affairs, professional supervision and control of the quality of performed works; technical inspection and acceptance of performed works; issuing of water-related documents; calculation of fees payable in this field and ensuring dedicated and rational use of funds collected on these grounds in compliance with the Government's programme; establishment and management of the water information system, water inventory, register of waters important for Montenegro and monitoring natural and other phenomena in order to collect data needed for protection from harmful effects of water; preparation of professional background for drafting of regulations, plans and programmes adopted by the Government or the Ministry responsible for water-related affairs; defining borders of water resources and defining the status of public water resources; protection of waters and water-bearing soil from usurpation and illegal exploitation, professional development (consultations, courses, etc.), cooperation with appropriate international organisations and institutions within its competences.

Water Council is an advisory and expert body of the Government, which reviews and provides opinion on the most important matters related to waters in regards to regulations, planning documents and proposals for improving the situation in this field. The Council has its President and ten members elected from the order of prominent public, scientific and professional workers in the fields of water, economy and finances, local self-government units, non-governmental organisations operating in the field of waters and environmental protection and scientific and professional

institutions which are important for sustainable management of water resources. The Council for Water particularly: gives opinions on proposals of laws and other regulations which regulate water management matters; gives opinions on strategic solutions offered by the national plan and plans for water management; participates in public debate in the phase of preparation of the water management plan; monitors implementation of the national water management programme and plan; gives proposals for wider participation of public in the process of planning, decision-making and the control of their implementation; gives proposals for educating the public on the importance of water as a natural public resource, on the need for rational water consumption and protection of waters and the role of water structures in providing services; gives proposals which are important for improvement of the situation in the field of waters.

On the second DIKTAS Steering Committee meeting, held on 27 April 2012 in Tirana, Albania, participating countries have agreed to create for the purposes of the project, a National Interministerial Committee (NIC), or its equivalent, composed of high level representatives of all the various ministries and agencies that are or should be involved in karst groundwater management (e.g: Treasury, Water, Agriculture, Forestry, Energy, Physical Planning etc.). The NICs are aimed (i) at involving all relevant governmental institutions in an effort to implement integrated land and water resources management and harmonize existing policy frameworks at the national level, and (ii) at contributing to the preparation, review and adoption of key DIKTAS outputs.

In this regard Montenegro initiated the process of establishment **National Interministerial Committee for DIKTAS in Montenegro.** This body will be composed of the representatives of: Ministry of Sustainable Development and Tourism as responsible ministry for DIKTAS project, Ministry of Agriculture and Rural Development, Ministry of Economy, Ministry of Health, Ministry of Transport and Maritime Affairs, Geological Survey of Montenegro, Directorate for Water, Hydrological and Meteorological Service and Environment Protection Agency.

Ministry of Sustainable Development and Tourism is responsible for administrative affairs related to: waste and waste water management; the system of public utilities; coordination of regional water-supply systems. This Ministry monitors the work of public utilities companies in all municipalities, and the work of regional enterprises “PE Regional Water Supply System for Montenegrin Coast” and “Vodacom” Ltd., whose work contributes to improvement of the situation in the field of waste waters and water-supply. This Ministry supervises the work of the Environment Protection Agency and the Hydrological and Meteorological Service of Montenegro as well.

Ministry of Health is responsible for health protection in relation to waters, drinking water in particular.

Ministry of Economy is responsible for administrative affairs related to: geology exploration of minerals, including, inter alia, ground waters, and administrative affairs related to the system of concessions and allocation of concessions in this field.

Hydrological and Meteorological Service is responsible for affairs related to: observing and measuring hydrological parameters, preparing studies, elaborates, analyses and information on surface and ground waters and the coastal sea; establishing and maintaining of hydrological stations for monitoring the status of waters; preparing and managing inventory of springs, fountains and water structures; examining sediments in water courses; control and assessment of the quality of surface and ground waters; providing data, information and studies needed for water management; implementation of international commitments related to hydrology and the control of the quality of water.

Environment Protection Agency was established pursuant to the Law on Environment (Official Journal of MNE, no. 48/08) and its task is to collect and update data on the quality of all environmental segments, including water, and to report to national and European institutions thereon.

Local Self Governments, as defined by the Law on Public Utilities (Official Journal of RMNE 12/95) and the Law on Waters, have an important role in water and water-bearing soil management of local importance; they organize and ensure public water-supply in their respective territories; provide for treatment of waste waters. It is important to note that due to the lack of funds and institutional capacities, the regional system of water-supply and treatment of waste waters in compliance with the EU standards is provided for by the Government through the Ministry of Sustainable Development and Tourism.

In addition to the above institutions, the sector of waters includes the Public Enterprises for managing marine resources, Budva, Public Institution "Centre for Ecological and Toxicological Research of Montenegro", Podgorica and the Institute of Public Health, Podgorica.

Ministry of Sustainable Development and Tourism, as well as Agency for Environmental Protection and Unit for Projects Implementation „PROCON Ltd", conducting water management issues which are related to regional watersupplying, waste waters treatment and certain monitoring issues in water sector. Further, „PROCON ltd" is relevant expert institution for preparing and implementing infrastructure projects, including constructing of waste water treatment plants, financed by foreign credit institutions as European Investment Bank, International Bank for Reconstruction and Development (IBRD) etc. Efficient horizontal coordination is imperative, so to create environment-sound water management police.

Marine waters management

Taking into account division of responsibilities for marine waters management between several state Ministries and agencies, Ministry of Sustainable Development and Tourism is in charge for integrated costal zone management instrument implementation (ICZM instrument), as well as implementation of EU Marine Strategy. Transposition and implementation of EU Marine Strategy Framework Directive (2008)

will be also responsibility of Ministry of Sustainable Development and Tourism, when it will be put into Montenegro's EU integration Agenda, and National Plan for Integration (NPI).

As it can be concluded from previously written, there is no structure/institution directly in charge for groundwaters management/protection, but it is within elaborated institutional framework. There are several reasons for this situation:

- Administrative capacities are unsatisfactory. Namely, the Water Management Sector of the Ministry of Agriculture and Rural Development employs, in addition to the Assistant Minister, 3 senior advisors, and the Water Inspectorate currently employs 3 inspectors although 7 positions have been envisaged. The Directorate for Water was established in 2005 with 8 employees who still work there and that is not enough to implement all the activities assigned to this authority. The Directorate currently has 5 full-time employees and 3 part-time employees.
- Lack of scientific knowledge and formal cooperation with institutions in charge for groundwaters researches-e.g. Institute for Geology, University of Montenegro),
- Monitoring system does not provide sufficient database for planning and management of groundwaters,
- Inter-state cooperation at regional level is not developed (particularly important role of DIKTAS Project).

There is urgent need for building of capacities for relevant institutions in sector of water management, for transposition and implementation of relevant European Union and international laws/regulations/agreement/conventions. It takes time, as well as mobilizing of financial sources and development of new projects and programmes. Also, in the light of decentralization, it is recommended to strengthen capacities of local administrations units (municipalities), so to delegate certain obligations to the local level.

2. LEGAL FRAMEWORK

The Constitution of Montenegro ("Official Journal of RMNE", no. 1/07), Article 23, and the main environmental law, the Law on Environment ("Official Journal of MNE", no. 48/08), Article 2, prescribe that everyone shall have the right to healthy environment and that the state shall provide special protection of the environment, and the water is one of the segments of the environment (Article 6, line 1 of the Law on Environment).

2.1. Law on Water

Water is a natural resource and an asset of national interest for every state, and, consequently, for Montenegro as well. Several laws and secondary legislation regulate the issues relating to water protection and use of water resources. The basic law for water related issues, *lex specialis*, is the ***Law on Water*** (Official Gazette of the Republic of Montenegro 27/07, Official Gazette of the Montenegro 32/11). The overview of the basic provisions of this Law, as well as of other laws which regulate some water related issues are set out below.

The Law on Water shall regulate the legal status and the method of integrated management of waters, aquatic and coastal land and water facilities, conditions and method of performing the water related activities and other issues of importance to the management of waters and water resources (Article 1). This law shall apply to:

- surface and ground waters and saline waters of mouths of rivers flowing into the sea;
- mineral and thermal waters;
- coastal zone;
- sources of drinking water in the territorial sea;
- coastal seawater, as regards pollution from land-based sources.

Water related activity, which is of public interest to the Republic of Montenegro, under the provision of Article 4 of the Law, consists of water management, water supply and use, along with long-term protection of the quality of water and water source, protection of water against pollution, regulation of waters and watercourses and protection from adverse effects of water, while, pursuant to provisions of Article 6, the water, being a natural resource and an asset of common interest, is the state property. The Ministry of Agriculture and Rural Development is competent for water related activities.

The provision of Article 21 of the Law determines, in the territory of the Republic, the two water basins as basic units for water management, as follows:

1. The Black Sea river basin district includes the following river basins: Ibar, Lim, Cehotina, Tara and Piva;
2. The Adriatic Sea river basin district includes the following river basins: Zeta, Moraca, Skadar-Shkoder Lake, Bojana/Buna, Trebisnjica and the coastal Montenegro sub-basins that flow directly into the Adriatic Sea.

The basic document for water management is the Water Basin, by virtue of which the Long-term plan of water management for individual water basin shall be drawn up (Article 22).

The planning document in Montenegro which is especially important for a long-term and sustainable water management is the **Water Basin Management** from 2001. This document contains a description of the current state of water regime and water management facilities by areas, the requirements for water regime maintenance and development ensuring the most optimum and expedient technical, economical and ecological solutions for an integral management of water resources, the protection from the harmful effects of waters, the protection of water resources from pollution and use of water. The solutions provided under the *WATER* Basin Management will be reviewed 10 years following the date of its enactment, so that a new *WATER* Basin Management will be drafted in 2011.

THE WATER Basin Management is adopted by the Government, on proposal of the Ministry of Agriculture and Rural Development , and it has to be reviewed after ten years from the date of its enactment, i.e. reconsideration (article 23 paragraphs 3 and 4).
Water management plans and programs of measures to be adopted pursuant to this Law shall be in accordance with the *WATER* Basin Management.

The Law on Waters, Article 25, stipulates that Water Management Plan shall be adopted by the Government, on proposal of the Ministry of Agriculture and Rural Development, to be reviewed after six years from the date of their adoption, i.e. reviewing. Article 169 defines that water management plans for the respective river basins shall be adopted within nine years from the date of enactment of this Law. Pursuant to this Law Montenegro is divided into two the river basins, as follows: **the Black Sea basin**, which includes the basins of the rivers of Ibar, Lim, Cehotina, Tara and Piva, with the belonging underground water, and **the Adriatic basin**, covering the basins of the Zeta, Moraca, Skadar Lake, Bojana, Trebišnjice and watercourses on the Montenegrin coast, which directly flow into the Adriatic Sea, with the belonging underground and coastal waters. According to the foregoing, within its jurisdiction, two such plans shall be inevitably adopted on the level of river basins.

The Law on Waters was passed in 2007, and the deadline for adoption of water management plans for river basins is 2016. However, due to the requirement of aligning domestic legislation with the regulations and procedures of the European Union, it is proposed to postpone the deadline for adopting the plans until the end of 2015, so that certain actions were already taken: based on the Law on Waters, the Decree on the content and method of preparing river basin management plans for the river basin or part thereof (Official Gazette of Montenegro, no. 39/09), while on 10 March 2011, the Directorate for Water, as the body responsible for expert preparation and all activities on the development of river basin management plans, issued the Notification on the commencement of preparation of water management plans.

Specifically, in accordance with Article 30 of the Law on Waters ("Official Gazette of the Republic of Montenegro", no. 27/07), the competent administrative authority, i.e. the Directorate for Water, shall notify the National Council for Water in writing and, through the media, all interested parties and the general public about initiating the preparation of the water management plan. The notification shall be made no later than three years prior to the commencement of the period for which the plan is adopted and it contains information about the status of the plan, including preliminary review of important elements of the river basin management for which the plan is adopted, at least two years before the period for which the plan is adopted.

The program of measures that will be applied within the river basin management plans has not been adopted yet for the following reasons:

- Article 169 of the Law on Waters stipulates that the program of measures shall be adopted within six months from the date of adoption of the river basin management plan. As the deadline for adopting the water management plans is 2016, both programs and measures shall be developed thereafter.

- As regards the legal regulation establishing the obligation of developing a program of measures for river basin management, please note the provisions of Article 32 of the Law on Waters providing that in order to achieve the goals of environmental protection, under the *WATER* Resources Development Master Plan and river basin management plans, the Government, at the proposal of the Ministry of Agriculture and Rural Development, shall adopt a program of measures for each river basin. It is further stipulated that the program shall determine, in particular, the measures relating to:

1) Water protection - set by law and regulations adopted pursuant to the law (in the field of health, environmental protection, agriculture, fisheries, etc.);

2) the regulation of water and watercourses and protection from the harmful effects of water (related to the conservation of water quantity, the improvement of hydromorphological conditions in the watercourse in order to achieve good ecological status and good ecological potential, the protection against flood, erosion and torrents, drainage, determining the required scale of construction of water facilities), including the priorities for their implementation;

3) To the use of water (terms of use, cost-effective and sustainable use, and recovery of the costs of using water).

In addition to these measures, a program of measures may include supplementary measures if they are necessary for achieving a good status of water (reduce adverse impacts on water, encouraging proper use, public awareness, scientific research). Review and, if necessary, amendment of measures shall be performed by the

Government every six years, while the expert preparation of measures shall be carried out by the competent governmental authority (Directorate for Water).

Protection of waters

Law on Waters defines that the protection of waters against pollution shall be realized by: organizing the control of water quality and pollution sources; banning and restricting any entry of hazardous and noxious substances-matter into the waters; prohibition of marketing any substances that are dangerous to waters which can be substituted by environment-friendly products, etc.; economic measures by charging a fee for water pollution, which is not lower than the cost of its treatment; wastewater treatment at the point of origin, by applying both technical and technological measures and introducing modern technologies in the production; water measures to improve the regime and quality of low waters by dedicated discharging pure water from reservoirs, and in particular to eliminate the effects of outfall pollution (article 74).

It is stipulated under Article 77 of the Law on Waters that the protection of waters against pollution shall be carried out in accordance with the Plan for the protection of waters against pollution adopted by the Government on the proposal of the Ministry responsible for water management for a period of six years, which, inter alia, includes measures to prevent or limit any introduction of hazardous and noxious substances-matter into water, measures for the prevention and disposal of waste materials, and other areas which may affect the deterioration of water quality, measures for the treatment of polluted waters, measures to prevent the influence of bulk pollutants, measures to protect aquatic ecosystems and other ecosystems that directly depend on the aquatic ecosystem, the method of implementation of intervention measures in specific cases of pollution, authorities, companies, other legal entities, institutions and enterprises which are obliged to implement certain measures and works, the deadlines for reducing water pollution, and both responsibilities and powers in relation to implementation of water protection, a plan for the construction of water treatment facilities with supporting facilities, measures to control the quality of polluted water applying a combined approach for point and diffuse sources of pollution and other measures necessary for protecting and improving water quality.

The Plan for the protection of waters against pollution, inter alia, shall include measures for water pollution quality control applying a combined approach for point and diffuse sources of pollution.

2.2 Decree on the classification and categorization of surface and ground waters

Pursuant to Article 75, paragraph 6 and Article 76, paragraph 2 of the Law on Waters, the Government adopted the **Decree on the classification and categorization of**

surface and ground waters ("Official Gazette of the Republic of Montenegro" no. 2 / 07). The Decree provides for a general classification of waters according to their use, with classes set for each particular use and the prescribed indicators and their limit values that apply to all surface and ground water on land and coastal marine waters in Montenegro.

The general classification of waters according to their use includes:

- Water used for drinking and food industry;
- Water used for fishing and shellfish farming, and
- Water used for bathing purposes.

According to the quality of water that must be maintained or achieved, bodies of surface and ground water on land and coastal marine waters are classified into classes and categories. The classification and categorization is done in a way that provides for the comparison of data with those in other European countries.

In order to determine whether surface and groundwater on the land and coastal marine waters fall under a particular class, monitoring of both the **qualitative and quantitative** parameters of water bodies shall be carried out by the state administration authority responsible for hydro-meteorological activities (Article 58 of the Law on Waters), according to the annual **Program for systematic testing of the quantity and quality of surface and groundwater.** Systematic testing of the quantity and quality of aquatic ecosystems in streams, natural lakes, coastal waters, groundwater, aquifers and any source of the first rank for regional and public water supply is done by measuring the physical - chemical, toxicological, microbiological, saprobiological and radiological parameters in water, sediment and biota.

The Decree on the classification and categorization of surface and ground waters (Official Gazette of Montenegro, 07/02), Article 21, defines that an **assessment of general ecological status of water** is determined by the parameters for the classification of water to be tested on the basis of specific water quality testing programs contained in the water management plans. Furthermore, these parameters are used to assess the quality of the sea directly at the main points of wastewater discharge into the sea, and the mouth of the rivers and canals, in order to undertake measures to reduce seawater pollution from the land. These tests are performed in accordance with special programs contained in the plans for water protection and other programs of study and seawater quality testing.

The Law on Waters, Article 57, stipulates that three zones of protection shall be delineated for sanitary protection of water sources for public water supply, namely: total catchment, outer and inner protection zone. Protection zones for potential regional sources of water supply shall be determined under the *WATER* Resources Development Master Plan. Sanitary protection zones for water sources shall be

determined in accordance with the hydrological, hydrogeological and other properties of the soil and catchment area and their designated use. Sanitary protection zones for water sources determined under the decision on source protection, as well as the area designated as a sanitary protection zone, shall be entered in the water management plans and spatial plans for special purposes.

2.3 Rulebook on determining and maintaining zones and belts of sanitary protection of water sources and restrictions in these areas

Article 2 of the Rulebook on determining and maintaining zones and belts of sanitary protection of water sources and restrictions in these areas ("Official Gazette of Montenegro", no. 66/09) provides that sanitary protection zones shall be determined depending on the type of source. The types of sources include:

1. Groundwater sources in confined aquifers;

2. Source in karst aquifers with water abstraction:
   - from the surface (water intake structures);
   - from the underground (wells, boreholes, tunnels, etc.);
3. Surface water sources from
   - reservoirs and lakes;
   - open watercourses;
   - the sea.

In accordance with Article 3 of this Rulebook, with respect to the protection regime, sanitary protection zones include:
- The zone of strict protection regime - Protection Zone I (inner zone);
- The zone of limited protection regime - Protection Zone II (outer zone);
- The zone of control - Protection Zone III (total catchment).
No Protection Zone III shall be established for the sources supplying drinking water to not more than 200 inhabitants, while the Protection Zones II and III shall not be established for water sources supplying drinking water to not more than 20 inhabitants.

b) and c) the types of hydrogeological studies required for the delineation of zones of sanitary protection and measures applied to different types of sources are provided in the Rulebook on determining and maintaining zones and belts of sanitary protection of water sources and restrictions in these areas ("Official Gazette of Montenegro", no. 66/09).

Thus, the Rulebook on determining and maintaining zones and belts of sanitary protection of water sources and restrictions in these areas ("Official Gazette of Montenegro", no. 66/09), Article 4, specifies that the source protection zones,

sanitary and other conditions for maintaining the zones and protective measures within the zones shall be determined in accordance with the final design of sanitary protection zones. Final design shall be prepared on the basis of previously performed research works for both surface and groundwater sources.

It is further defined under Article 8 that in the Protection Zone I only activities related to water supply, treatment and transport of water to the system of water supply shall be carried out.

Article 11 stipulates that in the Protection Zone II any performance of works, construction of structures and performance of activities that can pollute water sources shall be prohibited, in particular: discharging untreated wastewater, waste disposal, including disposal at sanitary landfills; construction of industrial chemical plants; construction of roads without a system for controlled drainage and storm water treatment; surface and underground mining of mineral resources; agricultural production, other than the production with no use of artificial fertilizers, pesticides and herbicides (the production of healthy food); animal production, other than for own domestic needs; the construction of facilities for the production, storage and transportation of hazardous materials; construction of cemeteries, or extending the existing ones; construction of other structures that may threaten water quality.

Article 13 stipulates that in the Protection Zone III no execution of works, construction and performance of activities that can pollute water sources shall be allowed, in particular: discharging untreated wastewater, waste disposal, other than the disposal to sanitary landfills; construction of roads without a system of controlled storm water drainage and treatment; construction of industrial and other facilities whose wastewater and other waste materials from the technological process of production can pollute water sources.

2.4 Other relevant laws

The Law on Water Management Financing ("Official Gazette of Montenegro", no. 65/08, 74/10) determined the sources of funds for water management financing, the method of calculation and payment of fees for the protection and use of water and water resources and other issues of importance for the provision and use of these funds.
Article 2 stipulates that the financing of water management activities shall be based, inter alia, on the fees payable under this Law which shall be established in accordance with the "user pays - the polluter pays" principle.

Pursuant to Article 18 of the Law on Water Management Financing, in 2009 the Government of Montenegro adopted a Decision on the amount and method of

calculating water charges and the criteria and method of determining the degree of water pollution ("Official Gazette of Montenegro", no. 29/09).

*THE LAW ON ENVIRONMENT (*Official Gazette of the Republic of Montenegro *48/08),* as the umbrella law for issues of environmental protection, shall regulate the principles of environmental protection and sustainable development, subjects and instruments of environmental protection, participation of the public in the environmental considerations and other issues of importance to the environment (Article 1), which also refers to waters as one of environmental segments. Protection of the environment is based on the polluter pays principle – the polluter, i.e. its legal successor, responsible for any pollution and damage done to the environment shall be required to reimburse the damage and bear the cost of eliminating the damage, in accordance with law and the user pays principle - Anyone who uses natural resources shall pay a fee for their use and reclamation of space in accordance with the law.

Chapter V (from Article 32 to Article 36) of this law shall define monitoring of the environmental situation. Article 33 defines that the monitoring, *inter alia*, refers to the observation of immision, i.e. the quality of air, water, sea, soil, flora and fauna, as well as utilization of mineral raw materials. The type of emission, immision, natural and other phenomena which are the subject of monitoring, the number and disposition of measuring stations, the network of measuring stations, measuring scope and frequency, indicators of environmental pollution, methodology of sampling and measuring, time limits, the method of data submission and the manner of notifying the public shall be regulate by government regulation.

Information system comprises data and information on the environmental situation, burdens and impacts (Article 38).

Register of Environmental Pollutants contains the data on sources, kind, quantity, method, and location of discharge, transfer, and disposal of polluting substances and waste into the environment (Article 40).

- The Law on Geological Research (Official Gazette of the Republic of Montenegro, 28/93, 27/94, 42/94, 26/07, 28/11) shall regulate the conditions and execution method of geological research of mineral raw materials, which, *inter alia*, also include ground waters (potable, mineral and thermal). Water use from ground water springs can be allowed only if the investigative works have been carried out in advance, which prove the possibility of their rational and safe use in accordance with the provisions of this Law.

-The Law on Ports (Official Gazette of Montenegro 51/08), Article 26 shall defines protection of the sea against pollution. The administration body, that is, a legal person and the concessionaire must ensure the fulfilment of conditions stipulated by international and internal regulations which regulate the prevention of the ship-source

pollution of environment, protection of the marine environment and the coastal zone and the civil responsibility for damage caused by pollution.

-**The Law on Coastal Zone** (Official Gazette of the Republic of Montenegro 14/92, 27/94, 51/08), Article 1 of this law shall regulate the management, use, enhancement and protection of the coastal zone. Chapter III of the Law refers to the protection of the coastal zone against pollution from hazardous and harmful substances from land-based sources and vessels, which is what harbourmaster's office is competent for.

- **The Law on Sea** (Official Gazette of Montenegro 17/07, 06/08), Article 1 of this law shall regulate the sea and undersea space of Montenegro. The use and discharge of hazardous and harmful substances and oils shall be carried out in a manner, which minimizes the negative environmental impact of the marine ecosystem of the epicontinental zone, in accordance with the law and international regulations.

- **The Law on National Parks** (Official Gazette of the Montenegro 56/09) Article 1 shall define that national parks shall be areas of outstanding and multiple natural values with ecological, economic, scientific, historical, aesthetic, cultural, educational, and recreational function. National parks in the territory of the Republic of Montenegro are: Biogradska gora, Durmitor, Lovcen, Lake Skadar and Prokletije. The protection, improvement and use of land, forests, water, flora and fauna and other natural resources as well as values created by work, are the activities of special social interest.

- **The Law on Nature Protection** (Official Gazette of Montenegro 51/08) shall regulate protection and preservation of nature which shall be implemented*, inter alia*, for conservation of natural qualities of the land, preservation of quality, quantity, and availability of water, including the sea water quality.

- **The Law on Environmental Impact Assessment** (Official Gazette of the Republic of Montenegro 80/05) which shall regulate the procedure for impact assessment for the projects which could have a substantial environmental impact, the contents of the EIA Study, the participation of the authorities, organizations and the public concerned, the procedure of assessment and issuance of the approval, notification on the projects which could have a substantial impact on the environment of another state, monitoring and other issues of importance to the environmental impact assessment.

- **The Law on Strategic Environmental Assessment** (Official Gazette of the Republic of Montenegro 80/05) - for the Water Basin and the Water Basin Management Plans in the water basin, that is, a part of the water basin, it is mandatory to draw up a Strategic Environmental Assessment, pursuant to Article 29 of the Law on Water.

- **The Law on Concessions** (Official Gazette of the Republic of Montenegro 08/00). The provisions of Article 1 of this Law lay down the conditions, method, and procedure of awarding concession on water use and other issues relevant for realization of concession.

- **The Law on Sea Fishing** (Official Gazette of the Republic of Montenegro 55/03, 40/04), regulates the management of biological resources of the sea.

National Strategy for Sustainable Development (NSSD), as State's umbrella strategic document defines following objectives:

a) ensuring sufficient quantity of good quality drinking water;

b) introducing integrated river basin management, with necessary legal and institutional changes and improvements in the quality control and monitoring of waters.

In order to achieve these objectives it is necessary to implement a set of short-term and mid-term measures. For the first objective, these measures include: more comprehensive protection and adequate control of the existing and potential water springs; improvements in water supply in rural areas (including the preparation of plans and creation of preconditions for better management of village water supply systems); better management of water supply systems, reduction of losses and prevention of the use of drinking water for other purposes; introduction of the system of water charges on the basis of cost recovery; construction of the water supply system for the Coastal Region; and use of potentials for water bottling. For the second objective, besides new legal framework which is in place, it is crucially important to sign and ratify international conventions in this area, then to work on capacity building for the implementation of integrated river basin management; consistent implementation of Integrated Prevention and Pollution Control (IPPC) Law, as well as consistent monitoring of water quality.

National environmental protection policy in the part of sea and coastal area protection is to a large extent based on implementation of the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention), which is at the same time the legal basis for activities of the Mediterranean Action Plan as the first program established for protection of the Mediterranean Sea within the United Nations Environment Program (1976). Montenegro ratified (Official Gazette of the Republic of Montenegro, 64/07) in 2007 the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention) and 4 Protocols thereto (Protocol for the protection of the Mediterranean Sea against pollution, concerning cooperation in preventing pollution from ships and in cases of emergencies, Protocol for the protection of the Mediterranean Sea against pollution form the land-based sources and activities, Protocol concerning specially protected areas and biodiversity in the Mediterranean, Protocol on prevention of pollution of the Mediterranean Sea by transboundary movements of hazardous waste and their disposal). *Montenegro ratified in december 2011 Protocol on* Integrated Coastal Zone Management in the Mediterranean.

2.5 Transposition

Montenegro is fairly advanced in transposing EU water legislation.

Montenegro is most advanced in transposing the Water Framework Directive 2000/60/EC.The main transposition measure is the Law on Water No. 27/2007, which covers virtually all definitions in the WFD as well as some substantive provisions, totalling . A number of decreeswere passed between May and August 2008 addressing some provisions of the WFD and some from other related directives (Waste Water Directive, Drinking Water Directive). Several measures are planned in the short to medium term to complete transposition, mainly relating to Arts. 4, 6, 8, 9, 10 and the annexes. The expected date of complete transposition is end of 2015.

There has been some progress achieved in the transposition of the Urban Waste Water Treatment Directive compared to the previous reporting period. For instance, the Program of Systematic Testing of Water Quality and Quantity No. 25/09 was recently adopted. In addition a ministerial order was adopted in July 2008: “Rulebook on Quality and Sanitary-technical Condition for Discharge of Wastewater into Sewerage System and Natural Recipient (No. 45/08 and No. 9/10). The current status of transposition is 43%. The deadline for full transposition forecasted for 2014.

Transposition is steadily progressing for the Nitrates Directive, the Ministry staff revised ToC and the monitoring score increased on 70%. Most of the transposition so far is the result of the adoption of the Law on plant nutrition means and the Law on Water in 2007. In addition, the program of systematic examination of quantity and quality of surface and ground water was adopted, which transposes the provision on monitoring the nitrate content of surface and groundwater (Article 5. 6).

Directive 2006/7/EC on Bathing is at the very beginning of transposition. Transposing score is 14%. The planned year for transposition is 2013.

The GroundwaterDirective 2006/118/EC is in very early stage of transposition. The full implementation is expected in 2015. The Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration in an early stage of transpositions. Annex I of this Directive has been fully transposed in Decree on classification of underground and surfaces waters (O.G. 02/07). AlsoMinimum list of pollutants and their indicators for which have to consider establishing threshold values(part B)is fully transposed in Decree on classification of underground and surface waters (OJ of MN, No. 02/07). The Directive is to be mainly transposed through Amendments tothe Law on Water defining the Act of protection groundwater against pollution and deterioration.

This is the first year that Directive 2008/105/EC of the European Parliament and of The Council of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council is covered by Progress monitoring. The current status of transposition is 16%. The main transposing instrument is the Law on Water, adopted in 2007.

The Competent Authority for the Drinking Water Directive is Ministry of Health. The Competent Authority for Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks 2007/60 EC –floods is Ministry of Interior Affairs.

2.6 Implementation

For most of the directives in the water sector, noconcrete planning steps have been made, and implementation is generally planned for the medium term. Montenegro would need to set a more detailed implementation timetable as a very first step.

No significant measures were taken since 2007 in implementing the Water Framework Directive. The competent authority was designated already in May 2007, which is the Ministry of Agriculture and Rural Development. Furthermore, two river basin districts also identified during 2007: the Black Sea river basin district and the Adriatic Sea river basin district. Programs of measures are foreseen to be developed by the competent authority. A system for public participation was put into practice upon the entering into force of the Water Law (Art. 30). A financial assessment of implementing the directive has not been carried out yet. It has not been determined yet when full implementation of the directive can be expected.

Some progress in implementing measures under the Waste Water Directive was reported, since the deadlines for a number of provisions have been met almost a year in advance by adoption of the Rulebooks on quality and sanitary-technical condition for discharge of wastewater into sewerage system and on natural recipients No. 45/08 and No. 9/10. More planning measures are needed and a concrete timetable for addressing all the provisions of the directive and for achieving full implementation should be devised.

No. significant implementation measures have been taken regarding the Nitrates Directive since 2008. The only provision which has been implemented is the one relating to the identification of waters that could be affected by nitrate pollution. However, it is not fully determined whether sufficient criteria have been introduced for identifying waters affected or which could be affected by nitrates pollution. Hence, it appears that this provision has not fully been implemented. In general, the implementation is in its early phase and in terms of planning, a detailed timetable for the implementation has not been prepared.

3. National SWOT analysis

Strengths

- High level of commitment to preservation of water resources
- Policy formulation supports further transposition and implementation of the EU acquis and expedites the EU accession
- Key issues and priorities are refined though a participatory process
- abundance of groundwater

Weaknesses

- Administrative capacity is dissatisfactory
- Lack of funding
- Unclear division of responsibilities among competent authorities and lack of coherence in their activities which is hampering progress in this area
- Overlapping of competences in the area of monitoring, tracking pollutants and information systems
- No categorization of groundwater bodies was performed in accordance with Directive 2006/118/EC (The Groundwater Directive)
- There is no organized network for groundwater monitoring in accordance with Directive 2006/118/EC (The Groundwater Directive)
- Lack of regulation in the area of groundwater in karst areas

Opportunities

- The requirement to develop a strategy for water protection from pollution, protection of water and water use;
- Investment in the field of wastewater collection and treatment, as well as in the area of drinking water supply;
- To strengthen the human and material capacities of institutions responsible for water quality and management;
- Groundwater has to be regulated by a special act in order to fully comply with Directive 2006/118/EC (The Groundwater Directive)
- Improve the program of groundwater monitoring
- Define priorities for the future negotiations with the EU on environment/ water, and consolidate environmental portfolio
- Improve information basis and strengthen application of public participation/ access to justice

Threats

- Lack of regulations on groundwater organization in karst areas;
- Lack of administrative capacity and insufficient investment funds in the field of water;
- Uncontrolled use and pollution of water
- Failure to resolve coordination and policy integration issues

principles

4. RELEVANT BILATERAL AND MULTILATERAL AGREEMENTS *BETWEEN DIKTAS COUNTRIES*

Agreement or contract on mutual relations in the water management area represents an umbrella legal document (instrument), without which a long term solution to water management issues between countries could not be found.

Bilateral relations between Montenegro and its neighbours are continuously improving, which creates a favourable political environment for the comprehensive development of cooperation in all areas. It seems that these relations, from the aspect of present results, are followed by the well established relations in the area of the management of waters of common interest, i.e. transboundary waters.

If it is known that water management covers activities and measures undertaken for the maintenance and improvement of the water regime with the aim of: providing necessary quantities of the prescribed quality water for specific purposes, protecting waters from pollution and protecting from the harmful effect of waters, then, mutual regulation of these issues deserves full attention and urgent solution.

4.1 COOPERATION BETWEEN MONTENEGRO AND REPUBLIC OF ALBANIA

Agreement for cooperation were signed between Ministries in charge of environmental protection (present Ministry of Sustainable Development and Tourism of Montenegro and Ministry of Environment, Forestry and Water Administration of Republic of Albania): Memorandum of Understanding in the field of environmental protection and sustainable principle implementation was signed in May 2003. This document defines that two parties should work on elaboration of sustainable development principle, in framework of national legal systems, as well as under relevant international agreements. Focus areas of the MoU were: monitoring, waste management, clean technologies, nature protection, environmental impact assessment etc. Also, this document called for establishment of working groups for certain activities-including water monitoring, pollution control, environmental impact assessment etc, especially for Skadar-Shkoder Lake watershed area, bot for surface and groundwaters.

Taking into account that titled MoU was signed for 5-years period and expired, it lead to the official proposal from Ministry of Sustainable Development and Tourism of Montenegro to the respective ministry in Albania for new bilateral agreement/memorandum, which will take into account new wider reality (political, regional, administrative). Generally, environmental protection and sustainable development are two main focus areas.

In relation to that, the Ministry of Spatial Planning and Environment (now the Ministry of Sustainable Development and Tourism) and the Ministry of Environment, Forestry and Water Management of the Republic of Albania signed the new **Memorandum of Understanding in May 2010 for the cooperation on environmental protection and sustainable management.**

This document defines that parties to the Agreement will build further cooperation in specific fields, as it follows:

- integrated protection and promotion of protection of all segments of environment
- sustainable management and protection of shared natural resources: Skadar Lake, River Bojana, Adriatic Sea and Prokletije Massif
- implementation of relevant sectoral international and regional agreements related to environment, particularly in cases of possible cross-border impacts on environmental condition and quality
- coordination of Government sectors of both countries in order to protect and conserve permanently ecologically sensitive ecosystems and natural resources,
- building institutional and human capacities in the sector of environment and management of natural resources
- operation of established cross-border structures such as the Commission for Skadar Lake and Working Groups of the Commission, and improvement of institutional framework for building cross-border and inter-state cooperation in the field of environmental protection
- support to research institutions and centres in order to develop quality policies for managing natural resources
- cooperation of local self-government units in both countries
- education and raising awareness on the importance of protection and rational exploitation of shared natural resources
- any other specific fields of environmental protection jointly accepted as appropriate.

The Memorandum is signed for indefinite period and shall come into force on the day of its signing.

The Montenegrin Academy of Science and Arts and the Albanian Academy of Science signed the Memorandum for the activities under the Project “Regulation of the Water Regimen of the Skadar-Shkoder Lake and Bojana-Buna River” based on the Bilateral Agreement on the scientific cooperation. The activities within the cooperation between two Academies are focused on the provision of necessary geodesy and hydrology grounds, which should be used as the foundation for

developing the Project for the Regulation of the Skadar Lake, based on which the Governments of Montenegro and Albania will make decisions.

Montenegro (present Ministry of Agriculture and Rural Development) and Albania (Ministry of Environment, Forestry and Water Management) **signed the Memorandum of Understanding on 14 December 2010 in Skadar with the aim of regulating the regime of Skadar Lake waters and the beds of the Bojana and Drim Rivers,** bearing in mind that unfavourable hydrological regime of this area increasingly poses a flood threat. This Memorandum defines short-term measures:

1. Intensify the work and broaden the composition of the Montenegrin-Albanian Commission for Water Management, by taking over the presidency and responsibilities by the Ministers responsible for water management;
2. Initiate development of the project documentation regarding development of the bed of the River Bojana aimed at the controlled increase of the flow of the River Bojana.

and long-term measures:

1. Development of the management plans of the basins of Skadar Lake, the Drim and Bojana Rivers;
2. Development of a complete project documentation regarding regulation of Skadar Lake, the Drim and Bojana Rivers;
3. and the implementation of the measures defined by the project.

Lake Skadar Integrated Ecosystem Management – regional project (LSIEMP)

Montenegro has established cooperation with the Republic of Albania through the project “Lake Skadar Integrated Ecosystem Management”. The project is financed through the donation of the Global Environmental Fund (GEF), while the World Bank is the implementation agency. Direct beneficiaries of the project are the Government of Montenegro and the Government of the Republic of Albania, i.e. line Ministries responsible for the area of environmental protection (Ministry of Sustainable Development and Tourism of Montenegro and Ministry of Environment, Forestry and Water Management of the Republic of Albania).

During the Project implementation phase which will last for 4 years (November 2008 - October 2012), activities defined by the Common Strategic Action Plan will be implemented in relation to integrated protection and sustainable development of the Skadar Lake between the two countries, implementation of targeted monitoring programmes, building institutions for managing protected areas of the Skadar Lake in Montenegro and in Albania, construction of facilities for waste water treatment in selected settlements in the Lake (Vranjina in Montenegro) and co-financing of

addressing of urgent ecological problems, in order to improve quality of ecosystems of the Lake and reduce the level of pollution.

Bilateral Commission for Skadar Lake was established within this project (LSIEMP)

(Agreement for protection and sustainable development of Skadar-Shkoder Lake, signed in February 2008, as one of PDF-B activity of GEF/WB Lake Skadar-Shkoder Integrated Ecosystem Management Project (LSIEMP). This document is called for establishment of Skadar-Shkoder Lake Commission, as structure supported by LSIEMP project.)

The existence of this structure has proved to be an efficient mechanism for the exchange of information, particularly in relation to infrastructural projects which are being implemented in the drainage basin of Skadar Lake. The permanent task of the Commission is to monitor the implementation of the project “Lake Skadar Integrated Ecosystem Management”and agree on the content and dynamics of joint activities. Through the implementation of the World Bank's project, a logistic support is provided to this structure and in the coming period, competencies of the Commission will be reviewed, with the aim of creating a long-term efficient mechanism for the cooperation between Montenegro and the Republic of Albania, so as to preserve the Skadar Lake ecosystem and use the resources in a sustainable manner.

Four bilateral working groups of experts and local stakeholders from both countries were formed as advisory bodies of the Commission: for planning and legislature, monitoring and research promotion, tourism and availability to the public and water management. Meetings of the Working groups are held regularly, where joint project activities are examined and the preparation of project tasks and the work of consultants on the development of certain documents are monitored.

Lessons learned

- The project "Lake Skadar Integrated Ecosystem Management" is in the stage of full implementation, bearing in mind that over 85% of activities is underway or in the initial stage of implementation.
- The existence of transboundary structures such as the Skadar Lake Commission and joint Working groups is of huge bilateral importance and in the next period, possibilities that the Commission obtains greater authority regarding coordinated interstate management of the Skadar Lake ecosystem should be considered.
- Cooperation with line institutions from the Republic of Albania is satisfactory, but it should be continued after the completion of the project (October 2012).
- For that purpose, initiation of a new project for the joint Skadar Lake management should be taken into account even after October 2012, with a possible financial support provided by the Global Environmental Fund and the World Bank or other donor institutions.
- The above mentioned is particularly important in the light of the full utilization of the project's results in the long-term framework (joint use of hydrological model, implementation of the joint monitoring and full functioning of joint bodies, particularly the joint Secretariat and bilateral working groups).

Thus, provisions of the Agreement on the protection and sustainable development of Skadar Lake, signed on the level of Ministers responsible for the environmental protection area in February 2008, as well as the provisions of the Memorandum of Understanding between two line ministries in the area of environmental protection and sustainable natural resources management (from 2010), could be continuously improved, particularly through strengthening the role and impact of the existing interstate Skadar Lake Commission and thereby the bilateral cooperation between the two countries in the area of this common resource management.

Multilateral Agreement

THE DRIN: A STRATEGIC SHARED VISION- Memorandum of Understanding for the Management of the Extended Transboundary Drin Basin -was signed in 25 November 2011. in Tirana, Albania.

Mindful of the Ohrid Declaration of 18 April 2011 in which we, the water and/or environment competent Ministers of the countries with territories making up the Extended Transboundary Drin Basin committed to negotiate and adopt a Shared Vision document on the coordinated management of the Extended Transboundary Drin Basin (hereinafter the "Drin Basin"); .

The “Parties” are the five water and/or environment competent Ministries of the States whose territories include parts of the Drin Basin represented by the respective Ministers (**Montenegro, Albania,** FYR Makedonia, Greece, Kosovo).The Parties, through their Ministers, commit to promote joint action for the coordinated integrated management of the shared water resources in the Drin Basin, as a means to safeguard and restore to the extent possible the ecosystems and the services they provide, and to promote sustainable development across the Drin Basin.

The “Sub-Basins" consist of the respective geographical areas of each of the following basins: the Prespa Lakes, Lake Ohrid, Lake Shkoder/Skadar (collectively, the “Three Lake Areas”); the Black Drin River (Crn Drim or Drin i Zi); the White Drin River (Beli Drin or Drin i Bardhë); the Drin River (Drim or Drini or Drin i madh), and the Buna/Bojana River.

1. In the short term (to 2013) a set of “No Regret Measures” should be initiated and carried out to promote integrated water resources management, also at national level, and facilitate enhancement of cooperation, including:

a. Elaboration of coordination enhancement mechanisms among the Parties. The Drin Core Group will be used for this purpose.
b. Enhancement of the knowledge basis about the Drin Basin that will allow planning of management and implementation of the EU WFD at national, Sub-Basin and Drin Basin level as well as enhanced cooperation among the Parties in the future. This may be achieved through the characterization of the Drin Basin in accordance to the EU WFD and the analysis of the hydrological patterns integrating consideration of: (i) the results achieved in the Three Lake Areas through previous and on-going GEF funded projects; (ii) the results of other on-going and past relevant projects; (iii) the karstic nature of large sections of the Drin Basin; (iv) the surface/groundwater interaction patterns and conjunctive uses throughout the Drin Basin; and (v) the coastal ecosystems, transitional waters and shallow marine environment. The characterization of each Sub-Basin should be done either at the national level or through bilateral or multilateral coordination or cooperation on the basis of related existing agreements among the Parties concerning the management of each Sub-Basin. This information will be available to all Parties through the system indicated in point 4.1.c and potentially in the future through this indicated in point 4.2.d.
c. Improvement of information exchange through the establishment of a system for regular exchange of qualitative and quantitative information among the competent authorities of each Party. Specific data regarding aquatic ecosystems, important habitats and species of importance should be also gradually included.
d. Enhancement of cooperation in the field of flood risk preparedness, management and mutual support. This may be achieved through the preparation of different options for the establishment of cooperation at

technical level in this regard, by a working group comprising of representatives of the competent authorities of the Parties under the coordination of the Drin Core Group.

e. Institutional strengthening in the field of integrated water resources management targeting managers, practitioners, relevant officers of national, regional and local authorities, other stakeholders etc. Towards this end, capacity building activities could be foreseen in fields of priority such as: (i) integrated basin planning and management in accordance with the EU WFD, (ii) practices of transboundary water cooperation in accordance to the UNECE Water Convention, (iii) GIS & spatial planning, (iv) Environmental Impact Assessments and industrial site inspections, (v) flood management, (vi) natural wastewater treatment systems, (vii) best agricultural practices, (viii) avoidance and containment of invasive species, (ix) environmental monitoring system design and management, (x) enforcement of water quality, water abstractions, recharge area protection and biodiversity regulations, (xii) groundwater management, (xiii) sustainable tourism, etc.
f. Promotion of public participation and stakeholders engagement. This may be achieved through the preparation and implementation of a Stakeholders Involvement Plan.

2. In the Medium Term (till 2015) actions undertaken should allow the establishment of instruments to be used for the sustainable management of water resources in the Drin Basin, including:

a. Achievement of a science based consensus, among the countries, on key (Drin Basin) transboundary priorities including climate change, main drivers of change and indicators of sustainable development for the basin, based on the knowledge basis established (see 4.1.b. above).
b. Preparation of an elaborated water balance for the Drin Basin as a useful decision support tool at national and transboundary levels.
c. Establishment of a harmonized Drin Basin Water Monitoring Program compatible with the UNECE Guidelines on Monitoring and Assessment of Transboundary Rivers, the relevant provisions of the EU WFD, and the Shared Environmental Information System (SEIS) of the EEA and;
d. Making use of the efforts described under 4.1.c., establishment of an Information Management System (IMS) that will enable authorities to collect, store and share data and information produced through the Drin Basin Water Monitoring Program.
e. Foundation of multi-country cooperative management on the basis of an agreement among the Parties and the establishment of a Basin Commission.

3. In the Long Term (after 2016) the instruments that will allow the Parties to work towards sustainable management of the water resources in the Drin Basin are expected to be in place, including:

a. Development of a Drin Basin Management Plan in accordance with the EU WFD and the UNECE Water Convention, that will serve as the guidance document for the development and implementation of river/lake basin management plans for each of the Sub-Basins at national and transboundary level in accordance with the bilateral and multilateral agreements among the Drin riparian countries.

By signing the Memorandum of Understanding on the management of the Drim River transboundary basin, a political willingness was expressed for the establishment of mutual understanding regarding the basin as a prerequisite for cooperation aimed at sustainable development and management of the Drim River basin, which could be achieved through transboundary cooperation in accordance with the principles of the European Union integration processes.

The Drim River basin has an international importance because of its morphology and biological diversity, given that protection and preservation of environment and sustainable use of natural resources in the Drim River basin, including the waters, represent an integral part of the development process which aims to satisfy the needs of present and future generations and that sustainable development in the Drim River basin should include development of major economic sectors, such as tourism, agriculture, energy management, fishery and forestry.

Compliance with the EU principles and legal framework has been harmonized, particularly the Directive of the European Parliament and Council, which establishes a framework for the activities in the area of water policy.

4.2. COOPERATION BETWEEN MONTENEGRO AND REPUBLIC OF CROATIA

In order to establish cooperation between Montenegro and the Republic of Croatia in terms of management of joint waters, an Agreement on mutual relations in the field of water management between the Government of Montenegro and the Government of the Republic of Croatia has been signed and ratified by the Parliament of Montenegro on December 26, 2007 (Law on Ratification, Official Gazette of Montenegro, 1/08). Issues related to all surface and underground waters which constitute or intersect border between Montenegro and the Republic of Croatia, or those waters which, due to its downstream influence, are important for both of the states, sea waters, water welfare and water systems, namely water objects, have been covered by the Agreement.

Permanent Montenegrin-Croatian Commission for management of waters of mutual interest and two sub-commissions: Sub-commission for the pipeline Plat-Herceg Novi

(which task is to propose a way of setting-up relations between the Municipality of Konevle and the Municipality of Herceg Novi, i.e. competent public communal enterprises, in the sector of using pipeline Plat-Herceg Novi) and Sub-Commission for setting-up inter-relations related to the issues of using potentials of river Trebjesnica are constituted.

Main topics covered by Agreement are:

- Water balance of surface and underground waters,
- Protection and defense from harmful influence of waters,
- Management and maintenance of water flows,
- Use of waters having joint interest and water transfer,
- Use and management of joint water constructions,
- Protection of waters from pollution,
- Researches of environmental impacts caused by water management interventions,
- Exchange of opinions, information and data, explorations, planning, performances and observations with reference to premises 1 to 7 of this paragraph,
- Mutual notifications, information and consultations and exchange of experiences and cooperation on the regional and other levels of organization and inter-relationships in the field of waters.

Also, Agreement is opened for third party(es), especially neighbouring countries and such a cooperation will be jointly regulated by an agreement. Namely, both parties express their readiness to conclude trilateral agreement on the usage and the protection of river Trebjesnica basin with Bosnia and Herzegovina.

Joint Montenegrin-Croatian Commission consists of six members. Each party nominates three members of the Commission: president, vice-president and secretary. Parties can nominate substitutes for the members of the Commission.

Joint Commission:

- Determines waters of mutual interest,
- Follows, regularly evaluates the realization of provisions of the Agreement, determines eventual deficiencies in cooperation of the Parties and proposes measures for their overcoming; if needed, even on-site examines the realization of the provisions of the Agreement,
- Determines, and if needed, innovates content and dynamics of regular exchange of data and information, exchange of data in emergencies, and controls accomplished exchanges,
- Follows the process of achieving and conservation of positive status of waters and proposes concrete measures to the Parties,
- Coordinates needed harmonization of management basin plans, created in accordance with Water Framework Directive, for territories of hydrograph sub-units spread over the border, and the fulfilment of those measures which, by the created plans, have an important cross-border influence,

- Analyses the flow-rate of surface waters and ecological need on the border water flow profiles, and in legitimate cases determines needed interventions,
- Analyses availability of ecological needs for water and requirements of other users for using water from natural and artificial cross-border water flows, carrying of waters through this water flows and establishes basic conditions that must be respected.,
- Harmonizes programmes of both Parties' interventions and makes a list of those to which gives accordance,
- Determines concerns of Parties for actions subject to Agreement, gives accordance and controls actions done by the Parties,
- Determines programmes of research, measures, analyses and studies, needed for the realization of provisions of the Agreement, which will be realized through harmonization or by joint work and actions,
- Evaluates events from the Agreement connected to water fluxion and accidental pollutions, as well as their effects,
- Adopts joint action plane related to potential sources of accidental pollutions and initiates undertaking of measures on eliminating consequences of accidental pollution,
- Prepares, adopts and if needed change or amends statutes required by this contract; if needed the Commission can make other statutes and written proceedings, which are not indicated in the Agreement,
- Determines assignments of permanent and *ad hoc* sub-commissions and expert groups, controls results of their work and approves minutes done during sub-commission and expert groups meetings,
- Follows activities and gives proposals and recommendations relevant to the implementation of international conventions, agreements, contracts, protocols concluded by the Parties, having the importance for the realization of the Agreement,
- Follows, considers and coordinates other international activities relevant to the subject of the Agreement and considers and proposes basis for joint performance of the Parties in front of relevant international organizations,
- Gives proposals for solving issues requiring special answers, and are subject to the Agreement,
- Gives proposals to the Parties for amendments of the Agreement,
- If needed, prepares and verifies translation of the Agreement and statutes to other languages,
- Solves other issues arising from the application of this agreement.

Lessons learned

Bilateral relations between Montenegro and the Republic of Croatia can be assessed as neighbourly and fair and without open issues, which creates a favourable setting for the comprehensive development of cooperation in all areas.

The relations between Montenegro and the Republic of Croatia in the water management area are based on:

- the manner which ensures a good status of waters;

- stable and sustainable economic development of Montenegro and the Republic of Croatia;
- sustainable use of waters which is based on long-term protection of available water resources and associated ecosystems;
- necessity of ensuring full publicity in making decisions regarding the issues in the water management area, and
- compliance and harmonization with the international agreements, standards and EU directives, as well as positive regulations in the water management area.

All activities, which are the subject matter of this legal act (water pollution damage, recovery of damaged water facilities, flood threat and other cases) are performed with prior consultations, consents and mutual support.

Particular attention has been devoted to the issues of the efficient use and maintenance of water facilities (pipeline Plat - Herceg Novi) and the sea protection from pollution, as well as the use and protection of the Trebišnjica hydro energetic system.

Multilateral cooperation

Trilateral Commission for protection of the Adriatic Sea and the coastal zone

At the 11th regular session of the Commission for the Protection of the Adriatic Sea and the coastal zones of **Croatia**, Italy and Slovenia (Trilateral Commission) held in Ancona on 25.05.2010, **Montenegro** was admitted as a full member of this important regional body. The admission was done after launching the procedure for recognition of the right to succession regarding the Agreement on Cooperation for protection of waters of the Adriatic Sea and the coastal area from pollution signed between the Socialist Federal Republic of Yugoslavia and the Republic of Italy, and following the negotiations under the Trilateral Commission in the period 2008-2009. By supporting membership of Montenegro in the Trilateral Commission, Italy, Croatia and Slovenia created preconditions for this Commission to become the Commission for Protection of the Adriatic. This is particularly important for efficient implementation of relevant international and European regulations, primarily the EU Marine Strategy Directive and the Barcelona Convention on the protection of marine environment and coastal zone of the Mediterranean.

COOPERATION BETWEEN MONTENEGRO AND BOSNIA AND HERZEGOVINA

Multilateral cooperation

New project "Regional initiative of the Western Balkans for the flood and drought management in the Drina River drainage basin" (this project is for three years from July 2011- to June 2014.),

Recognizing an urgent need for the protection from floods and droughts and defining the measures for mitigating their consequences in the River Drina drainage basin, the Regional initiative will serve as an efficient mechanism for the improvement of cooperation regarding water resources management of the Drina basin between **Montenegro, Bosnia and Herzegovina** and Serbia, which are located in its drainage basin area, help the development of transboundary and intersectoral cooperation focusing on the establishment of the more efficient protection from floods and droughts, as well as sustainable water resources management. Namely, the Drina River has a role of a "bonding body" of this complex (integral) water system which connects lakes, rivers, swamps and other water habitats into one ecosystem of a great importance regarding the preservation of biodiversity which represents a huge potential for the sustainable tourism development.

Montenegro will continue to support the preparation of the Management plan of the Drina River basin which is based on integral water resources management in accordance with the EU Framework Water Directive. The project idea is well presented, since the Drina basin is perceived as an integral unit for the first time, given that countries which share the Drina River basin: Serbia, Bosnia and Herzegovina and Montenegro are involved. This initiative will serve as a means of future possible support in providing assistance to Montenegro with the harmonization of national legislature with the European legislature in the area of transboundary water management, since Montenegro has been undergoing preparations to sign the UNECE Water Convention (Convention on protection and use of transboundary watercourses and international lakes), as an important legal framework for transboundary water management in the Pan-European region.

The common goal is development of the common Strategic vision as a means of integral basin management, as well as further strengthening and improving the transboundary cooperation for the sustainable management of the Drina River basin in accordance with the provisions of the EU Framework Water Directive and other multilateral agreements.

Conclusion

International cooperation achieved so far in the sector of water management can be measured from past and ongoing cooperation with Republic of Albania, but definitely it should be strengthen and opened for another countries in the region, especially in transboundary context (Republic of Croatia, Republic of Serbia, Bosnia and Herzegovina), and also regional approach in transfer of knowledge and experiences

in implementation of water-related legislation is desirable.

Lack of scientific data on groundwaters in Dinaric/Balkan region would be considered as main topic and precondition for development of any cooperation and coordinative and harmonized management of shared water bodies. In that sense, DIKTAS, as a platform for cooperation between (so far) 4 states, is excellent opportunity for collecting of information, knowledge and exchange of experience between different structures/organizations-scientific institutions, line Ministries, governmental agencies, civil sector and experts. Without conducting of new researches, or harmonized monitoring systems, it won't be possible to create environmentally-sound management of shared groundwaters.